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SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

DEPARTMENT OF GEODESY AND GEOMATICS

SPECIALIZATION IN GEOMATICS

**EVALUATION OF URBAN LANDSCAPE DYNAMICS AND ITS IMPACT ON
AGRICULTURAL LAND: The CASE OF GONDAR TOWN, Ethiopia**

**A Thesis Submitted to Graduate School of Addis Ababa University in Partial Fulfillment of
the Requirement for the Degree of Master of Science**

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CONTENTS

LIST OF TABLES	i
LIST OF FIGURES	ii
ABBREVIATIONS AND ACRONYMS	iii
ABSTRACT	vi
CHAPTER ONE	1
1.INTRODUCTION	1
1.1.Statement of the Problem.....	4
1.2. Objectives of the Study.....	5
1.3. General Objective	5
1.4 Specific objectives	5
1.5. Research Questions.....	6
1.6. Significance of the Study.....	6
1.7. Scope of the Study.....	6
1.8. Limitation of the Study.....	7
1.9 Organization of the Thesis.....	7
CHAPTER TWO	8
LITERATURE REVIEW	8
2.1. Urban Sprawl Concept.....	8
2.1.2. Urban Landscape Dynamics Patterns	9
2.1.3 Trends of Urban Landscape Dynamics	9
2.1.4 Global Trends in Urban Landscape Dynamics.....	9
2.1.5 Trends of Urban Landscape Dynamics in Africa.....	11

2.1.6 Trends of Urban Landscape Dynamics in Ethiopia	14
2.1.7. Trends of Urban Landscape Dynamics in Gondar Town.....	15
2.1.8. Causes of Urban Landscape Dynamics.....	17
2.1.9. Effects of urban landscape dynamics on agricultural activities.....	19
2.1.10. Emperical Studies	20
2.1.11. Conceptual Framework.....	21
CHAPTER THREE	23
RESEARCH MATERIALS AND METHODS	23
3.1. Description of the Study Area.....	23
3.2 Location and Topography of the Study Area.....	23
3.3. Population of the Study Area.....	24
3.4. Climatic condition.....	24
3.5. Materials.....	25
3.5.1. Data Sources and types	25
3.5.2. Soft ware's and Instruments.....	25
3.5.3 Methodology.....	25
3.5.4 Research design.....	26
3.5.5 Site Reconnaissance.....	26
3.5.7 Methods of Data Analysis.....	28
3.5.8 Methods of Data Processing.....	28
3.5.9 Acquiring of Satellite images.....	28
3.5.10 Image Enhancement and Visual Interpretation.....	29
3.5.11 Sub setting/Clipping of AIO/Area of interest.....	30

3.5.12 Training Samples/Signature Editor.....	30
3.5.13. Image Classification.....	31
3.5.14. Accuracy Assessment	322
3.5.15. Land Use/Land Cover Description	333
CHAPTER FOUR.....	34
RESULTS AND DISSCUSION.....	34
4.1 Introduction.....	34
4.2 Spatio-temporal urban landscape dynamics between 1985 and 2017	34
4.3 Accuracy Assessment of the Classification	40
4.4 Analysis of the Rates and Trends of Urban Landscape Dynamics.....	41
4.5 Rate and Magnitude of Built up Area Expansion (1985-2017).....	44
4.6. Built up Proportion in the Reclassified Image of Gondar town	45
4.7 Change detection analysis	47
CHAPTER FIVE.....	52
CONCULUSION AND RECOMMENDATIONS.....	52
5.1 CONCULUSION.....	52
5.2 RECOMMENDATIONS.....	53
References.....	54

LIST OF TABLES

Table 2.1 Urbanization trends by major regions (1950-2050).....	11
Table 2.2 Percentage of African Population Residing in Urban Areas by Region.....	14
Table 3.1 Characteristics of satellite image.....	29
Table 3.2 Land use/land cover classes ‘description.....	33
Table4.1. Areas of land use classes and spatio-temporal dynamics occurred.....	35
Table 4.2 Producer's and User's accuracy for individual land-use/land cover classes.....	41
Table 4.3 Overall accuracy and Kappa (K [^]) statistics for the classifications.....	41
Table 4.4 Amounts of Dynamics Occurred in Land Use / Land cover Classes for Three Time Periods of 1985, 2000 and 2017.....	42
Table 4.5 Rates and trends of Dynamics occurred in Land Use/Land cover Classes for Three Time Periods of 1985, 2000 and 2017.....	42
Table 4.6 Rate and Magnitude Built-up Area Expansion (1985-2017).....	44
Table 4.7 Built and non-built-up areas between 1985 to 2017.....	45
Table 4.8: Land use/Land cover transition matrix (ha) from 1985 to 2000.....	48
Table 4.9: Land use/Land cover transition matrix (ha) from 2000 to 2017.....	49
Table 4.10: Land use/Land cover transition matrix (ha) from 1985 to 2017.....	50
Table 4.11: Land-use/Land-cover class conversion to Built-up area in hectares.....	51

LIST OF FIGURES

Figure 2.1 Conceptual framework.....	21
Figure 3.1 Location map of the study area.....	24
Figure 3.2 Methodology of flow chart.....	27
Figure 4.1 Land use/land cover map of 1985.....	36
Figure 4.2 Land use /land cover map of 2000.....	38
Figure 4.3 Land use/land cover map of 2017.....	39
Figure 4.4 Built up area Expansion (1985, 2000 and 2017).....	44
Figure 4.5 Built-up and Non built up areas for 1985, 2000 and 2017.....	46

ABBREVIATIONS

ERDAS	Earth Resources Data Analysis System
ETM+	Enhanced Thematic Mapper
FUPI	Federal Urban Planning Institute
GCP	Ground Control Points
GIS	Geographic Information System
GLCF	Global Land Cover Facilities
GPS	Global Positioning System
Ha	Hectare
LULC	Land Use Land Cover Change
MLC	Maximum Likelihood Classifier
NGO	Non-Governmental Organization
RS	Remote Sensing
TM	Thematic Mapper
UN	United Nation
UTM	Universal Transverse

ABSTRACT

Rapid urbanization is a trend seen across the developing world, with the fastest rates of growth seen in Sub-Saharan Africa. Currently, Ethiopia like other African countries has experienced rapid expansion of urbanization due to economic development, industrialization, massive migrations as well as population growth. This expansion particularly unplanned consumed a huge amount of arable land in the urban milieu and in its surrounding areas. This is the case of Gondar town and its surrounding. Urban landscape dynamic is one of the problems in developing countries. Evaluating and understanding of urban landscape dynamics problems are important for appropriate planning and management of urban environment. This study focused on evaluating urban landscape dynamics and its effect on agricultural land in Gondar town by using Remote Sensing (RS) and Geographic Information System (GIS). Multi-spectral and multi-temporal Landsat TM (Thematic Mapper) image of 1985, Landsat ETM (Enhanced Thematic Mapper) image 2000 and Landsat OLI (Operational Land Imager) image of 2017 at the resolution of 30 m have been used to study the dynamics of urban expansion and its impact on agricultural land. The supervised classification algorithm was employed to identify the major land use/land cover types in the study area. Five types of land cover were identified: water bodies, vegetation, built up area, agricultural lands and bare lands. Results indicated that the study area has undergone a tremendous change in urban growth and pattern during the study period. Built-up area expanded from 567 ha in 1985, to 1472 ha in 2000 and further expands to 3773.79 ha in 2017, while agricultural areas decreased from 15,524 ha to 15,116 ha and 12297 ha during the same period. The increase of built up area is mainly at the expense of other land uses. So as, to alleviate the rapid population growth of the city, it is better to minimize rural-urban migration by creating conducive environment in rural areas. Instead of new housing development on agricultural land, renewal of older buildings and infill development of high rise buildings to meet the demands and needs of the increasing number of population in the town. In addition, construction of condominium house could be another solution. Finally, the use of remote sensing needs to be introduced for developers in order to reducing unplanned urban sprawls and the associated loss of agricultural lands.

CHAPTER ONE

1. INTRODUCTION

Studies indicate that half of the world population is living in urban areas (UNFPA, 2012) and this percentage will continue to grow in the coming years. The increasing urbanization is caused by a growing population and the tendency of people to move to the cities. The clustering of people in urban areas affects the landscape, the ecology of an area, travel patterns, resource consumption and water discharge (Tewolde, 2011). For local governments it is interesting to have exact information about the extent of the urban area (how is the land currently used) and the urban growth direction. This kind of information is needed for the urban planning of fast changing regions, to make sustainable and smart decisions.

Even though it is quite difficult to recognize urban sprawl in totality, good ways of understanding its complexity are land use/land cover change analyses and urban growth pattern recognition (Sudhira, 2004). Several studies such as (Chang et al. 2002; Clarek et al .1998; Herold et al. 2003; Sudhira et al. 2004; Thomas et al. 2003) show that urbanization is increasing in both the developed and developing countries. However, rapid urbanization is a characteristic of developing countries due to high population growth. Studies (Barnes et al. 2001; Chen et al.2000; Christiansen et al. 2011; Ewin et al. 1997; Harries et al.2002; Masek.etal. 2000) also show that the expansion of cities and towns, and the associated problems of unemployment, poverty, inadequate health, poor sanitation, urban slums and environmental degradation create unmanageable challenge in many developing countries.

Unchecked urbanization is often referred as sprawl which poses serious problems in infrastructure planning and implementation that leads to unforeseen consequences. Although both developing and developed countries have common urbanization processes, formerly the problem of urban sprawl was restricted to developed countries. The reason for urban sprawl for developed countries was mainly a result of higher incomes that make people preferring to live in the outskirts of the city, with open spaces at reasonable distances from cities. For developing countries sprawl is largely a result of necessity- people move to the city in search of better employment and opportunity which leads to an increase in size well beyond the limits of the city (Haregewoin, 2005).

Africa is the world's second-largest and second-most populous continent with a population of 1.2 billion people. Recently, African urbanization is characterized by rapid and uncontrolled urban growth. This has brought various socio-economic and environmental problems. In addition, the mass exodus to cities has already worsened the problems of urban poverty, food insecurity, shortage of housing and basic services, unemployment, ethnic tensions and violence, substance abuse, crime and social disintegrations. This leaves it with an under-developed continent (Jaglo, 2000).

The majority 62.1 percent of the African population is still rural, urban growth rates at nearly 4 percent per year are the most rapid in the world, and nearly twice the global average (United Nations Population Division 2001).

Growth rates are predicted to average 3.5 percent per year over the next 15 years, meaning that Africa's share of the world's urban population will increase from 10 to 17 percent between 2000 and 2015(United-Nations, 2001).

According to the United Nation World Population Prospects, if current demographic trends persist, the population will increase to 1.4 billion in 2025 and 2.47 billion in 2050. Based on the projected population by the year 2050 and the previous population, the population of Africa is estimated to reach 1.6 billion people in the year 2030. As a result, it still remains the second most populous continent in the world, but it makes up around 15% of the entire world.

As a result, many African cities have an increasing number of overcrowded, informal settlements, or 'shanty towns', characterized by inadequate housing and poor provision of infrastructure such as roads, street lights, water supplies, sanitation and waste management services. Thus, urbanization in Africa has brought many negative impacts both on the urban as well as on the peri-urban farm communities throughout the continent.

Ethiopia is one of the least urbanized countries in the world. It has only 20.4% of its population living in urban centers (CIA, 2017). However, given the 2.7% total annual population growth rate, high rate of in-migration to towns, and increase in the number of urban centers, the rate of urbanization is increasing at a rate of 4.64%(CIA,2015-20 est). "Experience over the last couple of decades in Ethiopia has shown that as human numbers increased, the population carrying capacity of the environment decreased. A high population growth rate induces increased demand for resources and the rate at which these resources are exploited. In Ethiopia, where technology has not kept pace with the demands for greater productivity, environmentally harmful and

economically counter-productive methods of exploiting land and associated resources (forests, animal resources, etc.) are resorted to in order to meet immediate needs. As a consequence of this, climatic conditions are becoming erratic and soil quality is declining at an alarming rate” (Aynalem, 2014).

As the cities expand, the main zone of direct impact is the peri-urban area (Nsiah-Gyabaah, 2000), which are characterized by diverse uses of land, that often vary in relation to their functional linkages to urban and rural sectors. Aguilar and Ward (2003), notes that peri-urban areas are transitional in nature and they become progressively more agriculture in orientation as one recedes from the urban center to the rural areas due to diverse land uses.

According to Olima (2003), rapid urban population growth goes with a lack of equivalent growth in urban land supply i.e. land is fixed in supply and does not increase with the increasing population. The pressure exerted by this increasing population tends to deprive other sectors of the needed land. Agricultural lands are the most affected by this rapid urbanization, as other land uses such as residential and commercial tend to dominate agricultural lands in competition for more space. As noted by Owusu and Agyei (2007), a key challenge of the urbanization process is the rapid conversion of large amount of prime agricultural land to urban land use (mainly residential, industrial, and infrastructural construction) in the urban periphery.

Due to the dynamic urban growth trends, town administrations and planners are faced with difficulties to supply basic amenities like sanitation, treated water supply, primary health center, etc., as planners were unable to visualize such growth during planning, policy and decision-making. These difficulties are caused by spontaneously construction of unplanned informal houses in and beyond the administrative boundaries of towns and cities. Moreover, the implications of these profound changes cause a change in land use patterns. So, this highly dynamic urban growth makes urgent town planning inevitable.

The conventional method of mapping urban growth is the use of ground survey and aerial photographs which is costly and slow process to get the necessary information such as the direction where urban growth occurs and the level of services needed on the new developmental sites. Maintaining up-to-date urban land cover information is both costly and time-consuming using traditional field and air photo methods. Remote sensing technology provides an efficient and less-expensive way for urban growth mapping (Hu. 2010).

Therefore mapping urban sprawl helps to identify areas where environmental and natural resources are critically threatened and to suggest likely future directions and patterns of sprawling growth (Simmons). The physical expressions and patterns of sprawl on landscapes can be detected, mapped, and analyzed using remote sensing and geographic information system (GIS) techniques in conjunction with the secondary and ground truth data (Barnes, 2001).

