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ADDIS ABABA UNIVERSITY

ETHIOPIAN INSTITUTE OF ARCHITECTURE, BUILDING CONSTRUCTION

AND CITY DEVELOPMENT (EiABC)

PREDICTORS OF LAND USE CONVERSIONS BASED ON URBAN EXPANSION IN BAHIR DAR CITY: NORTH WEST AMHARA REGION, ETHIOPIA

BY:

KALKIDAN GEDEFAW AREGA

NOVEMBER , 2023

ADDIS ABABA, ETHIOPIA

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Predictors of Land Use Conversions Based on Urban Expansion in Bahir Dar city: North West Amhara Region, Ethiopia

By:

Kalkidan Gedefaw Arega

A Thesis Submitted to the School of Graduate programs director's office, Ethiopian Institute of Architecture, Building Construction and City Development, in Partial Fulfillment of the Requirements for the Award of Masters of Science Degree in Urban Planning.

Advisor:

Birhanu Girma (PhD)

November, 2023

Addis Ababa, Ethiopia

Declaration

To the best of my knowledge, I hereby sincerely certify that the information included herein is accurate and truthful. All the information for the thesis project titled **“Predictors of land use conversions, based on urban expansion in Bahir Dar city. North West Amhara Region, Ethiopia."** It is truly my work and understanding and has never been delivered at an educational facility or other institution.

Name: Kalkidan Gedefaw Arega

Signature: ……....

Approval sheet

As a member of the team of examiners for Kalkidan Gedefaw's final master's thesis formal defense, we have studied and assessed Kalkidan Gedefaw's thesis, "Predictors of Land Use Conversions Based on Urban Expansion in Bahir Dar City: North West Amhara Region, Ethiopia." Additionally, mentioned that the Ethiopian Institute of Architecture, Building Construction, and City Development, located at Addis Ababa University, approve the thesis that meets the requirements for the award of a master's degree in urban planning.

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Abstract

The most visible kind of global environmental change happening at spatial and temporal scales is land use/cover (LULC). Land use is an indication of complex human activities that modify land surface processes, whereas land cover is the physical and biological cover of the land surface. Human effect on the environment is shown by the change of natural land to artificial landscapes. Therefore, the main objective of current study was identifying predictors affecting land use conversion through urbanization in Bahir Dar city, North-West Ethiopia. The study was conducted in Bair Dar City, North-West Amhara region between 2000 up to 2020. The study was carried out based on both qualitative and quantitative approaches employing spatial analysis of remote sensing and GIS techniques and survey methods. In this study both primary and secondary data sources were used via questionnaires, focus group discussions, interviews, and inspections. Satellite images, secondary documents, and standards are used to gather the secondary data sources. The results in this study indicate that urban expansion, population growth, city topography, and the increase in residential preference, political, economic and cultural centrality, activity of land brokers, informal land access, rural people migration and intended plan of the municipality significantly affected the degree of rapid land use conversion. The extent of change was 9% between the years 2000-2010. The highest rate of change occurred between the years 2010-2020 which was 25% change in land use conversions. In addition, using this study as a reference for improving the quality of life, the study recommended there should be ensured balanced horizontal expansion of the city with the integration of vertical developments, multimodal development such as resources and junction improvements at a higher density than the surrounding area, while imprinting the built-up structures; a productive green belt should be employed as a guiding structure such as considering slum areas for further development, can be considered as a solution for reduction of urban expansion and this further leads to reduce the rapid land use conversion.

Key words: (GIS) Geographic information system, change assessment, urban expansion, (LULC) land use land cover, actors and predictors/factors.

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Acronyms/Abbreviations

BA	Built Up Area
BD	Bahir Dar
DC	Dynamic Change
DPSIR	Drivers, Pressures, State, Impact, and Reaction
GIS	Geographic Information System
GPS	Global Positioning Systems
LULC	Land Use Land Cover
RS	Remote Sensing
TM	Landsat Imagery/Landsat Thematic Mapper
USGS	United States Geological Survey
UN	United Nations

Chapter One: Introduction

1.1. Background of the study

The biggest issues the globe will confront in the next century are predicted to be changes in land use and land cover. Research indicates that there is a clear global trend toward urbanization (United Nations Centre for Human Settlement, 1996). Urbanization, often known as the process of urban growth, is a universal phenomenon. Rapid population increase, a rise in the number of people working in non-agricultural sectors, and a switch from agricultural to built-up urban form are all examples of this (UN-Habitat, 2006).

The trend of more people relocating to urban areas is known as urbanization. People shifting from rural to urban areas is the main source of urbanization, which results in an increase in the population of cities and the size of urban regions. These demographic fluctuations have also had an impact on other aspects of land use, economic activity, and culture. The economy and society have always undergone considerable changes as a result of urbanization. For example, living in a city is linked to higher levels of literacy and education, better health, lower fertility, longer life expectancy, greater access to social services, and more opportunities for involvement in politics and culture (UNDESA, 2014).

Over the past 50 years, there has been a noticeable urbanization in many emerging countries, which appears to have coincided with an overly high level of urban population concentration in extremely large cities. Initially, some urban concentration may be beneficial to cut back on inter- and intraregional infrastructure costs (Vernon Henderson, 2002). For a number of reasons, including rural-to-urban migration, social, cultural, economic, and technological transformation, as well as rapid population growth, this rapid urbanization in developing countries results in LULC changes and environmental problems that are generally described as rapid and uncontrolled. It will also have an effect—both favorably and unfavorably.

Ethiopia is one of the least urbanized countries in the world with about 22.66% in 2022, according to the World Bank collection of development indicators. At more than 4.71% change, Ethiopia has one of the highest rates of urbanization in both Africa and the entire world (WDI, 2022). Given the decline in environmental quality shown in all populated neighborhoods surveyed as a result of the loss of trees and other greenery, there are doubts regarding the efficacy of green space

regulations. Green space planning and upkeep demand more attention.

The introduction of the motor vehicles, improved communications, and internal political developments in Ethiopia all had a substantial impact on the country's urbanization process. Bahir Dar, is in northern-western Ethiopia, at the southern end of Lake Tana, where the Blue Nile begins its long voyage. Bahir Dar, which was the capital of the Gojjam province, expanded quickly in the 1960s and 1970s. It was built by the central government as a market and transportation hub for Lake Tana and the Blue Nile basin's economic expansion.

Bahir Dar City is one of the largest and most rapidly expanding cities in Ethiopia. Bahir Dar city administration has designated main development reasons towards fast growth, i.e. the political, economic, and cultural center of Amhara National Regional State (ANRS), the second-most populous region in the country. In addition, the city is one of the major tourist centers in the country because of its cultural heritage (such as the Lake Tana and its Monasteries) and natural attractions (such as the Blue Nile Falls) (Appelhans, 2016). The methods in which cities change, as well as their ability to adapt to such changes, is crucial for long-term development. Bahir Dar is one of Ethiopia's fastest-growing cities. Until recently, as from assumptions of recent studies the city's sole driving force for development was its position as the capital of the Amhara region. Because of this reason many people migrate from the satellite cities this resulting an increase in population, this leads to a rise in public needs and other amenities that were evident to the city.

Numerous studies have been done to determine how the land use and cover of the rapidly growing metropolis of Bahir Dar have evolved. The main variables, measurement methods for measuring horizontal urban expansions, effects of LULC changes, and important land management determinants have not been explored in a clear and in good detail so that it addresses the major predictors of land use conversions due to expansion of the city. This emphasizes the requirement for more study. By measuring horizontal expansions using spatial analysis tools of GIS and remote sensing techniques, identifying the characteristics of urban expansion in various time periods, and identifying the key actors and factors responsible for the city's expansion and future impacts, the study, which focuses on this area, seeks to fill a gap in the negligible literature.

1.2. Statement of the Problem

In Ethiopia, the urban transition, in which populations are becoming more urbanized, and the demographic transition, in which death rates first fell and fertility rates later did the same, have occurred at the same time. The demographic shift began in the 1950s, while significant urbanization commenced in the 1960s. When the rapid phases of the two transitions overlaps a high urban growth rates are experienced (Tsegaye Tegenu, 2010). Urbanization's impact on land use and land cover is significant for regional climate, groundwater conditions, and environmental sustainability (Lambin et al., 2001; McGrane, 2016). In order to accommodate the need of growing population and economic development, urban environments continue to expand at a rate never before seen. Landscape changes as a result have put more strain on the environmental sustainability of natural resources.

The methods in which cities change, as well as their ability to adapt to such changes, is crucial for long-term development. Bahir Dar is one of Ethiopia's fastest-growing cities. Over the past 50 years, there has been a noticeable urbanization in many emerging cities like Bahir Dar, which appears to have coincided with an overly high level of urban population concentration in extremely large cities. For a number of reasons, including rural-to-urban migration, social, cultural, economic, and technological transformation, as well as rapid population growth, this rapid urbanization in developing countries results in LULC changes and environmental problems that are generally described as rapid and uncontrolled.

Land usage and its coverage change dramatically in any good city civilization. This is what has happened in Bahir Dar City throughout the last two decades of development. The city's open spaces are becoming progressively developed and paved for transportation routes. However, several human elements that have contributed to the city's development and change in land cover might be listed. The city's surplus resources, industrialization and commercialization, transportation and communication growth, the city's economic pull, and educational and recreational amenities are only a few of the driving forces. Before determining the effects of urban expansion on LULC change and the city's future growth, it is essential to quantify the city's horizontal expansions using spatial analysis GIS and RS methodologies as well as to evaluate the major factors and key actors. This is because the city's growth is a continuous process.

1.3 The objective of the study

1.3.1. General Objective of the study

The general objective of this study was investigating the dominant driving factors and its implications affecting the land use conversion in Bahir Dar city, North-Western Amhara region.

1.3.2. Specific Objectives of the study

- To assess the predictors of urban expansion on LULC changes in the study area.
- To investigate the major driving forces and actors of land use expansion of the study area.
- To determine the spatial trends of study area's land use over the duration of the study years and forecasting future expansion trends.
- To analyze the impacts of LULC change on the study area.
- To develop strategies for the actions to reduce the impacts of land use changes.

1.4. Research Questions

As this study mainly focuses on impacts of land use land cover changes, the following research questions were set

1. What are the predictors of urban expansion that encounter LULC changes in the study area?
2. What are the major driving forces and actors of land use expansion on the study area?
3. How did the spatial trends of expansion behave over the duration of the study years and what is expected for the coming years?
4. Did the change on LULC encounter any significant impacts on the study area?
5. What are the best strategies for the actions to reduce the impacts of the study area's land use changes?

1.5. Significance of the Study

A notable feature of the pressure on the limited land resources, which is caused by several environmental and human factors, particularly population growth, is the change in land use and land cover with a rapid and uncontrolled expansion. As a result, understanding the effects of land

use and land cover changes in the Bahir Dar city will depend more on the analysis and simulation of urban land use changes for the research community, urban planners, stakeholders, and decision-making groups.

This is an important study since it aims to extract information from observations and remotely sensed images and analyze it in the context of a specific research problem in order for the findings to be significant for academic purposes and to serve as a guide and input for other researchers, decision-makers, and urban planners.

Additionally, by identifying potential driving forces, it develops scenarios for the potential future land use change of the study region and tries to better understand the effects of changes in land use and cover. The study's conclusions may be used as a model for comparable future research to fill in any knowledge gaps in the field, have implications for controlling urban growth, and serve as a resource for firms having direct or indirect connections to the subject.

1.6. The Scope of the Study

This study focuses on evaluating the effects of land use and cover (LULC) changes by looking at patterns in urban growth over the period of the chosen years between 2000 & 2020 satellite images, which were chosen depending on the city's cloud-free season, the main determinant factors and actors responsible for the expansion, as well as its projected expansion direction is assessed. However, by identifying the main expansion corridors and recently emerging resettlements, the study's spatial scope is focusing on the areas of Bahir Dar city that are developing rapidly.

1.7. Limitations of the study

This study is not without limitation. One of the limitations is that the study is conducted in Bahir Dar city. If many other cities in the region are included in this study, further information can be gathered for policy implication. Future studies are recommended to conduct research including other cities in the region such as Dessie, Gondar, Debre Birhan, and Debire Markos for regional policy implication.

1.8. Organization of the document

The first chapter includes the problem description, introduction, study objectives, research questions, and the study's significance. The next section, chapter two, focuses on the review of the

theoretical literature and related work for this study. An overview of land use and land cover changes, land use change models, GIS and remote sensing applications for land use and land cover change, image classification, methods for detecting changes, and accuracy assessments of the generated land cover maps are provided in this part.

The general approach of the study, the data sets used, and the study area, are all thoroughly explained in the third chapter. All of the techniques and strategies that will be employed are highlighted in this chapter. The fourth chapter is all about the analysis of spatial, qualitative, quantitative data with graphs, charts and tables, result and discussion with respect to the research questions were discussed.

The last chapter which is chapter five is conclusion and recommendation, and mitigation measures for the research questions.

Chapter Two: Literature Review

2.1. Introduction

Due to urbanization, rapid and uncontrolled expansion, deforestation, and agriculture, humans have significantly changed the earth's surface over the last few decades. Even though rates of deforestation and land conversion vary globally, the number of people living in cities has been rising steadily. This chapter discusses the literature review on terms and concepts that are related to land use, theories of urban land use, historical touch on land use land cover changes, the use of technologies in assessing land use land cover changes, and including journal articles and research reports. In-depth research will be done on urban expansion and technology applications applications, the importance of applications or tools for analyzing urban expansion trends, policies to accommodate rapid urban growth, and horizontal city expansion. Additionally, it looked at the driving factors behind and key actors in urban growth.

2.2. Defining terms and concepts

2.2.1. Land use land cover changes

land: Land is a definable area of the earth's surface that contains all attributes of the global ecosystem instantly above or below this surface, including those of the relatively close climate, the soil and terrain types, the surface hydrology the relatively close sediment layers and linked groundwater reserve, the plant and animal populations, the pattern of human settlement, and physical results of past and present human activity (FAO, 1993).

Land Use and Land Cover: The biophysical condition of the earth's surface and immediate subsurface is defined as "land cover" (Turner et al. 1995, 20). Land cover, in other terms, "describes the physical status of the land surface, such as in agriculture, mountains, or forests" (Meyer 1995). It encompasses, for instance, the quantity and nature of surface plants, water, and earth components, according to Meyer and Turner (1994). According to Moser (1996) "the phrase originally referred to the sort of flora that covered the land surface, but has now broadened to encompass human structures, like buildings or pavement, and other elements of the physical environment, like soils, biodiversity, surfaces, and groundwater" (Moser, 1996).

Several decades ago, the idea that processes on the earth's surface affect climate made land use and land cover changes a prominent research topic on the global environmental change. Early in

the 1980s, it was recognized that changes in land use and land cover had a significant impact on the global climate through the carbon cycle, with terrestrial ecosystems acting as sources and sinks as a result of the changes (Di Gregorio and Jansen, 2000).

However, these two words refer to two different issues and ideas. The physical cover of the earth's surface, such as plants, bare soil, hard surfaces, and water bodies, is referred to as land cover. While land use is the human use of a specific form of land cover for agriculture, forestry, settlement, and pasture while modifying the biogeochemistry, hydrology, and biodiversity of the land surface (Di Gregorio and Jansen, 2000). Urban growth, or the factors affecting the change in land use and cover, is a measure of both the rate of urbanization and the physical expansion of cities and towns. In response to a population increase, a city adjusts its spatial configuration through this process (Reis et.al, 2015).

Land use and cover changes brought on by the direct and indirect effects of human activity on the environment in an effort to improve quality of life. One of the direct effects of people is population growth, whose expansion and decline, particularly in emerging countries, have an impact on land use over longer time horizons. As land use and land cover change is a complicated process, Lambin et al. (2003) claim that it can also be brought on by the reciprocal interactions between environmental and social factors at various geographical and temporal scales.

Changes in land use and land cover have a considerable impact on biodiversity, air quality, hydrology, and climate change. In their investigation, Meyer and Turner (1992), noted that it led to a number of microclimatic alterations. Deforestation due to changes in land use is linked to an increase in global surface temperature. This resulted to an urban heat island, a significant warming of the urban environment. Their research also demonstrated that land cover transitions from agriculture to settlement contributed to water contamination (urban areas). Additionally, it has been documented that the biodiversity is negatively impacted by the extinction of forest species.

The use of land use change models is advantageous for comprehending the effects of dynamic changes in land use and land cover because they provide information on future land use trajectories. Although necessary for better environmental management and land use planning, this capability of models (Verburg et al, 2002).

Understanding how people make decisions about land use and the interactions between various

environmental and social elements that affect these decisions is necessary to determining the causes and effects of land use and land cover change (Lambin et al, 2001).

2.3. Theoretical review

2.3.1. Theories of urban land use on urban expansion.

Numerous, frequently competing considerations play a role in decision-making by developers, which in turn affects how a city's property is used. These elements can generally be divided into the following categories: political, sociological, legal, economic, and demographic. Of these, sociological, economic, and demographic factors typically influence demand. Once more, economic aspects are used to help people choose between several options. While the legal and political variables will provide the context in which the development occurs and make an effort to influence the development's course for the good of society as a whole (McDonagh, 1997).

There are several different theories that clearly address and directly address land use in the theoretical literature on the shift in land use. Urbanization is one of the ways that human activities are changing the global land cover, from a broader perspective. (Habitat, 2001). Ernest Burgess offered a proposal in 1923 intended to explain the patterns of land usage in cities. Burgess created a concentric ring theory, according to which a city grows outward in a succession of concentric zones from its original center (McDonagh, 1997).

The phrase "central place" has been used to refer to an urban center in the central place theory, which is a hierarchical ranking of urban centers and their related market areas and transportation networks (William, 1970). According to Paul et al. (2000), this hypothesis is based on the supposition that urban settlements are situated on a uniform plane and that centralized service centers will be spread in a predictable manner.

An important alternative to the previously discussed concentric ring idea is the sector or wedge theory. Homer Hoyt created this notion in the 1930s after studying more than 200,000 neighborhood blocks spread over roughly 70 American cities. According to the sector theory, there will be several sectors or "slices" of land use in a city without geographic restrictions, stretching from the central business area to the city's outskirts. Like uses and individuals from similar social classes will gravitate toward one another within each sector, and expansion will be accommodated by moving further away from the city center rather than into a neighboring sector (McDonagh,

1997).

The multiple nuclei idea by Harris and Ullman from 1945 was a further advancement of the notion of urban land uses. By stating that cities and other metropolitan areas frequently develop with more than one business district, this expanded on Hoyt's argument. This is especially true in really big cities. There is still a principle or down town business CBD or central core, but when a city grows, one or more other business districts that are separated from the CBD and situated along major transportation corridors arise. According to the Burgess or Hoyt theories, each of them becomes the center of a hierarchy of land uses that is similar to those that are present near the CBD. (McDonagh, 1997).

The allocation of economic activity in a market economy, where land can be bought or sold, should not be arbitrary; rather, it should reflect each party's capacity to use the land as efficiently as possible. Land use, or bid rent theory, states that the ability of various economic activity, including retail, manufacturing, and residential construction, to pay rent determines how land is used. The central business center is typically the best site, with the highest level of accessibility (CBD). All activities rural and otherwise would prefer this site, but they are not able to pay the exorbitant rent that goes along with it (Rodrigue, 2020).

There is also trend known as "new urbanism" advocates for highly dense, diversified, walkable areas with mixed-use. Buildings with public spaces or on the street as gathering places for communities is the aim of New Urbanism design. Walking and cycling to locations can promote interaction while lessening the negative consequences of traffic and the environment caused by driving. The expansion of New Urbanism concepts, clarifies their mainstreaming, and highlights their broader impact through the collaborative efforts of its protagonists that have helped integrate these concepts into other programs, policies, and development regulations. In order to examine the significance of New Urbanism for future development, the concluding section presents current circumstances of development and changes that are exacerbated by the COVID-19 pandemic. These circumstances include those related to the nation's demographics, climate change, technological advancements, rapid growth of the digital economy, and acceleration of e-commerce. (Garde, 2020).

Urbanization is more productive, in accordance with the modernization idea. Instead, it is predicated on the notion that developing countries are characterized by a traditional, indigenous,

and underdeveloped sector. Despite the fact that economic activity and riches are initially polarized or concentrated in large cities, these nations' creative, westernized, and modernized sector and urban prosperity eventually flow down to disadvantaged regions (Potter, 1992).

2.3.2. The premise of land use change analysis on driving forces and actors of land use expansion.

Any analytical project must start with descriptive studies of land use change before moving on to more in-depth ones. Land use change descriptions document shifts from one form of land use to another during a specified time frame and within a specified spatial unit. The amount of detail depends on the spatial level of analysis and the accessibility of the necessary data, and it describes changes in both the qualitative and quantitative features of land use. Descriptive studies of land use change have sparked more in-depth inquiries into the "why" of these changes as well as the implementation of measures (policy) to mitigate their detrimental effects (Briassoulis, H. 2020).

The predictors or usually called the driving forces/factors of land use expansion are associated with urban growth contribute to a thorough understanding of the factors influencing urban growth. This usually depend on the city's current status and geographical, economic and environmental condition. The actors of land use expansion can be considered as the identification of the important individuals accountable for the determinant factors of the land use conversion. Those generally can be considered as the actors that greatly aided the city's quick land use changes with in the years (Briassoulis, H. 2020).

Even the most extensive and in-depth description is insufficient to grasp the observed land use changes or to direct policy- and decision-making towards practical means of coping with their negative effects. Explanatory studies try to close this gap. Explanation makes an effort to answer the issue of "why" certain changes have occurred (or are occurring) and to identify the causes or circumstances that either directly or indirectly, over the short or long term, cause these changes. Any study's level of explanation depends on the spatial and temporal level of analysis that is selected. Macro-analyses unavoidably discuss global developments and incorporate global causes or explanatory variables that affect land use change (Lambin et al, 2001) (Briassoulis, H. 2020).

Conducting such assessments is crucial for predicting future changes in land use in addition to documenting and explaining current changes in land use. Predictions might be either definite or

ambiguous. Unconditional forecasts, also known as trend extrapolations, show what a region's future land use patterns will look like if current trends continue (Verburg et al, 2002).

Unconditional forecasts can be mechanistic extrapolations of the past land use change or, if they are supported by theory, they can be more detailed projections of the past patterns in the determinants and the future land use change. Alternative land use futures for a region are produced by conditional projections of land use change under fictitious circumstances or scenarios. Some analyses are carried out to foresee changes in land usage brought on by climatic change, changes in future population, changes in food and other habits, etc. Conditional forecasts are commonly employed in the context of policy making on issues of global change (such as climate change, biodiversity loss, and desertification), and they are typically based on scenario analysis. (Briassoulis, H. 2020).

In addition to that it's better to identify the major predictors which are driving factors and the responsible actors of the changes in urban expansion. Many academics and organizations have written about the factors that contribute to urban growth (Handy, 2003; Batty, 2004; Bhatta, 2010), however the European Environmental Agency provides the finest explanation (2006). The research divided important elements that contribute to urban expansion into six areas, including issues with inner-city concerns, economic growth, additional space and better housing preferences, infrastructure and transportation issues, and aspects relating to various regulations.

Demography, which includes population growth and an increase in household formation, is one of the six categories. The investment demands brought on by economic expansion are felt in a variety of sectors, including manufacturing, trade, and services. The preference for housing, which calls for better living circumstances and greater room for each individual. Inner city issues include poor air quality, noise, cramped dwellings, hazardous neighborhoods, social issues, a lack of green open space, and subpar services. The other two are transportation and infrastructure, which can include private vehicle ownership, access to highways, reasonably priced fuel, and subpar public transportation. The final regulatory frameworks are weak land use planning, weak enforcement of current plans, and a lack of vertical and horizontal cooperation (European Environmental Agency 2006).

Generally speaking, analysis of land use change can be used to assess past, present, or future policy-driven changes in land use patterns in terms of a variety of criteria, including

environmental degradation or improvement, economic development or decline, or social impoverishment. More generally, this analysis can be done in comparison to the sustainability criterion. These evaluations' findings may be utilized to propose alternative land use strategies that would help achieve these objectives.

2.4. The role of technology on the detection of spatial trend analysis of LULC

Place and a place's uniqueness were valued highly before geographic information systems (GIS) were offered to the globe and the academic geography community. The emergence of theoretical and quantitative methods to geography questioned the uniqueness of location in the 1950s and early 1960s. The development of geographic information systems in the 1960s gradually paved the way for a more spatial and scientific approach to geography. Students who had received the necessary instruction and training to utilize and create these new software tools might find employment with GIS by the late 1980s (Waters, 2017).

Estimating reforestation levels and rates, habitat fragmentation, urbanization, wetland degradation, and many other landscape-level events using remote sensing and GIS are crucial. Remote sensing is the process of learning more about an object, phenomena, or location by the analysis of data gathered by a device that is not in close proximity to the thing, region, or phenomenon being researched. A GIS based on remote sensing is a computer-assisted system for the gathering, archiving, analysis, and presentation of geographic data. GIS makes it possible to create, maintain, and search electronic databases that contain information normally displayed on maps (Amanda, 2014).

A variety of regional to global scale models, including those that are used to establish parameters for emission fluxes and rainfall patterns, can then be built using such important information. Therefore, the use of remote sensing data as the foundation for answering crucial ecological problems with local to global ramifications is possible (Vogelmann et al, 2001). One benefit of remote sensing and GIS, according to Herold et al. (2005), is its capacity to produce spatially collected data sets encompassing huge geographic areas with high levels of temporal frequency and detail, including historical time series.

Only a few of the ecological and spatial variables that are typically altered by changes in land use and land cover include the amount of water, landscape, and atmospheric resources as well as the

activities and functions of habitats. GIS and remote sensing data and analytic tools provide precise, rapid, and comprehensive information to detect and track changes in land cover and land use. Technological software that provides data and analytical tools provides precise, timely, and comprehensive information in order to detect and identify the changes in land cover and land use.

2.4.1. Image processing

Image processing is the major role in GIS. The four core operations that comprise digital image processing are image restoration, image enhancement, image categorization, and image transformation. Image restoration focuses on the calibration and correction of pictures to produce the most realistic representation of the surface of the world. The fundamental goal of image enhancement is to alter images in a way that makes them appear better to the visual system. Visual inspection is an essential step in even digital image processing, and the outcomes of various techniques depend heavily on it (Amanda, 2014).

There are several image processing and analysis techniques that have been developed in order to optimize the amount of information that can be gathered from remote sensing images. The specific methods or algorithms to be employed are determined by the goals of each unique project. Spatial, spectral, radiometric, and temporal components are all possible in a digital image (Gao and Mas, 2008).

Numerous image classification approaches can be used to derive land cover information from remotely sensed images (Lu and Weng, 2007). However, how they should be implemented depends on the methodology and the type of data to be used. Among these methods are expert systems, fuzzy sets, and artificial neural networks. The several types of image classification techniques include hard and soft, supervised and unsupervised, parametric and nonparametric, per-pixel, sub-pixel, and per-field classification approaches.