1.1. Statement of the Problem

Urban sprawl can be defined as the expansion of human settlements to accommodate a growing population while depleting natural resources (Pathan, 1989). Urban sprawl creates inefficient use of land resources and large-scale encroachment on agricultural land. To this end, Sudhira *et al.*, (2004) state that understanding the patterns of urban sprawl can help with natural resource planning, natural resource utilization, and the provision of infrastructure facilities. The most pressing problem of sprawl is the substantial loss of fertile agricultural land around many towns because of urban developments.(Ewing, 1997)Argues that suburbanization as we know it is not the issue, but rather the wasteful form of development known as sprawl with which many towns have a problem. As the urban built expands, it impose a number of problems on the inhabitants, the surrounding environment and population.

Nechyba et al (2004, 186) list a plethora of ills related to sprawl: the loss of open space, urban decay, unsightly strip mall developments, the loss of a sense of community, patchwork housing developments in the midst of agricultural land, increasing reliance on the automobile, the separation of residential and work locations, and the spreading of urbanized developments across the landscape. "Sprawl has become the metaphor of choice for the shortcomings of the suburbs and the frustrations of central cities (Galster et al., 2001, 681)."

Recently, in Gondar town due to high demand of land for residential, commercial and other development activities the town administration annexed twelve surrounding rural kebeles to Gondar town. The communities of these rural kebel are dominantly depends on agriculture. These created land use conflict in the fringe of the urban area where there are competing demands on land for food production, industrial crops, urban expansion and industrial development. Land is limited resource, and it is under a great pressure due to the urban expansion. The main focus of this study which is Gondar town and the nearby twelve rural kebel are-scene of intense competition between housing and agricultural land uses.

Formal and informal settlements are stretching out horizontally from the central town in all directions. Land is ineffectively used; new developments are planned on virgin land usually leapfrogging from cores. Generally, as pointed by (Haregewoin, 2005), sprawl and misuse of land in Ethiopia is the result of population pressure (both from natural births and migration), poor land policies, lease system and planning and regional imbalance. Action is therefore needed to provide for immediate needs of the population while trying for solutions to overcome mismanagement of land and further horizontal expansion with minimum financial expenditure (Haregewoin, 2005).

The building of houses, construction of roads, highways and train ways, management of the urban environment, provision of public service, preservation of sensitive lands, minimizing the impact of the urban encroachment and other many issues need exact information. So in this research, it was intended to study the urban landscape dynamics and its impact on agricultural land that occurred in Gondar town by comparing the land use changes occurred for the study years 1985,2000 and 2017. For this purpose, first multi-temporal Remote Sensing and GIS data sets were used to map the urban landscape dynamics, because one of the prerequisite for understanding urban landscape dynamics is successful land use change detection. To work out the change detection Land sat satellite imageries of three time periods were used.

Therefore, consideration and careful assessment are required for monitoring and planning land management, urban development and decision making. Although specific growth patterns of the town are important to planners, in this paper it would show that the importance of GIS and RS on urban sprawl identification and analysis.

1.2. Objectives of the Study

1.3. General Objective

The general objective of this study was to evaluate urban landscape dynamics and its effect on agricultural land of Gondar town by using GIS and Remote Sensing techniques.

1.4. Specific objectives

- To investigate and quantify the spatio-temporal dynamics of urban landscape in and around Gondar town since 1985;
- Mapping horizontal expansion of the study area at different time periods

- To detect the trends and rates of urban landscape dynamics; and
- To analyze the major effects of urban landscape dynamics on agricultural lands present in peri-urban areas of Gondar town during the study period

1.5. Research Questions

1. How urban landscape dynamics is taking place in the study area based on characteristics of new urban growth?
2. How to explain the extent and rate of urban landscape dynamics Gondar town?
3. How to map the horizontal expansion of in Gondar town?
4. What are the effects of urban landscape dynamics on agricultural land?

1.6. Significance of the Study

One of the major impacts of urban sprawl is a shrinking of cultivated land, through the development of infrastructures and various development projects. The study of this kind reveals the type, extent and nature of urban landscape dynamics taking place in a region and the drivers responsible for the growth. This would help developers and town planners to project growth patterns and facilitate various infrastructure facilities. The results of this study could provide information relevant to contribute in the environmental management plans and improves urban planning issues. It is also expected to provide information on the status and dynamics of the urban land use of the area and the use of remotely sensed satellite imagery for such analysis for planners.

1.7. Scope of the Study

This study has been carried out to assess and analyze urban sprawl status in Gondar town. Currently, most of the towns of the country have little attention in terms of physical expansion and dynamic population growth which create a burden on basic supply of public services and infrastructural developments. Given the fact of current and future unmanageable urban growth problems, there is a need of decision making and planning to maintain at least some control of urban expansion. This is not possible without up-to-date information about various aspects in the

urban areas. Remote sensing and GIS techniques can help to get up-to-date information of the urban expansion with frequent coverage and low cost. Therefore, it is intended to investigate the level of urban landscape dynamics and its effect on agricultural land in the study area between 1985, 2000 and 2017 years.

1.8. Limitation of the Study

It is often not uncommon for a study to have some sort of limitation/s during its course of undertaking. One limitation of my research lies in the use of Landsat imageries with coarse spatial resolution of 30m for urban - land use/land cover classification due to expensiveness and unavailability of other imageries with the finest resolution like Quick Bird which is ideal for urban features distinction. Therefore, the difficulty to discern each land use/land cover category may result in misclassification of one land use/land cover into another. In order to overcome this problem, field data collection were undertaken to verify actual land use/land cover which in turn incurred me both time and energy expenditure.

1.9 Organization of the Thesis

The research paper is organized into five major chapters. **The first** chapter contains the introduction objective and significance of the study in which clear information to the readers has been provided. This part highlights the global status, prospects and problems of urban landscape dynamics. **The second** chapter is devoted to different worlds' approaches, methods and mechanisms of urban landscape dynamics studies, which have assisted the researcher to produce different arguments on the selected topic. Here the concept, both global and national trends, causes and impacts of urban landscape dynamics have been stated in brief. **The third** chapter starts with the description of the study area followed by the methods employed including data types and sources, software and instruments utilized to carry out the research. In this part, image classification algorithms and data analysis techniques are briefly described. **The fourth** chapter is dedicated to the results and discussion components of the thesis. Results from classification of images, the analyses of LULC change and its impact on agricultural land have been encompassed in this chapter part. This chapter is concluded with the discussion, which focuses on comparison of results obtained with existing theories and practices. The conclusion and recommendations are **the fifth and the last** chapter of the study. These have presented conclusive remarks based on the findings and the researcher's suggestions pertaining to the mechanisms of

checking urban landscape dynamics effects on the peri-urban green agro-rural setup of the study area.

CHAPTER TWO

LITERATURE REVIEW

2.1 Urban Sprawl Concept

Urban sprawl is often difficult to estimate because it can occur slowly over time. Wilson, 2003 argues that without a universal definition of sprawl it is extremely difficult to model. Not all urban growth is considered sprawl because what is sprawl to some may not be to others. "Creating an urban growth model instead of an urban sprawl model allows us to quantify the amount of land that has changed to urban uses, and lets the user decide what he or she considers to be urban sprawl" (Wilson et al., 2003). Urban sprawl is characterized by leapfrog land use patterns, strip commercial development along highways, and very low-density single-use developments, all of which occur over a relatively short period of time (Ewing, 1997). Sprawl is urbanization that takes place in either a radial direction around a well-established city or linearly along the highways over a given period of time (Sudhira et al., 2004). Clearly, radial and linear are just two types of map patterns that sprawl can take. Sudhira et al. (2004) state that to understand the complexity of urban sprawl, land use change analyses and urban growth pattern recognition must be determined.

Throughout the literature, there is ambiguity on the distinction between urban growth and urban sprawl except to suggest that urban sprawl is a type of urban growth. Some sources have been defined in terms of associated causes: urban sprawl is generally believed to result from poorly planned, large-scale new residential, commercial and industrial developments in areas not previously used for urban purposes (Zhange, 2001). However, there is one overriding theme in the recognition of urban sprawl: a spatial-temporal signature unique to the phenomenon. Urban sprawl can be described as low-density development occurring on the edge or outside of a municipal area that does not follow a specific growth pattern (Tallinn, 2002). As the word 'sprawl' is a multidimensional phenomenon, it has caused much confusion. Possible mathematical regressions attempting to explain sprawl from land use perspectives such as the degree of compactness did not generate statistically significant results (Wassmer, 2005) and

hence the difficulty to mathematically define the term. The Vermont Forum on Sprawl defines sprawl as: dispersed development outside of compact urban and village centers along highways and in rural countryside (web page, 2011). In her report, *Revisiting Sprawl: Lessons from the Past*, Burgess, (1998) defined sprawl as "...expanding physical development, at decreasing densities, in metropolitan regions, where the spatial growth exceeds population growth".

2.1.2. Urban Landscape Dynamics Patterns

Urban growth takes place either in radial direction around the core of the city/town or linearly along the highways. The form of development along highways, or surrounding the city and in rural countryside is often referred as urban sprawl (Theobald, 2001). The spatial development of urban sprawl can be divided in to three basic forms (Barnes *et al.*, 2001).

Linear Growth: This type of dynamics is characteristic by exploitative use of land for housing purpose along the margins of existing urban areas. This type of expansion is always supported by services like water, power and roads.

Cluster Growth: The development of this type of growth is following major road corridors outward from the urban centers. Lands adjacent to the major roads and highway are developed but lands with some distant from the roads and highway remain undeveloped.

Leapfrog Growth: This development of expansion is sporadic or an irregular pattern which consists of patches of developed land that is widely separated. It is more expensive to give services such as water, power and roads for this form of development.

2.1.3. Trends of Urban Landscape Dynamics

2.1.4. Global Trends of Urban Landscape Dynamics

As population increases, urban sprawl on a global scale is becoming more apparent than ever. Increases in population often lead to increases in development, which has a direct influence on agricultural land conversion. (Masser, 2003) States that urban growth is inevitable over the next two decades and that most of this growth will take place in less developed countries. Globally more people live in urban areas than rural areas, with 54 percent of world's population residing in urban areas in 2014. In 1950, 30 percent of the world's population was urban, and by 2050, 66 percent of the world's population is projected to be urban. Today the most urbanized regions include Northern-America (82 percent living in urban areas in 2014), Latin America and the

Caribbean (80 percent), and Europe (73 percent). In contrast, Africa and Asia remain mostly rural, with 40 and 48 percent of their respective populations living in urban areas. All regions are expected to urbanize further over the coming decades. Africa and Asia are urbanizing faster than the other regions and are projected to become 56 and 64 percent urban respectively, by 2050.

The rural population of the world has grown slowly since 1950 and is expected to reach its peak in a few years. The global rural population is now close to 3.4 billion and is expected to decline to 3.2 billion by 2050. Africa and Asia are home to nearly 90 percent of the world's rural population. India has the largest rural population (857 million), followed by China (635 million). (UN World urbanization prospects 2014 revision). The urban population of the world has grown rapidly since 1950, from 746 million to 3.9 billion in 2014. Asia despite its lower level of urbanization, is home to 53 percent of the world's urban population, followed by Europe (14 percent) and Latin America and the Caribbean (13 percent). Continuing population growth and urbanization are projected to add 2.5 billion people to the world's urban population by 2050, with nearly 90 percent of the increase concentrated in Asia and Africa. Just three countries India, China and Nigeria together are expected to account for 37 percent of the projected growth of the world's urban population between 2014 and 2050. India is projected to add 404 million urban dwellers, China 292 million and Nigeria 212 million. Close to half the world's urban dwellers reside in relatively small settlements of less than 500,000 inhabitants, while only around one in eight live in the 28 mega-cities with more than 10 million inhabitants. Tokyo is the world's largest city with agglomeration of 38 inhabitants, followed by Delhi with 25 million, Shanghai with 23 million, and Mexico City, Mumbai and São Paulo, each with around 21 million inhabitants. By 2030, the world is projected to have 41 mega-cities with more than 10 million inhabitants. Tokyo is projected to remain the world's largest city in 2030 with 37 million inhabitants, followed closely by Delhi where the population is projected to rise swiftly to 30 million. Several decades ago most of the world's largest urban agglomerations were found in the more developed regions, but today's large cities are concentrated in the global south. The fastest growing urban agglomerations are medium-sized cities and cities with less than 1 million inhabitants located in Asia and Africa.

Some cities have experienced a population decline in recent years. Most of these are located in low-fertility countries of Asia and Europe where the overall population is stagnant or declining. Economic contraction and natural disasters have contributed to population losses in some cities

as well. Nevertheless, rapid and unplanned urban growth threatens sustainable development when the necessary infrastructure is not developed or when policies are not implemented to ensure that the benefits of city life are equitably shared. Today, despite the comparative advantage of cities, urban areas are more unequal than rural areas and hundreds of millions of the world's urban poor live in sub-standard conditions. In some cities, unplanned or inadequately managed urban expansion leads to rapid sprawl, pollution, and environmental degradation, together with unsustainable production and consumption patterns.

As the world continues to urbanize, sustainable development challenges will be increasingly concentrated in cities, particularly in lower-middle- income countries where the pace of urbanization is fastest. Integrated policies to improve the lives of both urban and rural dwellers are needed.

Table 2.1 Urbanization trends by major regions (1950-2050)

Major region	Percentage urban				
	1950	1970	2014	2030	2050
<i>Africa</i>	14.4	23.5	40.0	47.7	56.0
Asia	17.5	23.5	47.5	55.5	64.4
Europe	51.3	62.8	73.4	77.4	82.2
Latin America and the Caribbean	41.4	57.1	79.5	83.4	86.0
Northern America	63.9	73.8	81.5	85.8	87.3
Oceania	62.4	71.2	70.8	71.4	74.0

Source: UN 2014

2.1.5 Trends of Urban Landscape Dynamics in Africa

Africa, along with Asia, is the epicenter of global urbanization. It is undergoing a rapid urban transition and is set to be the fastest urbanizing region in the coming decades. In 1990 only a third of Africa's population was urban (31 per cent) by 2035, the figure is projected to reach 49 percent.

Urbanization is a mega-trend with profound implications for Africa's growth and transformation. Africa is currently the least urbanized continent, but its urbanization rate of 3.5 percent per year is the fastest in the world. The rate and scale of urbanization is reshaping not only the demographic profile of the continent but also economic, environmental and social outcomes. By 2035 about half of Africa's population will be living in urban areas, presenting considerable demands for employment, services and infrastructure, but creating advantages for economic growth. The urban transition is also taking place as the continent faces a demographic shift and a burgeoning youth population becoming located in urban areas.

Africa's rapid urban growth is both an opportunity and a challenge. While the prevailing narrative has focused largely on the negative externalities of urbanization of Africa, there is now an increasing recognition of its potential to drive growth and transformation. African leaders clearly affirmed the need to harness the potential of urbanization for structural transformation through the Common African Position at the Third United Nations Conference on Housing and Sustainable Urban Development (HABITAT-III) adopted in 2016. The New Urban Agenda adopted at HABITAT-III and a dedicated Sustainable Development Goal on cities and human settlements in 2015 attest to urbanization's importance.

History and experience demonstrate that urbanization is closely linked to economic growth and the transformation of economies towards productive sectors, namely industry and services. Available evidence suggests that urban and industrial developments in Africa are disconnected, resulting in lost opportunities for job creation and improved well-being. It is also not surprising that Africa's cities are crippled by severe infrastructure and service gaps and unable to generate employment at the level and scale required to meet ever increasing demands, especially for youth.

Reconnecting urban and industrial development in Africa through deliberate policies, strategies and investments is a priority for the sustainability of both cities and industries. Cities require better performing industrialization and industrialization requires better functioning cities. At the

same time, industrialization and urbanization face common challenges. Thus, the core message of the report is that deliberate efforts are needed to link urban and industrial development in the context of national development planning. (United Nations Economic Commission for Africa 2017).

A first step in this is to recognize urbanization as an inevitable mega trend of considerable scale and speed, with cities playing a critical role in structural transformation, and especially in industrialization. Also important is to undo prevailing myths on the urban trajectory, including the assumption that curtailing rural to urban migration will reduce urban growth and that the urban agenda is primarily a social one. In reality, natural growth is the primary driver of urban growth while urbanization is at the core of economic development.

Urbanization in many African countries has not been driven by improving agricultural productivity. Indeed, most countries are urbanizing rapidly amid declining or stagnant industrial output and low agricultural productivity. In resource-rich countries, natural resource exports and related spending, largely on non-traded services, appear to be driving urban growth, generating “consumption cities.”

Africa’s target of structural transformation is to shift labor out of low-productivity agriculture into higher-productivity manufacturing and modern services. But the long-run trend of this shift has been dominated by the informal sector often services where jobs remain concentrated, many in urban areas, with detrimental effects for economy wide productivity.

African cities thus face low productivity, tepid job creation, high informality, huge infrastructure and service gaps, weak linkages with rural areas, high levels of informality, increasing inequalities, growing environmental damage and vulnerability to climate change and weak institutional systems and capacities. Unless resolved, these impediments will undermine Africa’s urban potential for structural transformation.

The challenge confronting Africa is thus to accelerate structural transformation by harnessing the rapid urban transition to promote economic diversification, with a special focus on industrialization that will create jobs, enhance access to basic services and reduce inequality and poverty.

The links between urbanization and industrialization have generally been weak or absent in Africa, underlining the urgent need to connect urban and industrial development given their interdependence and growth impacts.

Table 2.2 Percentage of African Population Residing in Urban Areas by Region

Region	1990	1995	2000	2005	2010	2015*	2020*	2025*
Africa	33.9	37.3	40.7	44.0	47.4	50.7	53.9	57.1
Eastern	21.8	25.4	29.0	32.5	36.0	39.6	43.2	46.8
Central	37.8	41.6	45.6	49.5	53.5	57.0	60.4	63.6
Northern	44.6	47.9	51.2	54.5	57.7	60.7	63.6	66.3
Southern	54.9	58.2	61.3	64.2	66.8	69.3	71.6	73.8
Western	32.5	36.1	39.8	43.6	47.3	51.0	54.6	58.0

Source: United Nations World Urbanization Prospects, (2006)

2.1.6 Trends of Urban Landscape Dynamics in Ethiopia

Ethiopia is the second most populous country in the whole of Africa exceeded only by Nigeria. The distribution of the total population varies by place of residence. About 80 percent of the total population in the country is found in rural areas, while the remaining 20.4 percent is living in urban areas. Urban population growth in Ethiopia is estimated at 6%, a much higher figure compared to other African countries. Serious social problems still prevail in large cities.

The country is one of the least urbanized areas in the third world. Its economy almost entirely depends on agriculture, although production and food provision is low due to bad weather conditions and lack of effective technology. Poverty prevents the country from using high tech and non-seasonal means of production. In addition, almost 80 percent of the populations practice only agriculture and animal rearing as a means to sustain them.

Another aspect of urbanization in Ethiopia is the wide range of regional differentials or polarization in the level of urbanization. Like most developing countries, serious rural to urban migration is a common phenomenon. Tribal wars and conflicts are common phenomena driving people from their villages. Slums are emerging in different parts of cities, especially the capital, and are the only choices for the majority of the city dwellers that are poor. Additional population in rich countries is the demand for larger suburban lots. With rise in household incomes, people who move into the suburbs are motivated to a significant degree by the desire for more living

space. Between 1950 and 1980 one-half of the increased sub-urbanization in America can be explained by people getting richer (Kahn, 2003). Compared to people who live in cities suburbanites live in larger houses on larger lots and use automobiles more often.

Developed countries like the USA also invest substantial amounts of money on road and transport infrastructures encouraging the use of private cars. The high correlation between using automobiles and living in low-density edge cities may not prove that cars caused sprawl but is an indication that the two strongly complement each other. Both rising incomes and automobile ownership were therefore necessary conditions. Most people do not want to live in the cities - they choose to move out. Thus, sprawl in developed countries is usually a matter of preference. In the developed world, the movements of people from rural area of the country to more heavily populated cities and towns have been reversed. In contrast, for developing countries sprawl is largely a result of necessity- people move to the city in search of better employment and opportunities (Menon, 2001).

They could be driven out of their farmlands for different reasons such as bad weather conditions, poor harvest or simply because they do not have the means of income. Increased urban population leads to an increase in size well beyond the limits of the city. When the cities are not expanding, the people are forced to live in informal settlements with increased congestion and density (higher number of people per household and no basic services).

2.1.7. Trends of Urban Landscape Dynamics in Gondar Town

Urbanization is one of the most important anthropogenic activities that create significant and extensive environmental implications at both local and global scales (Herold et al., 2003). Inevitably, population growth leads to a rapid expansion of urban growth, causing changes in land use land cover in many metropolitan areas. The rate of such change is obvious in developing countries with high population growth rates like Ethiopia. These uncontrollable urban changes around the Ethiopian towns can intensify a large number of social and physical problems, in addition to the agricultural lands changed (Masek. etal . 2000). Due to the effects of continued growth and expansion of cities, rural communities residing in the outlying areas have been subjected to increasing eviction and adverse effects such as pollution, environmental, social and cultural disturbances. The measures are being taken to manage the undesired effects, though not adequate. In this respect one of the typical manifestations of the undesired effects of

urbanization is informal and/or illegal ownership of land and housing which are particularly intensified in the peripheral areas. Rapid urban development and increasing land use changes due to increasing population and economic growth is being witnessed of in Ethiopia and other developing countries (Masser; 2003). The measurement and monitoring of these land use changes are crucial to understand land use cover dynamics over different spatial and temporal time scales for effective land management (Cerneal, 1995). Gondar is one of the fast growing urban center's" in the Amhara regional state (Gondar town municipality office). Hence the expansion of the town is becoming irregular, uncontrolled and often resulting in creation of fragmented development. The town's growing industry, manufacturing sector, service and its centrality to North Gondar Administration has led to increased investments and has resulted in high-speed economic and social development. Gondar, being one of the towns in the developing countries has never been in a position to escape the forgoing undesired realities of rapid urbanization. Urban planning implementation principles and guidelines fundamental to ensure healthy urban growth have never been put in place (Gondar town municipality office).

Gondar is characterized by low density and low-rise development. Like any third world town, leap frogging and sporadic developments are common in Gondar town. There has not been institutional and legal framework capable of managing informalities in trade and physical developments. Excessive alteration of land use has been taking place without formal procedures, and this could lead to imbalance between land uses, which gave Gondar an image of much of a town of stores (Gondar town municipality office).

The importance of putting in place planning principles to be referred to in the planning process is not well recognized. This could give way to haphazard planning and subsequent ineffective implementation.

Regarding settlement development two basic processes are identified in Gondar. The first step includes the development of rural settlements and/or informal and illegal land occupation, which usually starts, with the establishment of small rural/semi-rural housing units and settlements. The second step consists of informal land transfer from these original settlers to others. Informal land tenure rights especially that claimed by farmers have contributed to all the above processes to a great extent (Gondar town municipality office).

The result of the land use and housing ownership survey shows that there are informal housing constructions and extension in all areas of the town especially at the peripheries. The population of the town has been raised and consequently the need for homes became serious. In addition to this the growth of the town is a continuous process so that it is important to measure its horizontal expansions in order to recommend possible solutions for future development (Gondar town municipality office).

2.1.8. Causes of Urban Landscape Dynamics

In developing country, population growth is considered as the main causes of urban sprawl. From an economist point of view, as population raises in an urban area it becomes more difficult to locate the same percentage of residential houses and business activity if the urban boundaries remain fixed. In addition, higher income residents generally demand larger quantities of housing and the inexpensive land to build it on is more likely on the fringe of developed urban areas (Ewing, 1997). Another cause of urban sprawl to occur as stated by UN-Habitat (2010) report was because authorities pay little attention to slums, land, services and transport. Moreover, they lack the ability to predict urban growth and, as a result, fail to provide land for the urbanizing poor. In addition, the urban poor are denied land rights which are one of the main factors driving people to the periphery of towns, associated with urban sprawl in developing countries.

In developing country the causes of urbanization are twofold: people migrate from rural areas to cities for employment opportunities, and fertility rates of the people already living there are high. There is a critical key difference between urban sprawl development in developed and developing countries. In developed countries, people do not want to live in the cities and they choose to move out. However, in developing countries, people move out because there is not enough space for them to live in the city (Haregewoin, 2005). The movement of the people from the city center to the sub urban part due to lack of space results spread of development without sufficient infrastructural provision. This pattern of development crates problems such as the wastage of agricultural land become a burden for service provision. Currently, the high population growth in cities is seen to create pressure and competition for land related resources, which has also caused upward pressure on land values, particularly in sub-urban areas. Clearly, not enough attention is paid to developing solutions to the expansion of cities in sub-urban areas and the challenge this is causing in regard to the delivery of sustainable land management,

services and governance (UN-Habitat (2010)). In many African cities the urban land market is skewed against the poor. The rising costs of urban land and other factors prevent poor people and other vulnerable and disadvantaged groups from gaining access to suitable land, which does not pose economic, environmental or health risks to the residents (UN-Habitat 2010).

Another cause for urban sprawl is lack of clear regulation mechanism of the new development in sub urban area. The majority of local land use regulation is accomplished with zoning. The goal of zoning land is to regulate the use and intensity of development such as housing type and density. Although technical in their implementation, zoning regulations are often a community's expression of the unwritten rules of social order (Harris, 2002).

Urban zoning is a device of land-use planning used by local government. Zoning regulations can restrict the supply of land available for development operates to increase land prices. This is useful to maintain environmental quality open space or agricultural use, for commercial or industrial activities. However, absence of strict zoning regulations leads to rich men to buy a land on sub-urban area and to build houses for rental purposes. This provides cheap accommodation for other low-income resident or migrants who lack the means of constructing their own house. However, unregulated development is always aggravating scatter development.

2.1.9. Effects of Urban Landscape Dynamics on Agricultural Activities

According to Cooney (2008), when sprawl takes place at the periphery of a certain locality it has direct or indirect impact on other parts of the same locality within its border or on a neighboring community. The consequences of rapid urbanization on peri-urban areas include changing labor and market conditions, loss of farmlands, changes in social, cultural and lifestyles. Planning and development control becomes a problem where existing institutions are not adequately structured to handle consequences of urbanization and which cut across different administrative boundaries leading to land issues not being addressed or, at worst, leading to conflicting land use planning decision (Thuo, 2013).

The rapid urban expansion in developing countries is usually associated with unplanned development in the periphery that requires high cost of infrastructure. It is also evident that even in planned activity the development of infrastructure usually does not correspond to the large tract of land that develops in a low-density pattern. Thus, urban expansion consequently results social, environmental and economic problems to the society (Abdissa, 2005). Due to their spatial proximity to urban areas, agricultural lands are the first ones affected adversely from the

urban sprawl. In Europe, the cities have primarily expanded to the former agricultural lands in the recent years. For example, throughout the Mediterranean region, 3% of farmland was lost to urbanization in the 1990s, and 60% of this land was prime farmland (EEA, 2006). Turkey has also been subject to land transformations into urban–industrial land uses, especially with the loss of fertile agricultural lands to urbanization (Doygun et al., 2008).

Urbanization threatens food supply drawing from the fact that, as cities grows, they affect agriculture land because they expands into surrounding areas of agriculture and this greatly affects food production. An immediate consequence of rapid urbanization is the crowding out of agriculture land, and the reduction of agricultural capacity (Kim et al., 2003). Cohen and Garrett (2009) observed that there is a shift in employment within the food system, with fewer people working in agriculture and more working in transport, wholesaling, retailing, food processing and vending due to the need to meet the higher demand for processed agricultural products. The increase of urban encroachment onto farmland has “forced farmers to bring lower quality land under cultivation to meet the growing demand for agricultural products” (Statistics Canada, 2005b). Steady, long-term production is generally unsustainable on lower-quality land (ibid). Once farmland is bought, farmers cannot just simply move their farms farther away from urban areas and continue their livelihood (Cooney, 2008).

Urban centers often expand over their nations’ most productive agricultural land since most urban centers grew there precisely because of highly fertile soils (Satterthwaite et al., 2010). An instantaneous consequence to this is the threatened food supply drawing from the fact that, as urbanization grows, it affects agriculture land because it expands into surrounding areas of agriculture and this greatly affects food production with an impact on food security. According to Food and Agriculture Organization of the United Nations (FAO), food security is defined as a solution that “exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preference for an active and healthy life (FAO, 1996). Food security encompasses the four dimensions, availability, stability, safety, and access. Urban sprawl generally affects these four dimensions of food security in the sense that as population continue to grow and urbanize, the demand for food rises; rural and peri-urban area are required to cater for the rising food demand. Matuschke, (2009) observes that sprawling cities may hinder the ability to meet new demand patterns due to the expansion of cities on prime agricultural land being converted into residential, commercial and

industrial uses leading to the crowding out of peri-urban agriculture, which often plays a significant role in supplying perishable foodstuffs to cities (FAO, 2008). This threatens food availability of every developing city. As the cities and towns continue to expand more and more food will be required for the urban areas, putting additional pressure on rural infrastructures, transport, technologies, and food distribution, which are already insufficient further jeopardizing the stability of food supply (FAO, 2008).