2.4.2. Classification analysis

Different methods are used to perform digital classification. However, the most popular category techniques, supervised and unsupervised classification (Lu and Weng, 2007). The Multivariate toolbox offers capabilities for both supervised and unsupervised classification through the ArcGIS Spatial Analyst extension. A user-friendly setting for producing training data and signature files for supervised classification is offered by the Image Classification toolbar. The primary

classification technique is the Maximum Likelihood Classification tool. This utility requires a signature file as input, which lists the classes and associated statistics. The Image Classification toolbar is used to produce the signature file for supervised classification. Running a clustering program produces the signature file for unsupervised classification (Qian et al, 2007).

A supervised classification used pixels enclosed in polygons to identify known, defined classes (for instance, land-use type) to construct the signature file. Clusters, not classes, are derived from the statistical characteristics of the pixels in an unsupervised classification. Clusters are created in multivariate space by grouping pixels with comparable statistical characteristics. In contrast to classes in a supervised classification, clusters have no categorical meaning (for instance, land-use type). Running the Iso Cluster Unsupervised Classification tool generates the signature file for unsupervised classification using the Image Classification toolbar (Lu and Weng, 2007).

2.4.3. Accuracy Assessment

Any categorization effort must include an accuracy assessment. A different data source that is thought to be accurate or ground truth data is compared to the categorized image. Fieldwork can be used to gather ground truth, but it takes time and money. The interpretation of existing classified imagery, high-resolution photography, or GIS data layers can also yield ground truth data.

After any satellite image classification inquiry, accuracy assessment is a crucial step to take in order to determine whether the classification process was successful in achieving its goals. It entails evaluating the degree of correctness of the final categorized map produced by image classification and it is the final step in the analysis of remote sensing data which help us to verify how accurate our results are (Anupam, 2017).

Creating a collection of random points from the ground truth data and comparing them to the classified data in a confusion matrix is the most frequent method for determining how accurate a classified map is. Despite the fact that this is a two-step process, you could need to compare the outcomes of other classification techniques or training sites. Alternatively, you might be relying on the same images you used to construct the classification because you lack ground truth data (Lu and Weng, 2007).

According to Esri: (Since 1969), the accuracy of your classified result is assessed using a reference dataset in Accuracy Assessment. Your reference dataset's values must correspond to the

representation. There are various formats for reference data:

- A classified image that is a raster dataset.
- A shape file or a feature class for polygons. The feature class attribute table's format must coincide with the training samples. You can generate the reference dataset to make sure of this by reading and writing to the dataset on the Training Samples Manager page.
- A shape files or point feature classes. The output of the Create Accuracy Assessment Points tool must be followed exactly in terms of format. Use the Create Accuracy Assessment Points reprocessing tool to change an existing file to the required format if you're using one.

The number of random points and the sampling procedure are the two factors that must be given in order to execute accuracy assessment (Esri: Since 1969).

Number of random points: the random points that will be generated is indicated by the parameter Number of Random Points. Depending on the sample method and number of classes, the real number may be higher but never lower than this. There are 500 randomly generated spots by default.

Sampling Strategy Select the sample plan to be used:

- Stratified Random: Make points that are randomly distributed within each class, with the quantity of points in each class being proportionate to the size of the class. This is the standard.
- Equalized: Create stratified random points, where each class has the same number of points and where the points are dispersed at random within each class.
- Random: Create points that are dispersed at random across the entire image.

Accuracy of users

Users' accuracy is calculated by dividing the total number of pixels classified in a given class by the number of pixels that were properly categorized in that class. It shows the likelihood that a pixel labeled with a particular category truly corresponds to that category on the ground.

Accuracy of the Producer

The percentage of correctly categorized pixels in each class or category divided by the total number of pixels in the reference data that fall within that category is known as the producer's accuracy. This number indicates how accurately ground cover reference pixels are identified.

Generally, when evaluating the accuracy of data collected using remote sensing techniques, sample size is a crucial factor. For the error matrix, there must be a minimum of 50 samples for each land class (LC) group. The findings of calculating sample size using the multinomial distribution also appear to agree with this guideline. The minimum number of samples should be increased to 75 to 100 samples per category if the area is particularly large or the classification comprises a lot of LC categories (more than 12 categories) (Congalton, 1991).

2.4.4. Change Detection

Since restrictions including geographical, spectral, thematic, and temporal features affect digital change detection, choosing an appropriate approach or methodology is crucial to obtaining a more accurate change detection result. Even though there are numerous ways for detecting changes in remote sensing images, researchers have recently focused on image ratio, image regression, image differencing, and the method for detecting changes post classification method. (Xu et al, 2009; Bekalo, 2009).

2.5. Strategies and Policies Related to land use land cover changes (LULC).

Land policies and strategies are crucial for sustainable development, effective governance, the well-being of and access to economic possibilities for rural and urban residents, especially the disadvantaged. Developing a long term Vision for land use and developing policies to guide future growth is crucial for strategic land use planning (Anupam, 2017).

As a result, the World and other academic and civil society institutions have long been interested in study on land policy and examination of specific strategies linked to land. However, the results of such research have not always been successfully communicated to policymakers and other important stakeholders. Instead of carefully analyzing the possible contribution of land policies and strategies to broader development, the scope for interventions in the region, and the mechanisms that might be employed to achieve broader social and economic goals, this is defined by preconceived conceptions and ideological opinions (Klaus deininger, 2003).

The National Urban Development Policy was created by the Ethiopian government in 2004. (NUDP). The NUDP has developed a program and institution to deal with the issues as a result of Ethiopia's fast urbanization.

It seems unlikely that the strategy would create the conditions for Ethiopia to experience self-generated urbanization, even if the gap identified by the review can be closed. In order to achieve economic integration and reinforcing expansions for the aim of absorbing surplus labor, development should take place concurrently in both rural and urban areas. Rural problems cannot be solved without urban solutions, and vise - versa. (Tilahun, 2016).

2.6. Empirical Review

2.6.1. Summary of significant works related to LULC

Table 2.1: Summary of reviews on study's done on LULC by different authors. (Source: Based on reviewed literatures).

No.	Authors and publication year	Research area	Driving forces and actors	Major Findings
International LULC studies.				
1	Gao, Zhiqiang, Liu, Jiyuan & Deng, Xiangzheng.et al. (2003).	Spatial features of land use/land cover change in the United States	Based on the analysis, it is determined that forestry and grassland, which make up 71.24% of the entire nation, have taken the majority of the land in America. In addition, construction and arable land have taken up 19.22% of the total area, and the remaining land cover types, such as water area, wetland, and underdeveloped land, make up 9.54% of the total area.	With less ecologically damaged and disturbed environment, American land resources have huge development potential. Despite the fact that population density and altitude do, in a certain sense, affect the spatial variance of American land-use grade, respectively, there is little to no correlation between the two.

2	Hu, Y., Batunacun, Zhen, L. et al. (2019)	Assessment of Land-Use and Land-Cover Change in Guangxi, China	The results suggest a decrease in the extent of land types with higher ecological values, such as farmland, grassland, and woods. The national water sources/river protection policies that were put in place in the 1990s can be summed up as the main driver of the region's small growth in water bodies.	Built-up land and aquatic bodies had the biggest increases in land usage since 1990, growing by 1656 km2 (or 0.8% of the total area) and 197 km2 (or 0.8% of the total area), respectively. Each municipality has grown during the previous 27 years, In the research area, the agricultural and grassland areas shrunk by 753 km2 (0.32%) and 686 km2 (0.29%), respectively, over this time.
African cities LULC study's				
3	Petronella Tizora, Alize Le Roux, Gerbrand Mans, Antony Cooper.et. al (2016).	Land Use and Land Cover Change in the Western Cape Province: Quantification of Changes & Understanding of Driving Factors.	Population growth, decreasing household sizes, rising household numbers, high levels of migration, urbanization, and mounting development demands are all ongoing issues in the Western Cape Province. Due to these circumstances, there have been changes in LULC, which have sparked problems including urban sprawl, the marginalization of the poor, constrained public access to resources, land degradation, and climate change are the identified driving factors.	Political, economic, technical, demographic, biophysical, and cultural factors all influence LULC changes and must be taken into account when developing strategies and policies for the future in order to retain socioeconomic benefits while minimizing negative environmental effects.

4	Kisangau, Patrick. (2016).	Assessment of Land Use and Land Cover Change Using GIS and Remote Sensing Techniques: A Case Study of Makueni County, Kenya	Populated areas, agricultural lands, bodies of water, evergreen woods, savanna, grasslands, and bare land. The amount of land cover class conversions between time intervals was compared as the main driving factors for LULC.	The findings showed that between 2000 and 2016, there was both a rise and a decline in the various LULC groups. There were also noticeable movements from some classes to others. Drivers of the observed changes included socioeconomic as well as climatic influences including rainfall and drought. To measure and describe LULC changes, consistent LULC mapping should be done.
In context of Ethiopia.				
5	Belayneh Bufebo, (2021)	Land Use/Land Cover Change and Its Driving Forces in Shenkolla Watershed, South Central Ethiopia.	The main drivers behind the LU/LC changes were the increase of agriculture, policy changes and social instability, population pressure, a lack of farmland, and biophysical factors.	The Shenkolla watershed's natural resources and the local population's way of life are negatively impacted by the increase of agricultural land at the expense of forest cover.
6	Berhan, G. and Woldeamlak, B. (2014)	Drivers and Implications of Land Use and Land Cover Change in the Central Highlands of Ethiopia: Evidence from Remote Sensing and Socio-demographic Data Integration.	The main driving forces behind the LULC are various agricultural operations, timber harvesting, infrastructure development, complexes of economic, technological, demographic, political, institutional, and socio-cultural factors, as well as biophysical factors like topography, landslides, droughts, and natural fires.	As the results showed main causes of LULC change in their study area are proximate factors like traditional farming and overgrazing practices, wood extraction, and infrastructure expansion, as well as underlying pressures like poverty and population pressure coupled with the land tenure system and biophysical factors like the topography of the watershed.

2.7. Research Gaps

Most of the literatures overlooked the land use conversions of once own city can depend on the city's character and developmental stage. As this literature review done above looked through the majority of them, it is noticeable that they were lacking in the relatable identification of the predictors or the so called the major determinant factors for the land use conversions.

Numerous studies have been done to determine how the land use and cover of the rapidly growing metropolis of Bahir Dar have been evolved. The main variables, measurement methods for measuring horizontal urban expansions, effects of LULC changes, and important land management determinants have not been explored in great detail. Their primary areas of interest in the previous studies were the expansion of metropolitan areas, their effects on the environment, and the socioeconomic effects on local communities' ability to support them. However, the previous studies lacked in assessing the future scenarios and identifying potential indicators that would reveal if the influence on the LULC actors and drivers generate will be positive or negative.

This study intended to fill this gap in the contribution of limited study by attempting to create a built and unbuilt land use classification for the city of Bahir Dar in order to compare and comment on the area coverage for the given years by the corresponding increase in population size / rate, spot potential indicators based on the current situation, and develop scenarios for future possibilities. Furthermore strategic land management uses practices and technologies to maintain the land and ensure the protection of its resources, this study will further analyze the problems and identify opportunities for change by assessing land use suitability and address mitigating strategies as recommendations.

Chapter Three: Research Methodology

3.1. The study area

Bahir Dar, is in northern-western Ethiopia, at the southern end of Lake Tana, where the Blue Nile begins its long voyage. Bahir Dar, the capital of the Gojjam province, expanded quickly in the 1960s and 1970s. It was built by the central government as a market and transportation hub for Lake Tana and the Blue Nile basin's economic expansion. Bahir Dar is located in the northwestern region of Ethiopia. It is located at 11º 36' N and 37º 23' E on a map. Along the Addis Ababa-Debre Markos highway, Bahir Dar is located 567 kilometers from Addis Ababa, the capital town. It is one of the top tourist locations in Ethiopia, and the neighboring Lake Tana and Blue Nile River also provide a variety of attractions (Haimanot, 2009).

Figure 3.1: Location map of the study area. (Source: Bahir Dar City Administration, (2013)).

3.1.1. Demography

And as previous studies predicted, according to a study from the Central Statistical Agency for the year 2012, Bahir Dar city population is expected to be 318,429, with 130,482 residents. The city's annual growth rate is 5.3 %, with young people aged 15 to 59 accounting for 63 percent of this. (environmental health safety and quality office, Feb 2017).

In a parallel continuum, the total population of Amhara National Regional State in 2019 has been estimated at 21,841,999 out of which male accounts 10,900,396 (49.9%) whereas female is reported to be 10, 941, 6003 (50.09%). Correspondingly, the population living in urban areas is said to be 4,089,997 (18.72% of the region's population) of which 1,927,880 are male and the remaining 2,162,117 females. The percent shares of male-urban and the female urban are about 47.13% and 52.86% respectively.

Despite the low level of urbanization, the region has been experiencing the highest ever rates of urbanization. And this presented the highest load to rest on the city of Bahir Dar, the projected population of Bahir Dar city is hosting a total. 397,923, with 199,172 men and 198,751 women. The city's total area is 213.43 km2, with a population density of 1, 864.4 people per square kilometer. (Central statistics agency of Ethiopia, July 2019).

3.1.2. **Nature of the Study Area's Physiography**

3.1.2.1 **Topography**

Although there are certain areas of land with hills, uneven terrain, and sloping features, the Bahir Dar metro region is primarily distinguished by a flat, uniform topographic landscape. The elevation of the metropolitan region is insufficient between 1650 meters above sea level (to the north-east) and 2100 meters above sea level (to the north-west). When specifically viewed, Bahir Dar's average elevation is reported to range from as low as 1786 meters above sea level (by the edge of the lake) to as high as 1886 meters above sea level (to the south-east). (Bahir Dar City Administration, 2013).

3.1.2.2.**Hydrology**

One significant international river, known as "Abay," which has its source at Lake Tana in Ethiopia and travels through Sudan and Egypt, is located in the study area. It is 1,450 kilometers long in total, 800 of which are situated throughout Ethiopia. The river Abay's average yearly flow, as estimated by stream flow from 1960 to 2001 at the Bahir Dar monitoring stations, is around 123.07m3/s (Bahir Dar City Administration, 2013).

The Blue Nile originates at Lake Tana, which spans an area of more than 3000 km2. By having a range of attractions, Lake Tana and the river Abay have made Bahir Dar one of the most favored tourist destinations in Ethiopia (Bahir Dar City Administration, 2013).

3.2. Research Design

By evaluating trends in urban growth and figuring out how they affect LULC changes by merging observations, remote sensing, and GIS techniques over a period of chosen years, it is possible to detect and analyze changes in Bahir Dar city's land use and land cover (LULC). This is accomplished by locating the possible actors and determining factors that area responsible for these trends.

An explanatory study design is better to examine trends in urban growth and how they affect LULC change in the context of Bahir Dar city. This method is good choice because it made it possible to track urban expansion trends through time and understand how this affected changes in land use and land cover (LULC). Both qualitative and quantitative approaches, as well as primary and secondary data sources, were employed to address the study's stated objectives. Utilizing data gathering tools such closed-ended and open-ended surveys, Questionnaire's', observations, and other primary data sources were also used. Remote sensing were used to gather the secondary data sources, which is then be processed and analyzed using GIS.

The initial stage of the methodology involves data preprocessing, remote sensing image classification, and change detection analysis, as illustrated in the above figure. The next stage is to use sampling techniques to detect and analyze changes after classifying the land cover images. The validation of model outputs is then put into practice and evaluated. Future predictions of changes for 2030 were made in accordance with the validation results and model precision.

In addition, the society of the city and officials, experts, district administrators, and other sample participants were asked about their preconceptions of the factors and actors that made a significant contribution to the rapid growth of Bahir Dar city between the chosen analysis years. This survey method also used closed-ended and open-ended questionnaires. In this regard, the sampled respondents were evaluated in relation to the identified urban expansion driving factors and actors using the given Likert scale of totally agree to totally disagree, while for the open-ended questionnaire, the sampled respondents were asked to provide any feedback they may have regarding the factors and actors that significantly caused the rapid expansion of the study area.

Utilizing descriptive and inferential statistical approaches, the data has been set up and examined. Tables, graphs, and descriptive analysis were used to present the organized data.

The proposed flow diagram below provides a quick explanation of the main procedures that were followed, the applied approaches, and the data inputs used throughout this study is shown on the figure 3.2 below.

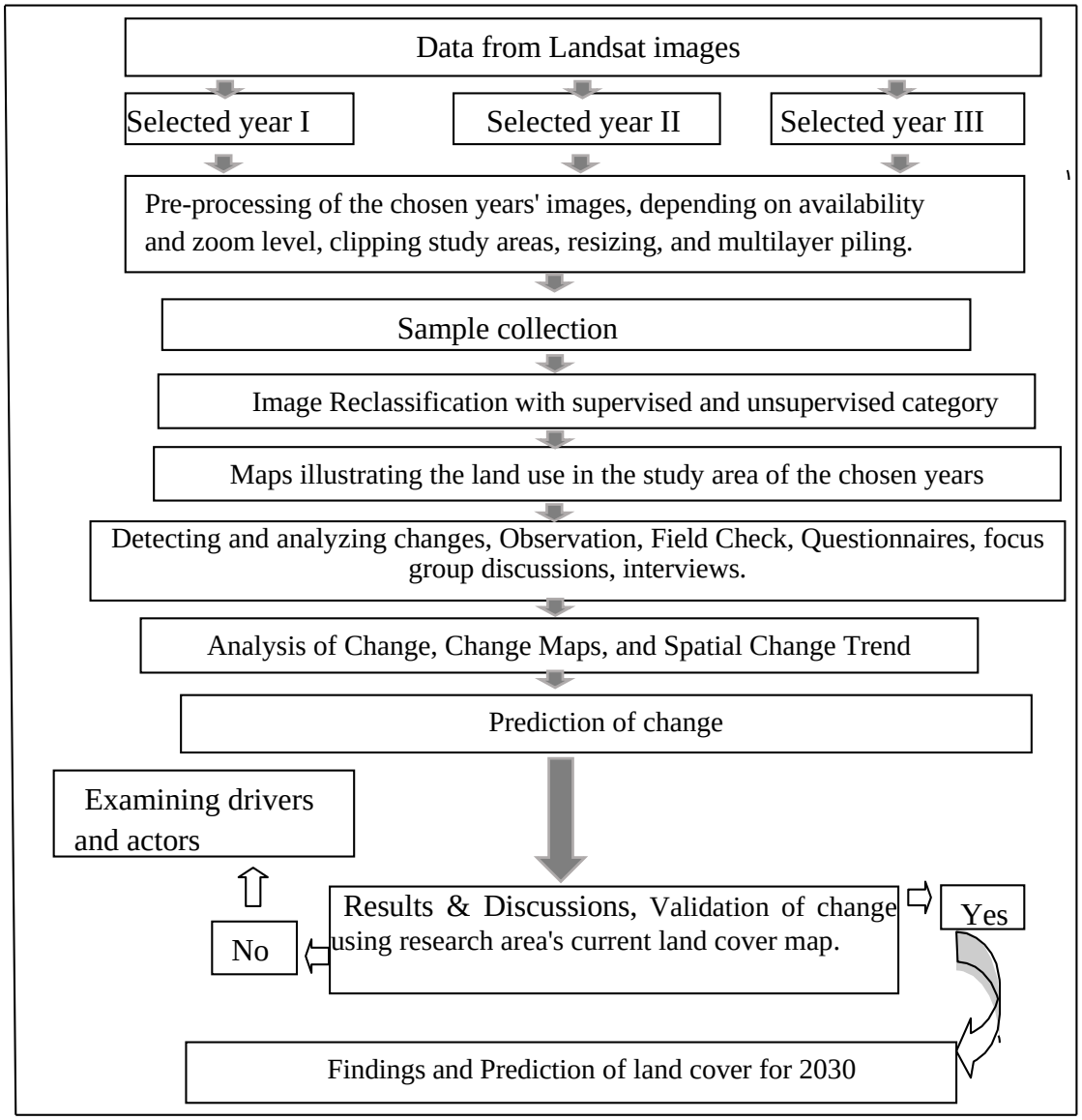


Figure 3.2: Flow diagram of the methodology. (Source: Organized by the author, (2022/23).

3.3. Source of Data

In order to accomplish the study's objectives, both the quantitative or statistical data type and the qualitative or descriptive data type were drawn from primary and secondary data sources. In order to successfully complete the study's intended objectives, accurate information has been used. Accordingly, there has been two categories of data sources: primary and secondary.

3.3.1. Primary Data Sources

The city's main frequent observations and closed-ended questionaries' which are from predefined set of responses and open-ended questionnaires which are phrased as a statement by constructing their own response. This primary data sources were prepared for the community, each kebele administrator, and officials and specialists from the Bahir Dar Land Development and Management office has served as the primary data sources.

3.3.2. Secondary Data Sources

Books, journals, government reports, websites, legal records, satellite images, records from prior studies, population data, and Ortho photo from Bahir Dar city's Land Planning and Management Office data has been used as secondary sources of information for this study.

3.4. Sampling Design

3.4.1. **Sampling Method**

Officials of the Bahir Dar city Land administration office (the municipality) representatives of the government, academics (Bahir Dar city municipal urban planning and implementation office), the public (the communities that live and lived for about 10 years and above in the city, and on the new resettlement areas, and the kebele admin (Zenzelma kebele administration officials, Sebat Amit kebele administration officials, Yibab Yinesa kebele administration officials, and zege kebele administration) where the main expansion direction of the city expected to be, has been utilized as the target group in a purposive using professional sampling technique. This is aided in gathering data about the primary determining factors and actors behind the expansion of Bahir Dar City as well as what the municipality recommendations regarding these changes to the land use and cover in relation to the new resettlements and in deciding the direction of expansion.

Through the use of a purposive sample technique, people who have resided in Bahir Dar city for at least 10 years has been selected from the communities that contain places where land uses have changed to another purposes than the structure plan suggests. These people can provide detailed information on how land use has evolved over time, from what it was to what it is now, and how that change has impacted the current situation of the community.

The communities that were in the city's main expansion direction but were relocated from there due to the recent displacement that is taking place would be subject to another purposive sampling. These people provided an in-depth information on how the new expansion strategy affects their

past way of life, their current living situation, and the state of the city.

3.4.2. **Sample population**

The Bahir Dar city municipal urban planning and implementation experts, the Kebele administration officials, communities in the city that were chosen based on the direction of the city's expansion were the respondents to this survey. Data regarding the complete study population samples of experts, officials, communities and kebele administrators has been generated and decided under the sample size determination. This will be accomplished by gathering information from the municipality and kebele authorities. Data from the city of Bahir Dar and the kebele offices, as detailed below, in order to choose the sample size from the total informant data regarding the municipality's urban planning and implementation office experts, officials, kebele administrators, and communities in the city. This information was used to determine the sample size for the entire research population samples of experts, officials, communities, and kebele administrators.

Table 3.1. Sampling frame data for office administrators and experts. (Source: Bahir Dar city municipal urban planning and implementation Office & Kebele Administration (Zenzelma kebele, Sebat Amit kebele, Yibab Yinesa kebele, and zege kebele) (2022)).

No.	Intended population	Kebele	Gender		Total number of employees
			Male	Female	
1	Bahir Dar city Municipal urban planning and implementation office experts.	-	59	8	67
2	Officials and experts in kebele level.	Zenzelma kebele	3	2	5
		Sebat Amit kebele	2	1	3
		Yibab Yinesa kebele	2	1	3
		zege kebele	2	2	4
					82

Here from the Bahir Dar city municipal urban planning and implementation office experts, 10%

of the total 67 populations were taken by simple random sampling, hence sample were 7 office experts.

And from the kebele officials all the population were taken by total enumeration method. This is because the population size is very small.

From Bahir Dar city special zone urban space sub cities according to the data obtained from Bahir Dar city central statistics administration office.

Table 3.2. Sampling frame data for Bahir Dar special zone urban sub cities. (Source: Bahir Dar city central statistics administration office, 2022).

No.	Bahir Dar special zone urban sub cities	Population	Male	Female
1	TANA	66,881	29781	37,099
2	BELAY ZELEKE	48,244	24,064	24,180
3	FASILO	47,454	20,625	68,079
4	DAGMAWI MENILIK	41,404	19,391	22,013
5	GISH ABAY	54,106	25,874	79,980
6	ATSE TEWODROS	39,526	18,519	21,007

From the total population of Bahir Dar there are urban six sub cities. Dividing the city in to 6 clusters (each cluster is the sub city of Bahir Dar). From the six sub cities 50% will be selected which means 3 sub cities by simple random sampling (lottery method).

Then from each cluster population allocation will be implemented to select 50 samples.in which the 50 people are the ones who live in Bahir Dar city for 10 years and above.

The selected sub cities are: GISH ABAY, FASILO, AND TANA

Total population of the selected 3 sub cities:

N=N1+N2+N3= 168,441

Where N1=POPULATION OF TANA SUBCITY=66,881

N2=POPULATION OF FASILO SUBCITY=47,454

N3=POPULATION OF GISHABAY SUBCITY=54,106

From this the plan is to have sample size n=50

Then by using proportional allocation, those sample sizes were selected using the following formula.

ni=Ni/N*n			
i=1,2, 3….	n=50	n=50	n=50
	n1= N1/N*n	n2= N2/N*n	n3= N3/N*n
	n1=66,881/168,441*50	n2=47,454/168,441*50	n3=54,106/168,441*50
	n1=20	n2= 14	n3= 16

3.4.3. **Sample size determination**

Purposive sampling has been utilized after purposefully choosing the responders to include in the sample size calculation. The use of a census for small populations, replicating the sample size of related research, and applying formulas to generate a sample size are a few of the sampling size methods that might be discussed. One of numerous formulas that are required to determine the required sample size for a specific combination of degrees of precision, confidence, and variability is applied when calculating sample size using formulas. Calculating the sample size of all respondents from the experts, officials, and communities in the city is thus the first stage. For this, a sample size calculation has been made using as credible literature and previously done research that are similarly conducted.

3.4.4. **Sample years for Expansion trend analysis**

There has been a selection of years between 2000-2020 based on the city's expansion trend where it is high and on the criteria of the year's vital rise of change in order to map urban expansion trends and measure their effects on LULC change of Bahir Dar city. In order to simplify categorization and promote comparison in classification activities, high resolution photographs and high quality cloud free images were chosen for this purpose based on the city's seasonal cloud free images.

3.5. Methods for Collecting Data

3.5.1. **Data Collection Instruments**

GIS and remote sensing methods, surveys, and observations were used in this study to collect data. By means of geographical analysis Using GIS and remote sensing methods were the ones that made possible to measure how changes in land use and land cover are impacted by the spatial patterns of a city over time between 2000-2020 (LULC). By converting satellite images into subcategory maps, this has been accomplished.

3.5.2. **Explanation of Data Collection instruments**

GIS technology combines the distinctive visualization and geographic analytical advantages provided by maps with conventional database functions such as query, statistical analysis and offers tools for data collection, organization, analysis, and presentation of findings in visual and report form, with a priority on maintaining and leveraging the intrinsic properties of spatial data These capabilities set GIS apart from other information systems and make it useful for a variety of public and private companies to exchange, forecast results, and plan strategies. Data sets from remote sensing cover huge areas with high spatial detail and frequency and are geographically consistent. Additionally, consistent historical time series data, spatial dynamics of urban growth, and land use change processes can be provided via remote sensing (Herold et al., 2003). In recent years, remote sensing has been utilized in conjunction with GIS and GPS to more effectively measure land cover change than by itself.

3.5.3. **Primary Data Collection Instruments**

In order to examine the primary driving factors and relevant actors for the LULC, questionnaires, focus group discussions, interviews, and inspections were main primary data gathering tools.

3.5.3.1. **Questionnaires**

Both closed-ended and open-ended questions has been posed to representatives of the government, academics (Bahir Dar city municipal urban planning and implementation office), the public (the communities that live and lived for about 10 years and above in the city, and on the new resettlement areas, and the kebele admin (Zenzelma kebele administration officials, Sebat Amit kebele administration officials, Yibab Yinesa kebele administration officials, and zege kebele

administration) where the main expansion direction of the city expected to be . A Likert scale from fully agree to fully disagree has been employed to assess the respondents' level of perception because the information received depends on individual perception, which can vary, and open-ended questions, since they had a direct connection to the research questions and the research and needed information from the community to characterize changes that would occur over the time between 2000-2020. These questions were added to the survey to give respondents a chance to express any additional worries they may have about the factors and actors that strongly impacted the study area's rapid expansion.

3.5.3.2. **Focus group discussions**

A focus group discussion with the chosen people, officials, and communities from the sampled zones of expansion were held to further analyze the change in land use and cover. This focus Group discussion included aged peoples who lived 10 years and above in the study area, youths and community leaders. This makes it easier to understand the perspectives of relevant parties and realistically bolster the questions posed.

3.5.3.3. **Interviews**

One of the basic methods for gathering data is conducting interviews. This makes it easier for this study to gather opinions about the effects of changing land use and land cover from people, particular officials, and the local community. From the particular officials the Bahir Dar city municipal urban planning and implementation office and for the local community the leaders of community associations, representatives for that specific kebele were included.

3.5.3.4. **Observations**

A set of regular checks, observations, and verification procedures, recording sheets and checklists were used to collect observational data in the most consistent manner possible, including pre-set questions and pre-determined responses.

3.5.4. **Secondary Data Collection Instruments**

3.5.4.1. **Satellite images**

The use of GIS and remote sensing satellite data allows for the accurate measurement of all these characteristics of land use and land cover change. The recently available method for tracking the

earth's various spectrally sensitive changes is GIS and remote sensing Technologies that are supported by geographic positioning systems. The United States Geological Survey (USGS), which is also the only source of widely-covering, free satellite images (Vogelmann et al, 2001).

Landsat imagery/Landsat Thematic Mapper (TM) for the chosen years between 2000-2020 has been utilized with a full scene as a source of data and purchased from the earth explorer website in order to evaluate patterns in urban expansion in the research region.

3.5.4.2. **Data from the secondary resources**

Secondary data can be obtained from the government officials, literature reviews, previously done researches and documented data to support the analysis.

3.6. Variables of the study

Anything whose amount, quality, or change throughout the course of a study is considered a variable. In the investigation of land use and cover change, independent and dependent variables are present. In the current study land use conversion was considered as dependent variable. The independent ones can be discussed and include the respondent's background, population size, infrastructures, officials, investors, and the community that were considered as the determinant factors /predictors of the land use change ,including the increase in population size, its location, its unplanned growth, its topography, City's intended plans, informal land access, residential preference, and its political, economic and cultural centrality. The other independent variables were the relevant actors including the city's community, Officials from the Government and Experts, the investors, active land brokers, and local farmers in the city were included.. Additionally, the rate of change and the LULC characteristics can be derived from the dependent variables.

Land use changes and their effects were studied using the respondents' experience and background information, urban expansion driving factors and players, LULC features, and rate of change. Address, gender, age, place of birth, educational attainment, background qualifications, occupation, and place of employment, position, and year of service in this position of the officials has been examined for accuracy and relevance for this purpose.

To evaluate the effects of the LULC of the city of Bahir Dar, the study's variables also include the actors and determining factors. The spatial and temporal LULC change in the study region were

undertaken in addition to by selecting land use land cover change variables in order to ascertain the expansion trends and characteristics detected in order to examine the impacts.

As per definitions a dependent variable on this study which is the land use conversion is what happens as a result of the independent variable which are the determinant factors as a predictors and the relevant actors as leading agents for the factors.

3.6.1 **Types of variables and measuring techniques**

There are dependent and independent variables in studying LULC in Bahir Dar city. This variable was measured through Descriptive statistics graphs, Likert scales Map, and charts.

3.7. Methods of processing data

There are various approaches and strategies that can be used to successfully achieve a goal using input data. But a lot depends on the accessibility of raw data and the class of the data.

3.7.1. **Processing images**

It is necessary to examine the changes over the chosen years in order to study the LULC in the city of Bahir Dar. The first step is to download satellite pictures for this use from the Earth Explorer website and the USGS Landsat archive webpage. Based on data availability and free from cloud coverage, image collection and favored seasons were determined. After data collection, image to image geometric correction utilizing satellite images from the chosen years has been carried out using ArcGIS software.

3.7.2**. Nomenclatures of images**

It is uncommon to find precisely specified classes that one would desire in practically any classification procedure. The land cover classes should be understood prior to gathering training samples in order to facilitate categorization (Bekalo, 2009).

For this research, supervised image classification were utilized to categorize the photos. To produce an accurate classification result, supervised classification requires the identification of areas. To get excellent quality classification results, it heavily depends on the quality and amount of samples. To ensure that the classifications created were accurate in relation to the source photos, accuracy evaluations has been performed after classification.

3.8. Method of Data Analysis

Data analysis techniques for the LULC study included were trend analysis, change detection analysis, spatial expansion rate analysis, and qualitative data analysis.

3.8.1. Expansion Trend Analysis

ArcGIS software was used to analyze and produce maps that depict the expansion trend of the research area in order to determine the primary impacts and changes on land use and land cover. Tables, figures, charts, maps, and reports were used to show and assess the results of the analysis of the land use statistics data.

3.8.2. LULC Change Recognition Analysis

In order to create themed maps for the chosen years, satellite photos of a chosen geographic area were processed and categorized. To see changes in the area over the given time period, the categorized maps has been compared and superimposed.

3.8.3. Rate of spatial Expansion Analysis

Using a formula discovered by reading relevant literature and studies provided, the total areas covered by each class in each chosen study year were computed. The amount and rate of change for each land cover class were studied.

3.8.4. Computing future built up Area

It is necessary to determine the average development rate in order to predict the future growth of the study region's built-up area. The average growth rate of the expansion determined using a formula based on the urban expansion of the city during the chosen years.

3.8.5. Forecasting Population

It is necessary to understand the population change over the chosen years in order to predict future population of the research area. This population change has been estimated using a formula. Knowing the area's population growth rate is necessary to forecast population size. As a result, the exponential growth rate model has been implemented.

$Pt = Po\ e\ rt$

Where Pt = Current population, Po = Base Year population, r = Growth rate, t = Time

After calculating the population growth rate population forecast will be done using the formula:

$Pt = Po*(1+r/100)\ t$

Where Pt = Current population, Po = Base Year population, r = Growth rate, t = Time

3.8.6. **Analysis of qualitative data**

To gain access to the important drivers and actors of the LULC of the study area, questionnaires were purposefully delivered to all sample respondents along with closed-ended surveys. Based on the results of the questionnaires, this has been examined.

Chapter Four: Result and Discussion

4.1. Introduction

In order to achieve its primary objective of analyzing land use and land cover changes (LULC) by looking at trends in urban expansion of Bahir Dar city, this chapter discusses the key findings regarding the land use land cover change of Bahir Dar city, between 2000 and 2020 G.c. The connection between changing land use and cover and the underlying causes is complicated and dynamic. Both natural and socioeconomic variables have an impact on it. According to some research, demographic dynamics are the process that alters land cover the most. Due to the rapid urbanization of recent decades, many areas are currently dealing with land-use changes (LUCs) that appear to be out of control and are accompanied by a number of environmental and socioeconomic difficulties.

One of Ethiopia's biggest and fastest-growing towns is Bahir Dar City. It serves as the political, economic, and cultural hub of the second-most populous area in the nation, Amhara National Regional State (ANRS). The city's cultural legacy (such as the Lake Tana and its Monasteries) and natural attractions also make it one of the main tourist destinations in the nation. (Such as the Blue Nile Falls). The key to evaluating the potential indicators in a demonstrating activity is to identify the main potential urban expansion zones. It is essential to pinpoint relevant areas in the region in order to comprehend the effects of built environment growth. As a result, a practical strategy with the city's basic boundaries being the lake to the north, the airport and the industrial area to the west, the Abay river to the east, and the southern boundary of Sebat Amit town.

According to earlier studies, Bahir Dar City's built-up areas have been gradually expanding over time. The rapid decline of farmland is primarily due to this expansion: 603 hectares (1991 to 2002), 1204 hectares (2002 to 2011), and 1598 hectares (2011 to 2018) (2018, Modeling the Impact of Urbanization on Land-Use Change in Bahir Dar City). In other words, Bahir Dar city had roughly four times as much farmland as it did developed space in 1991, but by 2018, the developed area had nearly twice.

Additionally, this chapter's analysis and presentation of data gathered directly from Bahir Dar city municipal urban planning and implementation specialists, the Kebele administration officials, and communities.

4.2. **Description of respondents and Response rate**

From 57 respondents that were planned, three sub cities were chosen by random sampling method from among six sub cities that were chosen by the communities of Bahir Dar city which will be 50 respondents and 7 respondents from the municipal urban planning and implementation office experts. A concentrated attempt was made throughout the data collecting process to standardize the quality of the data by giving service seniority level of educations, educational background, and place of employment, work position, and year of employment in the position precedence. The survey's open-ended and close-ended questionnaires were both filled out by each respondent in full.

As shown in the figure 4.4 and 4.5 respectively Out of the 7 respondents from the municipal urban planning and implementation office, 3 were female and 4 were male. The selected sub cities communities out of the 50 respondents 27 were male and 23 were female.

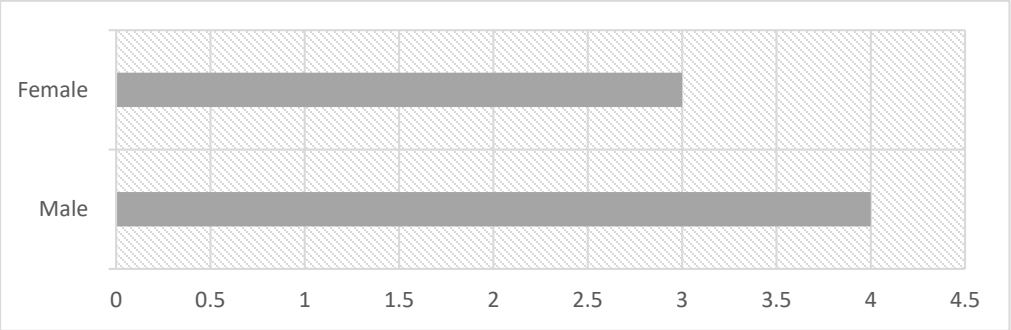


Figure 4.1. Gender of office experts (Source: Organized by the author (2023)).

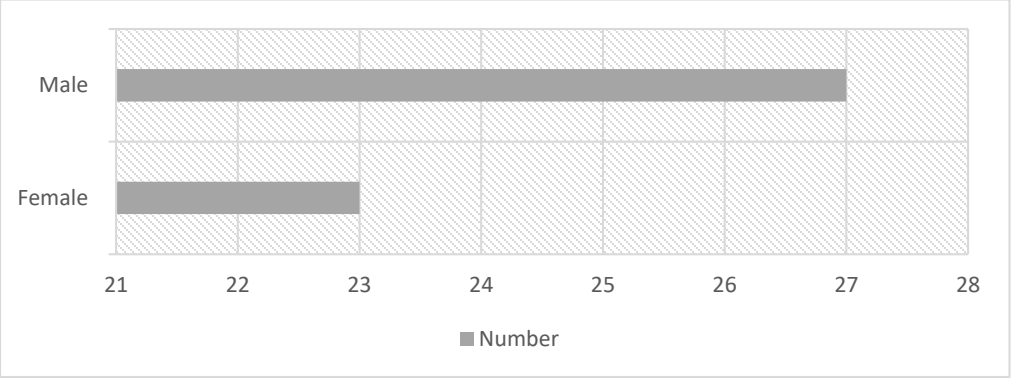


Figure 4.2. Gender of selected community members from sub cities of the study area. (Source: Organized by the author (2023)).

As shown in figure 4.6 and 4.7, the age character of the total expected 57 respondents from the office experts 7 samples and the communities from the selected sub cities 50 samples were presented below.

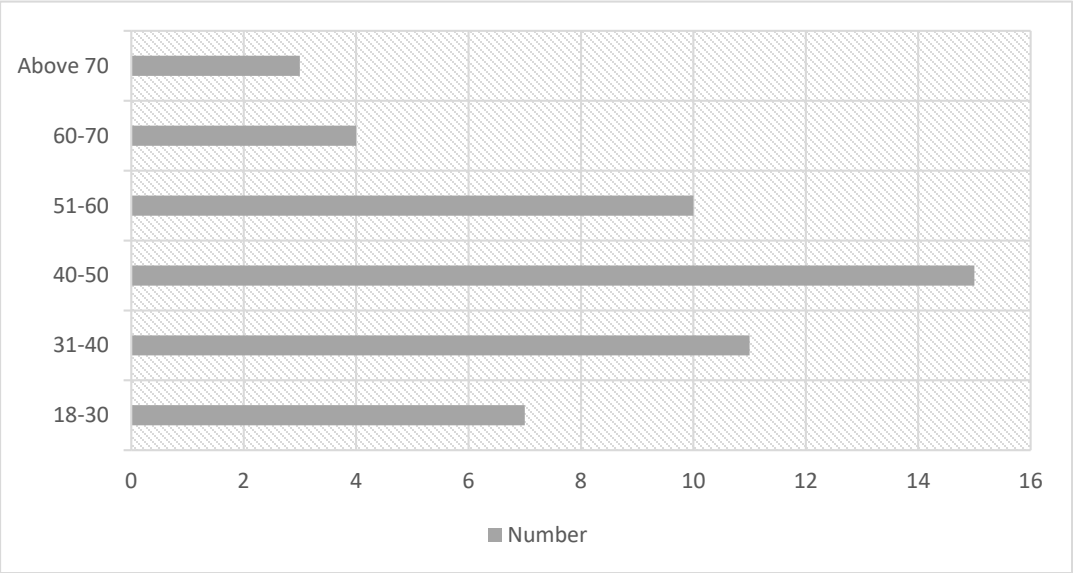


Figure 4.3. Age of selected community members from sub cities of the study area (out of 50 sample respondents). (Source: Organized by the author (2023)).

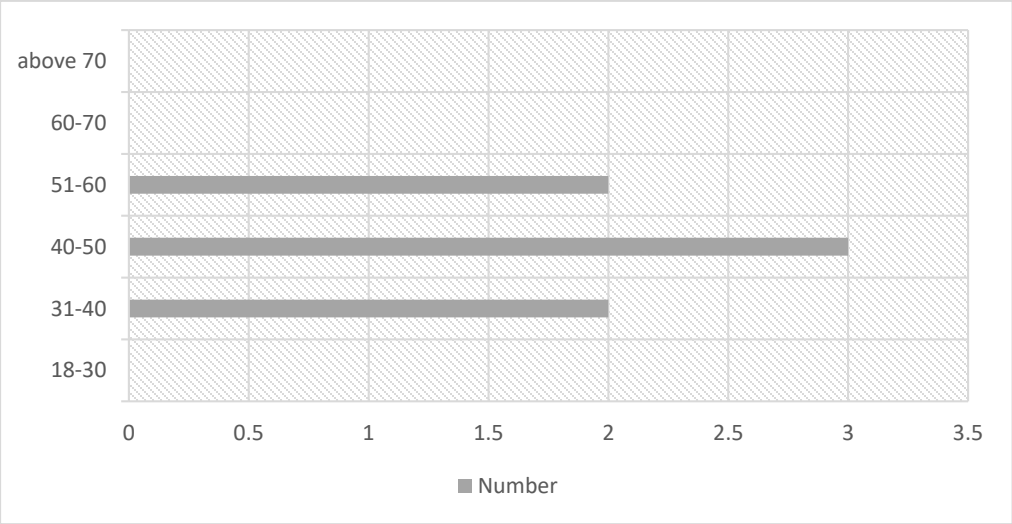


Figure 4.4. Age of selected office experts (out of 7 sample respondents). (Source: Organized by the author (2023)).

When choosing the respondents from the sample, the respondents' education level is given greater consideration. Out of the 7 responders that were chosen, 5 had first degrees, and 2 had master's degrees, as shown in the figures 4.5 and 4.6 below from the office specialists. By the same process,

out of the chosen 50 responses from the chosen sub-cities' community members, 8 had TVET degrees, 5 had degrees from higher education, 4 had diploma degrees, 26 had bachelor's degrees, and 7 had master's degrees.

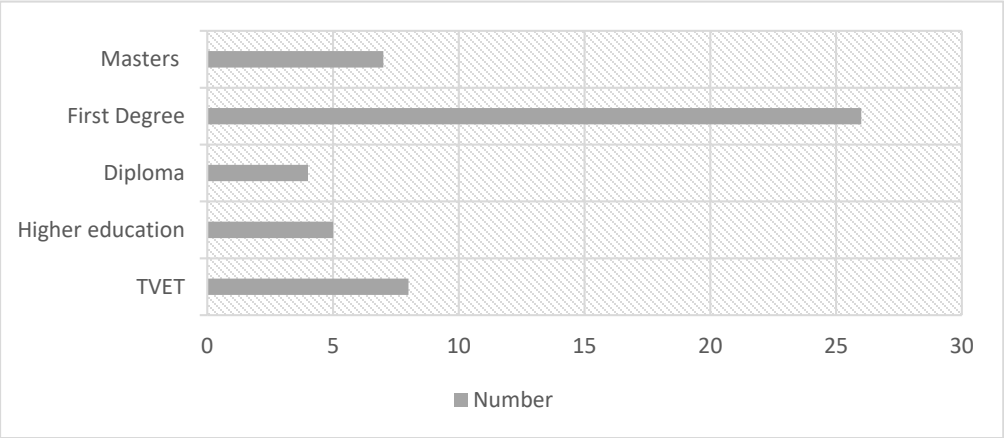


Figure 4.5. Education level of the selected sub cities respondents. (Source: Organized by the author (2023)).

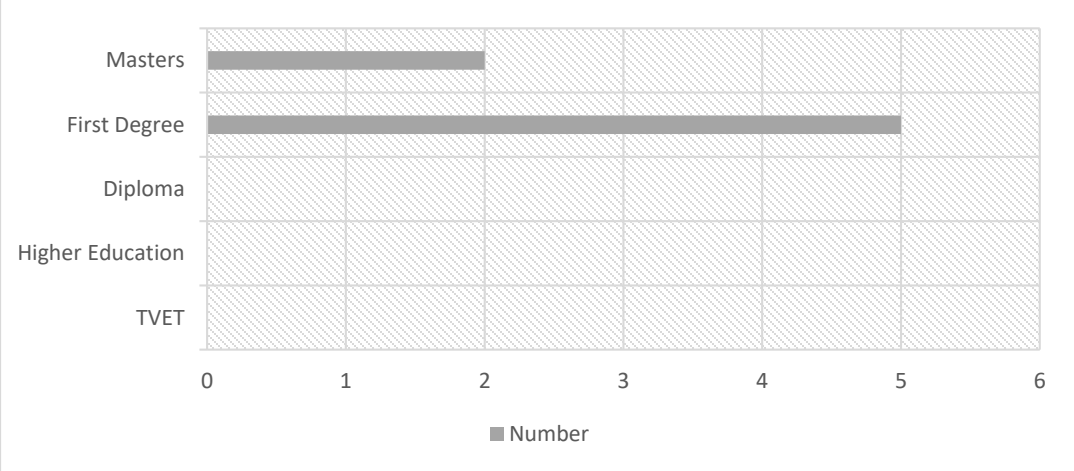


Figure 4.6. Education level of the selected office experts. (Out of 50 sample respondents) (Source: Organized by the author (2023)).

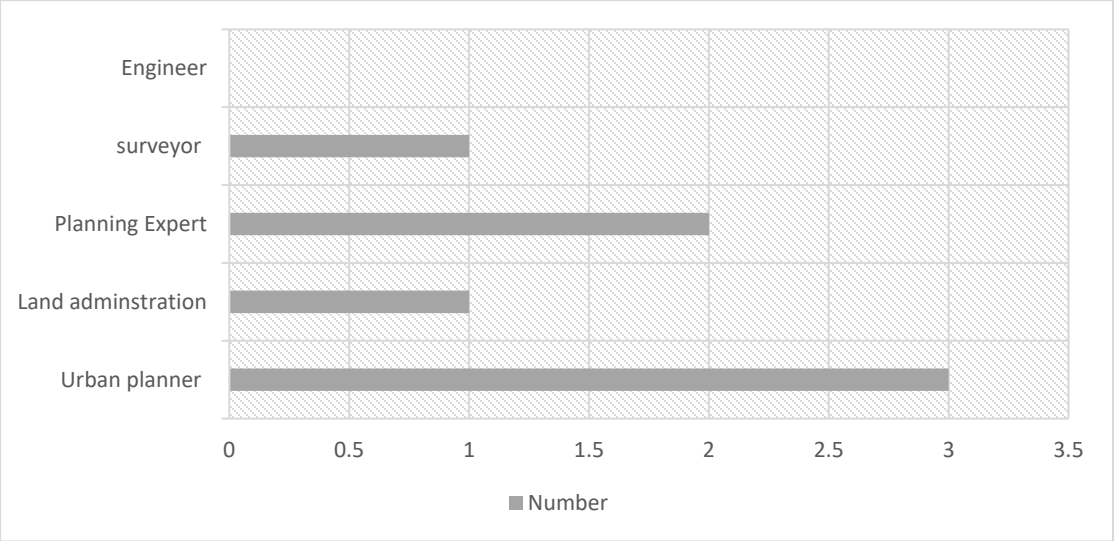


Figure 4.7. Qualification of the selected office experts (out of 7 sample respondents). (Source: Organized by the author (2023)).

From the chosen members of the community, as is done in Chapter 3; there are six urban sub cities within Bahir Dar's total population. Dividing the city into six clusters, each of which is a Bahir Dar sub city. Three sub cities were chosen by simple random sampling (lottery method) from among the six sub cities, or 30% of them. As a result, the addresses of the chosen community members are shown in figure 4.8 as follows.

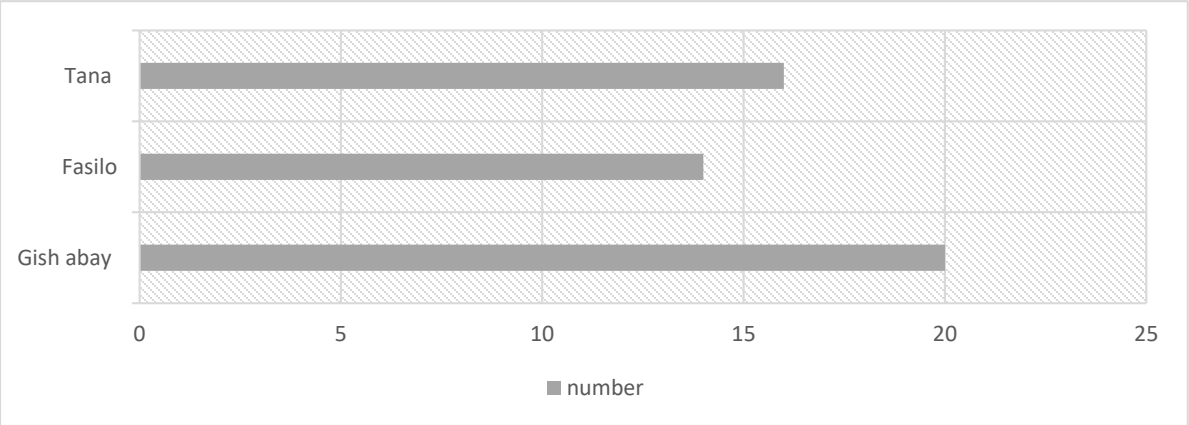


Figure 4.8. Address of the selected community members from the sub cites. (Source: Organized by the author (2023)).

As per the questionaries' distributed the response rate of the selected office experts (out of 7 respondents) is 100%. And out of the sampled 50 community members the replied response rate is also 100% as shown in Table 4.1 below.

Table 4.1. Showing the Response rate of respondents (Source: Organized by the author (2023)).

Questionaries’	Selected office experts (N=7)		
	Distributed	Replied	Rate
	7	7	7/7= 100%
	Selected community members (N=50)		
	Distributed	Replied	Rate
	50	50	50/50= 100%

4.2.1. **The current trends in the city of predictors as driving factors and actors**

The land use patterns associated with urban growth contribute to a thorough understanding of the predictors influencing urban growth. Those are usually called the determinant factors. The city's status as a political, economic, and cultural hub as well as its status as one of the country's top tourist destinations have both contributed to the city's development and change in land cover. These predictors have also caused the city to rapidly urbanize, which has caused migration from the nearby suburbs and increased population. The issue here is the city's rapid and often uncontrolled and unplanned land use conversions, particularly in the city's southern, southwestern, and northeastern areas, which are intrinsically tied to the lake to the north, the airport to the west, the Abay River to the east, and the Sebat Amit town border to the south.

Along with the growth in population, the city's uncontrolled, rapid expansion, which is closely tied to the topography and the city's intended plans, has played a significant role in driving outcome. Driving factors causes of informal land access include residential preference driven on by population growth, which finally results in informal land access, and among the key actors are local farmers, experts, government representatives, the community, and land brokers.

4.2.2. **Descriptive analysis of the selected office expert’s respondents' perceptions.**

Eight (8) determining factors that greatly supported Bahir Dar city's quick land use conversions between the years 2000 and 2020 were included in the survey questions for the assessment of respondents' perceptions. For the respondents of the office experts and selected community members, five Linkert scale parameters were presented. These factors included the location,

population size, uncontrolled growth of the city, its topography, the city's intended plans, the informal land access, the city's character of becoming the political, economic & cultural center of the region, and the residential preference related to the population increase.

The survey questionnaires' factors for land use expansion and conversions to other purposes, which include the increase in population size, its location, its unplanned growth, its topography, City's intended plans, informal land access, Residential preference Political, economic and cultural centrality by 96.7%, 85.4%, 90.3%, 86%, 32.9%, 81.9%, 85.4%, and 56.2%, respectively, were mostly agreed by the presented factors upon by the chosen sample 7 municipal office experts.

As a result, the following descriptive analysis techniques were utilized to analyze and quantify these perceptions. The following description covered measures of their distribution in order to further explain and examine the properties of perceptions as a mean, median, and mode. The results are based on Likert scale measurements from 0 to 4, where strongly disagree (score of 0), disagree (score of 1), neutral (score of 2), agree (score of 3), and highly agree (score of 4) are shown. The outputs in the table were calculated based on the value.

Most responses of office specialists strongly agreed that the population growth, unplanned expansion, topography, informal land access, residential choice, and political, economic, and cultural centrality, with an average mean of 3.43, 3.12, 3.08, 2.98, 2.82 and 2.71 correspondingly. The office experts who rate it at around 2, considered its location and intended uses to be neutral, which is mean of 2.13 & 2.07, respectively. The most common rating, which is the mode, is 3 ("agreed"), and the least common rating was strongly ("disagree") 2 value.