2.1.10. Empirical Studies

Land supports all forms of lives and other factors of production. Verheye and Paul (1997) noted that a vast majority of households, especially in developing countries, depend on land and other natural resources for satisfying their immediate needs and achieving their long-term ambitions. Land is often the only available resource on which rural families can rely to build their lives. American economist and philosopher, Henry George (1839-1897), emphasized the importance of land and remarked “so man not only lives off land, levying on it for its materials and forces, but he also lives on land. His very life depends on land. Land is the habitation of man, the storehouse upon which he must draw for all his needs, the material to which his labour must be applied for the supply of all his desires; for even the products of the sea cannot be taken, the light of the sun enjoyed, or any of the forces of nature utilized, without the use of land or its products. On the land we are born, from it we live, to it we return again - children of the soil as truly as is the blade of grass or the flower of the field. Take away from man all that belongs to land and he is but a disembodied spirit”. It was clear to George that there could be no production of any kind without land.

Earlier studies several urban growth studies have been conducted throughout the world. The studies that have been investigated over urban growth through similar methods to this study and in countries with similar demographic trends and structures have been closely monitored. The reports looked at have monitored urban growth in Ewing et al 1997(Los Angeles), China (Chen et al, 2000), Ouagadougou, Burkina Faso (de Jong et al, 1997), along the Islamabad highway, Pakistan (Naseem et al, 2000) and in Alexandria, Egypt (Azaz, 2001).

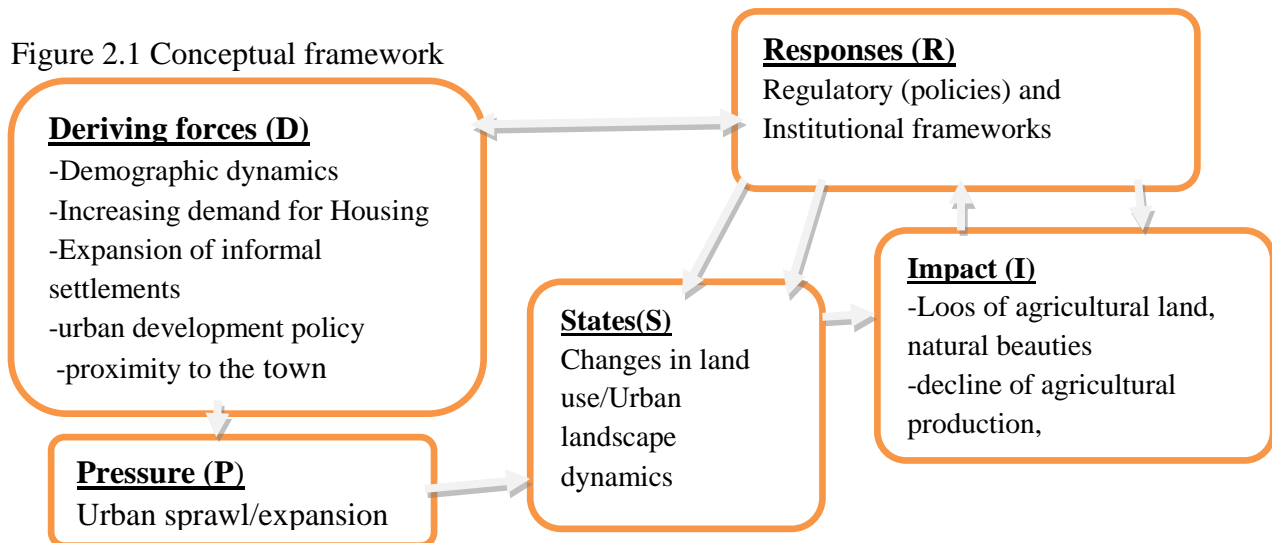
The results for all the case studies showed that a rapid urban growth had occurred in all of the investigated places, this through both an expansion of the main urban area and through urban sprawl. The main reason for the urban growth was in all of these cases due to a high natural population increase throughout the countries because of high birth rates and rural urban

migration. Urbanization was also taking place in the cities, these rates tend to increase when regional and national economy is prospering (Masek, 1996). This could clearly be seen in Oman when oil was found there. The reason for this is because of the employment opportunities that this offers to the cities (Al-Awadhi et al, 2003). Similarities could also be seen in the way the urban growth was occurring, it was so fast that it was taking place without any planning from the government which created huge areas of informal housing (Azaz, 2001, Naseem et al, 2000). These different case studies have all concluded that there was great change detection for several different land classes, this to show the effects that urban expansion have on other land use classes. This study has however only focused on urban landscape dynamics and its impact on agricultural land.

2.1.11. Conceptual Framework

Urbanization has greatly contributed to the modification of urban areas in Ethiopia. The major contributor to urbanization is natural population increase intertwined with rural-urban migration in search for better opportunities in the urban areas. As a result, a host of problems occur in these areas resulting to movement of population to the urban fringes leading to the sprawling of urban land uses in the urban fringes which are majorly agricultural areas. The encroachment of urban land uses in urban fringes results to crowding out of agricultural lands impacting directly or indirectly on the inhabitants and the immigrants in these areas. The impacts on land uses include loss of farmlands, loss of labor in the agricultural sector and creation of jobs in other sectors mainly non-agricultural sectors among others. Consequently, a decline in agricultural productivity resulting to food insecurity related problems as vividly illustrated in Figure 2.1

Figure 2.1 Conceptual framework



Source: Conceptual framework: Adopted from the Drivers Pressures State Impact and Responses (DPSIR) framework from European Environment Agency, (1999)

This study has adopted the Drivers Pressures State Impact and Responses (DPSIR) Conceptual model developed by the European Environment Agency (1999), (Figure 2.1). The urbanization process is propelled by population growth either by natural growth, migration leading to the sprawling to the urban fringes. The sprawling effect exerts pressure on agricultural land coupled with other factors resulting to loss of prime agricultural lands. The loss of prime agricultural land further leads to a decline in agriculture productivity, increased land values and house rent and pressure on existing infrastructure as more people settle, in the area among other effects. All these are as a result of the urban influence on agricultural lands in the peri urban areas. It is also important to note that the effects of urbanization can be reduced if not totally controlled through the efforts of the government both at the national and local level. The government through its numerous regulations which if well implemented with effectively empowered institutions can control the tempo of rapid population growth, resulting in effective land use planning and management.

CHAPTER THREE

RESEARCH MATERIALS AND METHODS

3.1. Description of the Study Area

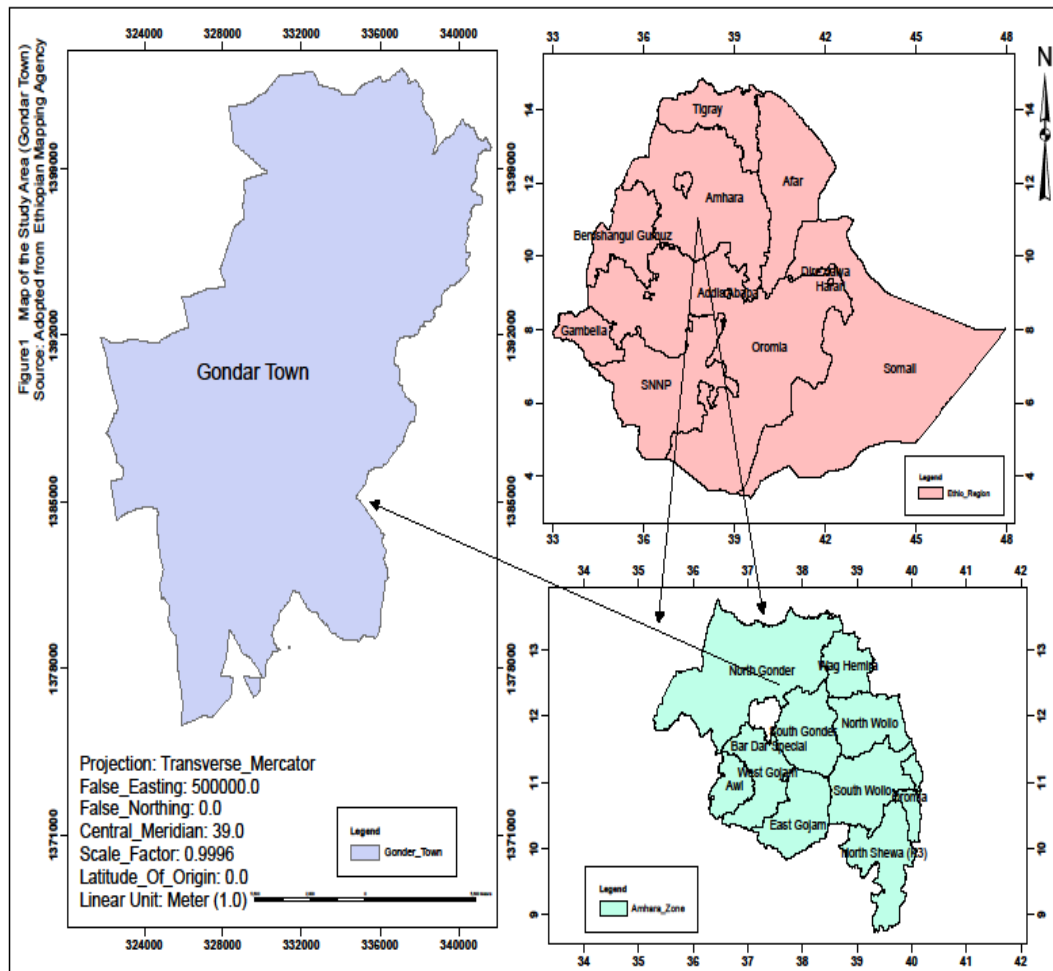
Gondar was founded by Emperor Fasilides around the year 1632, and grew as an agricultural and market town. It is a town and a separate woreda in Ethiopia, which was once the old imperial capital and the capital of the historic Begemder Province from 1632-1868. Located in the Semien Gondar Zone in the Amhara Region, Gondar is north of Tana Lake on the Lesser Angereb River and southwest of the Simien Mountains. The town administration of Gondar is comprised of 21 urban and 12 rural kebeles and one satellite town (Tewodros Ferede, 2011) .The town has a latitude and longitude of 12°36'N and 37°28'E with an elevation of 2200 meters above sea level. The town is nicknamed "The Camelot of Africa" due to the presence of a group of royal castles (From Wikipedia, the free encyclopedia) (refer annex 1).

3.2. Location and Topography

The study area is located in North Western Ethiopia, 748 km from the capital Addis Ababa. It stretches along a ridge in the northern Ethiopian highlands. The town is situated at an elevation of 2,200 meters, and is surrounded on three sides by a crown of 3,000-meter high mountains. It has a total area of 11.058 sq. km (Tewodros, 2011).

The town serves as zone administration, trade and tourism center. There are 190 Manufacturing industries 27 Wholesale trades 1,380 Retail trades, 2100 service trades, ten fuel stations, 14 garages and there are 11 banks and one micro financial institution in the town. The average annual revenue of the municipality within the 2010-2012 periods was 29,867,832.50 Birr and the major sources of revenue were taxes, rent and service charges. The major investment opportunities of the town are: manufacturing industry, agro processing industry, social services, hotel and tourism development (Ministry of Urban Development and Construction, 2015).

Figure3.1. Location Map of the Study Area



3.3. Population of the Study Area

Based on the 2013 national census projection by the Central Statistical Agency of Ethiopia (CSA), Gondar had a total population of 306,246 of whom 149,970 were men and 156,276 women.

3.4. Climatic Condition

The rainfall pattern of Gondar is unimodal and characterized by a single maximum rainfall pattern with peaks in July and August. About 80%-90% of the mean annual rainfall falls in the main rainy season (“Kiremt”), which starts in June/July and extends into August/September. The annual rainfall in the town reaches up to 1,172 mm (TewodrosFerede, 2011). Rainfall variability in time is considerably high especially at the beginning and end of the main rainy season. The

agro-ecological climatic zone is “Dega” with a mean annual temperature ranging from 12.90C to 26.40C and an average of temperature 20°C.

3.5. Materials

3.5.1. Data Sources and types

As it determines the quality of the research, collecting accurate and reliable data is the most determinant factor for any research. Both primary and secondary data was used in this particular thesis.

The primary Data: Primary data used in this research was collected by means of field observation, types of activities in the area, topography, infrastructure, services and the authentic environment was observed and noted.

Secondary Data: secondary data was also obtained from remotely sensed multi-temporal and multi-spectral images and collected from the review of related literature (i.e. valuable information from already done research papers, books, and journals, reports, by accredited scholars and researchers, both published and unpublished and aerial photographs from Google Earth, topographic maps, Internets, or other sources). This kind of information was incorporated to give a strong background to the study and also information on urban landscape dynamics, its definition, causes and consequences, urban mobility forms and challenges, urban infrastructural services and the challenges on service delivery. Secondary data about the study area including existing land use trends and patterns, Infrastructure, and environmental profile and its states was collected especially from State administrative organs within the study area’s jurisdiction.

3.5.2 Soft ware’s and Instruments

ArcGIS 10.4: was used to generate maps showing changes in urban development and occurrences of urban landscape dynamics of Gondar town. ERDAS IMADINE 2013; for land use/land cover classification and interpretation; Garmin GPS was used to collect sample representative of land use land cover class for accuracy assessment of the classified images.

3.5.3 Methodology

In this section the general methods implemented, applied techniques and the data inputs used throughout this study are explained briefly in the design below. In order to answer this objective the researcher was used both quantitative and qualitative techniques. The quantitative methods

involved the usage of Geographic Information Systems and remote sensing data to produce maps of 1985, 2000, and 2017 and calculate the urban expansion within the study area from the Landsat classified images. The Geographic Information System allowed for reclassification of land cover data into categories appropriate for the purposes of this study urban landscape dynamics and its impact on agricultural land.