Table 4.2. Showing the evaluation rate mean, median and mode of the expansion determinant factors by the office experts. (Source: Organized by the author (2023)).

N=7			
Determinant factors	**Mean**	**Median**	**Mode**
The increase in population size	3.43	3	3
Its location	2.13	2	3
Its unplanned growth	3.12	4	4
Its topography	3.08	3	3
City's intended plans	2.07	2	2
Informal land access	2.98	3	3
Residential preference	2.82	3	3
Political, economic and cultural centrality	2.71	3	4

The percentage rate of the values was calculated and shown in the table 4.2 and figure 4.13 below based on the calculated descriptive data.

Table 4.3. Showing the evaluation rate of the expansion determinant factors by the office experts. (Source: Organized by the author (2023)).

N=7					
Determinant factors	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
The increase in population size	56.5%	40.2%	2%	1.3%	0%
Its location	70.2%	15.2%	10.6%	4%	0%
Its unplanned growth	65.3%	25%	2%	7.7%	0%
Its topography	60.5%	25.5	4%	10%	0%
City's intended plans	12.5%	20.4%	10.2%	30%	26.9%

Informal land access	46.4%	35.5%	5.4%	10.7%	2%
Residential preference	70.2%	15.2%	10.6%	4%	0%
Political, economic and cultural centrality	20%	36.2%	10.8%	21.7	11.3%

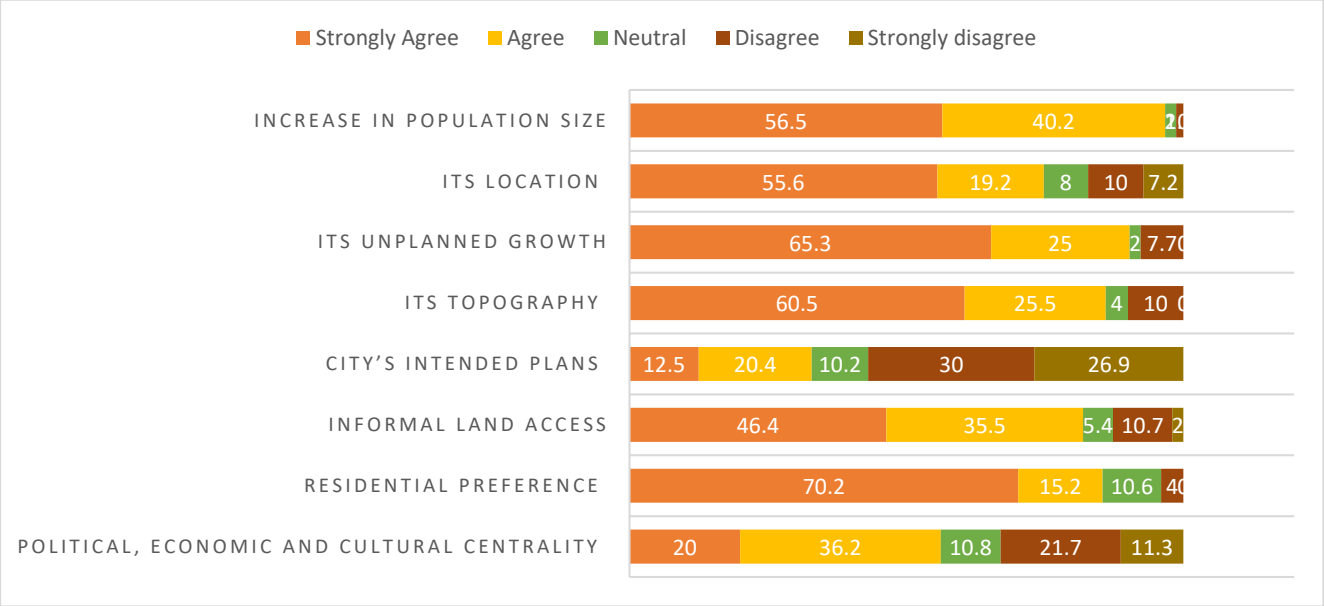


Figure 4.9. Graph of the evaluation rate of the expansion determinant factors by the office experts (Source: Organized by the author (2023)).

In addition to the close ended questionnaires: Out of the sampled 7 respondents, most of the experts explained issues related to residential preference and also large amounts of land are given to the local farmers so that this created a great need for housing and other necessities. This was obtained from the open ended questionaries' that are provided to the specific officials the Bahir Dar city municipal urban planning and implementation and representatives for that particular kebele regarding the land use change determinant factors of Bahir Dar city.

4.2.3. **Descriptive analysis of the selected community's respondents' perceptions (sub cities)**

The expectation was to the general public (the communities that have lived and lived in the city for at least ten years and on the new resettlement zones), as it is detailed in Chapter 3. There are six urban sub cities within Bahir Dar's total population. Dividing the city into six clusters, each of

which is a Bahir Dar sub city. Three sub cities were chosen by simple random sampling (lottery method) from the six sub cities, or 30% of them. Then, 50 samples were chosen from each cluster's population allocation, and all 50 of them were residents of Bahir Dar for at least 10 years. These sub cities have been chosen: GISH ABAY (N=20), FASILO (N=14), AND TANA (N=16), as it was presented on Table 3.2 above.

Correspondingly, the factors that contributed a lot for the land use land cover change of Bahir Dar city also included in the questionnaire for the city communities which includes, the location, population size, uncontrolled growth of the city, its topography, the city's intended plans, the informal land access, the city's character of becoming the political, economic & cultural center of the region, and the residential preference related to the population increase using five point Linkert scale measurement like wise.

Here too, these perceptions were analyzed and quantified using descriptive analysis techniques. The measurements of their distribution were discussed in the paragraphs that followed in order to further explore and explain the characteristics of perceptions as a mean, median, and mode. The outcomes were likewise based on ratings on a Likert scale from 0 to 4, with strongly disagreeing being represented by a score of 0, disagreeing by a score of 1, neutral by a score of 2, agreeing by a score of 3, and strongly agreeing by a score of 4. Based on the value, the outputs in the table were computed.

As shown in the Table 4.3 below, with average means of 3.72, 3.2, 2.92, 3.14, 3.12, and 3.89, respectively, the majority of responses from community members strongly concurred that population growth, location, unplanned expansion, informal land access, residential choice, and political, economic, and cultural centrality. The community members gave it a rating of roughly 2, which is a mean of 2.43 and 1.83 for its topography and intended purposes, respectively. The least frequent rating was strongly ("disagree") 1 value, while the most frequent rating, or the mode, was 3 ("agreed").

Table 4.4. Showing the evaluation rate mean, median and mode of the expansion determinant factors by the selected sub city community members. (Source: Organized by the author (2023)).

N=50			
Determinant factors	**Mean**	**Median**	**Mode**
The increase in population size	3.72	3	4
Its location	3.2	3	3
Its unplanned growth	2.92	4	4
Its topography	2.43	3	3
City's intended plans	1.83	2	1
Informal land access	3.14	3	4
Residential preference	3.12	3	3
Political, economic and cultural centrality	3.89	3	4

The survey questionnaires' factors for land use expansion and conversions to other purposes, which include the increase in population size, its location, its unplanned growth, its topography, the City's intended plans, informal land access, Residential preference Political, economic, and cultural centrality by 89.3%, 63.4%, 61.3%, 71.3%, 43.4%, 77.8%, 79.6%, and 89.8%, respectively, were mostly agreed upon by the selected sample of 50 respondents as shown in the Table 4.3 below.

Table 4.5. Showing the evaluation rate of the expansion determinant factors by the selected sub city community members. (Source: Organized by the author (2023)).

N=50					
Determinant factors	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
The increase in population size	67.2%	22.1%	5%	5.7%	0%
Its location	45.6%	17.8%	10.3%	12.4%	13.9%
Its unplanned growth	31.5%	29.8%	8%	19.5%	11.2%
Its topography	28.8%	42.5%	3%	20.7%	5%
City's intended plans	9.5%	33.9%	30%	25.3%	1.3%
Informal land access	45.5%	32.3%	2%	12.2%	8%
Residential preference	56.4%	23.2%	1.4%	9%	10%
Political, economic and cultural centrality	69.4%	20.4%	2.1%	3.6%	4.5%

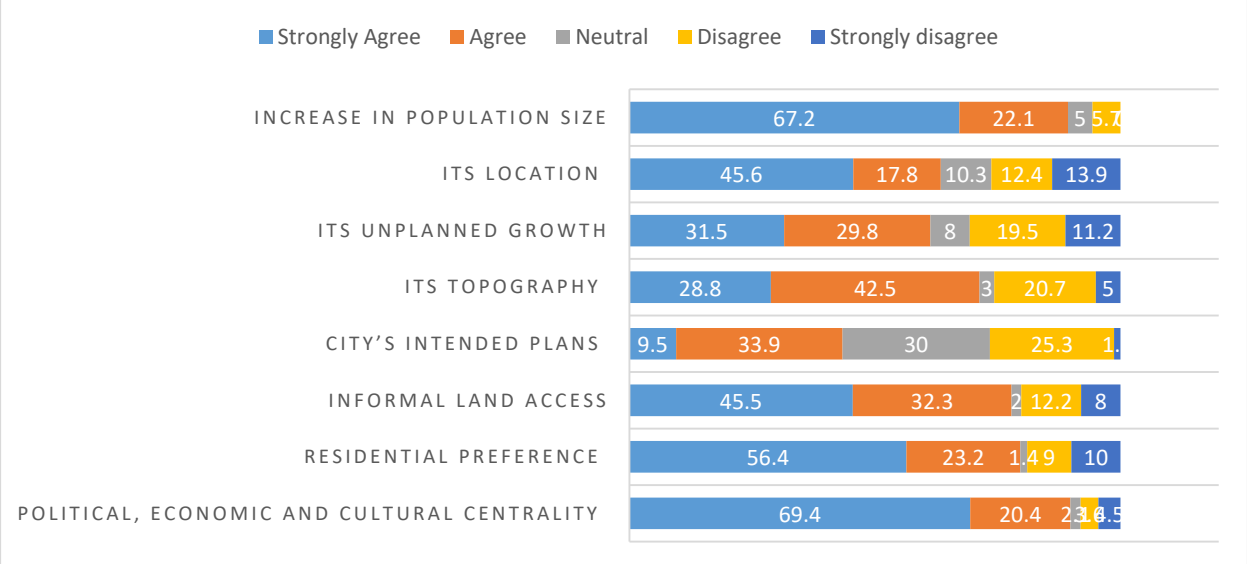


Figure 4.10. Graph of the evaluation rate of the expansion determinant factors by the sub city

community members (Source: Organized by the author (2023)).

Out of the 57 survey participants, the population growth, residential preferences, and Bahir Dar's regional prominence in politics, business, and culture were the most important determinants of the city's rapid land use conversions. This gives rise to the notion of interconnected determinant elements, such as the preference for residence, which is a result the population size increase and of the city's growing political, economic, and cultural prominence.

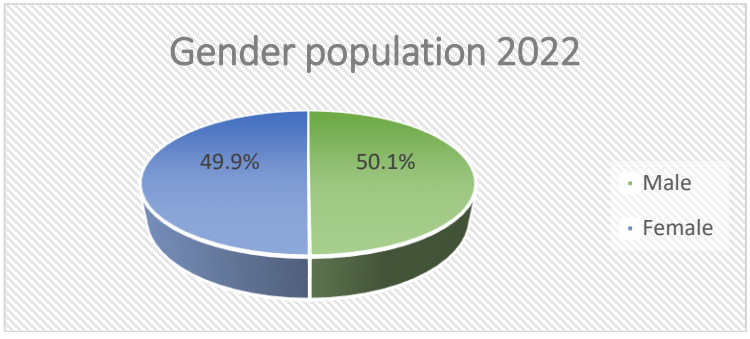
4.2.3.1. **The increase in population size**

So here, more importantly, comparing the population of Bahir Dar with the period covered by the selected study years in order to estimate the future and determine its trend of growth.

Table 4.6. Population of Bahir Dar city between the year 2000-2020(source: central statistics agency of Ethiopia, July 2019).

Year	**Population census**	**Male**	**Female**
2007	221,991	112,171	109,820
2012	318,429	118,720	199,709
2019	397,923	199,172	198,751

According to the data from the central statistics agency there is a population forecast projection of the year 2020, which shows Bahir Dar's city population is expected to be 455,901 by 2022 which encompasses 228,189 (49.9%) Male and 227,712 (50.1%) Female residents.



Gender	
Males	228,189(49.9%)
Females	227,712(50.1%)

Figure 4.11. Population projection data of the year 2020 (Source: central statistics agency of Ethiopia, July 2019).

As a result, the exponential growth rate model will be implemented.

Pt = Po e rt

Where Pt = Current population (year 2022), Po = Base Year population (Year=2019), r = Growth

rate, t = Time (1)

$$r = \frac{1}{t} * \ln\left(\frac{P_t}{P_0}\right)$$

r=1/1*ln(455,901/397,923)=**0.059=5.9%**

This study found that the high variant accounted for 6.23% of the total, the medium variant for 5.9%, and the low variant for 3.93% according to the above formula .The city's 5.9% annual growth rate is a medium-variable rate according to this study.

From this we can forcast the population by using the formula below (Pierre-Francois Verhuls).

Pt = Po*(1+r/100)t Where:

Pt = population at time required Po = Current population

r = Rate of population growth t = Projection time

Pt = Po*(1+r/100)t

P(2030)=455,901*(1+0.59)10

P(2030)=808,779

By 2030 the population projection by the above formula suggests that there will be a population growth of the city which will be 808,779 .This will lead to the analysis in which this prediction will demonstrate that an increase in population is anticipated during the next years. (based on the information obtained from the prior survey). This may be a sign that the city could eventually need to expand in order to accommodate its growing population. Area coverage also grows as the population does.

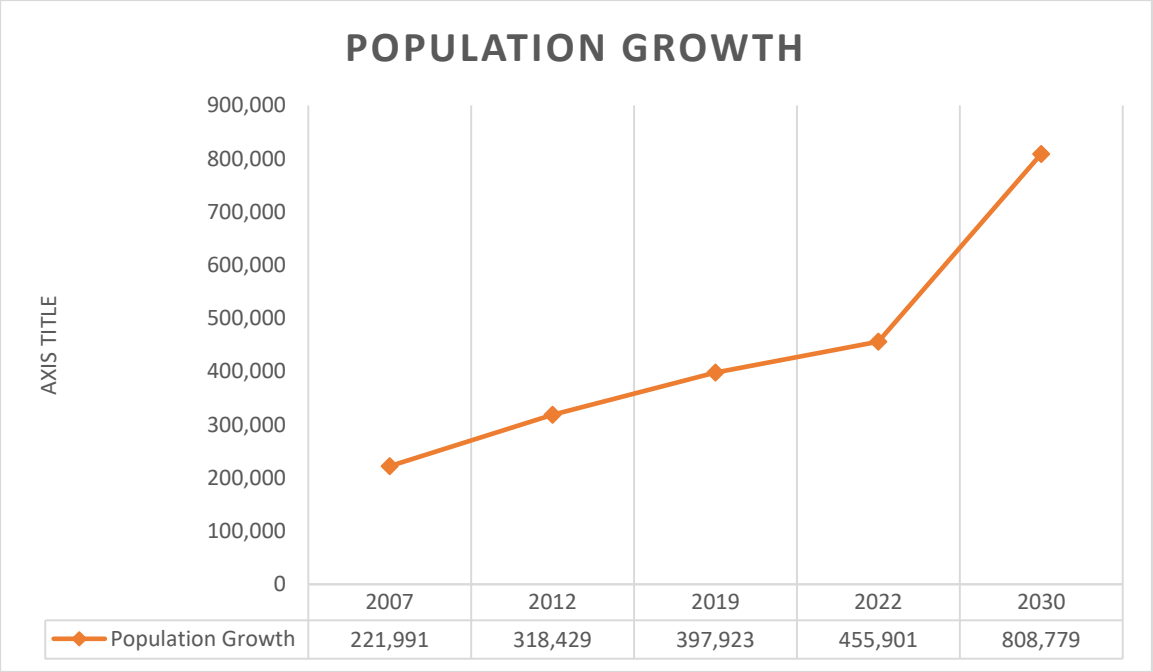


Figure 4.12. Population growth trend of the years in between 2000-2030 (Source: Organized by the author (2023)).

A number of human factors that have contributed to the city's growth and change in land cover may be found. As a result of the city's role as a major tourist attraction, its reputation as a political, economic, and cultural hub, as well as its rapid urbanization, have resulted in migration from the suburbs nearby and increased population. Due to the geography of the city, which includes factors like road accessibility, proximity to the city centre, slope variables, and, most importantly, environmental factors, it is anticipated that other land use types will continue to be converted to built-up areas in the city's southern, southwestern, and northeastern areas.

Specifically in the city's southern, southwestern, and northeastern areas which are inextricably linked to the lake to the north, the airport to the west, the Abay River to the east, and the border with Sebat Amit town to the south rapid and frequently uncontrolled and unplanned land use conversions are the problem.

4.2.3.2. **Residential preference and political, economic and cultural centrality**

The fact that Bahir Dar is the region's capital contributes to the city's rapid expansion as does the fact that it is growing quickly. The city's location in a region surrounded by numerous satellite

cities, its importance as a political, economic, and cultural hub, and its popularity as a tourist destination have all contributed to the city's rapid urbanization, which has prompted emigration from the nearby suburbs and increased population. This responds to the other determining element, which is the city's informal land access. This is one of the main causes of the city's rapid growth since it directly converts undeveloped land into built-up regions, which has an effect on the economy and the environment.

Out of the seven office experts surveyed, 98% fully agreed that the impact of population growth specifically, the preference for residential areas is the key to land use conversions because of the high demand.

4.3. **Driving forces and Actors of the land use land cover changes.**

For the investigation of changes in land use and cover, the identification of the important individuals accountable for the determinant factors is required. The researcher for this study provided five (5) actors that greatly aided Bahir Dar city's quick land use changes between 2000 and 2020 in order to investigate respondents' viewpoints. The respondents, office experts and selected members of the community, were given five Linkert scale factors to consider. These actors included the residents of the city, government officials and experts who developed the intended plans, investors (both public and private), the city's active land dealers, and the nearby farmers.

4.3.1. **Descriptive analysis of the selected office expert's respondents' perceptions on Actors behind LULC.**

The majority of the chosen office experts concurred that the investors (91.2%), active land brokers (89.7%), the city's community (83.2%), government officials and experts (72.3%), as well as the local farmers of the city (67.4%), were the main contributors to the city's rapid changes in land use and land cover.

The majority of office experts were in agreement that the investors, both those who enter the city and those already there, have played a significant role in changing the land use. They were followed by the active land brokers who bring the investors, the city's community, which includes both locals and migrants, officials from the governments & experts who prepared the intended plans, and the local farmers who contributed with an average mean of 3.5, 3.21, 3.1, and 2.8.

Table 4.7. Showing the evaluation rate mean, median and mode of the expansion Actors by the office experts. (Source: Organized by the author (2023)).

N=7			
Actors behind the LULC	**Mean**	**Median**	**Mode**
The city's community	3.1	3	3
Officials from the Government and Experts	2.8	2	2
The investors	3.5	4	4
Active land brokers	3.21	3	3
Local farmers in the city	2.31	2	1

The percentage rate of the actors based on the responses of the selected office experts is done in the table 4.8. Below.

Table 4.8. Showing the evaluation rate of the expansion Actors by the office experts. (Source: Organized by the author (2023)).

N=7					
Actors behind the LULC	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
The city's community	63.1%	20.1%	10%	6.8%	0%
Officials from the Government and Experts	40.6%	31.7%	20.7%	5%	2%
The investors	48.9%	42.3%	6.4%	2.4%	0%
Active land brokers	64.3%	25.4%	10.3%	0%	0%
Local farmers in the city	47%	20.4%	19.2%	10.4%	3%

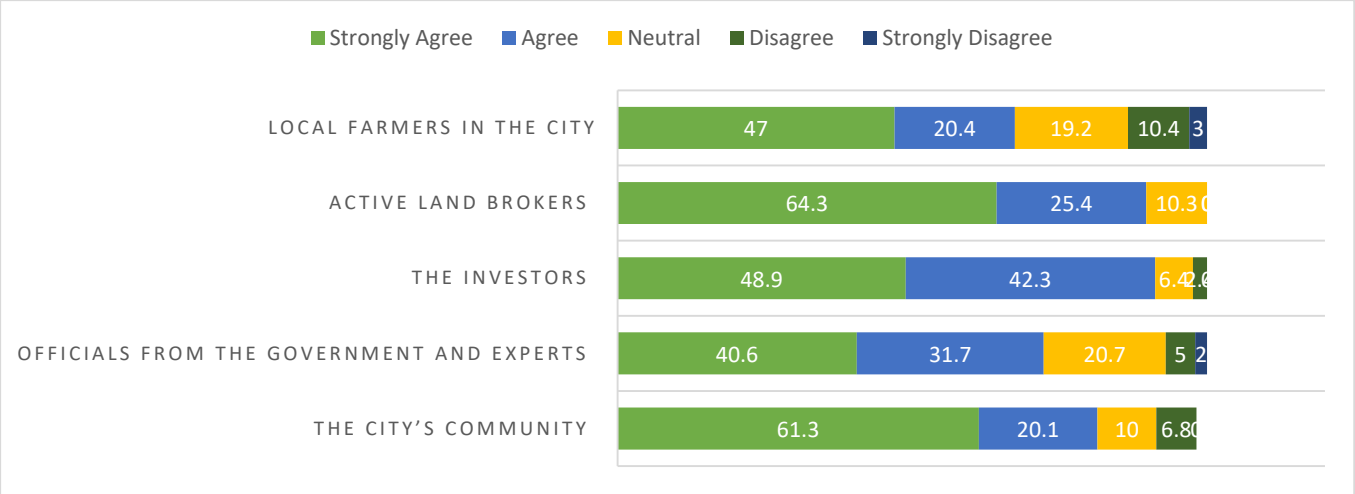


Figure 4.13. Graph of the evaluation rate of the expansion actors by the office experts (Source: Organized by the author (2023)).

4.3.2. **Descriptive analysis of the selected community's respondents' perceptions (sub city's) on actors behind LULC**

There may be crucial actors who are in charge of the land use conversions in addition to all the other determining elements for the change in land cover. It's crucial to examine such actors in order to find new mitigation strategies.

50 respondents were chosen from the chosen 3 sub cities, as described in chapter 3 of this study, in order to identify the key actors in the LULC of Bahir Dar city. 96.4% of the community members in the chosen sub-cities concurred that investors both newcomers and long-time residents have made important contributions to transforming the city's land usage. They were followed by the city's community 87.2%, active land brokers who bring the investors 79.5%, which includes both locals and migrants, and the local farmers 67.9%, they were also followed by the officials from the governments & experts who prepared the intended plans 91.3%. Who contributed with an average mean of 3.75, 3.54, 3.08, 2.95 & 2.53?

Table 4.9. Showing the evaluation rate mean, median and mode of the expansion Actors by selected sub city community members. (Source: Organized by the author (2023)).

N=50			
Actors behind the LULC	**Mean**	**Median**	**Mode**
The city's community	3.08	3	4
Officials from the Government and Experts	3.54	3	3
The investors	3.75	4	4
Active land brokers	2.95	3	2
Local farmers in the city	2.53	2	1

The percentage rate of the values was calculated and shown in the table 4.10 and figure 4.14. Below based on the calculated descriptive data.

Table 4.10. Showing the evaluation rate of the expansion actors by the selected sub city community members. (Source: Organized by the author (2023)).

N=50					
Actors behind the LULC	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
The city's community	69.5%	17.7%	2.8%	3.25%	6.75%
Officials from the Government and Experts	65.4%	25.9%	7.3%	1.4%	0%
The investors	60.4%	36%	3.6%	0%	0%
Active land brokers	37%	42.5%	5%	12.5%	3%
Local farmers in the city	54.6%	13.3%	11.5%	13.8%	6.8%

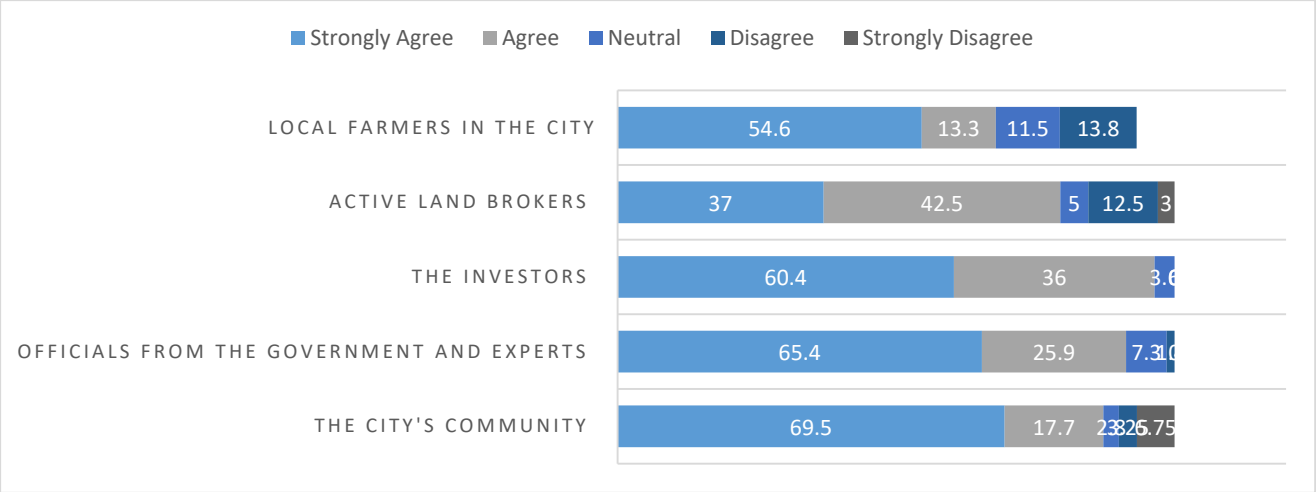


Figure 4.14. Graph of the evaluation rate of the expansion actors by the selected sub city community members (Source: Organized by the author (2023)).

The city's change in land use and land cover has been significantly influenced by private investors from both inside and outside the city who are frequently drawn to the opportunity by and assisted by the local land brokers. Government officials and planners support this phenomenon as a result of the city's growth. Bahir Dar's property value has increased significantly as a result of the influx of investors and migrants from other sub-cities, and these players have had a significant impact on the city's rapid changes in land use.

4.3.3. **Perceptions of selected stakeholders by Focus group discussion**

The most typical participatory activity is discussion, which is also one of the tenets of an inclusive strategy that may be used in focus groups with women, community leaders, burial committee members, etc. Community members identify current problems during the problem identification phase, which may be done in group conversations with all relevant stakeholders.

In the one-hour focused group discussion about the land use conversions and changes occurring in the city's urbanization during the recent past and its current happening impact with the community members, selected community members, some kebele officials, and resettled local farmers for the new Bahir Dar's expansion settlement implementation were involved.

According to the primary issues raised by the stakeholders, the city's land use changes are harming the local agriculture that contributes to the city's urban greenery, which has consequences for the

economy and the environment. Local farmers who were relocated as part of the new housing association's resettlement strategy, which was developed to maintain the housing preference owing to the population expansion, raised this problem. Many people in the city wrongly took land for housing one by the name of husband and the other by the name of wife considering them as divorced but they are living together. Therefore, this study recommends that, there should be a strict land audit in the city for fair distribution of housing preference.

4.3.4. **Perceptions of selected stakeholders by personal interviews**

One approach of gathering data that provides in-depth information from the participants on the study we do is interviewing. In order to understand the stakeholders' direct attitudes towards the subject issues, random interviews were conducted as part of this study.

One of the key findings from the interview was that the land uses that were reserved for multiple purposes were converted to another, which has an impact on the city's environmental and socioeconomic thematic areas. Land that was set aside for parks and green space is now used for parking, which is one of the land uses that changed. Both the social and environmental impacts of this change are present. Socially, it serves as a location for the neighborhood to build strong ties and to celebrate holidays, as well as a playground for kids. Environmentally-friendly places have benefits for both the neighborhood and the city. One park or a set of parks always creates a new living environment

4.4. **The spatial trends of LULC on the study area**

4.4.1. **Results of classifying and validating land cover maps**

Using the classification technique, which involves classifying pixels into a limited number of distinct classes, or categories of data, according to the values in their data files. However, there isn't a classification that is widely accepted because it depends on the goal of the user and sometimes the location; as a result, it's important to contextualize the classification of land use and land cover to the local environment. This leads to the classification of land usage into five classes.

1. Water features: (river, open water, lakes, ponds, and reservoirs).
2. The vegetation: (forestland, scrubland forest, garden center, and each kind of garden plots).

3. Built-up area: (including dwellings, businesses and services, industries, roads, work sites, mixed-use developments, and other urban areas).
4. An agricultural area/local forest: (crop fields, unseeded lands & land under preparation).
5. Open ground: (areas that are open and have little to no vegetation, such as beaches, dunes, bare rocks, and open places).

In figure 4.1 below, the land cover maps produced by a maximum probability supervised classification and a post classification method are shown. The built-up areas have grown, as evidenced by the numbers, from (1437 hectares) 5% of the study area in 2000 to (2906.24 hectares) 14% of the study area in 2010 and (8227.14 hectares) 39% of the study area in 2020. These values are shown in table 4.11. This is because of the infill developments for residential communities, which shows the built up regions are consuming a lot of other LULC types because of purpose shifts. The growth of built-up areas indicates that agricultural property nearby is being used more frequently as urban expansion space. (Specifically the area around the airport and the industrial zone to the west, the Abay River to the east, and the Sebat Amit town limit to the south.)

While the city's open ground or usually called the unbuilt areas shrank across all years, as shown in figure 4.15 below and in table 4.10. The figures show that the unbuilt areas have shrunk from (8534.94hectares) which is 65% of the study area in 2000 to (8385.94 hectares) which is 48% of the study area in 2010 to (7280.33 hectares) in 2020, representing 28% of the study area. This is because, during the study periods, built-up areas have dynamically grown while agricultural areas have steadily decreased. This might be brought on by a rise in population growth and the resulting higher demand for land and urban resources.

Between the research years 2000 and 2010, vegetation, including agricultural areas, increased steadily, going from 9% coverage to 24%, respectively. This is because local farmers frequently plant vegetation around water features in response to periodic wet lands especially around Lake Tana. And once more revealed a decrease from 22% to 13% between the years 2010 and 2020.this is because additional land is needed to be used for settlements afterwards built-up areas.

With values given in table 4.11 below, forest and semi-natural areas usually called local agricultural area have also consistently increased between the study periods 2000 and 2010, going from 17% of the study area in 2000 to 11% in 2010. And once more demonstrated an increase

between the years 2010 and 2020, showing a corresponding increase in the study area coverage of 11% to 14%. This is as a result of the city's local farms planting vegetation on the wetlands surrounding the water bodies.

Water entities have shrunk in size from 4% of the study area coverage in 2000 to 3% in 2010, and then again in 2010, resulting increase by becoming 6% of the study area coverage, as shown by Figure 4.15 and Table 4.11. The slight decline in water bodies and change to built-up areas in 2010 were associated with the Blue Nile River and Lake Tana's slight retreat due to sedimentation and the following use of this land for built-up areas. And one of the main causes of the shrinkage of the water bodies can be attributed to the plantations and vegetation surrounding the seasonal wetlands near the lake and the river.

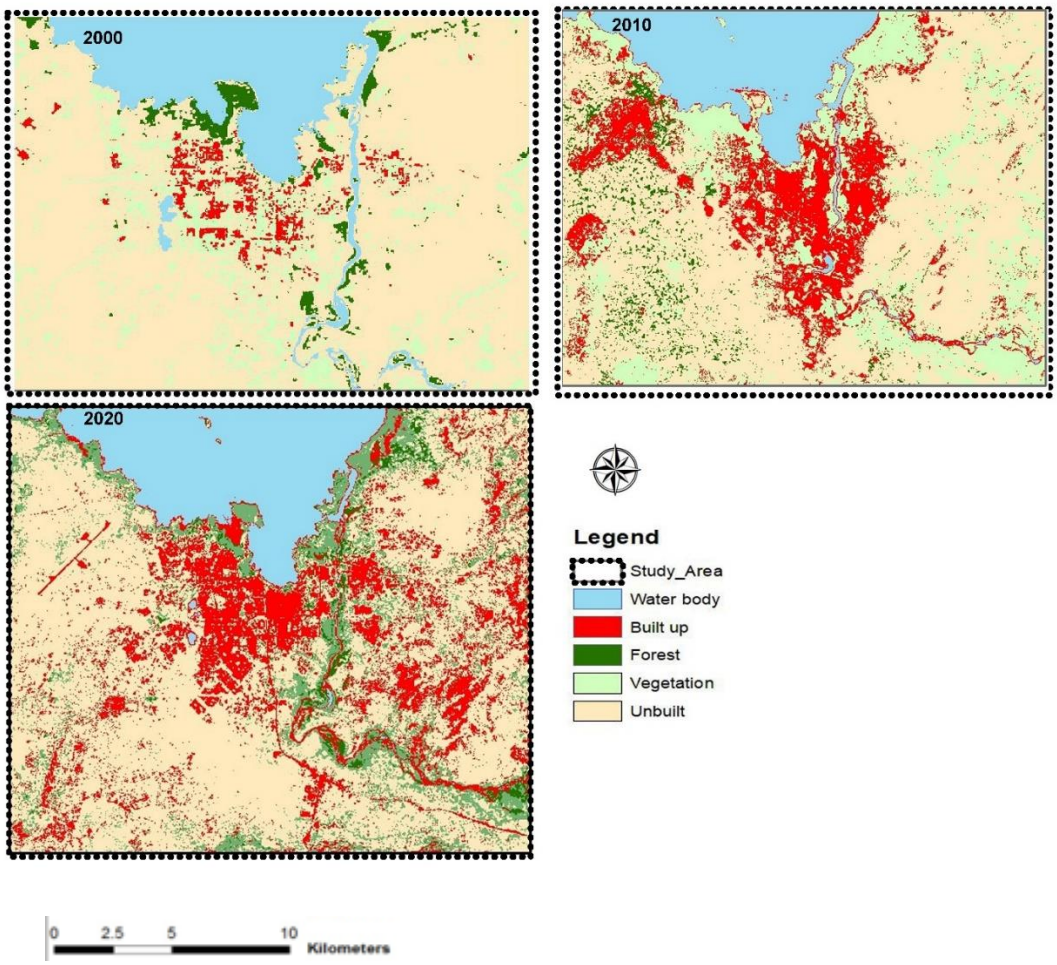


Figure 4.15. Supervised LULC map of Bahir Dar city for the years 2000, 2010 & 2020 G.C (Source: Organized by the author (2023)).

4.4.2. Analysis of Change from 2000 to 2020

For the purpose of identifying change-vulnerable areas and developing sustainable ecosystem services, mapping change comparison and quantifying the status of land use/land cover (LULC) changes and drivers of change are crucial.

Table 4.11. Analysis of change on LULC area statistics from 2000 to 2020. (Source: Organized by the author (2023)).

Land cover classes	Year-2000		Year-2010		Year-2020	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Built up Area	1437.00	5%	2906.24	14%	8227.14	39%
Open land (Unbuilt)	8534.94	65%	8385.94	48%	7280.33	28%
Vegetation cover	2306.02	9%	3888.24	24%	2137.15	13%
Agricultural area /local forest	2380.33	17%	2192.23	11%	2921.92	14%
Water body	536.15	4%	401.92	3%	451.32	6%
Total	15194.44	100%	17774.57	100%	21017.86	100%

4.4.2.1. Evaluation of the Classification's Accuracy

It is the responsibility of the researcher to identify the various kinds of errors present in classified land cover maps derived from remotely sensed images in order to make the maps reliable and simple for users to understand. Accuracy evaluation should be carried out since it restricts the classification outcomes of a remotely sensed imagery data once the classified image is integrated into a GIS and becomes an information source for researchers and municipal planners.

The built-up areas class had the highest class accuracy in 2000 (98.2%), and the agricultural regions class had the lowest accuracy (95.3%).The class accuracies range from 72.4% to 100% in 2010 and from 76.8% to 94.7% in the period starting in 2020. The lowest values of class accuracies were misclassified because distinct land cover classes share similar properties.

Agricultural areas were incorrectly identified as 100% while built-up areas were classified with a poor accuracy of 70.5% in table 4.12, whereas agricultural areas had been mistakenly classed as 100%.Because other land cover groups, such as open spaces and agricultural areas, have comparable spectral features, the lowest values for built-up areas were incorrectly categorized. And had extensive land covering as a result of the informal settlements that were there at the period.

The total accuracy for this study period in 2000 was 89%, in 2010, it was 90%, and in 2020, it was 94%. According to Anderson et al. (1976), the minimal overall accuracy value obtained from an error matrix should be 85% for a credible land cover categorization. This overall accuracy result is supported by a confusion matrix, sometimes referred to as an error matrix or contingency table, provides a visual representation of the gap between a models' actual and anticipated classifications.

4.4.3. Usage of land Analysis (LULC)

4.4.3.1. **LULC in 2000**

The land use/land cover (LULC) of Bahir Dar city is shown in Table 4.12 below and Figure 4.15 above, respectively, in terms of amount and map. The open land cover, also known as the unbuilt, had the largest coverage in 2000, with 8534.94ha, or 65% of the entire area inside the city limits. During this time, agricultural lands made up 2380.33 ha, or 17% of the city's total area, followed by vegetation covers, at 2306.02 ha, or 9%, built-up areas, at 1437.00 ha, or 5%, and water bodies, at 536.15 ha, or 4%.

Table 4.12. LULC area statistics of year 2000. (Source: satellite image analysis of 2000 using ArcGIS (2020)).

No.	LULC	Area coverage in hectare & Percentage	
		Area in Ha	Area in %
1	Built up Area	1437.00	5%
2	Open land (Unbuilt)	8534.94	65%
3	Vegetation cover	2306.02	9%
4	Agricultural area /local forest	2380.33	17%
5	Water body	536.15	4%
	Total	**15194.44**	**100%**

4.4.3.2. **LULC in 2010**

Since many new settlements, including industries and residential preferences, were in the process of formation in the city, Bahir Dar's settlement was enlarged in the year 2010. The built-up area, which makes up 2906.24ha, or 14% of the entire city limit, was one of the land use and land cover categories with the biggest shift during this year. The open land, which makes up 8385.94 ha or 48% of the total area, is followed by the vegetation cover, which is 3888.24 ha or 24%, the agricultural area, which is 2192.23% ha or 11%, and the water bodies, which are 401.92 ha or 3% have seen a minor drop.

Table 4.13. LULC area statistics of year 2010. (Source: satellite image analysis of 2000 using ArcGIS (2020)).

No.	LULC	Area coverage in hectare & Percentage	
		Area in Ha	Area in %
1	Built up Area	2906.24	14%
2	Open land (Unbuilt)	8385.94	48%
3	Vegetation cover	3888.24	24%
4	Agricultural area /local forest	2192.23	11%
5	Water body	401.92	3%
	Total	**17774.57**	**100%**

4.4.3.3. **LULC in 2020**

After a decade, the LULC for the research area received a dramatic change in 2020. Around 8227.14ha, or 39% of the total area, was built-up during this time, followed by 7280.33ha, or 28% of open ground, also known as the unbuilt, and 2137.15ha, or 13% of vegetation. This year, there was an increase in the amount of built-up land due to the purchase of undeveloped property by investors as well as the presence of informal settlements that are unsuitable for land use, which leads to an increase in built-up areas and a decrease in vegetation and forest cover. Due to the demolition of informal settlements that had been converting the area to built-up, the agricultural land, which has showed a little growth, is actually 2921.92ha, which is 14% of the city border. Water bodies made up the remaining 451.32ha, or 6%, of the area.

Table 4.14. LULC area statistics of year 2020. (Source: satellite image analysis of 2020 using ArcGIS (2020)).

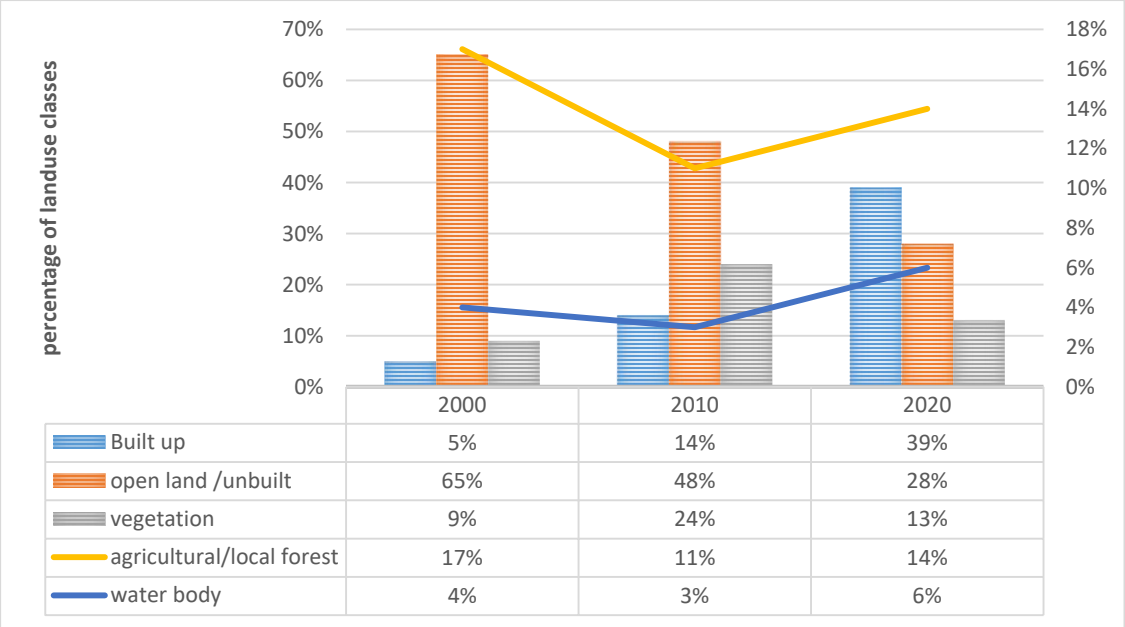
No.	**LULC**	**Area coverage in hectare & Percentage**	
		Area in Ha	Area in %
1	Built up Area	8227.14	39%
2	Open land (Unbuilt)	7280.33	28%
3	Vegetation cover	2137.15	13%
4	Agricultural area /local forest	2921.92	14%
5	Water body	451.32	6%
	Total	**21017.86**	**100%**

4.4.4. Analysis of Land cover changes of Built up areas

According to a prior study published in 2018 titled "Modeling the Impact of Urbanization on Land-Use Change in Bahir Dar City," built-up areas have been progressively expanding over time. The rapid loss of farms and other greenery covering the city as a result of this expansion has forced their conversion to other uses. Bahir Dar City is one of the fastest-growing cities in terms of population growth and urbanization, as can be seen from the viewpoint images above. The growth of built-up areas indicates that agricultural property nearby is being used more frequently as urban expansion space. In particular, the vicinity of the airport and the flowing amenities, since many

industries were established and becoming the industrial zone to the west, the existence of Abay River and the surrounding settlements following the river coast to the east which usually becoming the land that is planned for new settlements of residence, and the southern edge of Sebat Amit town which has a main reason of the establishment of the general hospital and commercials started to arise following the new road to Addis Ababa.

Due to the associated horizontal growth as well as the conversion of land cover classes during the various study periods, the study region has seen a spatial increase of different land use and land cover classes, such as built up areas. The reclassified images in figure 4.15 above and figure 4.16. Below demonstrated a quick transition in land cover from undeveloped to developed areas. The most dynamic classes during those study eras were agricultural areas, which aided in the growth of built-up areas. Additionally, a resettlement strategy was implemented throughout in 2014 for better infrastructure provision and land management. Following this, many built-up areas were converted to agricultural, open green spaces, and parks between the years 2010 and 2020, as shown in figure 4.15 above and in the figure 4.16 below, in an effort to balance the city's rapidly expanding built-up areas. This information also is represented graphically in Figure 4.16's bar graph so that the overall trend of all categories be more easily recognized.



	2000	2010	2020
Built up	5%	14%	39%
open land /unbuilt	65%	48%	28%
vegetation	9%	24%	13%
agricultural/local forest	17%	11%	14%
water body	4%	3%	6%

Figure 4.16. Graph of total area in percentage of the study area, 2000, 2010 & 2020 G.C (Source: Organized by the author (2023)

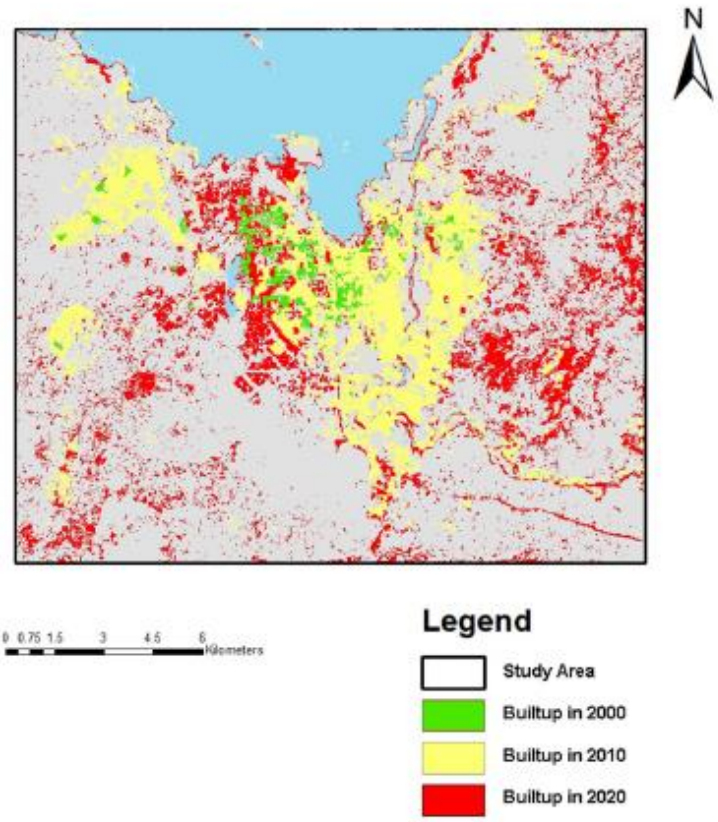


Figure 4.17. Overlaid LULC map analysis of built up areas of Bahir Dar city for the years 2000, 2010 & 2020 G.C (Source: Organized by the author (2023)).

Visualizing each categorization result on a separate map to highlight the growth of the built-up area in each year allows us to map and compare the changes in built-up area between the years 2000 and 2020. On the map, the built-up area for each year was represented by a different color: green for built-up area in 2000, yellow for built-up area in 2010, and red for built-up area growth in 2020. The increase in the built-up area from 2000 to 2020 is particularly notable because it virtually doubled the city's growth and added a significant amount of land, indicating the city's unanticipated rapid urban growth that enveloped the nearby non-built-up areas.

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4.5. Impacts of LULC change on the study Area

4.5.1. **Bahir Dar's future from the results perspective.**

4.5.1.1. **Forecast of future population vs built-up area**

The population of the city is anticipated to rise and reach 808,779 people by 2030, based on the population estimate created using the above method. This will result in a study that will demonstrate the accuracy of the population growth forecast for the following ten years. This can be a sign that the city will eventually need to grow to accommodate the population growth. Area coverage grows along with population growth.

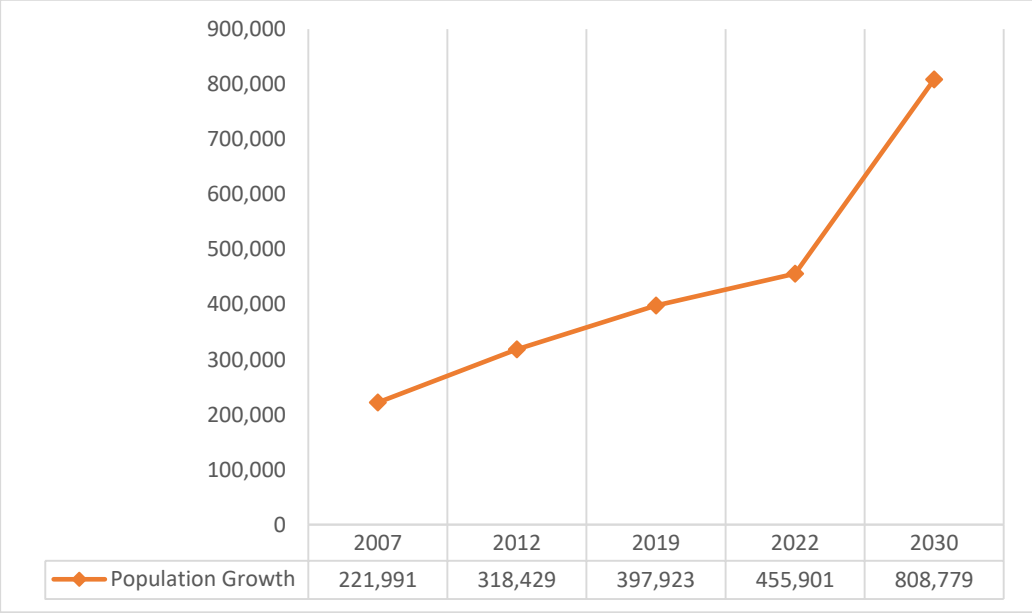

Figure 4.18. Graph showing the population's growth from 2007 to 2030 (Source: Organized by the author (2023)).

The city's population is rapidly expanding as a result of migration from the adjacent suburbs and the presence of water bodies that make the city a popular tourist destination and a pleasant place to live. Therefore, in order to forecast the anticipated rise in population, it is necessary for this study to determine the city's time to double.

Doubling time = 70/ Annual Growth rate (Sal Kahn).

=70/5.9%

=11.8

This indicates that it is expected that nearly after 10 years the city's population is expected to be double. This is considered to be fast doubling time for the city that has urban rural linkage and recently becoming one of the tourist destination.

In another way if the population increase there will be a preference of housing. This will lead to land use land cover change due to the increase in built up area.by the formula of exponential growth the rate of growth in built up area is computed.

The rate change of the spatial expansion of the built up areas of selected years can be calculated using a formula of dynamic change detection (Sewunet, 2017).

$$\mathbf{DC} = \left[\frac{BA_2 - BA_1}{BA_1} \quad X \quad \frac{1}{T2 - T1} \right] 100\ \%$$

Where DC = the dynamic change rate of urban expansion of the selected years of the study.

BA1 = total built-up area at time T1.

BA2 = total built-up area at T2.

DC= [(2906.24-1437.00/1437.00) *(1/2010-2000)] =0.10*100%=**10%**

DC= [(8227.44-2906.24/2906.24)] *(1/2020-2010)] =0.18*100%=**18%**

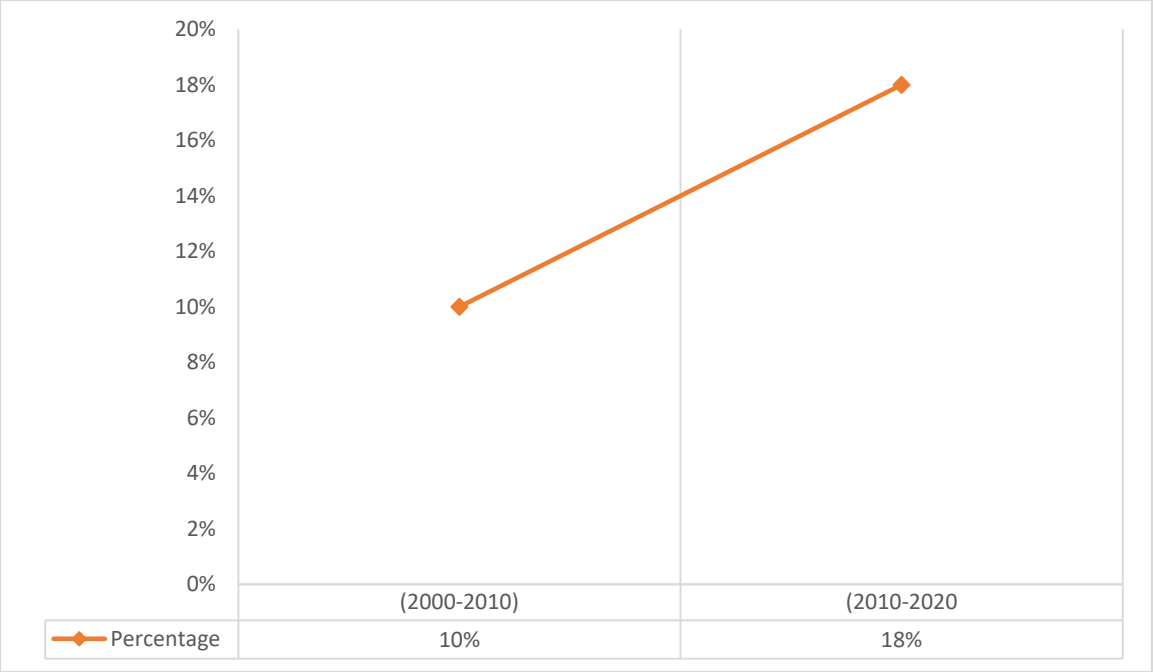

Figure 4.19. Rate of change in built up area between the years 2000-2020 (Source: Organized by the author (2023)).

Form the figure 4.19. above it is perceived that the trend of expansion of the city Bahir Dar is increasing for the past 10 years with a high amount of change which is 8% increase from the year between 2000-2010.here this results show that the rate change of the spatial expansion is occurring due to the increase in land use land cover change and the land use conversions with in the study area.

$$Bf = Bo\, e^{rt} \text{ -------> } r = \frac{1}{t} * \ln\left(\frac{Bf}{B_0}\right)$$

Bf = Final Built up

Bo = Initial Built up

r = Growth rate

t = Time (10 years)

$$r = \frac{1}{t} * \ln\left(\frac{Bf}{B_o}\right) =$$ r= 0.1*ln (8227.44/2906.24)

r= 0.1*ln (2.83)

r= 0.10=**10% (**rate in built up area growth)

Form the results above the urban expansion of the city Bahir Dar is estimated by exponential growth formula. This further will help to compare population and built up area comparison.

$$Bf = Bo * (1+\%/100)^{t\,(f-o)}$$

Where Bo = Built up area in 2020=8227.44

f = future year=2030

o = initial/base year=2020

% (r) = average growth rate per year=10%

t = time in year=10

Bf= 8227.44*$(1+0.10)^{10}$

Bf=21,339.86 hectare built up area for the year 2030.