The rate of change was calculated for each land use and land cover using the following formula:

Rate of change (ha/year) = (A-B)/C Where

A = Recent area of land use/ cover in ha

B = Previous area of land use/ cover in ha

C = Time interval between A and B in years

Percentage change (trend) = observed change/sum of change * 100

Thematic change analysis of the individual land-use/land-cover was also performed using ERDAS software. The relative change detection matrix result shows results from one class change to another.

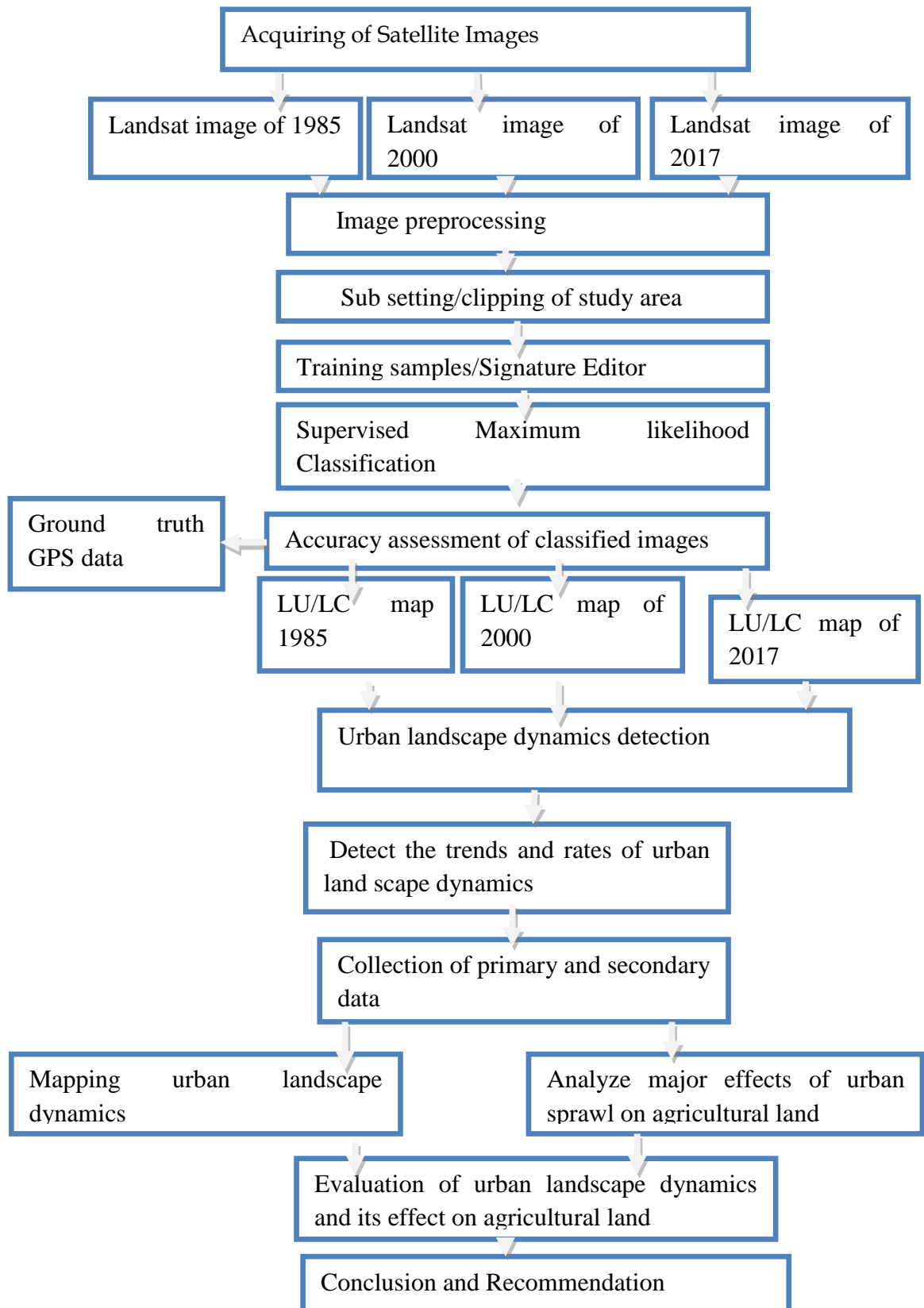
3.5.4 Research design

The study employed a descriptive (observational method) research design to make intensive investigation of the extent of urban expansion and its implications on land use in the town. Hence, to maintain triangulation in its findings, the design manifested the basic features of both the qualitative and quantitative research.

3.5.5 Site Reconnaissance

A preliminary reconnaissance survey was conducted in the town to capture the existing situation of the area, to aid in selection of study sample areas and the general idea of the physical characteristics of the area. Visual observations were made along selected routes for the identification of surface features and land-use types. The units of observation included new and upcoming residential developments, current state of agricultural land parcels in the area. Global Positioning Systems (GPS) points were taken in the study area for each land use/land cover. The GPS point recorded are overlaid and compared to the 2017 supervised classified image to determine the precision of classified satellite images and recoded where necessary. The GPS used in this study was Garmin Map 60 with precision of four (4) meters.

Fig 3.2 General Methodology of flow chart



3.5.7 Methods of Data Analysis

The collected data from different sources has organized into meaningful facts and made detail explanation and presented using photographs, maps, charts, simple tables and graphs. While the Qualitative data analysis, it has analyzed using content analysis method. Detail description has been given according to the pattern and themes that emerge during interviews and data obtained from questionnaires and in depth individual interview has analyzed in detail. The data obtained during discussion also used for the triangulation purpose and to enrich the data.

3.5.8 Methods of Data Processing

3.5.9 Acquiring of Satellite Images

To accomplish the objectives of the present study, three available satellite images are obtained from **United States Geological Survey (USGS)** databases online resources and spatially referenced in the Universal Transverse Mercator (UTM) projection with datum World Geodetic System (WGS) 1984 UTM zone 37N. The images are extracted to Tiff formats for processing and the detail of image properties are summarized in table 3 below. Landsat Thematic Mapper(TM), Enhanced Thematic Mapper (ETM+) and Operational Land Imager-Thematic Infrared Sensor (OLI-TIRS) data has several advantages for urban land use/land cover change detection application. In this study Landsat imageries of TM, ETM+ and OLI-TIRS are employed and acquired in the same season of February and the same level of resolution for the periods 1985, 2000 and 2017. The resolution of these Land sat images are 30 meters. Therefore, they are conducive for comparison of changes and patterns, which have occurred in the time under discussion, due to their constant spatial and temporal resolutions. These remotely sensed images were used and processed for identifying urban land use/land cover change as an indicator of urban landscape dynamics patterns of the study area.

Table3.1 Characteristics of Satellite Image.

Sensor	Acquisition time	Spatial resolution	Path/Row	Source
Landsat 5 TM	03/02/1985	30m	170/052	USGS
Landsat 7 ETM+	08/02/2000	30m	170/052	USGS
Landsat 8 OLI	10/02/2017	30m	170/052	USGS

3.5.10 Image Enhancement and Visual Interpretation

The goal of image enhancement is to improve the overall visual interpretability of an image by increasing the apparent distinction between the features. Image enhancement improves the clarity of images for human viewing by removing blurring and noise, increasing contrast, and revealing details. The process of visually interpreting digitally enhanced imagery attempts to optimize the complementary abilities of the human mind and the computer. The mind is excellent at interpreting spatial attributes on an image and is capable of identifying obscure or subtle features (Lillesand and Kiefer 1994). Contrast stretching was applied on all images and the false color composites (FCC) are produced. These FCC are visually interpreted using on-screen digitizing to delineate land cover classes that could be easily interpreted, such as urban and water.

Satellite bands were composed in different ways in order to identify surface features in the study area. True color composite usually known by RGB 321 combination where band 3 reflects red color, band 2 reflects green and band 1 reflects blue color. Another composite called "false color composite" which uses an RGB combination of 432. In this band combination band 4 represents the NIR infrared, band 3 belongs to red and band 2 to green. This combination gives better visualization in identifying vegetation which looks red in 432 combinations. Using the false color (432) combination and vegetation is seen as red and dark red, water is blue and shades of blue.

3.5.11 Sub setting/Clipping of AIO/Area of interest

AIO stands for area of interest\study area. In remote Sensing, it means the area showed in the remote Sensing image. When the Landsat image is downloaded from USGS online services the image were cover large area beyond the study area so the AIO/ study area should be sub stitted/clipped by using the shapefile or boundary of the study area by using GIS or ERDAS IMADINE software's.

3.5.12 Training Samples/Signature Editor

Training sample is the process of defining the criteria by which these patterns are recognized. The computer system must be trained to recognize patterns in the data. Training can be performed with either: Supervised or an Unsupervised image classification method. In supervised classification, you select representative samples for each land cover class. The software then uses these "training sites" and applies them to the entire image. Supervised classification uses the spectral signature defined in the training set. For example, it determines each class on what it resembles most in the training set. The common supervised classification algorithms are maximum likelihood and minimum-distance classification. In this study maximum likelihood classification were used.

The result of training is a set signature's that define a training sample or cluster. Each signature corresponds to a class. It is used with a decision rule to assign the pixels in the image file to a class. Signatures can be: **Parametric** or **Nonparametric**. **Parametric signature:** is based on statistical parameters of the pixels that are in the training sample or cluster. A set of parametric signatures can be used to train a statistically-based classifier to define the classes. **Nonparametric signature:** It is not based on statistics, but on discrete objects in a feature space image. These feature space objects are used to define the boundaries for the classes. In supervised classification, spectral signatures are developed from specified locations in the image. These specified locations are given the generic name 'training sites' and were defined by the user. Generally a vector layer is digitized over the raster scene. The vector layer consists of various polygons overlaying different land use types.

3.5.13. Image Classification

Image classification is defined as the extraction of differentiated classes or themes of land use and land cover categories, from raw remotely sensed digital satellite data. It is a technique to identify different features such as urban land cover, vegetation types, anthropogenic structures, mineral resources, or changes in any of these properties from the satellite image. Additionally, the classified raster image can be converted to vector features (e.g. polygons) in order to compare with other data sets or to calculate spatial attributes (e.g. area, perimeter) using different statistical methods. Image classification is a complex and time consuming process. In order to improve the classification accuracy, selection of appropriate classification method is required. This would also enable the analyst to detect changes successfully (Elnazir, 2000).

There are different types of image classification techniques. However, in most cases the researchers categorized them in to two major modes: supervised and unsupervised classification. For this study, the supervised classification type was applied. It is a type of classification which is based on the prior knowledge of the researcher to the study area. It requires the manual identification of Point of interest areas as reference (Ground Truth) within the images, to determine the spectral signature of identified features. It is one of the most common types of classification techniques in which all pixels with similar spectral value are automatically categorized into land cover classes or themes.

Supervised classification was much more accurate for mapping classes, but depended heavily on the cognition and skills of the image specialist. The strategy was simple: the specialist recognized conventional classes (real and familiar) or meaningful (but somewhat artificial) classes in a scene from prior knowledge, such as personal experience with what's present in the scene, or more generally, the region it's located in, by experience with thematic maps, or by on-site visits. This familiarity allows the individual(s) making the classification to choose and set up discrete classes (thus supervising the selection) and then, assign them category names. As a rule, the classifying person also locates specific training sites on the image - either a print or a monitor display - to identify the classes.

In this work, **Level I** supervised classification approach is used and passed through the steps such as: select training samples which are typical representative for the land cover classes; perform classification using maximum likelihood algorithm and finally assess the accuracy of the classified image through randomly generated training samples and analysis of confusion matrix.

The maximum likelihood algorithm is one of the most widely used in the classification of satellite imagery. The method is based on the likelihood that each pixel belongs to a particular class. The basic theory assumes that these likelihoods are equal for all class and that input bands are uniformly distributed. The method requires a significant calculation time and is based on a normal distribution of the data in each band in the classification. In this study five LU/LC classes were identified by supervised maximum likelihood classification technique. Based on this classification, five land use/land cover classes are identified; the description of each land use/land cover type is presented (in Table 3.2).

3.5.14. Accuracy Assessment

Assessment of classification accuracy is critical for a map generated from any remote sensing data. Although accuracy assessment is important for traditional remote sensing techniques, with the advent of more advanced digital satellite remote sensing the necessity of performing an accuracy assessment has received new interest (Congalton, 1991). Currently, accuracy assessment is considered as an integral part of any image classification. This is because image classification using different classification methods or algorithms may classify or assign some pixels or group of pixels to wrong classes. In order to wisely use the land cover maps which are derived from remote sensing and the accompanying land resource statistics, the errors must be quantitatively explained in terms of classification accuracy. The most common types of error that occurs in image classifications are omission or commission errors. The widely used method to represent classification accuracy is in the form of an error matrix sometimes referred as confusion matrix. Using error matrix to represent accuracy is recommended and adopted as the standard reporting convention (Congalton, 1991). It presents the relationship between the classes in the classified and reference maps. The technique provides some statistical and analytical approaches to explain the accuracy of the classification. Kappa coefficient, which is one of the most popular measures in addressing the difference between the actual agreement and change agreement, is also calculated. The kappa is a discrete multivariate's technique used in accuracy assessment. The error matrix can then be used as a starting point for a series of descriptive and analytical statistical techniques (Congalton, 1991).

3.5.15. Land Use/Land Cover Description

The type and number of land use classes are determined by a number of factors. The contribution of the land use type on the recorded change is the primary determinant reason. This is directly related to the area the land use shares 'in the town the other is land use types that its change easily recognizable and identifiable. Again, typical land features of the area are taken as a class. In order to make sample collection and classification easy, land use/land cover nomenclatures are required to create and define the possible land use/land cover classes first. Although the focus of the paper was on built-up areas, the land use/land cover map of the study areas are first generated using land use/land cover classes presented(in table 3.2).

The land use/land cover classes applied in this paper are adopted from AFRICOVER land use/land cover classification scheme which is widely applied in East African Countries (AFRICOVER, 2002). For the sake of simplicity, the researcher modified the descriptions of some of the land use/land cover classes considering the land use/land cover diversity of the study area. Therefore, five major land use/land cover nomenclatures: built up/ urban areas, agricultural lands, vegetated areas, open space and water body are used to produce the final land use/land cover map of the study area.

Table 3.2 Land use/land cover classes 'description.

Land use class	Description
Built up area	All residential, commercial and industrial areas, villages, settlements and transportation infrastructures.
Agricultural land	Including crop fields and fallow land.
Vegetation	In this study the vegetation includes planted of trees around compounds, eucalyptus wood lots and road side tree plants and parks.
Bare land	All vacant spaces, sands, rocky areas, cleared land
Water body	Including river, lake and dams.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents and discusses the results of the classified Landsat images and field survey conducted at Gondar town and its surrounding rural areas. Results of land-use and land cover changes and its impact on agricultural land are discussed. In order to achieve the objective, the present study focused on digging out the expansion of built-up area and its impacts on farmland. Total number of five land use/land cover classes is mapped, spread over 29,434 hectares of study area (which is the municipal limit). These classes include built-up, agricultural land, bare land/open space, vegetation cover and water body (Figure 4.1, 4.2 and Figure 4.3). The statistics derived out of different land use/ cover classes is given in Table 4.1 and their detailed explanation is as follows:

4.2 Spatio-temporal urban landscape dynamics between 1985 and 2017

The land cover maps generated after running a maximum likelihood supervised classification algorithm are presented in table 4.1 and figures 4.1, 4.2, and 4.3 below. The spatio-temporal dynamics in land use/land cover from 1985 to 2017 were extracted through the analysis of multi-temporal and multi-spectral Landsat images. From the ground truth data and classified Landsat images of 1985, 2000 and 2017; the study area has undergone various spatio-temporal land use dynamics. As shown from the figures, there has been an increase of built up areas with respective values 2% of the study area in 1985 to 5% in 2000 and 12.8% in 2017 indicated in table 4.1. The general statistics of the spatio-temporal landscape dynamics of the town for 32 years' period covered as derived from the thematic maps are presented in the Table 4.1 below;

Table 4.1. Areas of land use classes and spatio-temporal dynamics occurred.

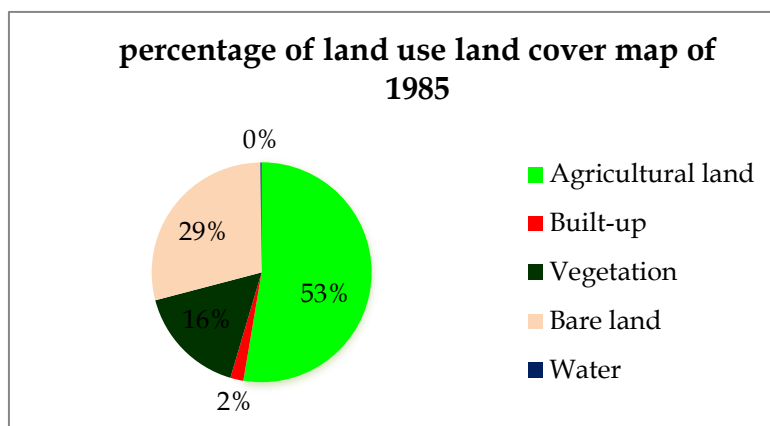
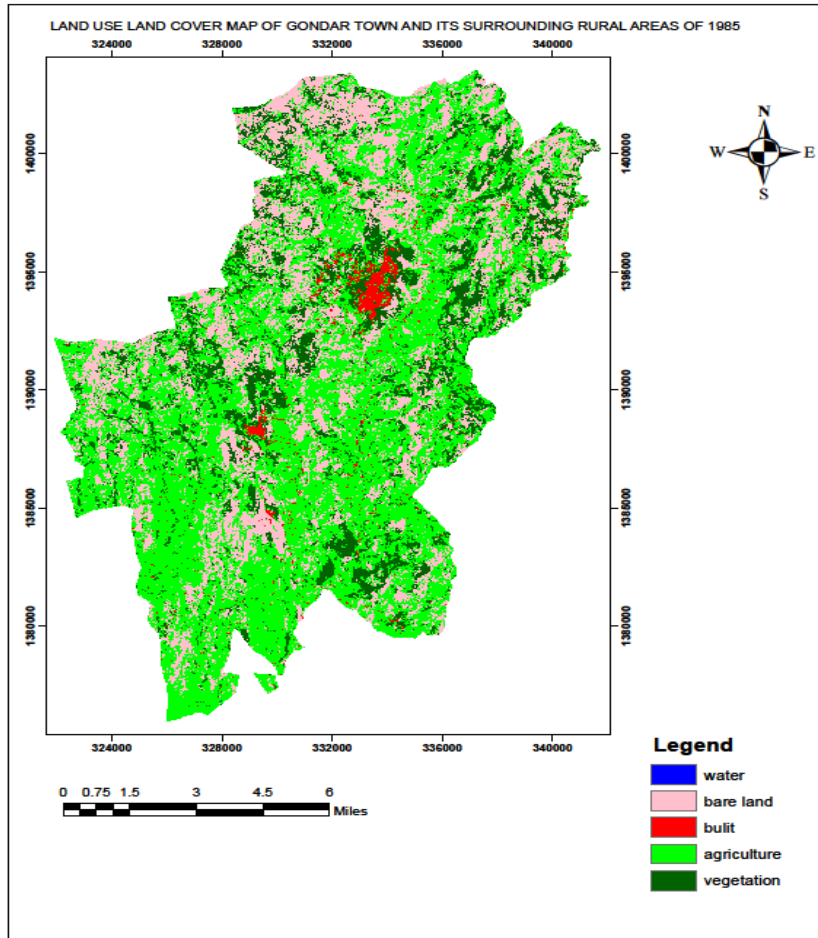
Class Name	1985		2000		2017	
	Area (ha)	Area (%)	Area(ha)	Area (%)	Area (ha)	Area (%)
Agricultural land	15524	52.7%	15116	51.3%	12297	41.8%
Built-up	567	2%	1472	5%	3773.79	12.8%
Vegetation	4815	16.5%	3821	13%	4075.18	13.85%
Bare land	8523	29%	8913	30.3%	9255	31.44%
Water	5	0.017%	112	0.4%	33.03	0.11%
Class Total	29434	100	29434	100	29434	100

Source: Extracted from analysis of Landsat images of 1985, 2000, and 2017

The spatial distribution of land cover dynamics within the area from 1985 is shown in table 4.1 and Figure 4.1 below, Agricultural land comprising of irrigated and rain fed arable lands, cropland with permanent crops, farming and fallow fields occupied the largest area of 15524 hectares attributed that the land was under largescale farming with majority holding. At 1985, large farm production was the mainstay of the town's economy and these had to remain intact in order to safeguard the economy. In 1985 Gondar town was dominated by cultivated land and bare land which together accounted for 81.7% of total area. In contrast, the urban built-up area was covered only 567ha, a mere 2% of the total area. Built up land comprising of residential, industrial and commercial units occupied 567 hectares attributed to less developments and increased agricultural activities. This situation expresses the low level of development at 1985 with a small compact urban area. This indicated that Gondar town was an agricultural dominated area, whereas urban development was in its initial stages at that time. Bare land comprised of all vacant spaces, sands, rocky areas, cleared lands occupied 8523 hectares attributed to the clearing of agricultural land in Preparation planting season. The area covered by vegetation cover shares

about 4815 hectares area whereas; area under water body covers only 5 hectares comprising rivers, dams occupied the least area. Figure 4.1 is shown below.

Figure 4.1 Land use land cover of map 1985



Source: Extracted from Landsat 5TM image of 1985

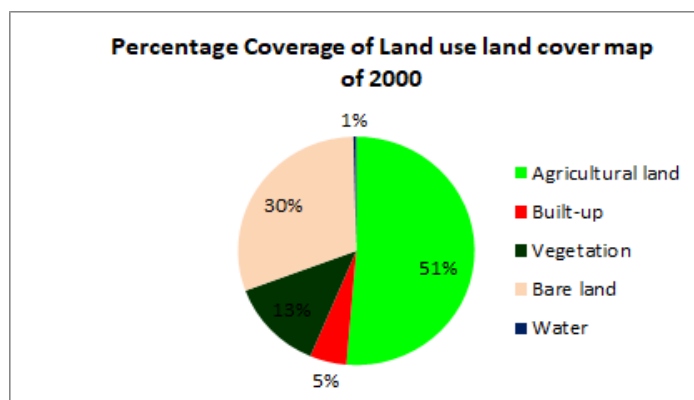
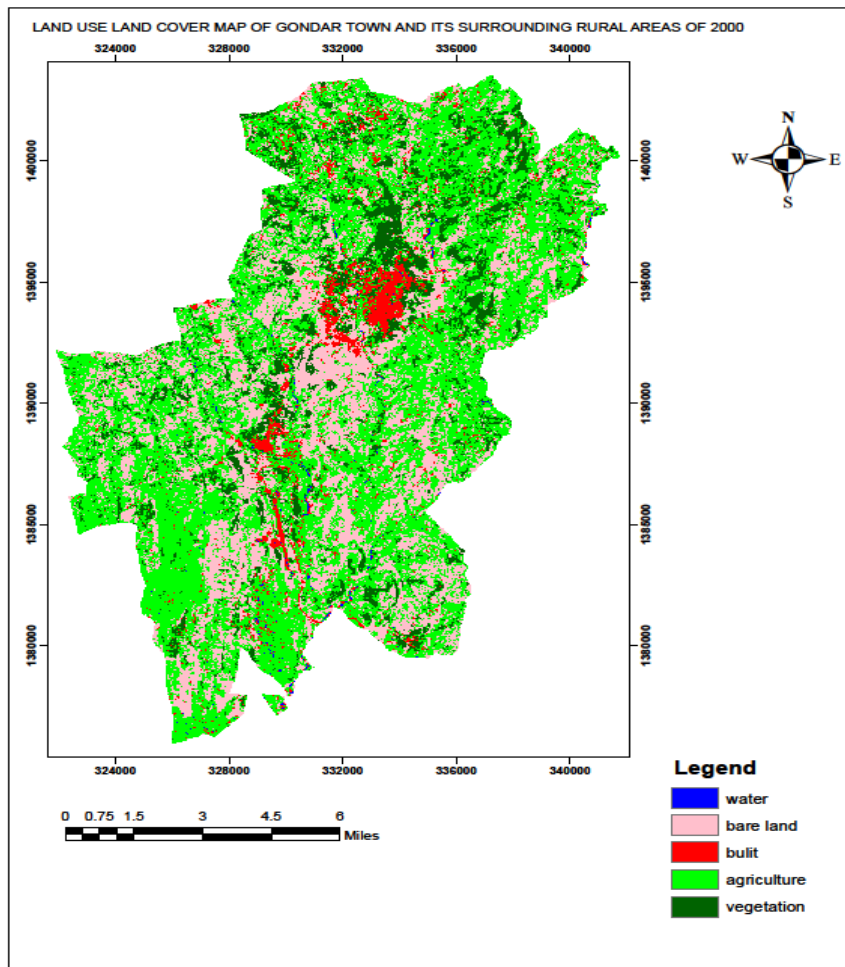
In 2000, the agricultural land in the study area covered a total of 15116 hectares in table 4.1 which was a decrease from the 15524 hectares recorded in 1985; Agricultural land was continuously being pushed and converted to urban uses in the process of urbanization. In 2000 agricultural areas covered 51.3% of the study area. From figure 4.1 below and table 4.1, agricultural land was the most dominant land cover class in the study area but showed a continuous decrease from 51.3% in 2000 to 41.8% in 2017. Because of the successive decrease of agricultural areas, built up areas have dynamically increased in the study periods. This horizontal physical expansion has led to a complete dispossession of agricultural land or farm size reduction.

Urban sprawl has been criticized for its inefficient use of land resources and energy and large-scale encroachment on agricultural land (Cheng, 2003). Not only the agricultural areas but also the plantation cover was also decreased, as Rahman et al., (2008) has noted that, the area of urban sprawl is characterized by a situation where urban development negatively interferes with urban setting which is neither an acceptable urban situation nor suitable for an agricultural rural environment. On the contrary the area under built-up land in 2000, increased and occupied 1472 hectares and increased from 567 hectares in 1985. In the first decade (from 1985 to 2000), the land cover change analysis revealed that built up area has shown a constant increase and finally it tripled. In many countries, the increasing demand is most likely to affect or is affecting rural-urban fringe areas. Ifeoluwa et al., (2011), observed that Akure city in Nigeria had haphazardly expanded outwards depleting cultivated land and vegetation in the fringe. This was particularly towards the north western part of the city where area covered by built-up/ settlement land had increased from 10.1% in 1986 to 32.51% in 2002 closely related to continuous construction of both residential and commercial buildings to serve the community. The increase in area coverage of built-up land attributed to the clearing of agricultural land for the planting season and explained by the clearance of agricultural land to pave way for urban developments, particularly, housing, and infrastructure (Nairobi Metro Strategy, 2008).

The area covered by vegetation cover occupied 3281 hectares decreased from the 4815 hectares in 1985. Unpredictably, water body increased from 5 hectares in 1985 to 112 hectares in 2000. Area under bare land increased to 8913 hectares from 8523 hectares in 1985. Figure 4.2 shows the spatial distribution of land uses in the Gondar town in 2000. As it is seen from land use/land cover map (Figure 4.2) it is evident that the built-up land had increased compared to 1985

spreading to the north, south and southwest of the study area.

Figure 4.2 land use/land cover map 2000

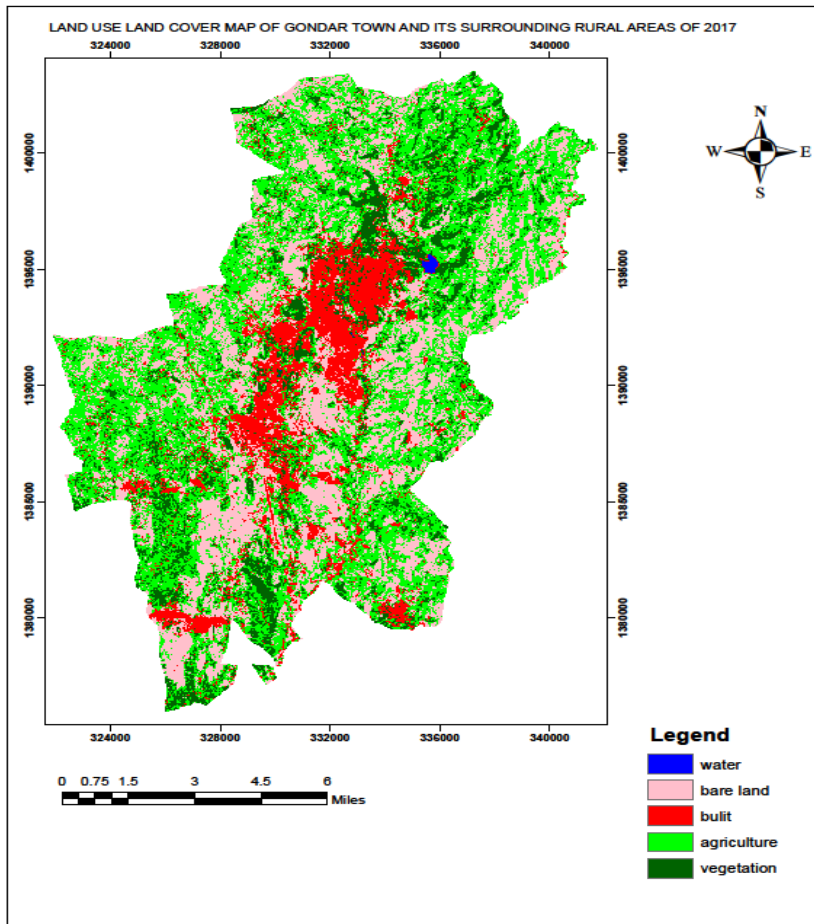


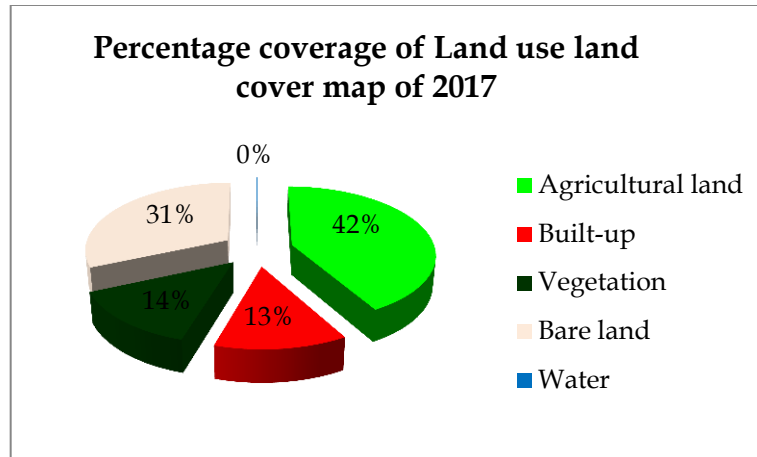
Source: Extracted from Landsat 7(ETM+) image of 2000

In 2017, the area under agricultural land had decreased from 15,524 hectares (52.7% of the total study area) to 12,297 hectares (41.8% of the total study area); while built-up land had increased

to an area of 3773.79 hectares, gaining more than 2301 hectares of land representing 12.8% of the land area in the study area. This indicates that the majority of urban growth was happening beyond the city center, in surrounding area. The area under vegetation cover increased to cover 4075.59 hectares as compared to 3281 hectares recorded in 2000. The area covered by water decreased to cover 33.03 hectares compared to 122 hectares in 2000 while the area under bare land increased and occupied a total area of 9255 hectares compared to 8913 hectares in 2000. The spatial distribution of the land cover and land use map in 2017 is shown in Figure 4.3 below.

Figure 4.3 land use/land cover map 2017





Source: Extracted from Landsat 8(OLI) image of 2017

Figure 4.3 shows the area in hectares and percentage of land-use/cover changes between 1985 and 2017. It is evident that the area covered by agricultural land was on the decline. The period between 1985 and 2000 shows a minimal decline in area coverage of Agricultural land where it occupied 15524 hectares and 15116 hectares, respectively, a decline of 408 hectares. This contrasts sharply with the period between 2000 and 2017 in agricultural land further declined, to occupy an area of 12297 hectares in 2017, a decline of 2819 hectares. This expansion of built-up area had engulfed the surrounding farmland.

4.3 Accuracy Assessment of the Classification

Because classified land cover maps from remotely sensed images contain various types of errors, it is the responsibility of the researcher to find out those errors so as to make the produced land cover maps become reliable and easily interpretable by users. Once the classified image is integrated into a GIS, to become an information source for urban planners and researchers, accuracy assessment should be processed as it limits the classification results of a remotely sensed imagery data. To do so, the accuracy of a classified map has to be assessed and compared with a referenced data using an error matrix as explained in chapter 3 of section 3.5.9. The accuracy assessment in this study is given in the table 4.2 below.

Table 4.2 Producer's and User's accuracy for individual land-use/land cover classes

Year	2017(%)			2000(%)			1985(%)		
Land use class	Produce r's	User's	KIA per Class	Produce r's	User's	KIA per Class	Produce r's	User's	KIA per class
Agriculture	85.71	85.52	0.82	82	86	0.72	86	91.5	0.88
Built up	82.76	94.12	0.78	86	83.33	0.79	88.46	100	1
Vegetation cover	80.70	92	0.76	86	84	0.78	95.92	88.68	0.82
Bare land	73.44	95.92	0.67	90	81	0.65	94	87.	0.85
Water	82.46	100	1	88	89	0.68	82.46	85	0.67

Table 4.3 Overall accuracy and Kappa (K[^]) statistics for the classifications

Year of study	1985	2000	2017
Overall classification accuracy (%)	91.04	82	82.49
Overall Kappa(K) statistics	0.88	0.79	0.78

4.4 Analysis of the Rates and Trends of Urban Landscape Dynamics

The Spatial Trend of Change result was based on the change of all the land classes to the Built up area, and it has shown a trend of sprawling of built up to the south southeast and southwest. The urban landscape dynamics trends and rates occurred in the town is presented for each individual land use classes in hectare and percentage below in table 4.4

Table 4.4 Amounts of Dynamics Occurred in Land Use / Land cover Classes for Three Time Periods of 1985, 2000 and 2017

Class Name	1985 to 2000		2000 to 2017		1985 to 2017	
	Change in (ha)	Change in percent (%)	Change in (ha)	Change in percent (%)	Change in (ha)	Change in percent (%)
Built-up	+905	+159.6%	+2031.79	+156.4%	+3206.79	+565.57%
Agriculture	-408	-2.63%	-2819	-18.65%	-3227	-20.78%
Bare land	+390	+4.6%	+342	+3.84%	+732	+8.59%
Vegetation	-994	-20.6%	+254.18	+6.65%	-739.82	-15.36%
Water	+107	+2140%	-78.79	-70.5%	+28.03	+560.6%

Source: Extracted from analysis of Landsat images of 1985, 2000, and 2017

Note: Positive (+) sign indicates an increase in aerial extent.

Negative (-) sign indicates a reduction in aerial extent.

Table 4.5 Rates and trends of Dynamics occurred in Land Use/Land cover Classes for Three Time Periods of 1985, 2000 and 2017

Class Name	1985 to 2000		2000 to 2017		1985 to 2017	
	Change in (ha)	Annual Rate of Change in(ha)	Change in (ha)	Annual Rate of Change in(ha)	Change in (ha)	Annual Rate of Change in(ha)
Built-up	+905	+60.33	+2031.79	+119.5	+3206.79	+100.2
Agriculture	-408	-27.2	-2819	-165.8	-3227	-100.8
Bare land	+390	26	+342	+20	+732	+22.88
Vegetation	-994	-66.26	+254.18	+14.95	-739.82	-23
Water	+107	7.133	-78.79	-4.6	+28.03	+0.88

Source: Extracted from analysis of Landsat images of 1985, 2000, and 2017

Note: Positive (+) sign indicates an increase in aerial extent.

Negative (-) sign indicates a reduction in aerial extent.

As it is shown in table 4.4 and 4.5, the amount of change that has taken place between 1985 and 2000 was extensive. All the land use classes have revealed some form of gains and losses except built up.

The results indicate that between 1985 and 2000 (15 years' period), the areas covered by agricultural land and vegetation cover decreased by 2.63% (-408 hectares) and (-20.6%) 994 hectares at annual a rate of 27.2ha and 66.26 ha/year respectively that shows a decreasing trend. while the built-up land and bare land rose by (+159.6%), +905 hectares and +4.6% (+390 hectares) and water body (2140%) 107 hectares with annual average rate of 60.33ha, 26 hectares and 7.133 hectares respectively that shows a great increasing trend.

The results also indicated that between 2000 and 2017 (17 years' period) the area covered by agricultural land continued to decrease by 2819 hectares of land which accounts 18.65% of the agricultural area decreasing at annual rate of 165.8 hectares while the built-up land continued to increase by 2031 hectares which accounts 156.4% urban land at annual average rate of 119.5 hectares of growth. This tells us urban land mass expanded rapidly between 2000 and 2017 (2031.79ha) compared to between 1985 and 2000 (905ha) (table 4.4). Interestingly, the area covered by vegetation increased by 254.18 hectares at annual average rate of 14.95 hectares ha/year which accounts (6.65%) of the vegetation area. The area covered by water decreased by 70.5% while the area covered by bare land increased by 3.84% with annual rate of 20 hectares per year.

For the period covered by the study (1985-2017) the area showed great land-use changes, 20.78% of agricultural land was converted to other uses at annual rate of 100.8 hectares per year. The built up area increased by 565.57% with annual rate of 100.2 hectares per year which shows a constantly increasing trend, while the area covered by vegetation cover decreased by 15.36%. During this period, the area covered by bare land and water also increased by 8.59% and 560.6% with annual average growth rate of 22.88ha and 0.88 ha respectively.

4.5 Rate and Magnitude of Built up Area Expansion (1985-2017)

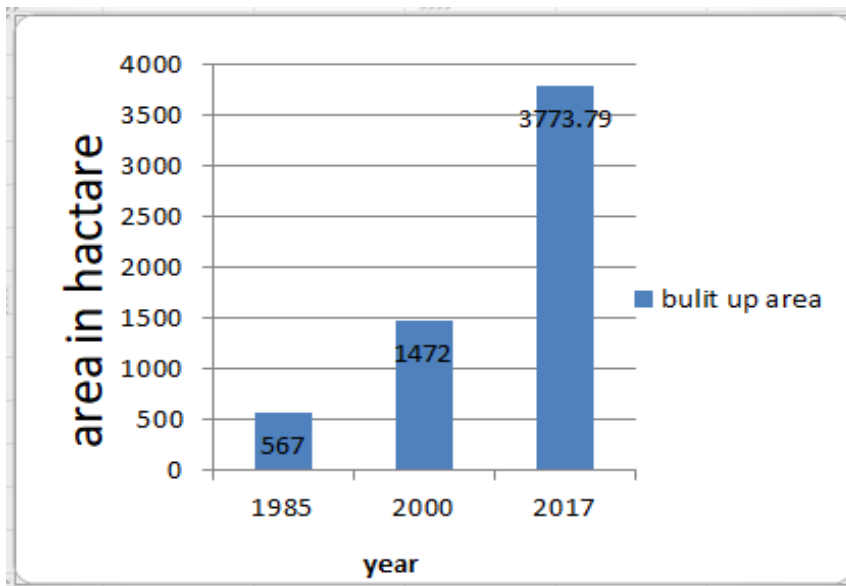
The built-up area in a span of 32 years between 1985 and 2017 were compared to find the changes (table 4.6 and figure 4.4). The built up area expansion of the town between 1985 and 2000 was 905 hectare which was a 159.6% expansion and annual rate of growth was also 60.33 hectares per year (Table 4.6). The output between 2000 and 2017 were also compared to find the changes in the built-up area (table 4.6). The built up area expansion of the town between 2000 and 2017 was 2301.79 hectares which is nearly 156.4% expansion and annual rate of growth was also approximates about 135.4 hectares per year (Table 4.6 and figure 4.6).

Table 4.6 Rate and Magnitude Built-up Area Expansion (1985-2017)

No	Study period	Built-up area in(ha)	Expansion(ha)	Expansion (%)	Annual rate of growth (ha)
1	1985	567	-		-
2	2000	1472	905	159.6	60.33
3	2017	3773.79	2301.79	156.4	135.4

Source: Extracted from Landsat images of 1985, 2000, and 2017

Figure 4.4 Built up area expansion (1985, 2000 and 2017)



4.6. Built up proportion in the reclassified image of Gondar town

In order to visualize and examine the spatial expansion of the built up areas during the three time periods, the LULC map was reclassified into built up and non-built up area (Figure 4.5). The main focus of this study was assessing and examining the spatial extents of built up areas within the three study periods. To achieve this, a reclassification was made to generate land use and land cover maps of built up and non-built up areas as shown in figure 4.5 below. These maps show a clear pattern of increased urban expansion prolonging both from urban center to adjoining non-built up areas along major transportation corridors. The maps show the spatio-temporal urban growth pattern in the study area. As clearly seen in table 4.5, the proportion of built up areas in 1985 was 2% of the entire study area. In 2000 the percentage of built up areas showed more than double increase and it was 5 % and in 2017 it reached to 12.8% of area coverage. By visual interpretation someone can have a quick picture of the spatio-temporal change of the urban area. Besides, the direction of expansion can be understood. It is also interesting to see that the trend of urban growth (Figure 4.5) and result map of the Spatial Trend of Change showed similar result.

Table 4.7: Built and non-built-up areas between 1985 to 2017

Land cover class	1985		2000		2017	
	Area(ha)	%	Area(ha)	%	Area (ha)	%
Built up areas	567	2	1472	5	3773.79	12.8
Non Built up areas	28867	98	27962	95	25660.21	87.2
Total area(ha)	29434	100	29434	100	29434	100

The study area has experienced spatial increase on different land use and land cover classes such as; built up areas, due to the corresponding horizontal expansion as well as conversion of land cover classes during the distinct study periods. The reclassified images in figure 4.5 showed that there had been a rapid land cover change from non-built up areas to built-up areas. In all study periods, agricultural areas were the most dynamic classes which contributed to the increase of built up areas. There was a huge decrease of agricultural areas from 1985 to 2017.

The latest data i.e. the 2017 image demonstrates a rapid and massive transformation of agriculture land to urban built up land. This substantial transformation from agricultural land use

to urban built-up zones is noticeable from the earlier existing built-up land maps and thus it can be concluded that the urban landscape dynamics has been taken place at the expense of fertile agricultural land parcels as it seen in figure 4.5 below.

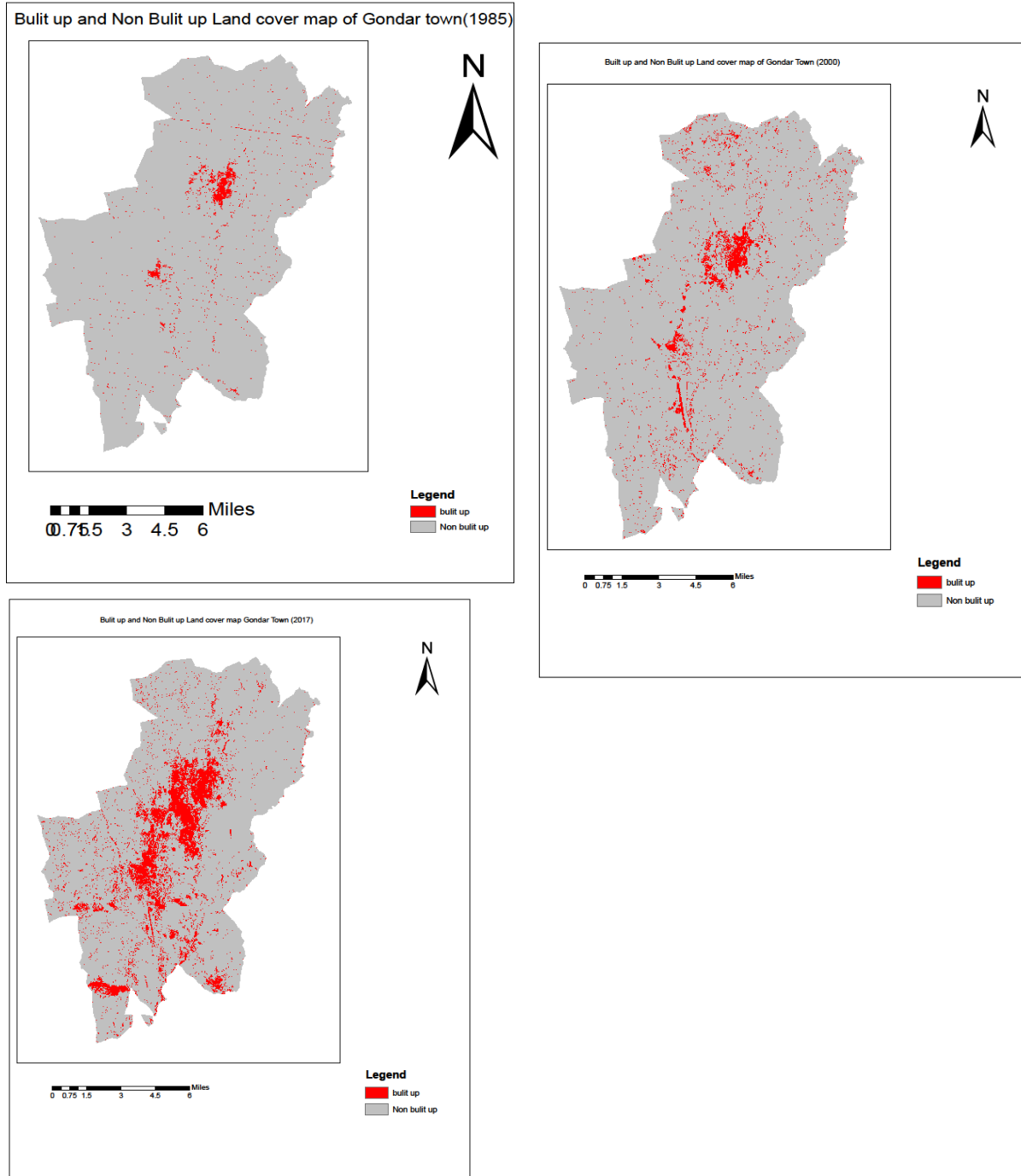


Figure 4.5 built up and non -built up areas for 1985, 2000 and 2017 respectively.

4.7 Change detection analysis

Multi-date post-classification comparison change detection was performed to investigate land cover change in the study area from 1985 to 2000. The post-classification change detection engrossed on a supervised classification using five classes: agricultural lands, bare land, built-up vegetation and water. The resulting 1985, 2000 and 2017 classifications were used as inputs to quantify the land transition matrix (Tables 4.8, 4.9 and 4.10). Land covers that had no change separated were from the land covers, which had change by comparing the three thematic layers. The same types of land cover for the three years identified were observed not to have changed, while different types of land cover changed. This analysis produced five change classes: change in agriculture land, change in bare land, change in built up and change in vegetation cover and change in water.

The diagonal values shaded in yellow from cross tabulation matrix (Tables 4.8, 4.9, 4.10) show land-use/land-covers that were unchanged in the given years. This thematic change detection was calculated by subtracting the area of each land cover classification of 1985 from 2000. Out of the 15703.99 hectares, that were Agriculture in 1985, 10172.33 hectares did not change while there was a 5531.66 decrease in hectares representing 35.22% of 1985 a period of 15 years.

For the Bare land, results show the extent to which was converted, where 420.73 hectares out of 8429.64 hectares of bare land were converted to built-up land while 711.80 hectares of the same bare land were converted to vegetation cover. 1949.17 hectares of a total of 4744.56 hectares of vegetation cover have changed to agriculture land while 526.18 hectares have changed to bare land and 126.02 hectares to built-up. 0.91 hectares of a total 4.01 of water have changed to built-up land while 0.19 and 1.62 hectare have changed to vegetation cover and agriculture respectively. This indicates that a significant area of water bodies has been converted for agriculture uses by draining farming and overgrazing, as well for urban development purposes such construction of residential, commercial and infrastructure development.

Table 4.8: Land use/Land cover transition matrix (ha) from 1985 to 2000

	2000						
	Classes	Agriculture	Bare land	Built-up	Vegetation	Water	Grand Total
1985	Agriculture	10172.33	4034.37	555.63	868.87	72.79	15703.99
	Bare land	3049.57	4242.61	420.73	711.80	4.93	8429.64
	Built-up	149.42	44.52	281.18	29.10	15.43	519.65
	Vegetation	1949.17	526.18	126.02	2138.92	4.26	4744.56
	Water	1.62	0.09	0.91	0.19	1.20	4.01
	Grand Total	15322.10	8847.77	1384.48	3748.89	98.61	29401.86
	Total Change	-381.89	418.13	864.83	-995.67	94.6	

Source; Landsat maps of 1985 and 2000

The diagonal values (shaded in yellow) from cross tabulation matrix (Table 4.9) show land-use/land-cover that were unchanged in the given years. In the study period of 2000 and 2017 out of 15321.87 hectares of land under agriculture in 2000, 8554.35 hectares remained unchanged while 1226.80 and 3522.87 hectares were converted to built-up and bare land respectively, assumingly to pave way for built-up area .5212.09 hectares out of 8849.08 hectares covered by bare land converted to built-up while 2326.12 hectares converted to agriculture. Area under vegetation cover, 158.96 hectares converted to built-up out of the total 3749.28 hectares while 1313.37 hectares converted to agriculture. It is interesting to note that 2010.36 hectares, out of 15321.87 hectares occupied by agriculture in 2000 converted to vegetation cover.5.61 hectares converted to built-up and 54.86 hectares to bare land, from the 98.69 hectares under water.

Table 4.9: Land use/Land cover transition matrix (ha) from 2000 to 2017

		2017					
2000	Classes	Agriculture	Bare land	Built-up	Vegetation	Water	Grand Total
	Agriculture	8554.35	3522.87	1226.80	2010.36	7.49	15321.87
	Bare land	2326.12	1058.66	5212.09	233.10	19.10	8849.08
	Built-up	263.26	715.14	321.12	80.74	4.47	1384.73
	Vegetation	1313.37	675.83	158.96	1600.08	1.04	3749.28
	Water	24.04	54.86	5.61	13.57	0.61	98.69
	Grand Total	12481.13	3731.29	9220.66	3937.84	32.72	29403.65
	Total Change	-2840.74	-5117.79	7835.93	188.56	-65.97	

Source; Landsat maps of 2000 and 2017

For the entire period covered by the study area, it is clear that the area covered by agriculture is slowly being edged out by other land uses, mainly by built-up land. Out 15703.99 hectares of land under agriculture in 1985, 1722.922832 hectares were converted to built-up and 4074.690414 hectares converted to bare land, assumingly to pave way for built-up area (Table 4.10.). 4337.721136 hectares out of 8430.145548 hectares covered by bare land were converted to built-up while 2652.833271 hectares were converted to agriculture; 583.8035091 hectares of a total of 4744.919046 of vegetation have changed to built-up land as shown in Table 4.10. The change detection result indicates that agricultural land is being edged out slowly by other land uses, especially by built-up land. The implication of these rapid changes of land use is a decline in area under agricultural land.

Table 4.10: Land use/Land cover transition matrix (ha) from 1985 to 2017

		2017					
1985	Classes	Agriculture	Bare land	Built-up	Vegetation	Water	Grand Total
	Agriculture	7358.92757 9	4074.6904 14	1722.92 2832	2031.5325 61	20.5531 9046	15208.62 658
	Bare land	2652.83327 1	943.15502 6	4337.72 1136	488.05943 38	8.37668 0953	8430.145 548
	Built-up	99.7750283 2	340.82181 22	42.3676 8233	488.05943 38	0.68786 9173	519.5765 3
	Vegetation	2219.27431 3	708.02765 63	583.803 5091	1230.7064 12	3.10715 6542	4744.919 046
	Water	1.06472544 8	1.9501048 63	0.03161 957	0.9675803 92	0.3526	4.014030 273
	Grand Total	12331.8749 2	3716.8774 32	9038.61 4361	3787.1901 25	32.9984	28907.28 173
	Total Change	-2876.75	-4713.27	8519.03	957.73	20.9843	

Source; Landsat maps of 2000 and 2017

The primary focus of this study was to understand the level of change in built-up area in the designated study area period. The major land-use/land-cover that contributed to the increase of built-up area is presented in Table 4.10. Based on the land-use/land-cover change statistics between 1985 and 2000, 555.63 hectares of agricultural land, 420.73 hectares of bare land, 126.02 hectares of vegetation cover land and 0.91 hectares water converted to built-up area. Between 2000 -2017, 1226.80 of agricultural land, 5212.09 hectares of bare land, and 158.96 hectares of vegetation cover and 5.61 hectares of water were converted to built-up area. The overall change for the period of the study (Table 4.10) indicates that agricultural land is the most affected by the land use/cover changes.

Table 4.11: Land-use/Land-cover class conversion to Built-up area in hectares

Land use/Land cover	1985-2000		2000-2017		1985-2017	
	Area (Ha)	%	Area (Ha)	%	Area (Ha)	%
Agriculture to Built-up	553.63	50.3	1226.80	18.6	1723	25.93
Bare land to Built-up	420.73	38.2	5212.09	78.92	4337	65.28
Vegetation to Built-up	126.02	11.44	158.96	2.4	584	8.78
Water to Built-up	0.91	0.08	5.61	0.08	0.03	0.0005
TOTAL	1101.29	100	6603.46		6644.03	100

Source; Landsat maps of 1985, 2000 and 2017

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

This study has been carried out to assess and analyze urban landscape dynamics and its impact on agricultural land in the study area. The research has been conducted and aimed at the use of remote sensing and GIS techniques to analyze the urban landscape dynamics and its impact on agricultural land to detect changes of urban land use/land cover based on Landsat satellite images. Landsat imageries of 1985, 2000 and 2017 were utilized to track urban landscape dynamics in the study area through analysis of LULC changes during these periods.

Results have revealed that in the study area LULC was occupied by agriculture, which covers 52.7% of entire area in 1985, 51.3% in 2000 and 41.8% in 2017. Its conversion to built-up area was the main factor for its decline in 2017. The built up areas, vegetated, bare land and water body possess 2%, 16.5%, 29% and 0.017% of entire study area in 1985 and in 2000 5%, 13%, 30.3% and 0.4% and 12.8%, 13.85% 31.44% and 0.11% in 2017 respectively. Even though many changes have observed among the LULCs in the year between 1985 and 2017, the highest rate of changes are seen in agricultural lands which was decreased by 100.8 hectares in every year and built area was increased by 118 hectares per annum.

The increase of urban/built up use is mainly at the expense of other land uses and the principal factors contributed for expansion of the town were: population growth, high demand for housing, urban development policy, expansion of informal settlements etc. The urban sprawl is one of the potential threats to sustainable development therefore; identification and analysis of the sprawl patterns would help in effective land use planning and environmental management in urban area. This study judiciously demonstrates the application of geo informatics in studying the dynamics of urban sprawl in any town. The rate of expansion of the town, especially residential areas are threatened the existence of natural resources in the future. This strongly warns the need of searching an alternative solution or a wise utilization.

5.2. RECOMMENDATION

There is a need to plan for balanced physical urban growth and population growth in our cities and towns. This can only be possible if there is an understanding of the nature of urban growth change, the urban demographic pressure, the level of service available to supply, the source and amount of resources to future growth of cities and towns. Urban planning authorities and town planners should think about the future growth of the town and should understand the consequence of unbalanced physical urban growth and public service and infrastructure supply. They should have to depend on a GIS data base and information system to regulate their urban development in a sustainable way such that they will manage the supply of public services and infrastructures that will be needed as a result of future urban expansion.

Satellite remote sensing with repetitive and synoptic viewing capabilities, as well as multispectral capabilities, is a powerful tool for mapping and monitoring the ecological changes in the urban core and in the peripheral land-use planning. The use of remote sensing needs to be introduced for monitoring the activities of developers. This will help in reducing unplanned urban sprawls and the associated loss of agricultural lands.

At current rate of population dynamic, land-use/land-cover change is certain to increase. Therefore, the following management strategies are recommended.

- ❖ Instead of new housing development on agricultural land, renewal of older buildings and infill development of high rise buildings to meet the demands and needs of the increasing number of population in the town. In addition the construction of condominium houses is another solution. It is already beginning to implementation by the government and should be continuing in the future.
- ❖ For effective urban developments, Environmental Impact Assessment (EIA) and public participation in decision making are also recommended. These are essential to assess the likely impacts of urban development on the surrounding ecosystems.
- ❖ Population growth is one of the major causes for urban expansion especially rural- urban migration to seek employment opportunity and services. So as, to alleviate the rapid population growth of the town, it is better to minimize rural-urban migration by creating conducive environment in rural areas.
- ❖ Sustainable use of land resources and avoiding agricultural land loss by uncontrolled horizontal urban expansion.

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