From the above result the urban expansion of Bahir Dar city is expected to be 21,399.86 hectares by 2030.which is 13,172.42 hectares change from the year 2020.

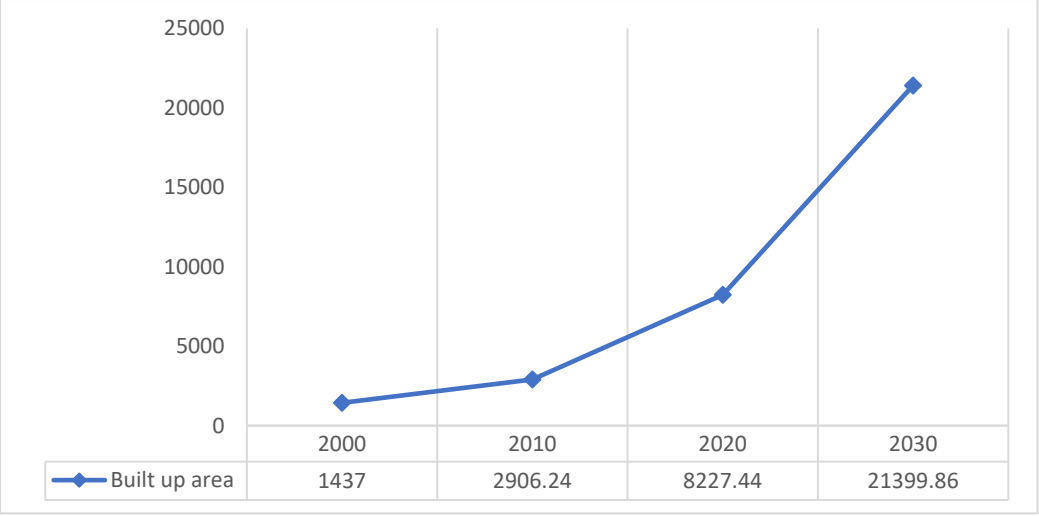

Figure 4.20. Trend of change in built up area and estimation for 2030. (Source: Organized by the author (2023)).

4.5.1.2. **Comparing population vs built-up area trend of change**

In assessing the impact of land use conversions population changes has direct impact on the rate change of spatial expansion. Accordingly, from the above analysis done the population of Bahir Dar city in the years between 2000-2010 was 221,991, built up area highest record was 2906.24 hectares of the total land. The population size of the city increased by the years in between 2010-2020 which is 455,904, and by the same way the built up areas of the city has expanded with 8227.44 hectares.

From this the estimated population size of the city by 2030 will reach 808,779, while the estimated built up area will be 21,399.86 hectares of the total land. This shows that there is a parallel increase with change in population change and its impact on land use change which is especially on built up areas due to the residential preference.

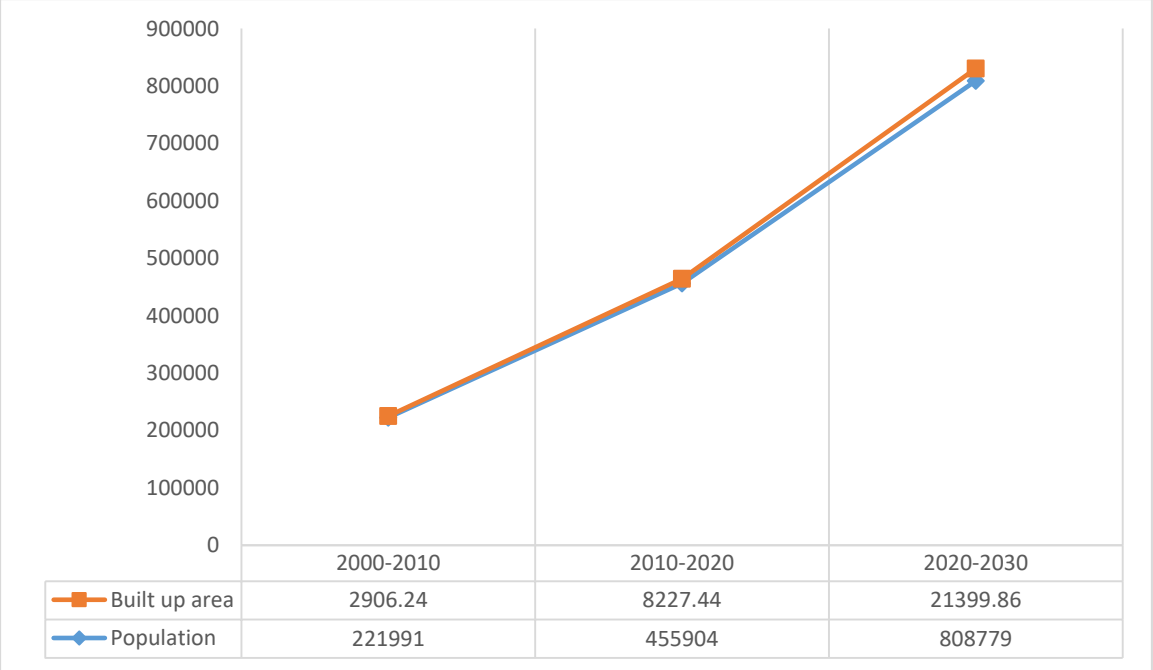

Figure 4.21. Population Vs built up area comparison between the years 2000-2020 and 2030. (Source: Organized by the author (2023)).

4.5.2. **Analyzing Expansion direction of the Bahir Dar city**

Using the satellite image analysis of the years 2000, 2010, 2020 we can estimate the trend of expansion of Bahir Dar city and it is also possible to identify the direction of expansion for the coming years by 2030. The issue here is the city's rapid and often uncontrolled and unplanned land use conversions, particularly in the city's southern, southwestern, and northeastern areas, which are intrinsically tied to the lake to the north, the airport to the west, the Abay River to the east, and the Sebat Amit town border to the south.

From this observation distance from the central business district, distance to key roadways, and distance to water bodies can all be competing urban expansion variables. The city is located at the crossroads of three major roads (Addis Ababa to Gondar, which crosses the city from southwest to north east), (Bahir Dar to chis abay, which runs from the city center in a southerly direction), and (Bahir Dar airport to the city center, which runs from the western direction), forming two major central business districts, the tana market in the west and the 'abay-mado' in the east. The city is becoming into a sprawling metropolis with numerous cores. Certain firms are drawn to one place. And, in addition to the city's development, the expansion has resulted in a sharp and rapid reduction in farmland.

This study reveals expansion is directed by distance to main roadways and proximity to city centers, leading in expansion and densification in the city's southern, southwestern, and northwestern areas. Distance to the road, distance to the central business area, and distance to water bodies can be major drivers in the city when biophysical and socioeconomic elements are combined.

As from the new structure plan of the city as it is represented by Figure 4.22 below, the residential preference of the city which is one of the determinant factors of the study’s predictors of land use conversion is represented by the future plan of the cities by 2030.hence this structural plan of the city supports the city’s trend of expansion is leading towards horizontally by dominant need of residential blocks due to the expected increase in population for the coming years.

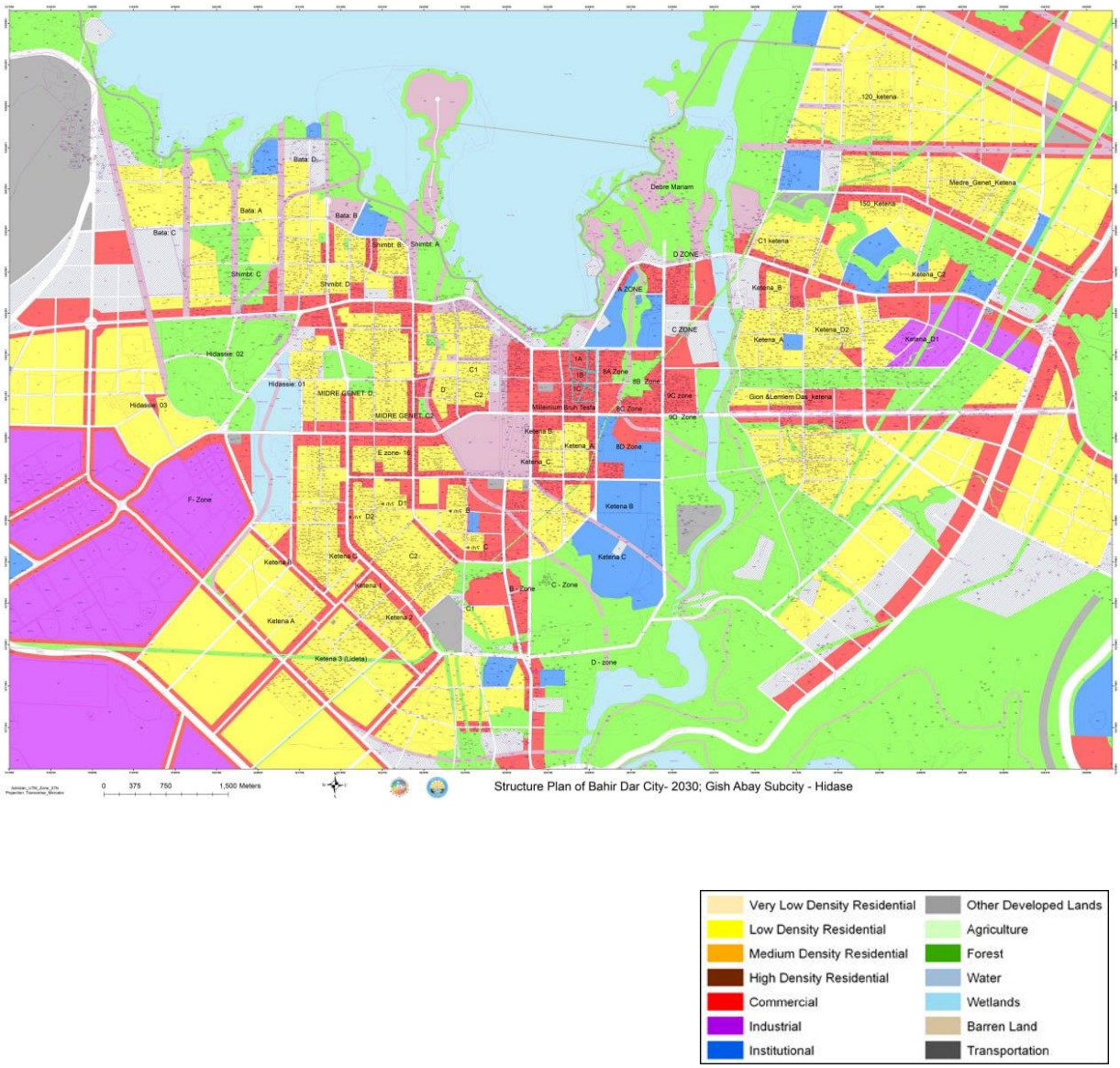

Figure 4.22: structural plan of Bahir Dar city for 2030 (Source: Bahir Dar city urban planning and municipality office (2023)).

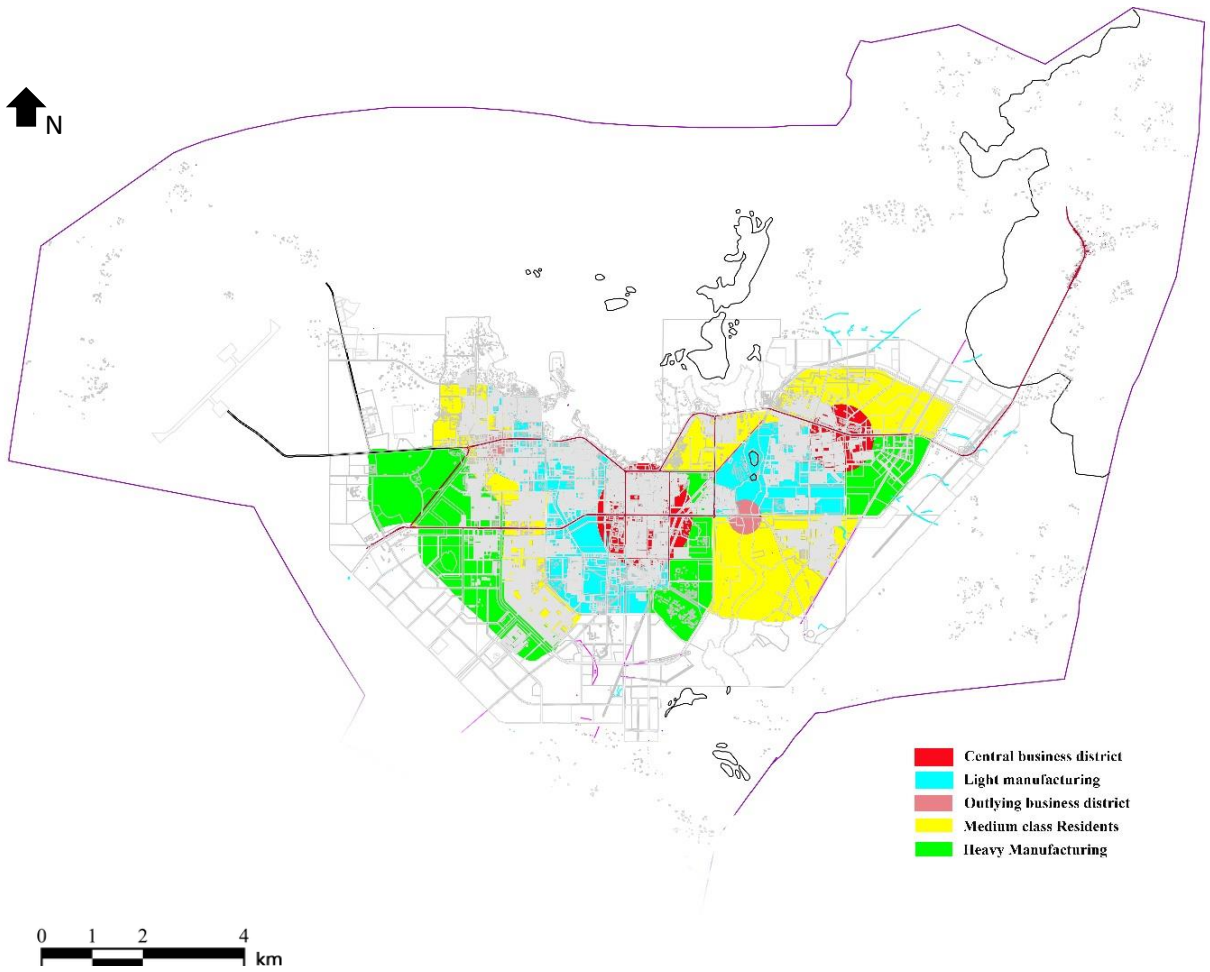

Figure 4.23. Bahir Dar city's current expansion trend and expansion direction trend identification image (Source: Organized by the author (2023).

4.6. Strategies to reduce the impact of LULC

4.6.1. **Major Findings and Discussion of results**

4.6.1.2. **Trend of LULC change**

The urbanization-related land use conversions, population growth from migrants from satellite cities nearby, and the city's expansion trend are all factors contributing to Bahir Dar's tendency to grow. These factors created shortages in housing and prompted land use conversions. The economic strategy (policy) that the country follows is agricultural development led industrialization. The policy allowed the rural migrants to be absorbed by the activities produced in combination with the sectors development since it places a lot of attention on agricultural

development without ignoring the development of industries, but in the rend of expansion what is currently implemented is not the same.

In this way, the LULC change trend is interpreted as pointing towards expanding the buildup areas in order to meet the demand for housing and other industrial operations that support the city's economy. However, the urban agriculture that supported the urban-rural linkage to the satellite cities or the cities that Bahir Dar's expansion trajectory leads to has been identified here as a trend of expansion. To point out some, zenzelima, tisabay, zege, and meshenti in various directions.

4.6.1.3. **Scenario planning for the coming decade**

It is shown that, despite an overall drop in vegetation cover over the study years, built-up areas are rapidly increasing. This study will gradually blend tales spanning multiple scenarios to show how the determining factors behaved in this transition. A causal framework for comprehending the linkages between society, the economy, and the environment and major element in consolidating scenario combinations is the DPSIR model of intervention (drivers, pressures, state, impact, and reaction).

The assumptions of the scenario arise from the study's demonstrations that built-up areas are fast expanding in Bahir Dar despite a general loss in farming and vegetation cover, apart from all the linked aspects of the city's rapid urbanization. According to the referred to analyses performed on this study, some human factors that have contributed to the city's development and change in land cover may be recognized. The city's position as the nation's political, economic, and cultural hub as well as its popularity as a tourist attraction have sped up urbanization, which has attracted residents from the nearby suburbs and increased population. Additionally, its location, topography, proposed plans, and residential preferences are highlighted, followed by population growth.

Due to the geography of the city, which includes variables like road accessibility, slope variables, and, most importantly, environmental factors, it is anticipated that other land use types will continue to be converted to built-up areas in the city's southern, southwestern, and northeastern areas. Here in the figure 4.24. Shown below the general driving forces, pressures followed by the state and impacts that this study conducted.

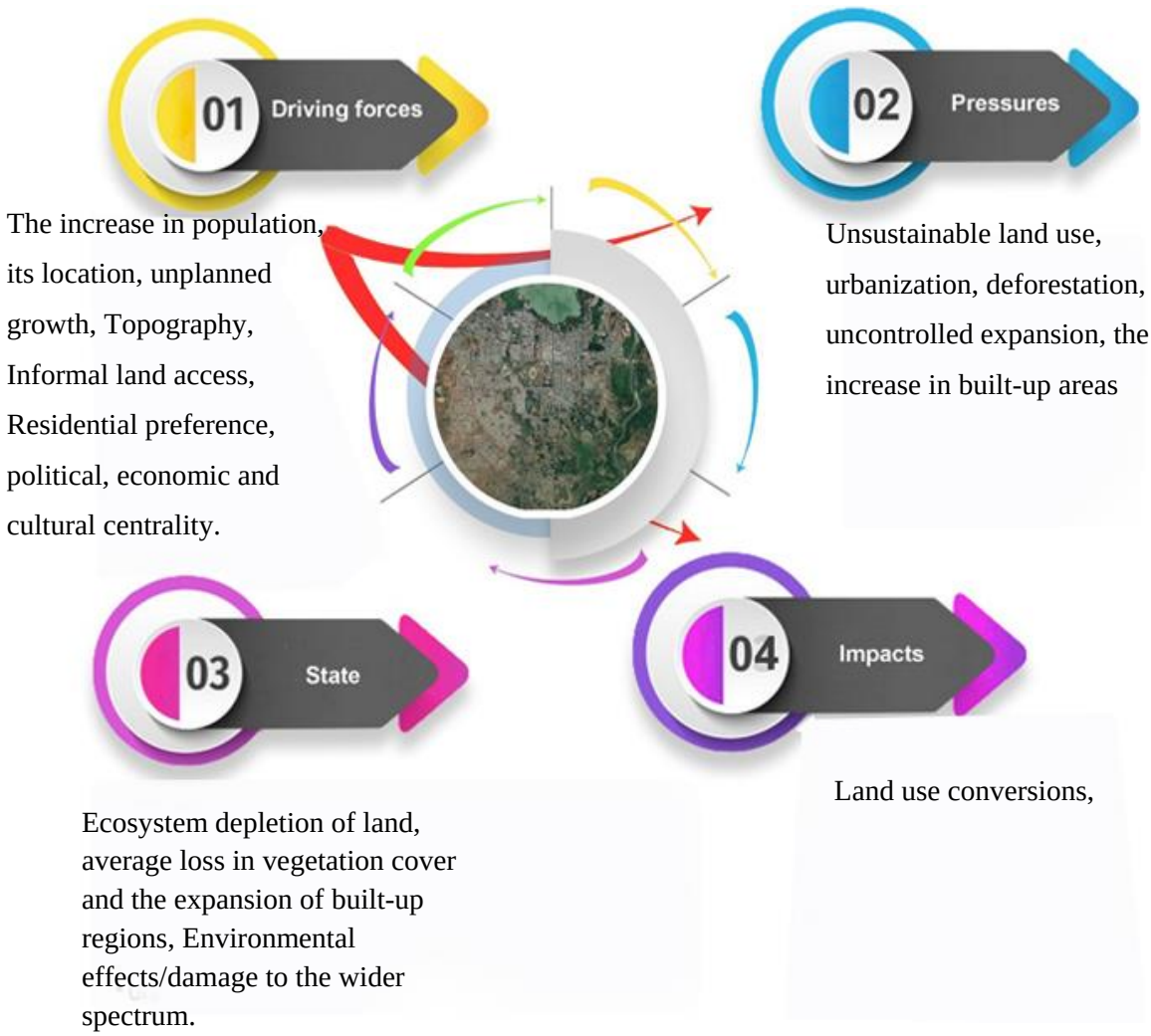

Figure 4.24. The driving forces, pressures, state and impacts analysis (Source: Organized by the author (2023)).

Filtering the most important contributing component to the response that is shown in the LULC conversions is always beneficial while constructing the DPSIR framework.

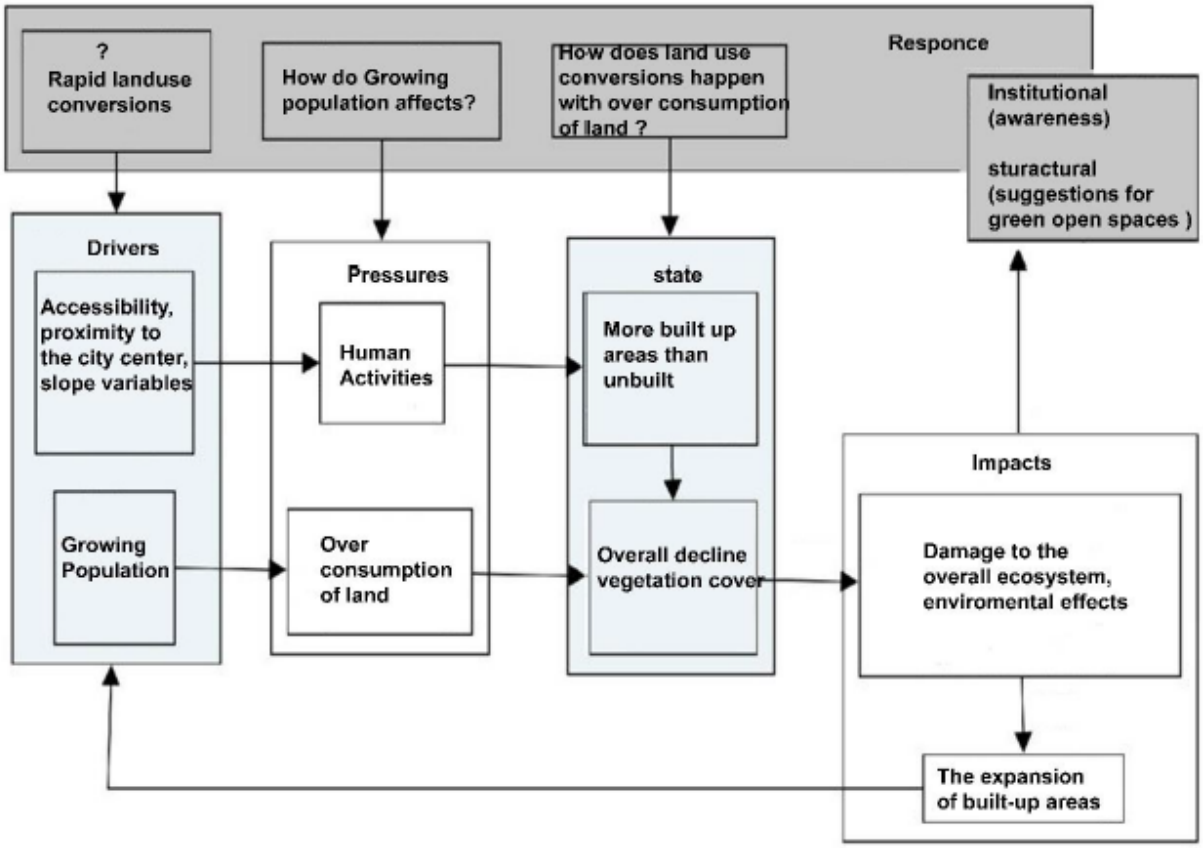

Figure 4.25. The DPSIR framework (Source: Organized by the author (2023)).

As from the listed Driving Factor's listed in the figure 4.24 above and filtered major driving factors and the DPSIR frame work in the figure 4.25 above. From them identifying which activity is responsible for these fast and frequently uncontrolled, unexpected land use conversions? It is the growing population. As the Pressures- How do the fast and frequently uncontrolled, unplanned land use conversions influence the rising population? That is, there is an unsustainable use of land. As a State – How does land use conversions occur as a result of excessive land consumption? The average loss in vegetation cover and the expansion of built-up regions are examples of this. As an Impact, what are the consequences of the changing state? Environmental effects/damage to the wider spectrum. Response, how do we response for the impact? Institutional, encouraging education on blending natural environment into built-up areas and the advantages of doing so structural, implying Greenland within a particular distance of the buildups.

It is demonstrated that, over the study years, built-up areas are fast developing despite a general loss in vegetation cover. Step by step creating scenario narratives on how did the driving factors behave on this change.

- Determining the driving forces, the population growth, and the ratio of land use change over population rate, and the policies that is directly helping to the development of built-up areas the value given to construction instead of sustainable usage of land.
- Distinguishing the drivers to key uncertainties. Population growth (Predictable), Economic growth (which is highly unpredictable), Traffic density (predictable), Technology adaptions for change. (Slow changing phenomenon), Political situations, Investments (slow changing phenomenon).
- How did those driving factors behave for the change in land use within the increase land built ups and general loss in vegetation cover. I.e. environmental impacts. By this stage, other land-use conversions to built-up areas are expected to continue in the wide city's southern, southwestern, and northeastern regions, owing to unequal geographies of road accessibility, closeness to the city center, and slope characteristics. This occurred expansion of built up areas mostly results in a rapid and dramatic decrease in agriculture especially to the borders of the city (the west zone of industry) which rapidly changing to build up areas with in the recent 2-3 years. The expansion's transition probabilities could subsequently be used to determine the potential changes for future environmental consequences. Informal settlement expansion will be expected for the next decades unless policy and regulations has to be formulated to regulate what the informal settlement contributed to the current land use change. Natural population increase and migration from rural to urban areas are expected to continue.
- Scenario immersion – By the current situation of Bahir Dar city, the rapid change in land use coverage will actually lead to major effect to the city’s water body’s and also climate condition. how to improve this expected scenario? What to do for the future?

  Risk assessments and climate action plans co-generated with the full range of stakeholders and planners will be most effective way to consider. Proper urban planning and land use management are required to prevent excessive expansion into nearby rural towns and overpopulation in core metropolitan districts. To this aim, municipal stakeholders, particularly city administrators and urban planners, might consider adopting successful

urban planning methods by establishing new sub centers and developing road infrastructure. Climate action is enabled through improving city sustainability, developing strong city institutions, and engaging in city partnerships. This will help to Access to both municipal and outside financial resources is necessary in order to fund climate change solutions.

Chapter Five: Conclusions and Recommendations

5.1. Conclusions

Changes in land use and land cover have a variety of effects on all geographical and chronological scales. It has grown to be one of the main issues for managing natural resources as well as environmental change as a result of these consequences and influences. To forecast future developments, establish decision-making processes, and create alternative scenarios, it is crucial to understand the intricate interaction between changes and their drivers over place and time.

By combining GIS, remote sensing, and other analytical methodologies, this study has been carried out. These strategies were used to identify and examine modifications and conversions in land cover classes. In the first portion, land cover maps were produced using a maximum likelihood supervised image classification using satellite data for the research periods of 2000, 2010, and 2020. Processes for accuracy evaluation and change detection have also been completed. The investigation of the changes that took place in the city throughout the chosen study years is the necessitated data from image classification accuracy. Then data collected from selected stakeholders through questionnaires', personal interviews and focus group discussions that involves the determinant factors and actors behind the land use conversions were used as a supporting analysis for the study.

The southern end of Lake Tana, where Bahir Dar is located, is where the Blue Nile starts its lengthy journey, is in northern-western Ethiopia. In the 1960s and 1970s, Bahir Dar rapidly grew. The central government constructed it as a market and transportation hub for the economic development of the Blue Nile basin and Lake Tana. Urban expansion factors that compete with one another include the distance from the central business center, the distance to major roads, and the distance to water bodies.

Important variables affecting the degree of rapid land use conversion were identified in this study. Hence, the increase in population size, migrants from urban and satellite cities, the topography of the city, the musicality intended plan, informal land access residential preference, political, economic and cultural centrality played a significant contribution for the rapid land use conversion due to expansion of the city.

The increase in population size leads for the increase of needs of residential house and infrastructures. This further leads for the expansion of the city by changing the agricultural lands in to built-up areas. This result is supported by one of the previous studies (Naab. et al, 2013).

Accordingly, Bahir Dar's built-up areas changed from 1437 hectare in 2000 to 2906.24 hectare in 2010, and then increased by amount 8227.14 hectare in 2020, according to its trend analysis of land use conversion. This illustration demonstrates that the LULC change rate was increased with high land use conversions.

From the survey results The 57 survey respondents found that the city's quick land use changes were mostly caused by population expansion, residential preferences, and Bahir Dar's position in regional politics, business, and culture. As a result of the city's expanding political, economic, and cultural prominence as well as its growing population, this gives rise to the idea of interconnected determining elements, such as the preference for residence.

A lot of individuals being migrant from the rural and satellite cities due to different reasons also leads for the expansion of Bahir Dar City by rapid conversion of the productive agricultural land in to built-up areas. This result is also similar with results obtained from the previous studies conducted in Ethiopia (Assefa, et al., 2021). People are running from rural areas to urban areas because of shortage of land in the rural area to be daily laborer such carpenter and other participation in building houses of urban people. This also helps to gate alternative means of income.

Land brokers in the city also facilitates for the expansion of the city. The municipality has large areas of land for lease for those people living anywhere. In this procedure, land brokers participate to get profit from the lease they obtained. This result is supported by the studies conducted previously (Zhong, T., et al., (2020).

Bahir Dar city is the capital of Amhara region and this leads for the city to become the center of politics, economic and cultural activities (Damu, Z.Y. (2012). Governmental offices are built-up every year by converting the agricultural land to construction use. Hence, the city expands horizontally every year and agricultural land is considered to be catmint area of the city (Haregeweyn, N., et al. (2012). Because of this, the satellite cities such as Meshenti, Chice Abay, Zege and Zenzelima are now considered as part of the Bahir Dar City.

Both the primary and secondary data source in this study revealed that rapid population growth in the city, intended plan of the municipality, informal land access, migration of individuals from rural areas to urban to become daily laborer, housing preference, topography of the city, Political and economic activities were main driving forces for the rapid change of the productive agricultural land into built-up areas. This is why every year, we are facing unexpected price of agricultural products. If the municipality continues in delivering of the land for horizontal expansion, Bahir Dar city will join with other urban areas like Merawi. Hamusit, Adet and other catchment areas of the city by converting agricultural land into built up areas.

The study in general suggests there should be ensured balanced horizontal expansion of the city with the integration of vertical developments, multimodal development such as resources and junction improvements at a higher density than the surrounding area, while imprinting the built-up structures; a productive green belt should be employed as a guiding structure, can be considered as a solution for reduction of urban expansion and this further leads to reduce the rapid land use conversion.

5.2. **Recommendations**

This study recommends that the municipality should think alternatives for housing preference and other demands of land. One of these alternatives may be vertical increase rather than horizontal such as condominium, considering slum areas for built-up areas. Many people in the city have two or more houses whereas; others have high demand to get residential houses. Many people in the city wrongly took land for housing one by the name of husband and the other by the name of wife considering them as divorced but they are living together. Therefore, this study recommends that, there should be a strict land audit in the city for fair distribution of housing preference. This study also recommend that there should be restricted planed jointly worked with stockholders such as the city municipality with regional urban bureau.

The subsequent recommendation points are based on research questions and findings addressing the impact of land use conversions and mitigating approaches to manage the expansion trends.

- Being reachable through a condensed scenario combining process is always a good thing. Flexible or multimodal development is beneficial for a large city like Bahir Dar because of the helpful linkages and relationships that occur with in it, such as resources and junction

improvements at a higher density than the surrounding area. Using the land between the nodes for the lower density will be made easier by this.

- Coverage of greenery and a city's environmental state are two positive representations of a city. According to the study's findings, the city of Bahir Dar is expanding in more built-up areas than are covered by vegetation. The preservation of those regions, along with the city's diminishing urban-agricultural areas that nevertheless provide ecosystem services, can act as the structural support for the spatial organization of urban-rural linkage in the socioeconomic and environmental sectors. While imprinting the built-up structures, a productive green belt should be employed as a guiding structure.
- The river Abay and lake Tana are brought up first as symbols of the city. The river, the lake, and wet land habitation's provisions connecting people to bluish infrastructures such as green spaces and wet land productive farms, that in all sectors help as if it is integrated with the city's future expansion plan land use conversion strategies, should be constituted.
- When viewed on land, the majority of the land uses that the study analysis of land sat pictures and from the structure plan presentations represented were inverted. As most of the city's land uses are planned, there is no pure land use category for them. Even the structural plan is concentrated on the structural aspects that significantly affect the entire city and the sub-city levels, which means the nonstructural aspects need in-depth research and community involvement.
- Seeking strategies like innovative growth and infill development that protect the fertile agricultural land that is being used and implemented for the preference of housing and industries in the cities expanding directions is important because of the city's rapid expansion and change of land use. For a better balance of land between the built-up areas and both the agricultural and green covers of the city's surrounding satellite towns, there should be ensured balanced horizontal expansion of the city with the integration of vertical developments.
- Inclusive development on land use allocation is necessary, and plans should be implemented more easily without compromising the safety and wellness of the city's residents. The loss of greenery should be compensated for by other innovative approaches like vertical agriculture, environmentally friendly architecture, and other environmental mitigation techniques like reforestation.

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Annex I: Publishable Manuscript

Predcitors of land use conversion due to Urban expansion in Bahir Dar City. North west Amhara region, Ethiopia

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ABSTRACT

Background: *The most visible kind of global environmental change happening at spatial and temporal scales is land use/cover (LULC). Land use is an indication of complex human activities that modify land surface processes, whereas land cover is the physical and biological cover of the land surface. Human effect on the environment is shown by the change of natural land to artificial landscapes. Therefore, the main objective of current study was identifying predictors affecting land use conversion through urbanization in Bahir Dar city, North-West Ethiopia.*

Methods: *The study was conducted in Bair Dar City, North-West Amhara region between 2000 up to 2020. The study was carried out based on both qualitative and quantitative approaches employing spatial analysis of remote sensing and GIS techniques and survey methods. In this study both primary and secondary data sources were used via questionnaires, focus group discussions, interviews, and inspections. Satellite images, secondary documents, and standards are used to gather the secondary data sources.*

Results: *The results in this study indicate that urban expansion, population growth, city topography, and the increase in residential preference, political, economic and cultural centrality, activity of land brokers, informal land access, rural people migration and intended plan of the municipality significantly affected the degree of rapid land use conversion. The extent of change was 9% between the years 2000-2010. The highest rate of change occurred between the years 2010-2020 which was 25% change in land use conversions.*

Conclusion: Accordingly, Bahir Dar's built-up areas changed from 1437 hectare in 2000 to 2906.24 hectare in 2010, and then increased by amount 8227.14 hectare in 2020, according to its trend analysis of land use conversion. This illustration demonstrates that the LULC change rate was increased with high land use conversions. The authors in study recommended there should be ensured balanced horizontal expansion of the city with the integration of vertical developments, multimodal development such as resources and junction improvements at a higher density than the surrounding area, while imprinting the built-up structures; a productive green belt should be employed as a guiding structure, can be considered as a solution for reduction of urban expansion and this further leads to reduce the rapid land use conversion.

Keywords: GIS, change assessment, urban expansion, land use land cover, actors and factors.

INRODUCTION

The biggest issues, the globe will confront in the next century, are predicted to be changes in land use and land cover. Research indicates that there is a clear global trend toward urbanization [1]. Urbanization, often known as the process of urban growth, is a universal phenomenon. Rapid population increase, a rise in the number of people working in non-agricultural sectors, and a switch from agricultural to built-up urban form are all examples of this [2].

The trend of more people relocating to metropolitan areas is known as urbanization. People shifting from rural to urban areas is the main source of urbanization, which results in an increase in the population of cities and the size of urban regions. These demographic fluctuations have also had an impact on other aspects of land use, economic activity, and culture. The economy and society have always undergone considerable changes as a result of urbanization. For example, living in a city is linked to higher levels of literacy and education, better health, lower fertility, longer life expectancy, greater access to social services, and more opportunities for involvement in politics and culture [3].

Over the past 50 years, there has been a noticeable urbanization in many emerging countries, which appears to have coincided with an overly high level of urban population concentration in extremely large cities. For a number of reasons, including rural-to-urban migration, social, cultural, economic, and technological transformation, as well as rapid population growth, this rapid urbanization in developing countries results in LULC changes and environmental problems that are generally described as rapid and uncontrolled.

Ethiopia is one of the least urbanized countries in the world with about 18% of its inhabitants living in cities today [4]. However, this trend is changing, much like in many other developing countries. At more than 4.0% annually, Ethiopia has one of the highest rates of urbanization in both Africa and the entire world [5]. Given the decline in environmental quality shown in all populated neighborhoods surveyed as a result of the loss of trees and other greenery, there are doubts regarding the efficacy of green space regulations. The introduction of the motor vehicles, improved communications, and internal political developments in Ethiopia all had a substantial impact on the country's urbanization process [6].

Bahir Dar, the capital city of Amhara region, is located in northern-western Ethiopia, at the southern end of Lake Tana, where the Blue Nile begins its long voyage. Bahir Dar city is one of the largest and most rapidly expanding cities in Ethiopia. It is the political, economic, and cultural center of Amhara National Regional State (ANRS), the second-most populous region in the country. In addition, the city is one of the major tourist centers in the country because of its cultural heritage (such as the Lake Tana and its Monasteries) and natural attractions (such as the Blue Nile Falls) [7]. The highest level of land cover conversion for new residential settlements and industrial uses has thus been used in Bahir Dar city.

Numerous studies have been done to determine how the land use and cover of the rapidly growing metropolis of Bahir Dar have been evolved [8-10]. The main variables, measurement methods for measuring horizontal urban expansions, effects of LULC changes, and important land management determinants have not been explored in great detail. Their primary areas of interest in the previous studies were the expansion of metropolitan areas, their effects on the environment, and the socioeconomic effects on local communities' ability to support them [11]. However, the previous studies lacked in assessing the future scenarios and identifying potential indicators that would reveal if the influence on the LULC actors and drivers generate will be positive or negative [12]

Assessing the horizontal expansion helps to identify the trends of urban expansion in the various time periods. This also helps in identifying the key actors and factors responsible for the city's expansion and future impacts, the study, which focuses on this area, seeks to fill a gap in the negligible literature. Therefore, the current study aimed to assess the land use and land cover changes (LULC) and future impacts of Bahir Dar city, North-West Ethiopia.

METHODS AND MATERIALS

The study area

The study was conducted in Bahir Dar city located in North-West Ethiopia. Bahir Dar, the capital of the Gojjam province, expanded quickly in the 1960s and 1970s. It was built by the central government as a market and transportation hub for Lake Tana and the Blue Nile basin's economic expansion. Along the Addis Ababa, Debre Markos highway, Bahir Dar is located 567 kilometers from Addis Ababa. Correspondingly, the population living in urban areas is about 4,089,997 (18.72% of the region’s population) of which 1,927,880 are male and the remaining 2,162,117 females. The percentage shares of male-urban and the female urban are about 47.13% and 52.86%

respectively. The city's total area is 213.43 km2, with a population density of 1, 864.4 people per square kilometer[13].

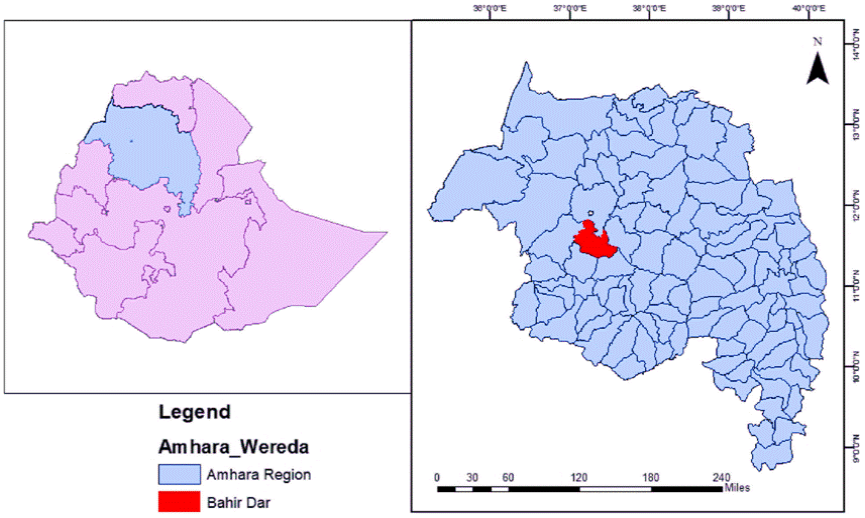

Figure 1: Location map of the study area. (Source: Bahir Dar City Administration, (2013)).

Data collection Instruments

By evaluating trends in urban growth and figuring out how they affect LULC changes by merging observations, remote sensing, and GIS techniques over a period of chosen years, it is possible to detect and analyze changes in Bahir Dar city's land use and land cover (LULC). This is accomplished by locating the possible actors and determinant factors affecting for these trends.
An explanatory study design is better to examine trends in urban growth and how they affect LULC change in the context of Bahir Dar city. Both qualitative and quantitative approaches, as well as primary and secondary data sources, were employed to address the study's stated objectives. Utilizing data gathering tools such closed-ended and open-ended surveys, Questionnaire's', observations, and other primary data sources were also used. Remote sensing was used to gather the secondary data sources, which is processed and analyzed using GIS.

Source of Data

In order to accomplish the study's objectives, both the quantitative or statistical data type and the qualitative or descriptive data type were drawn from primary and secondary data sources. In order to successfully complete the study's intended objectives, accurate information has been used. Accordingly, there have been two categories of data sources: primary and secondary.

Primary Data Sources

The city's main frequent observations and closed- and open-ended questionnaires for the community, each kebele administrator, and officials and specialists from the Bahir Dar Land Development and Management office has served as the primary data sources.

Focus Group Discussion

A focus group discussion with the chosen people, officials, and communities from the sampled zones of expansion were held to further analyze the change in land use and cover. This focus Group discussion included aged peoples who lived 10 years and above in the study area, youths and community leaders. This makes it easier to understand the perspectives of relevant parties and realistically bolster the questions posed.

Interviews

One of the basic methods for gathering data is conducting interviews. This makes it easier for this study to gather opinions about the effects of changing land use and land cover from people, particular officials, and the local community. From the particular officials the Bahir Dar city municipal urban planning and implementation office and for the local community the leaders of community associations, representatives for that specific kebele were included.

Inspections

A set of regular checks, observations, and verification procedures, recording sheets and checklists were used to collect observational data in the most consistent manner possible, including pre-set questions and pre-determined responses.

Secondary Data Sources

Books, journals, government reports, websites, legal records, satellite images, records from prior studies, population data, and Ortho photo from Bahir Dar city's Land Planning and Management Office data has been used as secondary sources of information for this study. Secondary data can be obtained from the government officials, literature reviews, previously done researches and documented data to support the analysis.

Sampling Techniques

Sampling Method

Officials of the Bahir Dar city Land administration office (the municipality) representatives of the government, academics (Bahir Dar city municipal urban planning and implementation office), the public (the communities that live and lived for about 10 years and above in the city, and on the new resettlement areas, and the kebele admin (Zenzelima kebele administration officials, Sebatamit kebele administration officials, Yibabyinesa kebele administration officials, and Zege kebele administration) where the main expansion direction of the city expected to be, has been utilized as the target group in a purposive using professional sampling technique. This is aided in gathering data about the primary determining factors and actors behind the expansion of Bahir Dar City as well as what the municipality recommendations regarding these changes to the land use and cover in relation to the new resettlements and in deciding the direction of expansion.

Through the use of a purposive sample technique, people who have resided in Bahir Dar city for at least 10 years has been selected from the communities that contain places where land uses have changed to other purposes than the structure plan suggests. These people can provide detailed information on how land use has evolved over time, from what it was to what it is now, and how that change has impacted the current situation of the community.

The communities that were in the city's main expansion direction but were relocated from there due to the recent displacement that is taking place would be subject to another purposive sampling. These people provided in-depth information on how the new expansion strategy affects their past way of life, their current living situation, and the state of the city.

Sampling Frame

The Bahir Dar city municipal urban planning and implementation experts, the Kebele administration officials, communities in the city that were chosen based on the direction of the city's expansion were the respondents to this survey. Data regarding the complete study population samples of experts, officials, communities and kebele administrators has been generated and decided under the sample size determination. This will be accomplished by gathering information from the municipality and kebele authorities.

Data from the city of Bahir Dar and the kebele offices, as detailed below, in order to choose the sample size

from the total informant data regarding the municipality's urban planning and implementation office experts, officials, kebele administrators, and communities in the city. This information was used to determine the sample size for the entire research population samples of experts, officials, communities, and kebele administrators.

Table 1: sampling frame for office administrators and experts.

No.	Intended population	Kebele	Gender		Total number of employees
			Male	Female	
1	Bahir Dar city Municipal urban planning and implementation office experts.	-	59	8	67
2	Officials and experts in kebele level.	Zenzelima kebele	3	2	5
		Sebatamit kebele	2	1	3
		Yibabyinesa kebele	2	1	3
		Zege kebele	2	2	4
					82

Source: Bahir Dar city municipality urban planning and implementation Office (2022).

From the total population of Bahir Dar city, there are six urban sub cities. Dividing the city into 6 clusters (each cluster is the sub city of Bahir Dar). From the six sub cities, 30% (3 sub cities) was selected using simple random sampling (lottery method).

Then from each cluster, about 50 samples, living for 10 years and above in Bahir Dar city were selected. The selected sub cities were: Gish Abay, Facilo, and Tana sub cities.

Total population living in the selected sub cities is N=N1+N2+N3= 168,441

Where N1=Population living in the Tana sub city= 66,881, N2=Population living in Facilo sub

city=47,454 and N3=Population living in Gishe Abay sub city=54,106. Of these populations about 50 participants were selected using stratified random Sampling technique.

Hence, by using proportional allocation, the sample size was determined using the following formula;

$$ni=Ni/N*n, \text{ where } i=1, 2, 3$$

Applying the above formula, about 20, 14 and 16 participants were selected from N1, N2 and N3 respectively.

Variables under study

Dependent Variable: In the current study land use conversion was considered as dependent variable.

Independent variables: The independent variables considered under the current investigation were urban expansion, population growth, city topography, the increase in residential preference, political, economic and cultural centrality, activities of land brokers, informal land access, rural people migration and intended plan of the municipality

Methods of Data Analysis

In data analysis, descriptive statistics graphs, Likert scales Maps, trend analysis; change detection analysis, spatial expansion rate analysis, and qualitative data analysis were used.

RESULTS

In Figure 2 below, the land cover maps produced by a maximum probability supervised classification and a post classification method are shown. The built-up areas have grown, as evidenced by the numbers, from (1437 hectares) 5% of the study area in 2000 to (2906.24 hectares) 14% of the study area in 2010 and (8227.14 hectares) 39% of the study area in 2020 as shown in Table 2. This is because of the infill developments for residential communities, which shows the built up regions are consuming a lot of other LULC types because of purpose shifts. The growth of built-up areas indicates that agricultural property nearby is being used more frequently as urban expansion space (specifically the area around the airport and the industrial zone to the west, the Abay river to the east, and the Sebatamit town limit to the south.)

While the city's open ground or usually called the unbuilt areas shrank across all years, as shown in Figure 2 below and in Table 2. Figure 2 shows that the un-built areas decreased from (8534.94 hectares) accounted for 65% of the study area in 2000 to (8385.94 hectares) accounted 48% of the study area in 2010. The un-built area further decreased to (7280.33 hectares) accounted for 28% the study area in 2020. This is because, during the study periods, built-up areas have dynamically grown while agricultural areas have steadily decreased. This might be brought on by a rise in population growth and the resulting higher demand for land and urban resources.

Between the research years 2000 and 2010, vegetation, including agricultural areas, increased steadily, going from 9% coverage to 24%, respectively. This is because local farmers frequently plant vegetation around water features in response to periodic wet lands especially around Lake Tana. And once more revealed a decrease from 22% to 13% between the years 2010 and 2020, this is because additional land is needed to be used for settlements afterwards built-up areas.

Table 2 indicates that, forest and semi-natural areas usually called local agricultural area have also consistently increased between the study periods 2000 and 2010, going from 17% of the study area in 2000 to 11% in 2010. The result in this study indicates that there was an increase of coverage areas of 11% to 14% the years 2010 and 2020. This result further indicates that the city's local farms planting vegetation on the wetlands surrounding the water bodies.

Water entities have been shrunk in the study area from 4% coverage in 2000 to 3% coverage in 2010. This result revealed that there was increase of town expansion 6% coverage of the study area as shown by Figure 1 and Table 2. The slight decline in water bodies and change to built-up areas in 2010 were associated with the Blue Nile River and Lake Tana's slight retreat due to sedimentation and the following use of this land for built-up areas and one of the main causes of the shrinkage of the water bodies can be attributed to the plantations and vegetation surrounding the seasonal wetlands near the lake and the river.

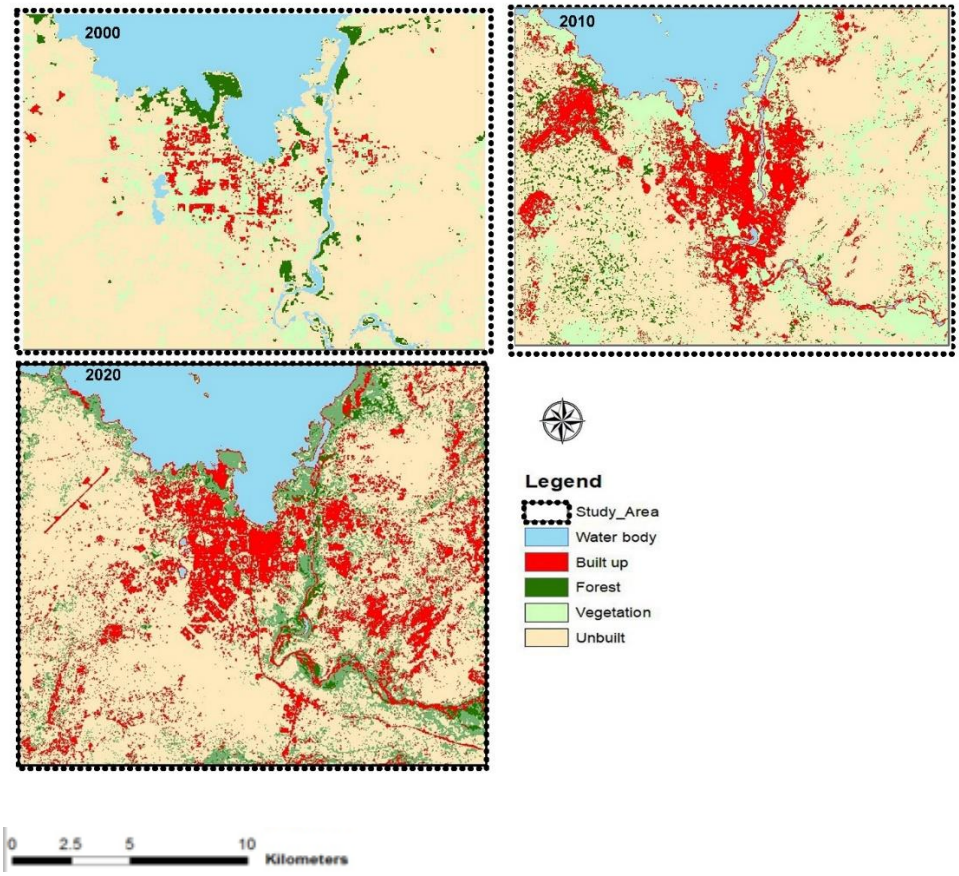

Figure 2: Supervised LULC map of Bahir Dar city for the years 2000, 2010 & 2020 G.C (Source: Organized by the author (2023)).

Table 2: Analysis of change on LULC area statistics from 2000 to 2020 (Source: Organized by the author (2023))

Land cover classes	**Year-2000**		**Year-2010**		**Year-2020**	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Built up Area	1437.00	5%	2906.24	14%	8227.14	39%
Open land (Unbuilt)	8534.94	65%	8385.94	48%	7280.33	28%
Vegetation cover	2306.02	9%	3888.24	24%	2137.15	13%

Agricultural area /local forest	2380.33	17%	2192.23	11%	2921.92	14%
Water body	536.15	4%	401.92	3%	451.32	6%
Total	15194.44	100%	17774.57	100%	21017.86	100%

Evaluation of the Classification's Accuracy

It is the responsibility of the researcher to identify the various kinds of errors present in classified land cover maps derived from remotely sensed images in order to make the maps reliable and simple for users to understand. Accuracy evaluation should be carried out since it restricts the classification outcomes of a remotely sensed imagery data once the classified image is integrated into a GIS and becomes an information source for researchers and municipal planners.

Accuracy of users

Users' accuracy is calculated by dividing the total number of pixels classified in a given class by the number of pixels that were properly categorized in that class. It shows the likelihood that a pixel labeled with a particular category truly corresponds to that category on the ground.

The built-up areas class had the highest class accuracy in 2000 (98.2%), and the agricultural regions class had the lowest accuracy (95.3%), as indicated in Table 3 below, which summarizes the study's user accuracy data. The class accuracies range from 72.4% to 100% in 2010 and from 76.8% to 94.7% in the period starting in 2020, as indicated in Tables 3 and Table 4. The lowest values of class accuracies were misclassified because distinct land cover classes share similar properties. Tables 3, Table 4, and Table 5 show that the user's accuracy was lowest for agricultural regions since some agricultural areas were predominantly misclassified as built up, forest, and semi-natural open spaces.

Accuracy of the Producer

The percentage of correctly categorized pixels in each class or category divided by the total number of pixels in the reference data that fall within that category is known as the producer's accuracy. This number indicates how accurately ground cover reference pixels are identified.

Agricultural areas were incorrectly identified as 100% in Table 3, while built-up areas were classified with a poor accuracy of 70.5% in Table 4, whereas agricultural areas had been

mistakenly classed as 100% in Table 3. Because other land cover groups, such as open spaces and agricultural areas, have comparable spectral features, the lowest values for built-up areas in Tables 3 and Table 4 were incorrectly categorized and had extensive land covering as a result of the informal settlements that were there at the period.

Overall Accuracy

The calculation is done by dividing the total number of correctly identified pixels, which is equal to the sum of the major diagonal's members, by the total number of reference pixels. It displays a summary of the tabular error matrix's findings. As shown in Tables 3, Table 4, and Table 5, the total accuracy for this study were 89% in 2000, 90% in 2010 and 94% in 2020. According to Anderson et al. (1976), the minimal overall accuracy value obtained from an error matrix should be 85% for a credible land cover categorization.

Table 3: Confusion matrix for land cover map of year 2000

		Reference Map						
Classified Map	Land cover classes	Built up areas	Open land (unbuilt)	Vegetation cover	Agricultural Areas	Water Bodies	Grand total	User's Accuracy
	Built up areas	55	0	0	0	1	56	98.2%
	Open land (unbuilt)	0	39	1	0	0	40	97.5%
	Vegetation cover	1	0	21	0	0	22	95.5%
	Agricultural Areas/local forest	0	0	0	41	2	43	95.3%
	Water Bodies	11	0	0	0	49	60	98%
	Grand total	67	39	22	41	52	221	
	Producer's accuracy	82%	100%	95.4%	100%	94.2%		
	Overall accuracy	89%						

Source: Satellite image analysis of 2000 using ArcGIS (2020).

Table 4: Confusion matrix for land cover map of year 2010

	Reference Map						
Land cover classes	Built up areas	Open land (unbuilt)	Vegetation cover	Agricultural Areas	Water Bodies	Grand total	User's Accuracy

Classified Map	Built up areas	44	2	3	0	3	52	84.6%
	Open land (unbuilt)	0	18	2	0	0	20	90%
	Vegetation cover	2	0	36	0	0	38	94.7%
	Agricultural Areas/local forest	11	3	3	63	2	82	76.8%
	Water Bodies	3	0	2	2	33	40	82.5%
	Grand total	60	23	46	65	38	232	
	Producer's accuracy	73.3%	78.2%	78.2%	96.9%	86.8%		
	Overall accuracy	94%						

Source: Satellite image analysis of 2010 using ArcGIS (2020).

Table 5: Confusion matrix for land cover map of year 2020

	Reference Map						
Classified Map	Land cover classes	Built up areas	Open land (unbuilt)	Vegetation cover	Agricultural Areas	Water Bodies	Grand total	User's Accuracy
	Built up areas	44	2	3	0	3	52	84.6%
	Open land (unbuilt)	0	18	2	0	0	20	90%
	Vegetation cover	2	0	36	0	0	38	94.7%
	Agricultural Areas/local forest	11	3	3	63	2	82	76.8%
	Water Bodies	3	0	2	2	33	40	82.5%
	Grand total	60	23	46	65	38	232	
	Producer's accuracy	73.3%	78.2%	78.2%	96.9%	86.8%		
	Overall accuracy	94%						

Source: satellite image analysis of 2020 using ArcGIS (2020).

Usage of land Analysis (LULC)

LULC in 2000

The land use/land cover (LULC) of Bahir Dar city is shown in Table 6 below and Figure 3 above, respectively, in terms of amount and map. The open land cover, also known as the unbuilt, had the largest coverage in 2000, with 8534.94ha, or 65% of the entire area inside the city limits. During this time, agricultural lands made up 2380.33 ha, or 17% of the city's total area, followed by

vegetation covers, at 2306.02 ha, or 9%, built-up areas, at 1437.00 ha, or 5%, and water bodies, at 536.15 ha, or 4%.

Table 6: LULC area statistics of year 2000

No.	LULC	Area coverage in hectare & Percentage	
		Area in Ha	**Area in %**
1	Built up Area	1437.00	**5%**
2	Open land (Unbuilt)	8534.94	**65%**
3	Vegetation cover	2306.02	**9%**
4	Agricultural area /local forest	2380.33	**17%**
5	Water body	536.15	**4%**
	Total	**15194.44**	**100%**

Source: satellite image analysis of 2000 using ArcGIS (2020)

LULC in 2010

Since many new settlements, including industries and residential preferences, were in the process of formation in the city, Bahir Dar's settlement was enlarged in the year 2010. The built-up area, which makes up 2906.24ha, or 14% of the entire city limit, was one of the land use and land cover categories with the biggest shift during this year. The open land, which makes up 8385.94 ha or 48% of the total area, is followed by the vegetation cover, which is 3888.24 ha or 24%, the agricultural area, which is 2192.23% ha or 11%, and the water bodies, which are 401.92 ha or 3% have seen a minor drop.

Table 7: LULC area statistics of year 2010

No.	LULC	Area coverage in hectare & Percentage	
		Area in Ha	**Area in %**
1	Built up Area	2906.24	**14%**
2	Open land (Unbuilt)	8385.94	**48%**
3	Vegetation cover	3888.24	**24%**
4	Agricultural area /local forest	2192.23	**11%**
5	Water body	401.92	**3%**
	Total	**17774.57**	**100%**

Source: Satellite image analysis of 2000 using ArcGIS (2020).

LULC in 2020

After a decade, the LULC for the research area received a dramatic change in 2020. Around 8227.14ha, or 39% of the total area, was built-up during this time, followed by 7280.33ha, or 28% of open ground, also known as the unbuilt, and 2137.15ha, or 13% of vegetation. This year, there was an increase in the amount of built-up land due to the purchase of undeveloped property by investors as well as the presence of informal settlements that are unsuitable for land use, which leads to an increase in built-up areas and a decrease in vegetation and forest cover. Due to the demolition of informal settlements that had been converting the area to built-up, the agricultural land, which has showed a little growth, is actually 2921.92ha, which is 14% of the city border. Water bodies made up the remaining 451.32ha, or 6%, of the area.

Table 8: LULC area statistics of year 2020

No.	**LULC**	**Area coverage in hectare & Percentage**	
		Area in Ha	**Area in %**
1	Built up Area	8227.14	**39%**
2	Open land (Unbuilt)	7280.33	**28%**
3	Vegetation cover	2137.15	**13%**
4	Agricultural area /local forest	2921.92	**14%**
5	Water body	451.32	**6%**
	Total	**21017.86**	**100%**

Source: satellite image analysis of 2020 using ArcGIS (2020).

Analysis of Land use conversion in the study area

According to a prior study published in 2018 titled "Modeling the Impact of Urbanization on Land-Use Change in Bahir Dar City," built-up areas have been progressively expanding over time. The rapid loss of farms and other greenery covering the city as a result of this expansion has forced their conversion to other uses. Bahir Dar City is one of the fastest-growing cities in terms of population growth and urbanization, as can be seen from the viewpoint images above. The growth of built-up areas indicates that agricultural property nearby is being used more frequently as urban expansion space. In particular, the vicinity of the airport and the flowing amenities, since many

industries were established and becoming the industrial zone to the west, the existence of Abay River and the surrounding settlements following the river coast to the east which usually becoming the land that is planned for new settlements of residence, and the southern edge of Sebatamit town which has a main reason of the establishment of the general hospital and commercials started to arise following the new road to Addis Ababa.

Due to the associated horizontal growth as well as the conversion of land cover classes during the various study periods, the study region has seen a spatial increase of different land use and land cover classes, such as built up areas. The reclassified images in Figure 2 above and Figure 3 below demonstrated a quick transition in land cover from undeveloped to developed areas. The most dynamic classes during those study eras were agricultural areas, which aided in the growth of built-up areas. Additionally, a resettlement strategy was implemented throughout in 2014 for better infrastructure provision and land management. Following this, many built-up areas were converted to agricultural, open green spaces, and parks between the years 2010 and 2020, as shown in Figure 2 above and in the Figure 3 below, in an effort to balance the city's rapidly expanding built-up areas.

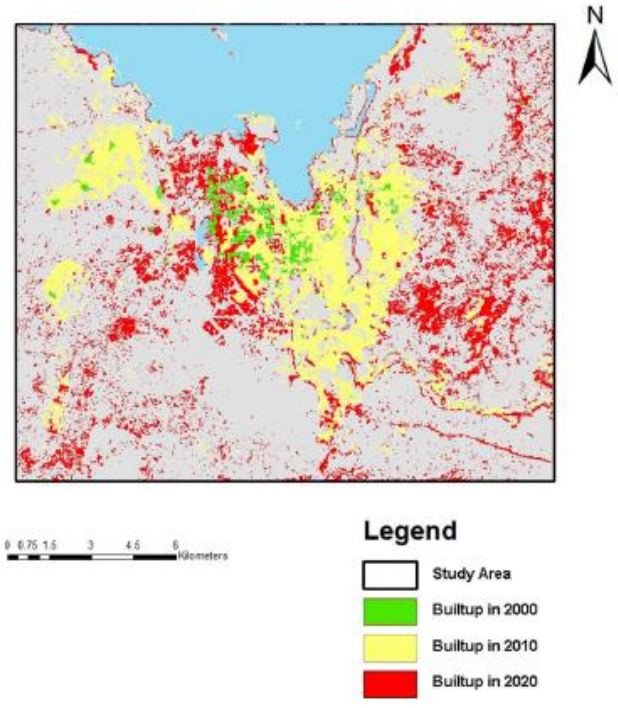

Figure 3: Overplayed LULC map analysis of built up areas of Bahir Dar city for the years 2000, 2010 & 2020 G.C (Source: Organized by the author (2023)).

Visualizing each categorization result on a separate map to highlight the growth of the built-up area in each year allows us to map and compare the changes in built-up area between the years 2000 and 2020. On the map, the built-up area for each year was represented by a different color: green for built-up area in 2000, yellow for built-up area in 2010, and red for built-up area growth in 2020. The increase in the built-up area from 2000 to 2020 is particularly notable because it virtually doubled the city's growth and added a significant amount of land, indicating the city's unanticipated rapid urban growth that enveloped the nearby non-built-up areas.

Respondents' descriptions

A concentrated attempt was made throughout the data collecting process to standardize the quality of the data by giving service seniority level of educations, educational background, and place of employment, work position, and year of employment in the position precedence. The survey's open-ended and close-ended questionnaires were both filled out by each respondent in full.

The current trends in the city as a determinant (driving) factors and actors

The land use patterns associated with urban growth contribute to a thorough understanding of the forces influencing urban growth. Those are usually called the determinant factors. The city's status as a political, economic, and cultural hub as well as its status as one of the country's top tourist destinations have both contributed to the city's development and change in land cover. These factors have also caused the city to rapidly urbanize, which has caused migration from the nearby suburbs and increased population. The issue here is the city's rapid and often uncontrolled and unplanned land use conversions, particularly in the city's southern, southwestern, and northeastern areas, which are intrinsically tied to the lake to the north, the airport to the west, the Abay River to the east, and the Sebatamit town border to the south.

Along with the growth in population, the city's uncontrolled, rapid expansion, which is closely tied to the topography and the city's intended plans, has played a significant role in determining outcome. Driving causes of informal land access include residential preference driven on by population growth, which finally results in informal land access, and among the key actors are local farmers, experts, government representatives, the community, and land brokers.

Descriptive analysis of the selected office expert’s respondents' perceptions on determinant factors

Eight (8) determining factors that greatly supported Bahir Dar city's quick land use conversions between the years 2000 and 2020 were included in the survey questions for the assessment of respondents' perceptions. For the respondents of the office experts and selected community members, five Likert scale parameters were presented. These factors included the location, population size, uncontrolled growth of the city, its topography, the city's intended plans, the informal land access, the city's character of becoming the political, economic & cultural center of the region, and the residential preference related to the population increase.

The survey questionnaires' factors for land use expansion and conversions to other purposes, which include the increase in population size, its location, its unplanned growth, its topography, City's intended plans, informal land access, Residential preference Political, economic and cultural centrality by 96.7%, 85.4%, 90.3%, 86%, 32.9%, 81.9%, 85.4%, and 56.2%, respectively, were mostly agreed by the presented factors upon by the chosen sample 7 municipal office experts. As a result, the following descriptive analysis techniques were utilized to analyze and quantify these perceptions. The following description covered measures of their distribution in order to further explain and examine the properties of perceptions as a mean, median, and mode. The results are based on Likert scale measurements from 0 to 4, where strongly disagree (score of 0), disagree (score of 1), neutral (score of 2), agree (score of 3), and highly agree (score of 4) are shown. The outputs in the Table 9 were calculated based on the value.

Most responses of office specialists strongly agreed that the population growth, unplanned expansion, topography, informal land access, residential choice, and political, economic, and cultural centrality, with an average mean of 3.43, 3.12, 3.08, 2.98, 2.82 and 2.71 correspondingly. The office experts who rate it at around 2, considered its location and intended uses to be neutral, which is mean of 2.13 & 2.07, respectively. The most common rating, which is the mode, is 3 ("agreed"), and the least common rating was strongly ("disagree") 2 value.

Determinant factors	**Mean**	**Median**	**Mode**
The increase in population size	3.43	3	3
Its location	2.13	2	3
Its unplanned growth	3.12	4	4
Its topography	3.08	3	3
City's intended plans	2.07	2	2
Informal land access	2.98	3	3

Residential preference	2.82	3	3
Political, economic and cultural centrality	2.71	3	4

Table 9: The mean, median and mode values of the expansion rates for predictors (N=7) Source: Organized by the author (2023).

Determinant factors	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
The increase in population size	56.5%	40.2%	2%	1.3%	0%
Its location	70.2%	15.2%	10.6%	4%	0%
Its unplanned growth	65.3%	25%	2%	7.7%	0%
Its topography	60.5%	25.5	4%	10%	0%
City's intended plans	12.5%	20.4%	10.2%	30%	26.9%
Informal land access	46.4%	35.5%	5.4%	10.7%	2%
Residential preference	70.2%	15.2%	10.6%	4%	0%
Political, economic and cultural centrality	20%	36.2%	10.8%	21.7	11.3%

Table 10: The descriptive data related to percentage rate of the Likert scale (N=7) **Source:** Organized by the author (2023).

Descriptive analysis of the selected community's respondents' perceptions (sub city's)

The expectation was to the general public (the communities that have lived and lived in the city for at least ten years and on the new resettlement zones), as it is detailed in Chapter 3. There are six urban sub cities within Bahir Dar's total population. Three sub cities were chosen by simple random sampling (lottery method) from the six sub cities, or 30% of them. Then, 50 samples were chosen from each cluster's population allocation, and all 50 of them were residents of Bahir Dar for at least 10 years. These sub cities have been chosen: Gishe Abay (N=20), Fasilo (N=14), and Tana (N=16), as it was presented on Table 1 above.

Correspondingly, the factors that contributed a lot for the land use land cover change of Bahir Dar city also included in the questionnaire for the city communities which includes, the location, population size, uncontrolled growth of the city, its topography, the city's intended plans, the informal land access, the city's character of becoming the political, economic & cultural center of

the region, and the residential preference related to the population increase using five point Likert scale measurement likewise.

Here too, these perceptions were analyzed and quantified using descriptive analysis techniques. The measurements of their distribution were discussed in the paragraphs that followed in order to further explore and explain the characteristics of perceptions as a mean, median, and mode. The outcomes were likewise based on ratings on a Likert scale from 0 to 4, with strongly disagreeing being represented by a score of 0, disagreeing by a score of 1, neutral by a score of 2, agreeing by a score of 3, and strongly agreeing by a score of 4. Based on the value, the outputs in the table were computed.

DISCUSSIONS

Important variables affecting the degree of rapid land use conversion were identified in this study. Hence, the increase in population size, migrants from urban and satellite cities, the topography of the city, the musicality intended plan, informal land access residential preference, political, economic and cultural centrality played a significant contribution for the rapid land use conversion due to expansion of the city.

The increase in population size leads for the increase of needs of residential house and infrastructures. This further leads for the expansion of the city by changing the agricultural lands in to built-up areas. This result is supported by one of the previous studies [14].

A lot of individuals being migrant from the rural and satellite cities due to different reasons also leads for the expansion of Bahir Dar City by rapid conversion of the productive agricultural land in to built-up areas. This result is also similar with results obtained from the previous studies conducted in Ethiopia [8, 10, 15]. People are running from rural areas to urban areas because of shortage of land in the rural area to be daily laborer such carpenter and other participation in building houses of urban people. This also helps to gate alternative means of income.

The topography of Bahir Dar city is something level as compared to other cities like Gondar, Dessie, Woldia and others. This leads for rapid horizontal expansion of the city rather than think about vertical increasing. Every year, a lot of people, organized in association, request land for house construction and the municipality is forcing to displace the farmers with small amount of

compensation and gave the land to associations for house construction and the productive lands are changed to built-up areas. This result is supported by previously conducted studies [16-18].

The municipality's intended plan also played a significant role for the expansion of the city and this expansion further leads for rapid land use conversion. Previous studies also indicate that the municipalities considered horizontal expansion of land leads for displacement of rural dwellers to get extra land for built-up areas [19-21] .

Informal land access and residential housing preference are also other factors affecting the rapid land use conversion from agricultural land to built-up areas. Government and non-government workers living in the city have high demand for built-up areas saving their money with block account, approved by the municipality. This further leads for expansion of the city by displacing the farmers in the catchment areas or cover them from producer to daily laborer [22, 23].

Land brokers in the city also facilitates for the expansion of the city. The municipality has large areas of land for lease for those people living anywhere. In this procedure, land brokers participate to get profit from the lease they obtained. This result is supported by the studies conducted previously [24, 25] .

Bahir Dar city is the capital of Amhara region and this leads for the city to become the center of politics, economic and cultural activities[26, 27]. Governmental offices are built-up every year by converting the agricultural land to construction use. Hence, the city expands horizontally every year and agricultural land is considered to be catmint area of the city[28]. Because of this, the satellite cities such as Meshenti, Chice Abay, Zege and Zenzelima are now considered as part of the Bahir Dar City.

CONCLUSION

Accordingly, Bahir Dar's built-up areas changed from 1437 ha in 2000 to 2906.24 ha in 2010, and then increased by amount 8227.14 ha in 2020, according to its trend analysis of land use conversion. This illustration demonstrates that the LULC change rate is increasing with high land use conversions. The extent of change is 9% between the years 2000-2010. The highest rate of change occurred between the years 2010-2020 which is 25% change in land use conversions of

built-up areas. It indicates that agricultural land surrounding the city has been turned into urban areas and has increased in value as a site for new residences and industries.

Both the primary and secondary data source in this study revealed that rapid population growth in the city, intended plan of the municipality, informal land access, migration of individuals from rural areas to urban to become daily laborer, housing preference, topography of the city, Political and economic activities were main driving forces for the rapid change of the productive agricultural land into built-up areas. This is why every year, we are facing unexpected price of agricultural products. If the municipality continues in delivering of the land for horizontal expansion, Bahir Dar city will join with other urban areas like Merawi. Hamusit, Adet and other catchment areas of the city by converting agricultural land into built up areas.

This study recommends that the municipality should think alternatives for housing preference and other demands of land. One of these alternatives may be vertical increase rather than horizontal such as condominium, considering slum areas for built-up areas. Many people in the city have two or more houses whereas; others have high demand to get residential houses. Many people in the city wrongly took land for housing one by the name of husband and the other by the name of wife considering them as divorced but they are living together. Therefore, this study recommends that, there should be a strict land audit in the city for fair distribution of housing preference. This study also recommend that there should be restricted planed jointly worked with stockholders such as the city municipality with regional urban bureau.

Limitation of study: This study is not without limitation. One of the limitations is that the study is conducted in Bahir Dar city. If many other cities in the region are included in this study, further information can be gathered for policy implication. Future studies are recommended to conduct research including other cities in the region such as Dessie, Gondar, Debre Birhan, and Debire Markos for regional policy implication.

List Abbreviations: BD=Bahir Dar, DC= Dynamic change, DPSIR=Drivers, Pressures, State, Impact, and Reaction, GIS- Geographic information system, GPS= Global Positioning Systems, LULC= land use land cover, RS= Remote Sensing, TM= Landsat imagery/Landsat Thematic Mapper, USGS= United States Geological Survey, UN-United Nations.

DECLARATION SECTION

Authors' contribution: *Kalkidan Gedefaw contributed in proposal development, data collection, data analysis and writing the manuscript. Birhanu Girma participated in data analysis, writing the manuscript and edited the manuscript based on his rich experience in publication.*

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Annex II: Questionnaires

Questionnaires for Government officials, Kebele administrators and Experts

Survey date_____Survey Place_____Who collected the survey_____

Greetings, Respondent

The main objective of this survey is to collect data for the research project "Predictors of land use conversions, based on urban expansion in Bahir Dar city." Ethiopia's North West Amhara Region. The objective is to finish the Master of Science (MSc) in Urban Planning requirements at EiABC Addis Ababa University. Therefore, it is expected of you to provide authentic and correct information about the factors that significantly influenced the land use conversions of Bahir Dar.

Thank you!

Part I: Background of Respondents

1. **Address (Kebele): .....**
2. **Gender:** □ Male □ Female
3. **Age:** □ 18-30 (1) □ 31-40 (2) □ 41-50 (3) □51-60 (4) □61-70(5) □above 70 (6)
4. **Level of educations:** □ Elementary (1-8) (1) □ Secondary School (9-10) (2) □ Preparatory school (11-12) (3) □TVET (4) □Higher Educational Diploma (5) □ First Degree (6) □Masters (7)
5. **Qualification background:** □Urban Planner (1) □Urban Land Administration (2) □Management (3) □ Urban Land Development and Management (4) □Geographer (5) □Surveyor (6) □Engineer (7) □Economist (8) □Sociologist (9) □Geologist (10) □Other_____ (11)
6. **Work place:** □Bahir Dar City land development and management office (1) Other.....(2)
7. **Work position:** □ Office Manager (1) □ Deputy Office Manager (2) □Kebele administrators (3) □ Deputy Kebele administrators (4) □Experts (5 □Site Supervisors (6) □Secretary (7) □Other _____(8)
8. **Year of services in this position:** □ 1-5 (1) □ 6-10 (2) □11-15 (3) □above 15 (4)

Part II: Factors that contributed for the land use land cover change (LULC) of Bahir Dar city.

What do you consider about the following elements that significantly aided Bahir Dar's rapid growth (LULC) between 2000 and 2020 G.C?

Key Factors	Strongly agree	Agree (3)	Neutral (2)	Disagree (1)	Strongly disagree
The increase in population size					
Its location					
Its unplanned growth					
Its topography					
City's intended plans					
Informal land access					
Residential preference					
Political, economic and cultural centrality					

What do you think on the key Factors who contributed a lot for the rapid expansion of Bahir Dar city between 2000 and 2020 G.C other than what is listed above?

Part III: Key Actors who contributed for the land use land cover change (LULC) of Bahir Dar city.

What do you consider about the following key actors that significantly aided Bahir Dar's rapid growth (LULC) between 2000 and 2020?

Key Actors	Strongly agree (4)	Agree (3)	Neutral (2)	Disagree (1)	Strongly disagree
The city's community					
Officials from the Government					
The investors					
Active land brokers					
Local farmers in the city					
The city's community					

What do you think on the key actors who contributed a lot for the rapid expansion (LULC) of Bahir Dar city between 2000 and 2020 G.C other than what is listed above?

<u>ለባህር ዳር ከተማ ነዋሪዎች የተዘጋጀ መጠይቅ</u>

ቀን_____ቦታ_____

ይህ መጠይቅ ዋና አላማው የድህረ ምረቃ ትምህርት ማስተርስ በከተማ ፕላን የት/ክፍል በአዲስ አበባ ዩኒቨርሲቲ ለመስራት ለጥናታዊ ጽሁፍ የሚረዳ ሀሣብ ለመሰብሰብ ነዉ። የጥናታዊ ጽሑፍ ርእስም *"Predictors of landuse conversions,based on urban expansion in Bahir Dar city,North West Amhara Region,Ethiopia"* ለባህር ዳር ከተማ መስፋፋት እና የመሬት አጠቃቀም የመሬት ሽፋን ለውጥ ምክንያት ሊሆኑ የሚችሉ ሀሳቦችን እና ይህን ርዕስ በተመለከተ ጠቃሚ መልሶች እንዲሰጡኝ በታላቅ አክብሮት እጠይቃለሁ።

የግል መረጃ

አድራሻ ፡ _____ ቀበሌ ፡ _____

ፆታ: ወንድ☐ ሴት☐

እድሜ: <30☐ 30-40☐ 40-60☐ ከ70 ዓመት በላይ☐

የትምህርት ደረጃ፡

ማንበብና መፃፍ☐ የመጀመሪ ደረጃ (1-8)☐ የሁለተኛ ደረጃ (9-10)☐

መሰናዶ (11-12)☐ ቴክኒክና ሙያ☐ ዲፕሎማ☐ ድግሪ☐ ማስተርስ☐

ስራ:

የግል ሰራተኛ☐ የመንግስት ሰራተኛ☐ስራ ፈላጊ☐ ጡረተኛ☐

<u>ለባህር ዳር ከተማ ከ1992 ዓ.ም - 2012 ዓ.ም ድረስ የመስፋፋት፡ የመሬት አጠቃቀም እና የመሬት ሽፋን ለውጥ ምክንያት ሊሆኑ የሚችሉ ፡ አስተዋፅኦ ካደረጉ ከተዘረዘሩት ምክኒያቶች ወይም አስተዋፅኦ ያደረጉ አካላት መካከል የትኛዉ ይበልጥ አስተዋፅኦ አድርጓል?</u>

<u>ምክኒያቶች ወይም አስተዋፅኦ ያደረጉ አካላት</u>	መሟሟኪያ				
	እጅግ በጣም	በጣም	በከፊል	ያንያህል	አይገናኝም
የህዝብ ቁጥር መጨመር					
እድገት በንግድ እና በአገልግሎት					
የውሃ አካላት መኖር ጋር የተያያዘ ምክንያት					
ለመኖር ተስማሚ አካባቢ ስላለ					
የመንገድ መሰረተ ልማት እና ትራንስፕርት መስፋፋት					
አማራጭ የመኖሪያ ስፍራ ፍላጎት ጋር የተያያዘ ምክንያት					
ህገ ወጥ የመሬት ወረራ					
የከተማዉ ፕላን መዘጋጀት ጋር የተያያዘ ምክንያት					
ለሌሎች ታዳጊ ከተሞችበቅርብ ርቀት ላይ መገኘት					
የከተማዉ መሬት አቀማመጥ					
የመሬት ዋጋ					
የከተማ ነዋሪ ማህበረሰብ					
አርሶ አደሩ					
የመሬት ደላላ					

ከላይ ከተጠቀሱት ምክንያቶች ውጪተጨማሪ ሀሳብ: