Analysis of Urban Sprawl spatial pattern in Akaki Kality Sub city

Addis Ababa, Ethiopia

Robel Negash Jiru

A Thesis Submitted to the department of Architecture

School of Civil Engineering and Architecture

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in Urban Planning and Design

Office of Post Graduate Studies

Adama Science and Technology University

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Adama, Ethiopia

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Declaration

I hereby declare that this Master Thesis entitled "Analysis of Urban Sprawl spatial pattern in Akaki Kality Sub city Addis Ababa, Ethiopia" is my original work. That is, it has not been submitted for the award of any academic degree, diploma or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation .

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I/we, the advisor(s) of this thesis, hereby certify that I/we have read the revised version of the thesis entitled "Analysis of Urban Sprawl spatial pattern in Akaki Kality Sub city Addis Ababa, Ethiopia"prepared under my/our guidance by Robel Negash submitted in partial fulfillment of the requirements for the degree of Mater's of Science in Urban Planning and Design.

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I/we, the advisors of the thesis entitled "Analysis of Urban Sprawl spatial pattern in Akaki Kality Sub city Addis Ababa, Ethiopia" and developed by Robel Negash hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

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LIST OF ACRONYMS

ERDAS	Earth resource Data analysis System
GPS	Positioning System
GIS	Geographical Information System
LULC	Land Use/Land Cover
RS	Remote Sensing
USGS	United State of Geological Survey
TIRS	Thermal Infrared Sensor
TIFF	Tagged Image File Format
TM -	Thematic Mapper
ETM+	Enhanced Thematic Mapper Plus
OLI	Operational Land Imager
LISS	Imaging Self Scanner
FAO	Food and Agricultural Organization
LCM	Land Change Modeler
CSA	Central Statistical Agency of Ethiopia
ECA	Economic Commission for Africa
GDP	Gross Domestic Products
UTM	Universal Transverse Mercator
GII	Geospatial Information Institute

ABSTRACT

This research aims to enhance the public's understanding of the diverse environmental and socioeconomic problems that arise from rapid population expansion and urbanization in Ethiopia. Akaki Kality is one of the 11 sub-cities of Addis Ababa, Ethiopia's capital. Since 1975 Akaki Kality was divided into two Woredas namely Woreda 26 and Woreda 27. The sub-city got its name by merging Akaki Kality. Akaki is home to a popular market called Akaki Gebeya, situated in old Akaki town. Three decades ago, most of the land in this sub-city was covered with agricultural crops and forests. The sub city is divided into 11 woreda and 135 sub woreda, as well as 683 Sefers and 1660 blocks administratively. It is home to a diverse range of residents, including factory workers, daily laborers, urban agriculture workers, civil servants, military personnel, unemployed youth and women. Due to rapid urbanization and high population influx, the area was designated as one of the ten sub-cities in 2005.The study used primary and secondary data to achieve its objectives. The primary and secondary data came from a literature review of books, legal documents, reports, and other sources. GIS and remote sensing (RS) have many applications for urban planning, change detection, monitoring, and mapping. For assessment, monitoring, and urban district expansion mapping, remote sensing provides valuable and cost-effective data from various sources, including aerial and satellite images. The study analyzed the unplanned growth of the city's-built area due to urban sprawl using GIS techniques. The study used aerial photos from 1996, 2006, 2016 and 2022 of the study areas and ERDAS IMAGINE 2015 for accuracy assessment and its results clearly show the increases in its spatial extent by 4.77 % from 1996_2006, 6.04 % from 2006_2016 and 14.95 % from year 1996-2022 though the era in which vast amount of agricultural or barren land is converted to settlement were from 2016 to 2006, forecasting dynamic change in settlements in Akaki Kality sub city would be highly dependent on the neighboring zones.

Key words: Akaki Kality, Land use Land cover change, remote Sensing,

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CHAPTER ONE

Introduction

1.1 Background of study

Land use and land cover Change often occur as a result of urban growth in various regions worldwide, including established and developing countries. These changes are particularly significant in developing nations like Ethiopia and have a notable adverse effect on the environment.

“In early 19th the construction of the railway line was stopped in Akaki. Akaki, was the starting point and destination of the railway station half a century before decided to move carts out of the city center. In the mid-1950s. Like many cities in Eastern Ethiopia, the history of Akaki commercial and trading places started in that era. Akaki, which was the first to handle trains before Addis Al-Pawla railway station, was slow to develop and later became the recipient of carts that were driven out of the city center. Akaki, where the municipality built modern brick shops (halls) in the late period, is now known not only as an industrial area but also as a commercial center. were written in the book called kentoto hamus gebeya eske merkato (1889 up to 2000) by birhanu semu Akaki Kality is a sub city located in the eastern part of Addis Ababa, Ethiopia. It is one of the largest sub cities in the city and is divided into two main areas - Akaki and Kality. The sub city is home to a diverse population and is known for its bustling markets, industrial areas, and residential neighborhoods.

Akaki Kality is home to several important institutions and landmarks, including the Addis Ababa University Institute of Technology, the Ethiopian Civil Aviation Authority, and the Kality Prison, one of Ethiopia's largest correctional facilities. The sub city is also known for its large industrial zones, which are home to a variety of manufacturing and production facilities.

The concept of urban sprawl has been a subject of debate in the past century. According to Bruegmann, it was first introduced in the US in the 20th century, but others claim that it emerged between the 1970s and the 1990s (Bruegmann 2005). Moreover, Drapar from the Tennessee Valley Authority coined the term "development" in 1937 while addressing a national planners' conference. (Ismael, 2020) Ethiopia’s capital, Addis Ababa City, is also the country’s economic and political hub. According to the CSA, the city is located at 901 48 N latitude and 380 44 24 E longitude, 2408 meters above sea level. It enjoys a wet season from June to September and receives about 1180 mm of precipitation year on average. On the other hand, a lot of urban dwellers engage in urban farming during the dry season, which runs from January to May. The city has experienced tremendous physical expansion during the past 20 years.

1.2 Statement of the problem

With the increase in area and population of Addis Ababa, the conversion of farmland and grazing land to urban use by urban policies has increased significantly (Case & Town, 2020). The most important direct drivers of land use change (LULC) are the proliferation of various farms, deforestation and infrastructure development. In addition, biophysical factors such as topography, landslides, drought and wildfires have been identified as biophysical factors underlying land use and land cover conversion (LULC).

The interplay of various factors such as economics, technology, demography, politics, institutions, and sociocultural aspects are the key determinants of land use and land cover changes, as identified in 2016. Unfortunately, Ethiopia, much like other developing nations, has been adversely affected by environmental degradation, leading to problems such as deforestation, loss of vegetation, and water resource concerns. Urban sprawl arises from the need to accommodate a growing urban population in many metropolitan areas and the need for more housing and other housing facilities. The causes of urban sprawl in Addis Ababa include:

Rural-to-urban migration and rapid population growth are increasing demand for housing and services. Land development and speculation encourage investors and developers to buy or rent properties for profit, often resulting in the eviction of the area's original residents. Land use regulations and property rights enforcement are weak, allowing encroachment on public and private land, especially in rural areas adjacent to cities.

Expanding urban areas have been linked to amplified energy consumption, pollution, traffic congestion, and a decline in community identity and cohesion. The rise in urbanization has resulted in more people residing in cities, leading to the expansion of existing urban areas and significant environmental modifications, both of which are significant forms of land use and land-use conversion change (LULC). The Mojo Branch, which includes the cities of Dukuem and Debrezeit, is the area with the highest growth rate of urban sprawl

The expansion of urban areas, known as urban sprawl, is linked to a surge in energy consumption, pollution, traffic congestion, and a decline in community identity and cohesiveness. Furthermore, this trend results in the devastation of wildlife habitats and the fragmentation of the few remaining natural areas, as metropolitan areas expand their physical and ecological 'footprint.'

According to Kassa (2014), urban sprawl is linked to amplified energy consumption, pollution, traffic congestion, and a decline in community identity and cohesiveness. Additionally, this trend results in the destruction of wildlife habitats and fragmentation of the few remaining natural areas due to the expanding physical and ecological 'footprint' of metropolitan areas.

The downtown area of Akaki Kaliti is growing rapidly, but town expansion is erratic and uncontrolled, and development is often fragmented (Ababa & Bekele, 2015). Measuring horizontal extent through the spatial analysis capabilities of GIS and RS techniques, as well as assessing key drivers and key players to determine the impact of urban expansion on land use land cover (LULC) change and future growth determining the impact is important.

1.3. Objectives

1.3.1. General objective

The main goal of this study is to investigate how land use, urban sprawl, and land cover have changed over the past 26 years in lower urban Akaki-Kality land use landcover and urban sprawl have changed over the past years since 1996

1.4.2. Specific objectives

The objectives of this study are as follows:

- To utilize GIS and Remote Sensing application to discern the extent of changes occurred over particular time periods of 1996-2022
- To identify and delineate different LULC categories and pattern of land use change.
- To examine the potential of integrating GIS with RS in studying the spatial distribution of Different LULC changes.
- To determine the shift in LULC categories through spatial comparison of the LULC maps produced.

1.4.Questions

The present investigation aimed to address the following inquiries:

1. What type of urban sprawl pattern observed since the establishments of Akaki as part of Addis Ababa administrative in 1975?
2. What are different kinds of land use and land cover were present in Akaki Kality and Akaki old Town?
3. How LULC change detected between 1996 and 2022in Akaki Kality?
4. What are the variables influencing Akaki's old town's growth?

1.5. Significance of the Study

The study provides crucial and accurate information that highlights the concerning rate of urbanization in the study area due to urban expansion. This information is vital for all land administration and urban planning activities, as it enables decision-makers, planners, stakeholders, and legislators to make informed, multipurpose decisions based on an understanding of how land use and cover are changing. This, in turn, leads to better land use policies being developed.

Application of remotely sensed data made possible to study the changes in land cover in less time, at low cost and with better accuracy in association with GIS that provides suitable for data analysis, update and retrieval, the advent of high spatial resolution satellite imagery and more advanced image processing and GIS technologies, has resulted in updating land use/cover maps.

1.6. Scope

The thematic scope of this research mainly focuses on studying urban sprawl trends and land use land cover changes detected between this period of 1996-2022. The spatial or geographic scope of the study was conducted in the case of Akaki old town, in which the second largest market and main transit corridor of our country are also having to accommodate standard services for both residents and transistors. Thematically, this study uses GIS and remote sensing to analyse and assess the impact of urban growth changes related to environmental issues over the 26-year periods of 1996, 2006, 2016, and 2022 focused on.

1.7. Operational Definitions

The process by which cities and towns typically expand geographically as a result of population growth and changing lifestyle preferences is referred to as urban expansion.

- Infilling: This type of expansion occurs when new developments are built in previously unused or redeveloped areas within existing urban boundaries. Infilling can reduce sprawl and make use of existing infrastructure and services, but it can also increase density and congestion.
- Extension: This type of expansion occurs when new developments are built adjacent to existing urban areas, forming a continuous urban fabric. Extension can accommodate population growth and provide more living space, but it can also consume agricultural land and natural resources and increase infrastructure costs.
- Linear development: This type of expansion occurs when new developments are built along existing transport corridors, such as highways or railways, taking advantage of the accessibility

they offer. Linear development can promote economic activity and connectivity, but it can also create ribbon-like patterns of urbanization that fragment the landscape and increase traffic.

- Sprawl: This type of expansion occurs when new developments are scattered across the countryside, often without regard for existing urban patterns or planning regulations. Sprawl can provide more affordable housing and personal freedom, but it can also result in low-density, car-dependent, and homogeneous communities that consume large amounts of land and energy and generate pollution and social isolation.
- Large-scale projects: This type of expansion occurs when a large infrastructure project, such as a port, airport, industrial zone, or intermodal terminal, is built in a previously undeveloped area, creating a new urban node. Large-scale projects can stimulate economic growth and innovation, but they can also disrupt the existing environment and social fabric and require massive investments and coordination.

The definition of urban sprawl is a topic of debate, but it is generally described as an unplanned and uneven growth pattern that is driven by various processes, leading to an inefficient use of resources. The primary impact of urban sprawl is on land use and land cover in the area, as it results in an increase in built-up and paved areas (Sudhira & Ramachandra, 2007). However, there is no consensus among researchers, policymakers, activists, and the general public on the issue of urban sprawl, and this lack of agreement on how to define it makes it challenging to characterize and limit this type of land development (Bhatta, 2010). Despite this, researchers have attempted to define urban sprawl in various ways.

CHAPTER TWO

2. Literature Review

This chapter not only defines urbanization but also delves into the analysis and study of land use and land cover (LULC) changes and their specific dynamics across different scales. It is essential to revisit previously introduced ideas, concepts, and practices. Relevant literature on GIS remote sensing and its application to spatial-temporal LULC research, as well as the findings to date, gaps, and the need for action, are reviewed in this chapter. Furthermore, LULC mapping and change analysis techniques and their impact on urban dynamics are assessed. Overall, this chapter provides a comprehensive overview of LULC changes and their dynamics in relation to urbanization.

Theoretical Review

In urban areas, economies of scale and economic activities are concentrated. As a result, it improves the overall financial profits of the place. As a result, people moved from rural areas to cities and sometimes even from one rural area to another urban area. These movements are known as both rural-urban migration and urban-by-migration (Doumergue &Folliot, 2010). (Doumergue & Folliot, 2010). Urban latex also spreads to the periphery because of this rise in urban population. However, due to frequent social connections and online work, this region has more traction than metropolitan areas, leading to the aggregation of many people on a smaller parcel of land than in rural areas. Two main theories of urban growth are based on this: the importance of economic gains and the function of cities in social production. (Clark 1996, as cited in Mera 2015).

It is widely recognized that the expansion of cities is the result of the growth of wealth and changing lifestyles, as well as the considerable rise in personal mobility facilitated by the use of the private automobile. The car created an automobile dependency and made the car dependent on sprawl, which led to the dispersed form of the modern metropolis. Written in 1998 by Newman and Keown. That transport creates travel demand for goods and services is understood as an underlying principle of transport economics; it is easily understood that suburbanization increases the spatial division of labour which brings about increasing mobility (Newman & Keown, 1998).

2.1 Land use/Land cover: concepts and definitions

Land cover

Before commencing the study, it is crucial to understand the meaning of Land Cover (LC) dynamics. Land cover refers to the physical material observed at the Earth's surface, including vegetation, water, soil, and man-made features. Land cover is subject to change over time due to natural or human factors. Land cover dynamics involves the study of these changes, their underlying causes, and their consequences.

Land use

Land use pertains to the process of managing and altering the natural environment or wilderness into a built environment, including settlements, and semi-natural habitats such as arable fields, pastures, and managed woods. Land use encompasses the management of land for various purposes such as urbanization, agriculture, forestry, mining, and others (Sinha et al., 2016).

The acronym LULC stands for Land Use and Land Cover. LULC change refers to the identification and tracking of long-term shifts in response to local or global anthropogenic or climate-induced factors. The framework for categorizing digital images is developed through the plan, which aims to provide a more comprehensive understanding of the information classes. The various types of LULC include:

Table 1 ESRI land use land cover classification

CLASSES	DEFINATION
Water	Areas where water was predominantly present throughout the year; may not cover areas with sporadic or ephemeral water; contains little to no sparse vegetation, no rock outcrop nor built up features like docks; examples: rivers, ponds, lakes, oceans, flooded salt plains.
Trees	Any significant clustering of tall (~15-m or higher) dense vegetation, typically with a closed or dense canopy; examples: wooded vegetation, clusters of dense tall vegetation within savannas, plantations, swamp or mangroves (dense/tall vegetation with ephemeral water or canopy too thick to detect water underneath).
Flooded vegetation	Areas of any type of vegetation with obvious intermixing of water throughout a majority of the year; seasonally flooded area that is a mix of grass/shrub/trees/bare ground; examples: flooded mangroves, emergent vegetation, rice paddies and other heavily irrigated and inundated agriculture
Crops	Human planted/plotted cereals, grasses, and crops not at tree height; examples: corn, wheat, soy, fallow plots of structured land.

Built Area	Human made structures; major road and rail networks; large homogenous impervious surfaces including parking structures, office buildings and residential housing; examples: houses, dense villages / towns / cities, paved roads, asphalt.
Bare ground	Areas of rock or soil with very sparse to no vegetation for the entire year; large areas of sand and deserts with no to little vegetation; examples: exposed rock or soil, desert and sand dunes, dry salt flats/pans, dried lake beds, mines.
Snow/Ice	Large homogenous areas of permanent snow or ice, typically only in mountain areas or highest latitudes; examples: glaciers, permanent snowpack, snow fields.
Clouds	No land cover information due to persistent cloud cover.
Rangeland	Open areas covered in homogenous grasses with little to no taller vegetation; wild cereals and grasses with no obvious human plotting (i.e., not a plotted field); examples: natural meadows and fields with sparse to no tree cover, open savanna with few to no trees, parks/golf courses/lawns, pastures. Mix of small clusters of plants or single plants dispersed on a landscape that shows exposed soil or rock; scrub-filled clearings within dense forests that are clearly not taller than trees; examples: moderate to sparse cover of bushes, shrubs and tufts of grass, savannas with very sparse grasses, trees or other plants.

Source: Karra,Kontgis,et al ”Global land use/landcover with sentinel-2 and deep learning’’ IGARSS 2021-2021 IEE International Geoscience and Remote Sensing Symposium.IEE,2021

According to the United Nations World Urbanization Report (2014), the percentage of the urban population in 1950 was 30%, increased to 54% in 2014 and projected to 66% in 2050. More recently, it has been estimated that 54.5% of the world's population is urban. (Demography, 2016). Therefore, given the current rate of urbanization, it is likely that there will be an increase in urbanization in the 3000s. (Weber, 2005). Studies show that by 2050, there will be a large disparity in urbanization between developing and developed countries, with global urban growth expected to shift to developing countries. Unprecedented rapid

growth is expected in developing countries, while it will stagnate or even decline in developed countries

Baudot (2005) and Moir (2014) predict that developing nations will account for approximately 90% of global urbanization by 2050, with India, China, and Nigeria alone contributing to 37% of global urban growth between 2014 and 2050. Moir (2014) further notes that the annual urban population growth in six major cities in developing countries - New Delhi, Mumbai, Dhaka, Lagos, Kinshasa, and Karachi - is expected to surpass that of the entire European continent. Additionally, Angel (2011) highlights that the world's urban population is projected to double in 43 years, while urban expansion is likely to double in just 19 years at current growth rates.

Although developed countries have the highest urban population, cities and towns in the developing world have experienced rapid urbanization and expansion over the last two decades from 1995 to 2015, occupying a significant portion of their environment, as stated by UN-Habitat (2016). In contrast, most people in the Third World continue to live in rural areas. Currently, Asia and Africa account for 48 percent and 40 percent of the less urbanized population, respectively. Government and municipalities have little time to plan and deliver the necessary infrastructure and services to a growing number of people as the pace of urbanization increases rapidly. (SHIFERAW, 2017).

2.2.1 Urbanization in Africa

The rate of urbanization and urban sprawl in developing countries, particularly in Africa, is increasing at an alarming pace due to the concentration of populations in urban centers. The estimated urban growth in developing nations from 2000 to 2025 is 90%, up from 57% between 1975 and 2000, as reported by Johns Hopkins University (2006). Mundia and Murayama (2013) predict that Africa will have 11 megacities with over 10 million inhabitants and approximately 3,000 cities with more than 20,000 inhabitants by 2020. Moreover, Africa is expected to triple its urbanization rate in the next 50 years (Freire, 2014; Moir, 2014). East Africa is projected to experience urban growth above the African average, according to the RUAF Foundation (2010).

Africa is changing the urbanization trends that have occurred in other parts of the world for two reasons. Firstly, urbanization is progressing rapidly. Secondly, urbanization in Africa is not leading to the expected economic growth and capital investment. As stated by Freire (2014), Africa's urbanization encounters four significant challenges:

- Rapid demographic growth, low levels of economic activity, and inadequate capital are all contributing factors.
- Detachment, a low population density, and a lack of formality close to the urban fringe
- It is difficult to improve welfare in both urban and rural areas due to the uneven distribution of infrastructure services like water, energy, and sanitation.
- Administration, organizational and global planning capabilities are flawed.

Consequently, despite the recent economic growth of some African nations, urbanization has been described as "pathological" or "dysfunctional," or non-growth urbanization. Economists have regarded African urbanization as an "anomaly" or "exceptionalism" because, unlike the rest of the world, it has not been accompanied by sustained economic growth or poverty reduction. This is according to the United Nations Human Settlement Programme (2011).

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Urban sprawl in African cities

Lagos, Nigeria

As per the arrangements of this Guideline, as per passages 1 and 2 of the Guideline of the European Parliament and of the Committee of Pastors of International Concerns, the accompanying arrangements will apply: (as of late, accentuation has again been put on the investigation of metropolitan frameworks, as urbanization stays a significant formative test, coming down on friendly, financial and natural maintainability. (Pickett et al., 2001). The world's most established number is 1900 from 2000 million to 15 million from 2000 to 2.9 billion from 2000. By 2030, 5 billion public state-run administrations were laid out. The world's metropolitan populace has duplicated by 15 from 200 million in 1900 to around 2.9 billion in 2000 and is supposed to arrive at 5 million by (Cohen, 2004).

This work creates a statistical model of urbanization by combining remote sensing and spatially explicit data. There has been relationship between land use change and quantification of the in residential and industrial/commercial areas and the determinants. Briefly it needs to say main geographical drivers of urban land use change are accessibility, neighborhood relations, and spatial policy. Rural livelihoods near urban areas may be affected by border population growth on forests and farmland. A number of institutional factors, including unequal distribution of private property, high cost of underdeveloped land, and inadequate land use planning laws, contribute to this problem Land reform. It is therefore expected that African countries will face significant difficulties and challenges due to increasing urbanization in the coming years. ((Braimoh & Onishi, 2007))

2.2. Urbanization in Ethiopia

Despite the fact that the nation was the support of humankind, a mosaic of mankind, home to in excess of 80 ethnic gatherings and old developments with a long history of the country building, none of these have added to the nation's urbanization. Didn't contribute and remained generally agrarian social orders. Before Addis Ababa was laid out as the extremely durable capital, different urban communities experienced rhythmic movements at various times, connected with the ascent and fall of rulers and the resulting shifts in power in the country. Ethiopia's urbanization traces all the way back to the nation's old and archaic history, like the development of many stone landmarks at Axum (around the first-century Promotion) and rock-cut holy places at Labella (eleventh 100 years) (Aalund, 1985). Urbanization likewise went on with the foundation of Gondar (seventeenth 100 years) and the walled city of Harar (Aalund, 1985; Marcus, 1994). Specifically, Aalund (1985) noticed that the number of inhabitants in Gondar came to 70,000 at its top, while the number of inhabitants in Harar was around 35,000 in 1875 and around 42,000 after 1885. Nonetheless, the pace of urbanization is still under a fourth of the complete populace, a long way behind even by African norms. Ethiopia is perhaps the most suburbanized country on the planet. In 2007, just 16.1% of the populace lived in metropolitan regions. In 2017, this extent was 20.4% and is assessed to be 25.4% in 2027 (CSA, 2013). At present, Ethiopia's urbanization is changing with monetary development and modern foundation not just in the suburban communities of Addis Ababa and Akaki Kality yet additionally in numerous other more modest urban communities in the country. Up to this point, the nation didn't have a far-reaching metropolitan groundbreaking strategy. At present, the Ethiopian government has made a vital metropolitan arrangement covering all locales of the nation in light of its ability and reasonableness for a future turn of events.

2.2.3 Urban planning of Akaki Kality under the city structural plan

Empress Taytu, the wife of Menelik II, founded Addis Ababa in 1886, and it was declared the capital of Ethiopia in 1889, as stated by Mikyas Tesfaye (2011) and Mulu Eshete (2015). Initially, Addis Ababa was a cluster of small villages, and by 1900, the population had grown to approximately 65,000, according to Marcus (1994). Soon the emperor gave the palace, in particular, cobbled streets and roads, railroads linking the city with the outside world, his conduits for water, electricity, telephone and telegraph services, schools, and the opening of his schools. Began to introduce modern life. Hospital (Ababa, 2020). However, the changes in urbanization initiated by Emperor Menelik did not reach a higher level due to the lack of domestic peace that had pervaded the country for many years and the occupation by the Italians. After the emperor built the first railway line, it took about 100 years for the country to build a second railway line, not only in the cities but also in the countryside.

In the 1970s, Akaki Kality would have been a primarily agricultural area with small villages and settlements. The area was known for its fertile soils and production of crops such as teff, maize, and wheat. There would have been few paved roads and limited infrastructure.

In the 1980s, Akaki Kality would have undergone some changes due to the government's efforts to modernize and industrialize the country. The area would have seen the establishment of more factories and industries, leading to an increase in employment opportunities. However, the area would still have maintained its agricultural roots, with farmers continuing to cultivate crops on the outskirts of the urbanizing area. The population would have also increased, and there would have been more infrastructure development, including the construction of more paved roads and buildings.

In the 1990s, Akaki Kality would have continued to experience significant development and urbanization. The area would have seen continued growth in the number of factories and industries, which would have attracted more people to the area seeking employment opportunities. With this growth, there would have been an increase in the construction of residential areas, commercial centers, and other infrastructure, such as schools and healthcare facilities. The area would have become more densely populated and urbanized, with paved roads, electricity, and other modern amenities becoming more common. Despite these changes, agriculture would have still played a significant role in the local economy, with farmers continuing to cultivate crops in the surrounding rural areas.

In the 2000s, Akaki Kality would have undergone further development and urbanization. The area would have seen the establishment of more businesses, including banks, supermarkets, and shopping centers. The population would have continued to grow, and there would have been an increase in the construction of residential areas to accommodate the growing number of residents. The area would have become more cosmopolitan, with a diverse range of people from different parts of Ethiopia and other countries living and working in the area. Infrastructure development would have continued, with more paved roads, public transportation, and other amenities becoming available. However, agriculture would have still played a significant role in the local economy, with farmers continuing to cultivate crops in the surrounding rural areas.

In the 2010s, Akaki Kality would have undergone significant transformation, becoming a bustling urban center with a vibrant economy. The area would have seen further expansion of businesses, including the establishment of more factories and industries, leading to an increase in employment opportunities. The population would have continued to grow, and there would have been an increase in the construction of high-rise buildings, shopping malls, and other modern infrastructure. The area would have become more connected, with improved road networks, public transportation, and access to the internet. Agriculture would have still played a role in the local economy, but the area would have become more focused on manufacturing, trade, and services. The area would have also become more diverse, with people from different parts of Ethiopia and other countries living and working in the area.

2.3 Urbanization and Development

Urbanization refers to the process of people moving from rural areas to urban areas, resulting in the growth of cities and urban centers. Changes in society's social, economic, and environmental facets frequently accompany this process. As more people move to urban areas, there is often a need for increased infrastructure development, such as housing, transportation, and public services, to support the growing population. Urbanization can also lead to changes in land use, with more land being converted for residential, commercial, and industrial use.

Development, on the other hand, refers to the process of improving the economic, social, and environmental conditions of a society. There are many different types of development, including economic development. Social development, and environmental development. Economic development refers to the growth of the economy, including increases in productivity, income, and employment. Social development refers to improvements in health, education, and other social indicators. Environmental development refers to efforts to protect and improve the natural environment.

Urbanization and development are often linked, as urbanization can be a driver of economic and social development, but it can also lead to environmental degradation and social inequalities if not managed properly. The challenge is to balance the benefits of urbanization and development with the need to protect the environment and promote social equity.

2.4 Application of Geospatial technologies:

Metropolitan sprawl is a term used to describe the unchecked growth of metropolitan areas, frequently at the expense of open space and agricultural fields. The ecosystem may suffer from urban sprawl's increased greenhouse gas emissions, loss of biodiversity, and lowered water quality, among other negative effects. The word "geospatial technology" refers to a variety of instruments and methods for gathering, processing, and displaying spatial data. Urban sprawl may be studied and tracked using geospatial technology because it offers precise and fast data on changes in land use and land cover, urban growth trends, and environmental effects. Applications of geospatial technology for measuring urban sprawl include the following:

- **Remote sensing**: The practice of taking pictures or gathering data of the Earth's surface using satellites, airplanes, drones, or other sensors. The size, rate, and direction of urban expansion, as well as its effects on flora, soil, water, and air, may all be determined by remote sensing.

2.5 Land use Land cover (LULC) planning

Land Cover (LULC) planning is a crucial procedure that involves the systematic classification of electromagnetic data visible in images into various thematic categories. These LULC maps offer valuable information that aids in comprehending the existing terrain of an area. This information is essential in some planning and management activities, as well as being a fundamental element in examining and understanding the earth's system. The annual LULC data that is made available on public spatial databases facilitates the monitoring of changes that occur over time in agricultural ecosystems, forest conversions, and surface water bodies.

2.5.1 Remote Sensing for Land Cover Change

Remote Sensing (RS) refers to the scientific and artistic technique of gathering information about an object, area, or phenomenon by analyzing data that is obtained from a device that does not make direct contact with the object, area, or phenomenon studied. It provides a wide variety and volume of data about the Earth's surface for detailed analysis and change detection using various space-based and airborne sensors. It provides powerful capabilities for understanding and managing Earth's resources. RS has proven to be a very useful tool for land cover change detection. ‘‘Over the past few decades, RS has had a major role in the study of land cover change detection. With the availability of historical RS data, the reduction in data cost, and the increased resolution of satellite platforms, RS technology appears poised to make an even greater impact on monitoring land cover change .Change detection studies of land cover are becoming challenging tasks with the availability of a wide range of sensors operating at different imaging scales and the scope of using different techniques as well as increasing opportunities for monitoring effective and accurate land cover change. Considerable research has been conducted on the various components of land cover change, including accuracy assessment, which is receiving equal attention from scientists today. In general, land cover change detection involves the interpretation and analysis of multi-temporal and multi-source satellite imagery to identify temporal phenomena or changes over a period of time.’’ (NANG,2012).

2.6 Land use/Land cover: concepts and definitions

Before beginning the investigation, it is possible to evaluate the dynamics of land cover (LC). The Food and Agriculture Organization (FAO 2016) defines land cover as the physical (bio) cover that is visible on the earth's surface, including vegetation types including forest, herbaceous/grassland, shrub land, built-up areas, agricultural wetlands, barren areas, and open water(Mougeot2000).The term "land cover" refers to the biophysical covering of land, such as lakes, forests, lakes, and natural regions. The word "land cover" refers to the many resources and characteristics found on the earth's surface. It is the biophysical system that has been seen on the earth's surface. Land use is the economical use of land for a variety of purposes, including agriculture, trade, habitation, and pleasure. There may be several and varied land uses anywhere. When it is feasible to see many economic and social systems occupying areas that are comparable, it shows the nature of a society's connection with its physical surroundings. (Sinha et al., 2016).

Land uses (LU), on the other hand, include human activities performed on the land, such as agriculture and forestry, and extend to the situation in which the land is managed(Mohan et al., 2011). Examples of land uses include agricultural land, pastures, fields, and recreational wildlife habitat plantations. LULC change is the detection and monitoring of temporal dynamics in response to various local or global anthropological or climatic changes. Information classes are thematic categories for image classification ((Owolabi et al., 2020)). These are categories of land cover types such as vegetation, maintained grassland, water bodies, and wetlands. LULC mapping is the process of digitally classifying electromagnetically digitally detectable classes of information into a number of subject categories. The phrase "urban sprawl" refers to the unplanned growth of urban areas (also known as "urbanization") as a result of population growth. The LULC categorization method was adapted from a modified version created by the New Jersey Department of Environmental, the scheme creates broader framework developing information class that guided the digital image classification same of these LULC types used in this study are five categories listed as follows:

- **Settlement or built-up areas**: Urban area is a human settlement with high population density where match of the land is covered by infrastructures including business district residential areas roads and other infrastructural facilities such as road network (highways and other major roads) power and communication etc.
- **Forest**: a dense growth of trees, together with other plants, covering a large area of land or a piece of land with many trees. It includes natural forests and forest plantations. It is used to refer to land with a tree canopy cover of more than 10 percent and area of more than 0.5 ha. Forests are determined both by the presence of trees and the absence of other predominant land uses. They are an ecosystem which includes many plants and animals. Temperature and rainfall are the two most important things for forests.
- **Vegetation areas**: These are areas dominated by density populated trees and woodlands, which is the land scape is covered by small trees or urban green space vegetation.
- **Farm lands or Agricultural land**: Agricultural lands are land cover devoted to the represent cultivated crop or arable lands. It is land covered with various teff, corn, maize, beans, and another crop production

- **Grass/Barren lands**: This land covered grasses (open area) or no grass and mainly covered with bare rock gravel pits pavement and soils or other earthen material etc. it is Vast portion of land (infertile) where plant growth may be spares, stunted and /or contain limited biodiversity. It is also lands affected by toxic or infertile soil, mining areas and climatic conditions are often key factor in poor plant growth and development.

2.6.1 Land use Land cover (LULC) mapping

The actual modification of the world's earthbound surface because of human exercises is regularly the alleged Land use land cover (LULC) change all over the planet. This adjustment of land by people to acquire business and different basics has been there for millennia; the degree, power, and pace of LULCC are far more prominent now than were before. These progressions are the main impetuses for nearby, local, and worldwide level remarkable changes in biological systems and ecological cycles. In this way, land utilizes land cover change assumes a significant part in the review and examination of worldwide changed situations today as the information accessible on such changes is fundamental for giving a basic contribution to the decision-production of biological administration and ecological deciding for what's in store. Land use land cover displaying is an interaction that measures the ebb and flow of land assets and how they are changing into a progression of topical classes, like woodland, water, vegetation, build, and cleared surface (YIRSAW, 2017).

A few investigations have decided in favor of land use and land cover change displaying (Balakeristanan and said 2012: Rawat and Kumar, 2015: Butt, 2015 Cheruto, 2016. For example, to measure the nearby changes in Makueni country, Kenya from 2000-2016. Cheruto (2016) tracked down critical land change.

For the most part, land use and land cover changes affect natural and scene credits including the nature of water, land and air assets, environment cycles, and works (Rimal, 2011). Consequently, the utilization of remote detecting information and investigation procedures give exact, opportune, and point-by-point data for recognizing and observing changes in land cover and land use.

2.6.1.2 Land use land cover (LULC) change detection

The actual modification of the world's earthbound surface because of human exercises is regularly the alleged Land use land cover (LULC) change all over the planet. This adjustment of land by people to acquire business and different basics has been there for millennia; the degree, power, and pace of LULCC are far more prominent now than were before. These progressions are the main impetuses for nearby, local, and worldwide level remarkable changes in biological systems and ecological cycles. In this way, land utilizes land cover change assumes a significant part in the review and examination of worldwide changed situations today as the information accessible on such changes is fundamental for giving a basic contribution to the decision-production of biological administration and ecological deciding for what's in store. Land use land cover displaying is an interaction that measures the ebb and flow of land assets and how they are changing into a progression of topical classes, like woodland, water, vegetation, build, and cleared surface ((Regassa et al., 2020)).

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2.7 Urban Land Use Land Cover Image Classification

Image classification is the process of segregating various categories or themes such as land cover and land use categories from raw data collected by digital satellite imagery through remote sensing techniques (Weng, 2012). The scientific community has been interested in image classification because the results of classification form the foundation of environmental, social, and economic applications (Lu and Weng, 2007). However, achieving accurate results in image classification is challenging due to several factors, including the characteristics of the study area, the availability of high-resolution remotely sensed data, the availability of ancillary and ground reference data, the use of appropriate classification algorithms, and the analyst's expertise and time constraints. Image classification involves grouping image pixels into categories or classes to generate a thematic representation, which is a crucial aspect of image processing for GIS. Image classification operations, such as image restoration, image pre-processing, enhancement, compression, spatial filtering, and pattern recognition, are applied to image data. Various image classification methods, such as artificial neural networks, support vector machines, fuzzy sets, and expert systems, can be applied to extract land cover information from remotely sensed images (Lu and Weng, 2007). However, the selection of a particular classification method depends on the methodology and the type of data to be used. Image classification approaches can be categorized as supervised and unsupervised, parametric and nonparametric, hard and soft (fuzzy) classification, or per-pixel, sub-pixel, and per-field.

2.8 Supervised Image Classification

Amarabrakemi (2013) discussed various supervised image classification methods, including Parallelepiped Classification, Minimum Distance Classification, Maximum Likelihood Classification, Mahalanobis Distance Classification, Binary Encoding Classification, Artificial Neural Network (ANN) Classifier, and Support Vector Machine (SVM) Classification.

Parallelepiped Classification involves defining regions in multidimensional data space based on the spectral values of training data, and then assigning pixels that fall within these regions to the appropriate categories. This method can be extended to as many bands or categories as needed, and decision boundaries can be defined by standard deviations instead of ranges.

Minimum Distance Classification uses the central values of spectral data from training fields to assign pixels to informational categories. Each cluster is represented by its centroid, and unassigned pixels are assigned to the closest cluster based on multidimensional distance to the cluster centroid.

Maximum Likelihood Classification estimates means and variances of classes from training data to estimate probabilities and consider the variability of brightness values in each class. This method is based on Bayesian probability theory and is one of the most powerful and widely used classification methods when accurate training data is provided.

Mahalanobis Distance Classification is similar to Maximum Likelihood Classification but assumes all class covariance are equal, making it a faster method. Pixels are classified to the closest training sample class unless a distance threshold is specified.

Binary Encoding Classification encodes data and end member spectra into zeros and ones and compares each encoded reference spectrum with the encoded data spectra to produce a classification image. Pixels are classified to the end member with the greatest number of matching bands unless a minimum match threshold is specified.

Artificial Neural Network (ANN) Classifier uses a multi-layered feed-forward ANN to perform non-linear classification. Learning occurs by adjusting the weights in the node to minimize the difference between the output node activation and the output, and the error is back propagated through the network.

Support Vector Machine (SVM) Classification separates classes with a decision surface that maximizes the margin between classes and can function as a multiclass classifier by combining several binary SVM classifiers. SVM classification output is the decision values of each pixel for each class, which are used for probability estimates, and an optional threshold can be set to report unclassified pixels.

2.8.1. Unsupervised image classification methods

(Mickael S.,2002) proposed a classification algorithm that models observed data as a mixture of mutually exclusive classes, each described by linear combinations of independent, non-Gaussian densities. The algorithm estimates the data density in each class using parametric nonlinear functions that fit the non-Gaussian structure of the data. This improves classification accuracy compared to standard Gaussian mixture models. The algorithm can be applied to unsupervised classification, segmentation, and denoising of images, and is effective in classifying complex image textures such as natural scenes and text. It is also useful for denoising and filling in missing pixels in images with complex structures. One advantage of this model is that image codes can be learned with increasing numbers of classes, providing greater flexibility in modeling structure and finding more image features than Gaussian mixture models or standard independent component analysis algorithms. This model can be used for blind source separation, denoising, fill-in missing data, image coding, independent component analysis, maximum likelihood, segmentation, and unsupervised classification.

2.8.2 Causes of urban Expansion toward Akaki Kality

One of the main causes of urban expansion towards Akaki Kality is the urban land lease policy implemented in Ethiopia since 1993. This policy allows the state to transfer land for residential, commercial and public use. Industry for private and public investors. As a result, many cities, including Addis Ababa, have seen great expansion of their borders, mainly through the conversion of farmland. This has led to urban expansion, land hoarding, and fragmentation of land use in many extended areas, such as the sub-cities Bole and Akaki-Kaity. Another cause of urban expansion towards Akaki kality is the population growth and rapid urbanization of Addis Ababa. The city's population increased from about 2.11 million in 1994 to 3.3 million in 2010 and reached nearly 4 million in 2017, creating strong demand for housing and infrastructure. In addition, the city's development has been influenced by its political and economic importance as the capital of Ethiopia and the State of Oromia, as well as the headquarters of the African Union and international organizations. Other. The third cause of urban expansion towards Akaki kality was the displacement of peri-urban farmers who lived and worked on their lands along the Akaki

River. These farmers have been evicted from their land without adequate compensation or rehabilitation plans, and have lost their livelihoods and social relationships. Some of them have been moved to government-built condominiums, but others remain homeless or moved to other residential areas. Urban expansion towards Akaki Prefecture has had a significant impact on socioeconomic and environmental conditions in the region, such as loss of agricultural land, biodiversity and ecosystem services, poverty and unemployment increase, social conflict and identity crisis among displaced farmers; and challenges for urban planning and governance.

Gaps of literature review

Several studies applied on evaluate the impact of urban expansion on land use/land cover change in deferent areas. According to (Biney & Boakye, 2021) Urban sprawl and its impact on land use land cover dynamics of Sekondi-Takoradi metropolitan assembly, Ghana by using Landsat imageries from 1991, 2002, 2008, and 2018 of Sekondi-Takoradi, together with geospatial and Shannon's entropy techniques. Other studies conducted on the Impact of Urban Expansion on Agricultural Land and Crop Output in Ankpa, Kogi State, Nigeria (Khan & Himanchal, 2019). Two methods used for data collection. The first was geospatial technology used to obtain Land use/Land cover and to check the rate of urban expansion. The land-sat image of Ankpa was acquired for three different years of 1987, 2001 and 2016 with the aid of Idrisi Andes land use change modeler and Arc GIS 9.3 used to generate the statistics to show change over the period of 29 years of study. The second data was on crop yield obtained from Kogi Agricultural Development Project. The obtained result where indicate that built-up areas had expanded, though previous studies (Khan & Himanchal, 2019) depend on the impact of urban expansion on agricultural land only but current study is conducting the impact of urban expansion on farmland, open space, and vegetation. The land-sat image of Ankpa was acquired for three different years of 1987, 2001 and 2016 with the aid of Idrisi Andes land use change modeler and Arc GIS 9.3 used to generate the statistics to show change over the period of 29 years of study.

The inclusion of these resources Such as high and medium resolution Satellite image and ground truth analysis make this research differ from previous studies because of this high-resolution satellite images and ESRI LULC provide a more precise representation of the area's land use and expansion over time and the cause of urban expansion. Furthermore, the research incorporates historical data, such as a 1975 topo sheet map, to gain a better understanding of the establishment of old Akaki town before it was incorporated into Addis Ababa's administration. GIS technology, specifically the ERDAS IMAGINE VERSION 2015 and GIS version 10.8.1, is utilized in the research to classify land use through supervised maximum likelihood and Spot 5 satellite images as input resources.

CHAPTER THREE

Methods and Materials

This study utilized various alternative approaches that incorporated different techniques and methods to gather and examine data. Among the methods employed were mixed research methods, which included both quantitative and qualitative data gathering and analysis techniques.

3.1.Description of the study area

It is found with a rough center located at 8◦4600” N–9◦11030” N latitude and 38◦35030” E–38◦57030” E longitude, Covering an area of 124 km^2. The total population of the sub city was181202 for 2007/8 data from Addis Ababa bureau of finance and economics. Overall, Akaki Kality is an important and vibrant part of Addis Ababa, contributing to the city's rich cultural and economic landscape.

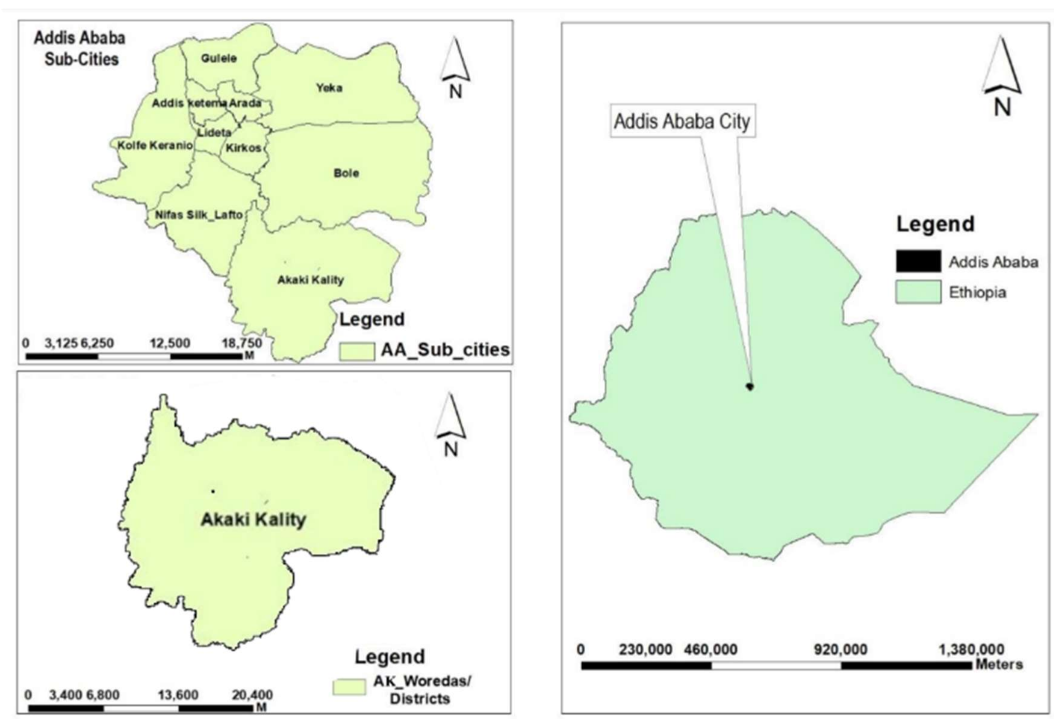


Figure 1 Location Map of Study Area

3.1.2 Climate

Akaki Kality experiences a subtropical highland climate, which is characterized by a complex blend of highland weather patterns. Temperature fluctuations of up to 10°C (18°F) can occur depending on prevailing wind patterns and elevation. The city's high altitude helps to moderate temperatures throughout the year, and its proximity to the equator means that temperatures remain relatively stable from month to month.

The climate of Addis Ababa, including Akaki Kality, is marked by two distinct rainy seasons. The first, a shorter rainy season, occurs from September to November, while the second, longer rainy season typically takes place from June to August.

3.1.3 Topography

In Akaki Kality sub city the altitude ranges from 2050 to 2331m, 281m. The highlands are located in north and east part of Kality. There are relatively small mountains, and the altitude is lower in south Akaki. Slope is measured in the slope analysis map of Akaki, as percentage rise classification in to seven different ranges, Most of Akaki sub-city land is gently to moderately sloped, 35.49% to 30%of the area respectively. Very steep land in the area comprises not greater than 3% slope. As a result of these, most of the people settled in low and moderate sloppy area (fig.4)

Large part of the urban sprawled site is flat. Starting from the northern perimeter about 1.5 KMs along the main road and 500 meters across centering the main road is in the same level. After the 1.5KM there is some level difference. The flat rectangle table of the area is centered on the main road, before two decades Akaki Kality was divided into two Woredas namely Woreda 26 and Woreda 27.

The sub-city got its name by merging the area Akaki Kality. The sub city divided administratively into 11 woreda and 135 sub woreda,683 Sefers and 1660 blocks. Most industries and factories in Addis Ababa are found in this sub city known as industry zone/city.

3.2 Data Collection Method

To determine the growth of urban sprawl over a decade, the researcher utilized SPOT 5 satellite imagery from 2006 and compared it with the classified satellite imagery obtained from the built-up area of the satellite image of 2016. The spatial analysis method was employed using RS and GIS techniques. The study area, Akaki Kality subcity, was assessed for urban expansion and changes using satellite images from 1996, 2006, 2016, and 2022. These images were downloaded from various sources such as Google Earth, SPOT 5, SENTINEL, and Explore USGS website, and then processed and analyzed using GIS 10.8.1 software. To manage the data, reshape files, and document the data, as well as represent the findings, the researcher utilized percentage, graphs, photographs, and tables.

Research Design

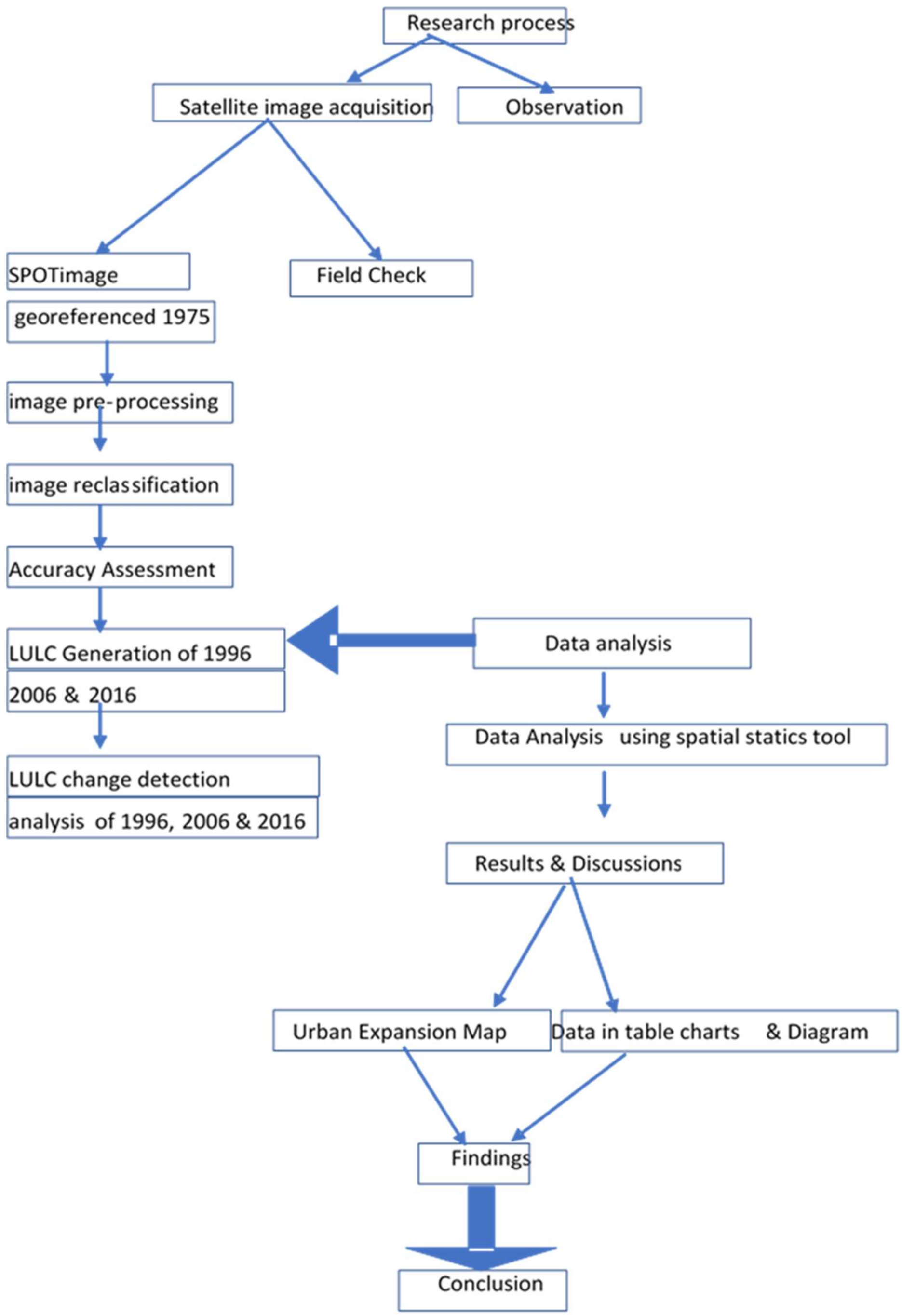


Figure 2 Research design diagram

The study used primary and secondary data to achieve its objective. The primary data and the secondary data came from literature review of books, legal documents, reports, and other sources. The study analyzed the unplanned growth of the city's-built area due to urban sprawl using GIS techniques. The study used Aerial photos from 1996, 2006, 2016 and 2022 of the study areas and ERDAS IMAGINE 2015 for accuracy assessment.

Types and Data Collection Methods

3.2.1 Data Collection Instruments

The following methods are planned to be engaged during the data collection period. These are field observations and collecting geomorphological maps of the different periods from Landsat images from USGS (United States geographical survey), Google earth, and also capturing photography.

The data collection tools applied in this study are GIS and remote sensing techniques, questionnaires, and observations. Measuring spatial expansion from classification maps generated from satellite imagery to quantify the trend of city expansion at different time period and its impact on land use change (LULC). using spatial analysis of GIS and remote sensing techniques.

Land cover change detection features are used to evaluate land use cover change (LULC) over space and time in the study area. It is the identification of variations of land cover types by observing a defined area at different times using multi-temporal data sets from satellite images. Spatial and temporal satellite images of a specific geographic area are processed and classified to create thematic maps for the years 1996, 2006, 2016 and 2022, after which the classified maps are compared and stack to visualize regional changes over time. It is also possible to calculate the increase and/or decrease of each type and see the percentage change per year.

3.2.2 Justification of Data Collection Instruments

Remote sensing provides datasets covering large areas with both high spatial granularity and high temporal frequency. It can also provide consistent historical time series data and spatial and temporal dynamics of urban development and land use change. Recently, remote sensing has been used in combination with geographic information systems (GIS) and global positioning systems (GPS) to assess land cover changes more efficiently than using data alone. Explore. Therefore, this method has proven to be useful for mapping urban areas and as a data source for analyzing and modeling urban growth and land use/cover change.

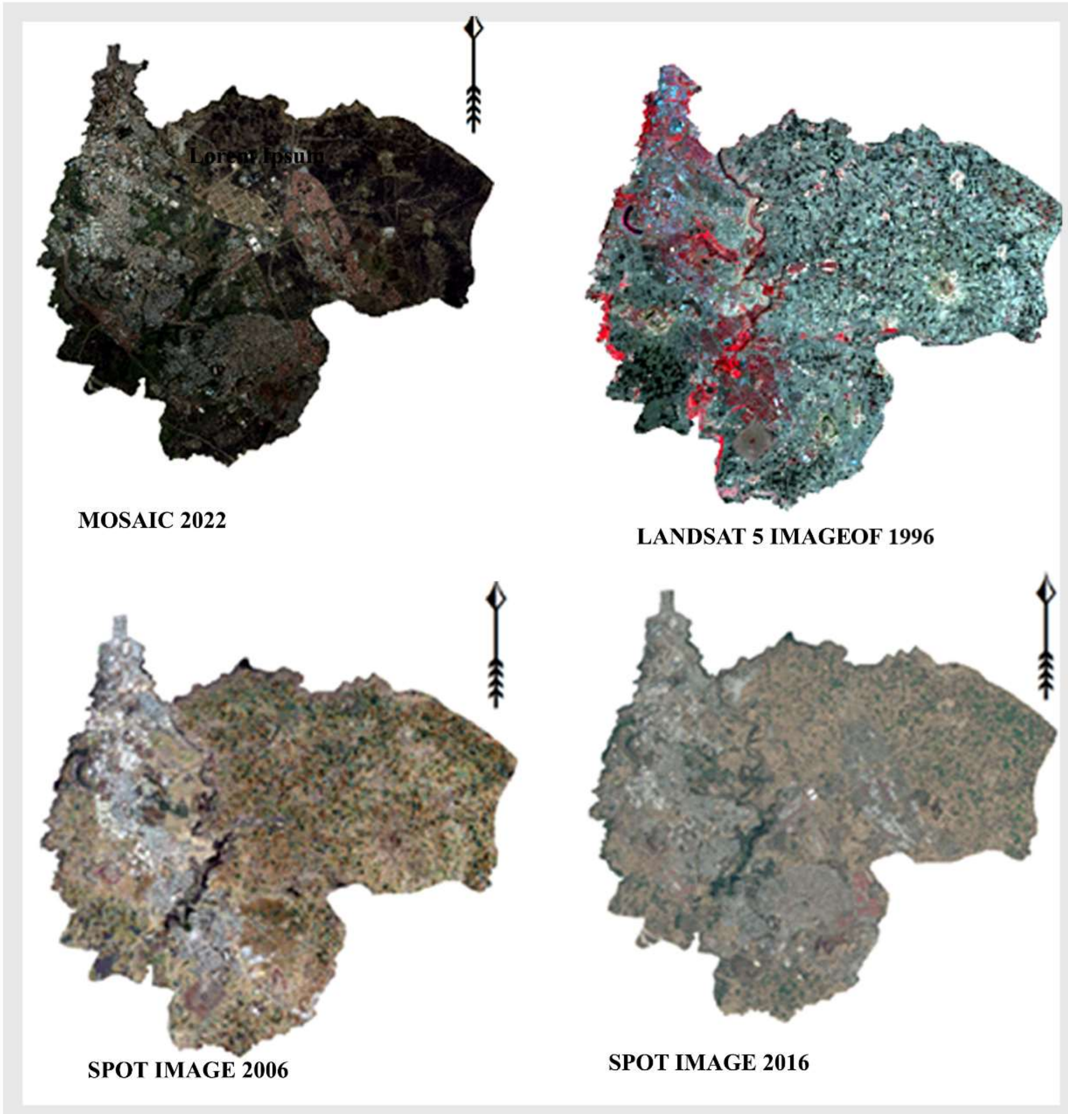
GIS and remote sensing (RS) have many applications to solve problems in urban planning, change detection, monitoring, and mapping. Remote sensing is a good alternative to provide the most valuable and cost-effective data from various sources, mainly aerial and satellite images, for assessment, monitoring, and urban district expansion mapping. Indeed, urban areas are dynamic and complex in nature, and conventional data collection methods cannot cope with the many changes that occur in very short periods of time. Data collection and processing can also be time-consuming and a better data source exists urgently needed.

Observations

Field data on the ground were collected by direct observation at the study area. The researcher observed and collected the necessary camera information about the existence of urban expansion.

Satellite Imageries

To study the urban expansion trend of Akaki Kality sub-city, Landsat/Landsat Thematic Mapper (TM) images for 1996 and SPOT 5 satellite images for 2006, 2016, and 2022 were used as sources. Data obtained from Earth Explorer. Website. However, in 1975, the Topo plate was used due to the availability of this document from the Ethiopian mapping agency. Terrain plates represent the physical features of an area. They are used to detect land use and land cover. In the January season of the year, priority is given to cloudless images for easy classification and comparison in classification activities. These data are used to generate historical land use and cover maps of the study area and urban expansion changes.



Coordinate System: WGS 1984 UTM Zone 37S
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 10,000,000.0000
Central Meridian: 39.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Figure 3 SATTEILITE images used in analysis

No	Sample Year (Gc)	Selection Criteria/Reason
1	1975,1988	In 1973, there was the first topo sheet prepared jointly by the help of British government's ministry of overseas development directorate of overseas and development overseas surveyors with Ethiopian government's ministry of land reform and administration(survey and mapping department). In 1988 there is line map generated from the layers obtained from all previous air photography.
2	2006	In 2006, Akaki Kality underwent significant urban development, which is the uncontrolled expansion of urban areas into the surrounding countryside. This expansion has been driven by population growth and entailed demand for housing, infrastructure, and services. The impact of urban expansion in Akaki Kality is enormous, as it has caused residential areas to encroach on formerly farmland and forest land, leading to deforestation, soil erosion, and loss of biodiversity. In addition, unplanned city expansion has resulted in inadequate provision of basic services such as water, sanitation, and waste management, contributing to poor living conditions for residents. in the area.
3	2016	To address these challenges, the Addis Ababa Revised Master Plan was developed in 2010, which aimed to guide the sustainable development of the city and manage the urban sprawl. The revised master plan in 2016 marked an important year.
4	2022	To achieve Addis Ababa master plan there were amendment on building height, road network and land use plan in June 2022.

Table 2 Criteria for the selection of the years

In order to map urban expansion trends and measure its effects on LULC change of Akaki Kality sub city , four periods of years 1996, 2006, 2016 and 2022 selected because during those periods the town expansion was very high and those years are critical boom period of change, for more clarification major reasons considered are specified in detail (Table ---13)To ensure ease of classification and facilitate comparison in classification activities, high resolution and high-quality cloud-free images were selected. The January season of the year was preferred to get cloud-free images.

3.2.2. Study Variables

Study variables such as the background of respondents, urban expansion driving factors and actors, land use land cover (LULC) characteristics, and rate of change were utilized in order to meet the study's objective of investigating trends in urban expansion and its effects on land use land covers (LULC) change in the case of Akaki Kality sub city.

The study area's spatial and temporal land use land cover (LULC) change was evaluated using the land cover change detection characteristics. For this purpose, five (5) land use land cover (LULC) variables were chosen: an agricultural area, a green area, a bare land or open space, a forest, and an urban area each land cover class's amount and rate of change were analyzed, along with the total areas covered by each class in each study year

3.2.3 Types of Variables and Measuring Techniques

1	LULC characteristics: Built-up area, Agricultural land, Green area, Bare land and Forest	Agricultural land, Green area, Bare land and Forest Map, graphs and charts were used	Dependent
2	Rate of change Dependent Graphs and charts were used	Rate of change Graphs and charts were used	Dependent

Table 3 Types of measuring techniques

3.2.4 Validity of Methods and Materials

The following precautions are taken to guarantee the validity of the thesis result, materials, and methods. The value of the conclusion is raised by the combination of quantitative and qualitative methods used simultaneously to achieve the results.

Furthermore, consistent historical time series data can be obtained through remote sensing; urban growth and land use change processes: spatial and temporal dynamics (Herold et al., 2003). Geographical Information Systems (GIS) and remote sensing have recently been combined to better assess land cover change (Weng, 2002). As a result, a number of academics have already demonstrated that the method is useful for mapping urban areas and serving as a data source for the analysis and modeling of urban growth and changes in land use and land cover (LULC).

To compare the results of various classification techniques, as well as the quality and dependability of the obtained results, it is also necessary to evaluate the accuracy for each category and the entire image. A sufficient number of samples, ranging from 35 to 105-pixel samples for each class, were taken, which is an important consideration for accuracy evaluation. In addition, high-resolution Orthophoto and ground truth (physical survey) were utilized to enhance the data's clarity and validity for the accuracy evaluation of the classified images

3.3 Material and data collection

Type	Data/material	Source
Primary data	Topo sheet 1975	Ethiopian mapping agency Scale 1:50000
	SPOT 5 satellite image dated January 2006,2016 sentinel satellite image 2022, Landsat 5, landsat 7 and land sat 8	Spatial resolution of 10*10 meter
	2017Sentinel-2 LULC	Karra,Kontgis,etal"Global landluse/landcover with sentinel-2 and deep learning''IGARSS 2021-2021 IEE International Geoscience
	2022 Sentinel-2 LULC	

		and Remote Sensing Symposium.IEE,2021.
Secondary data	Demographic data from primary census abstracts for 1996 and 2022	Central statistics agency of FDRE

The data collection was carried out in two phases: primary and secondary data collections. The nature of These data and their sources are shown in table 4

Table 4 Material And Data

3.3.1 Band combination

It is known that band combination is best experience to show Landsat image pixels very well or clearly visible remotely sensed Landsat image data from satellite the following table illustrates band combinations.

Band Combinations for Landsat 5, Landsat 7 and Landsat 8			
	Landsat 5	Landsat 7	Landsat 8
Composite name	bands	bands	bands
Color infrared (Vegetation)	4,3,2	4,3,2	5,4,5
Natural color	3,2,1	3,2,1	4,3,2
False color (Urban)	7,5,3	7,5,3	7,6,4 (5,4,3)
False color	7,4,2(5,4,3)	7,4,2(5,4,3)	
Agriculture			6,5,2
Land/water			5,6,4
Vegetation analysis			6,5,4

Table 5 Band combinations distribution

3.3.2 Classification scheme

A land use land cover scheme is a classification system that assigns different types of land and vegetation to categories based on their physical and functional characteristics. Land use refers to the human activities that take place on a specific area of land, such as agriculture, urbanization, or recreation. Land cover refers to the natural features that cover the surface of the land, such as forests, grasslands, or water bodies. A land use land cover scheme can help to monitor and analyze the changes and impacts of human activities on the environment, as well as to plan and manage natural resources.

Sr.no	Land use category	Description
1	Built up Area or settlement	Includes all developed areas roads, buildings, housing units, Commercial and resident areas, under construction areas
2	Farm or Agriculture land	Includes all areas employed for agricultural activities farmland parcels both with and without
3	Vegetation area	Refers to areas covered by vegetation of any type, including riverine trees or vegetation and other pockets of green areas.
4	Barren land	Refers to open spaces without any function, bare soils, rocky areas, quarries and gravel pits, grazing land, open areas in side vegetation and resident areas,
5	Crop land	Human planted/plotted cereals, grasses, and crops not at tree height; examples: corn, wheat, soy, fallow plots of structured land

Table 10 land use land cover classification scheme

3.3.3 Accuracy assessment

It is Precision evaluation and an obligatory movement after any satellite picture characterization examination to know regardless of whether the grouping system met its goal. The term "accuracy assessment" is used to confirm a classified map and ground truth data or reference data that are assumed to be accurate in order to determine the classification result's accuracy level.

A map made from any remote sensing data must be evaluated for classification accuracy. According to Congalton (1991), the necessity of carrying out an accuracy assessment has gained new interest with the introduction of more advanced digital satellite remote sensing, despite the fact that accuracy assessments are crucial for traditional methods of remote sensing. According to Levin (1999), **accuracy assessment** is the degree to which a classified map and ground truth data or reference data correspond to reality or observation.

The most commonly known method of accuracy assessment includes, producer’s accuracy, user’s accuracy, overall accuracy and kappa coefficient (Lu, 2004). All of this technique is applied for all years in order to check the performance of supervise classification activities.

Producer's accuracy: measures the percentage of correctly classified pixels from sample data or reference data taken from the field.

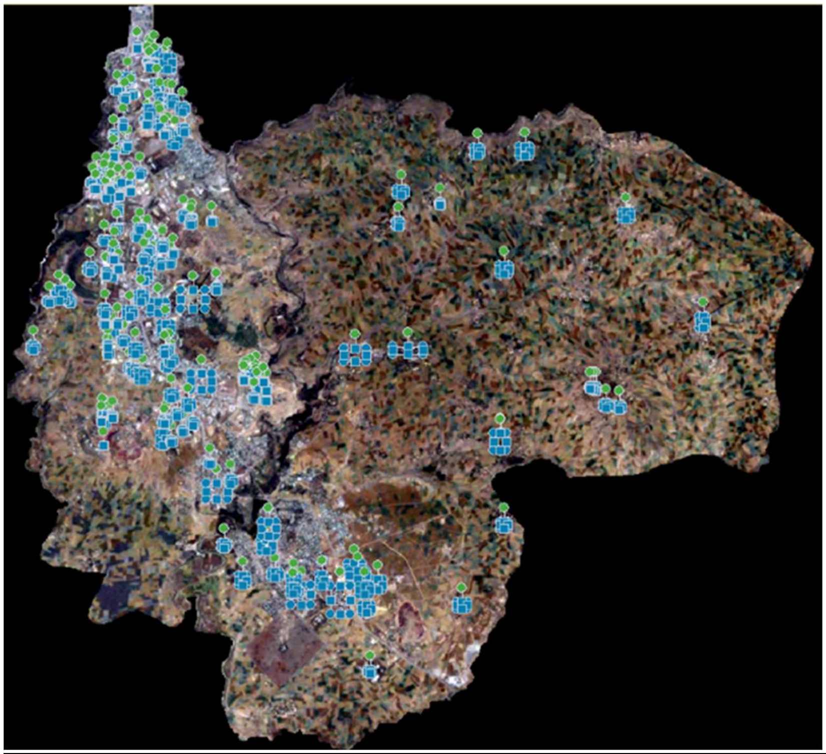
User's accuracy: measure the probability of each classified pixels category on the map Overall accuracy: also, the so-called percent correct classified (PCC) it is simply measuring the overall accuracy of the data and calculated the sum of diagonal divided by the total number of samples.
Kappa coefficient: it is a better estimate than of overall accuracy because it is a capable of controlling PCC index and incorporates off diagonal values to calculate the coefficient. represented on the ground.

Value of kappa -hat	Interpretation of agreement
0.81 < K<1.00 or 81% - 100%	Almost perfect agreement or excellent
0.61<K<0.80 or 61% - 80%	Substantial agreement or very good
0.41<K<0.60 or 41 – 60%	Moderate agreement or good
0.21<K<0.40 or 21% - 40%	Fair agreement or satisfactory
0.0<K<0.20 or <20%	Slight agreement
K<0.0 or 00%	Poor agreement

Table 6 Interpretation for argument for kappa coefficient

According to Levin (1999), existing map and field data checks can provide reference data for accuracy evaluation. The kappa analysis and error matrix, two statistical indices that should be used for accuracy assessment, are the method that is used the most frequently. Kappa analysis (Cohen 1960, Conglaton 1991) is a powerful multivariate technique that can provide information about the accuracy of image classification. It is calculated by subtracting the chance of agreement from the actual agreement of the error matrix. The range for KAPPA, which ranges from 0 to 1, is the.

Figure 4 Ground truth data



Source: usgs, Scale 1:90000 Datum: Utm Mercator

On the other hand an error matrix is accuracy assessment defined as the proportion of agreement between classified maps and the once assumed to be the correct map an error matrix consists of a serious of rows and column the headings of the rows in the columns are the classes of interest the columns contain the reference data will the rows contain the classified information the intersection the rows and columns summarize the number pixels clusters of pixel in particular category shows the matrix diagonal n number of pixel in particular category(class)(Jensen 2015) The number of correctly classified pixels is shown on the diagonal of the matrix numbers. The ratio of correctly classified pixels to the total number of pixels yields an index that measures overall classification accuracy.

Producer and user accuracy were two additional accuracy indices; producer accuracy is a measure of omission error. When a feature is excluded from the category being evaluated, errors of omission occur. It is a number that tells how likely it is that ground reference data will be correctly classified. The producer might want to know how well an area can be classified, so this statistic is calculated. In contrast, user accuracy is a measure of commission error and is calculated by dividing the diagonal number from a class's column by the sum of the entire column, including the diagonal number (Jensen, 2015).

The majority of classification problems involve "salt and pepper," also known as "speckles," which are a single or small group of pixels that have been misclassified. A majority filter is a common smoothing operation (Mather & Koch, 2011). In a majority filter, the moving window replaces the central pixel with the majority class in a specified neighborhood. In addition to "cleaning up" the image and making it appear less noisy, the smoothing process would shape every edge and improve classification accuracy. The filter window was determined using the ERDAS imagine package in this study. In the end, smoothed images will be clipped into the study area at sizes that are appropriate.

3.3.4 Change detection

Change detection involves comparing classified images from different dates to identify changes in land use and land cover over time. This process requires several steps, including analyzing the spatial distribution of changed types, determining the rate of change, identifying change trajectories of land-cover types, and assessing the accuracy of change detection results. In this study, separate LULC maps from 1986, 2000, 2010, and 2020 will be created and compared to identify changes in each category of land use and land cover. Change areas are those areas that are classified differently at different times. Change detection has been applied in various fields such as ecosystem mapping, land use change analysis, forest management, vegetation phenology, seasonal changes in pasture production, risk assessment, and other environmental changes.

CHAPTER FOUR

Result and discussion

4.1 Classification and Results of LULC maps (1976-2022)

The land cover maps were generated after running the classification algorithm for estimated maximum monitoring in 1996, 2006, 2016 and 2022, as shown in the figures below (Figure 19 - Figure 20). These maps show residential or construction areas in red, agricultural areas in dark green, vegetation in light green, and finally vacant or bare land in yellow.

The evolution of the coverage of each category from 1996 to 2022 is clearly visible on the maps presented. At the beginning of 1996, Akaki Kality was a very small, scattered settlement, but a vast agricultural area, occupying only half of its total area.

As a result, at the end of 2022, Akaki's kality farm area is very small and rapidly declining, representing only a fraction of the farm area that year (1996, 2006, and 2016). In other words, it is consumed. Varies by agricultural establishment or urban area.

In general, based on 30 years of land use, population or built-up areas are increasing at alarming rates, forcing uncontrolled urbanization. The rapid expansion of cities leads to the loss of huge amounts of land resources and sensitive environmental impacts such as soil erosion, soil degradation, air pollution and disturbances Environmental.

As per the broke down land use land cover hung on 26 years (1996, 2006, 2016 and 2022) of the postulation yield the settlement or developed region has been addressed graphically and shows the additional example of metropolitan extension.

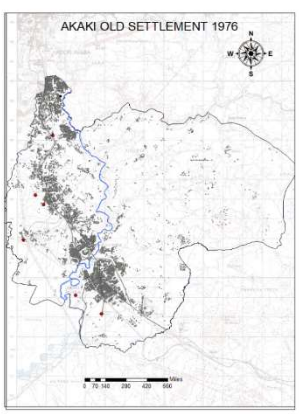


Figure 5Akaki Kality settlement in 1976

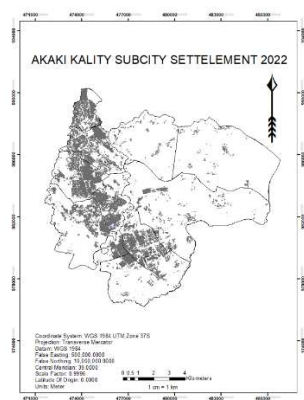


Figure 6 Akaki Kality settlement in 2022

Since1976 up to 2022 there are Major development projects such as:

- The new stadium
- The 12 condominiums sites of Kality, including the new city of KOYU FECHE, its university and its tertiary center.
- The KILINTO new industrial area project, north east of Kality sub center

Kilinto industrial zone is among the five districts to be established in the country (Bole lemi of Addis Ababa, Kombolcha, Hawassa and Dire Dawa) for industrial development. The Kilinto industrial zone, which is currently under study by the World Bank, is found in close proximity to Kaliti sub center. The district anticipates accommodating pharmaceutical, food processing and construction related manufacturing industries that target both local and export markets. The total area to be developed will be 243 hectares with the first phase amounting 153 hectares launched in 2014. Completion of this industrial zone is expected to create enormous employment opportunity in the area which would necessitate associated services like business centers, catering and hospitality related services, health services and the like. If these facilities couldn't be accessed easily, people's migration to the nearby areas would be apparent. Creation of sub-centers like Kaliti with broader catchments would thus be one issue for the success of such industrial zones.

The Kilinto industrial area:

This industrial area is under development. It is located in Akaki / Kaliti sub city, 2 to 4 Kms far from the sub center, with easy access through the new expressway. The total project should be 250 ha (with a first phase of 150 ha funded by the World Bank) to welcome agro processing both for local and export.

Similarly, establishment of terminals usually attract transit-oriented employment and developments including commerce, housing, retail and similar developments. Proximity to such facilities particularly increases accessibility to employment for working families and empirical studies conducted in these matters witness significant gains in accessibility to low- wage job near transit developments. Presence of, Endode freight terminal in the nearby is thus no exception in this regard. It is expected to generate enormous employment which would obviously impact the nearby Kaliti sub center in terms of different service needs including commercial centers, social service facilities, entertainment demands and the like.

The endode freight platform

It is under service , along the new national rail track, 4 kms far from the sub center, and accessible through a new road connected to the Kotari Tulu Dimtu new expressway which will connect it with major industrial areas around such as Kilinto and Gelan / Dukem industrial

Goro highway

A new east/ west express way from CMC to Kaliti and Jemo , with a possible BRT system on it , allowing to connect the eastern part of Addis to the southern and western one without congesting Megenagna and the Ring Road . This new expressway will be very strategic to connect the east part of the Metropolis to the southern and western part , with a direct access to the new airport , would it be in the southern corridor or in Teiji , south west of Addis .

LULC (1996-2022)

the land use land cover characterization classification for the year 1996 is produced and introduced as follows, vegetation inclusion is 34.8% from the absolute region, settlement is 9.86 % huge change from the year (1996 and 2022), Cropland is 10.04 %, barren land is 5.51 % and agriculture region is 39.79 %).

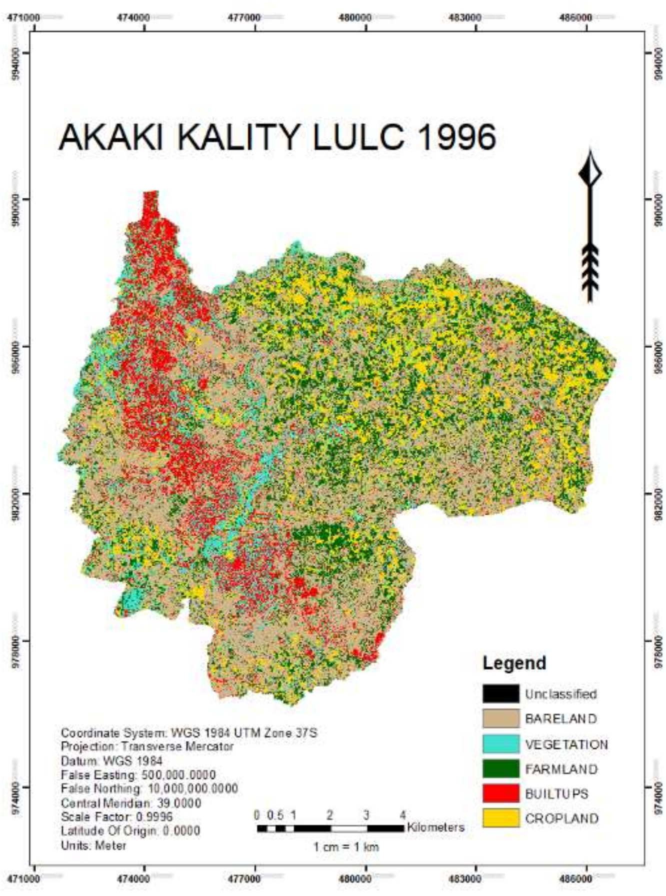


Figure 7 LULC 1996

Source satellite image of years 2006 and processed by ERDAS

The land use land cover characterization classification for the year 2016 is produced and introduced as follows, vegetation inclusion is 20.34 % from the absolute region, settlement is 23.37 %, cropland 10.02 %, barren land is 19.37 % and agriculture is 26.9 % which diminishes how much that of the year (2006)

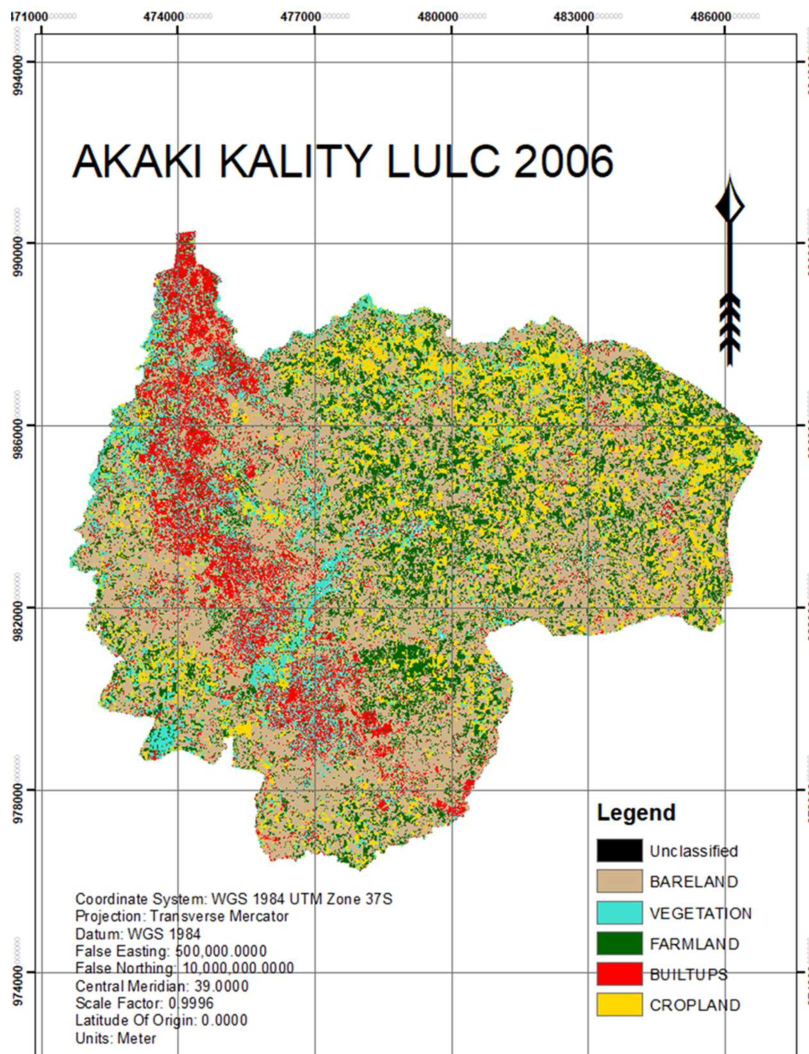
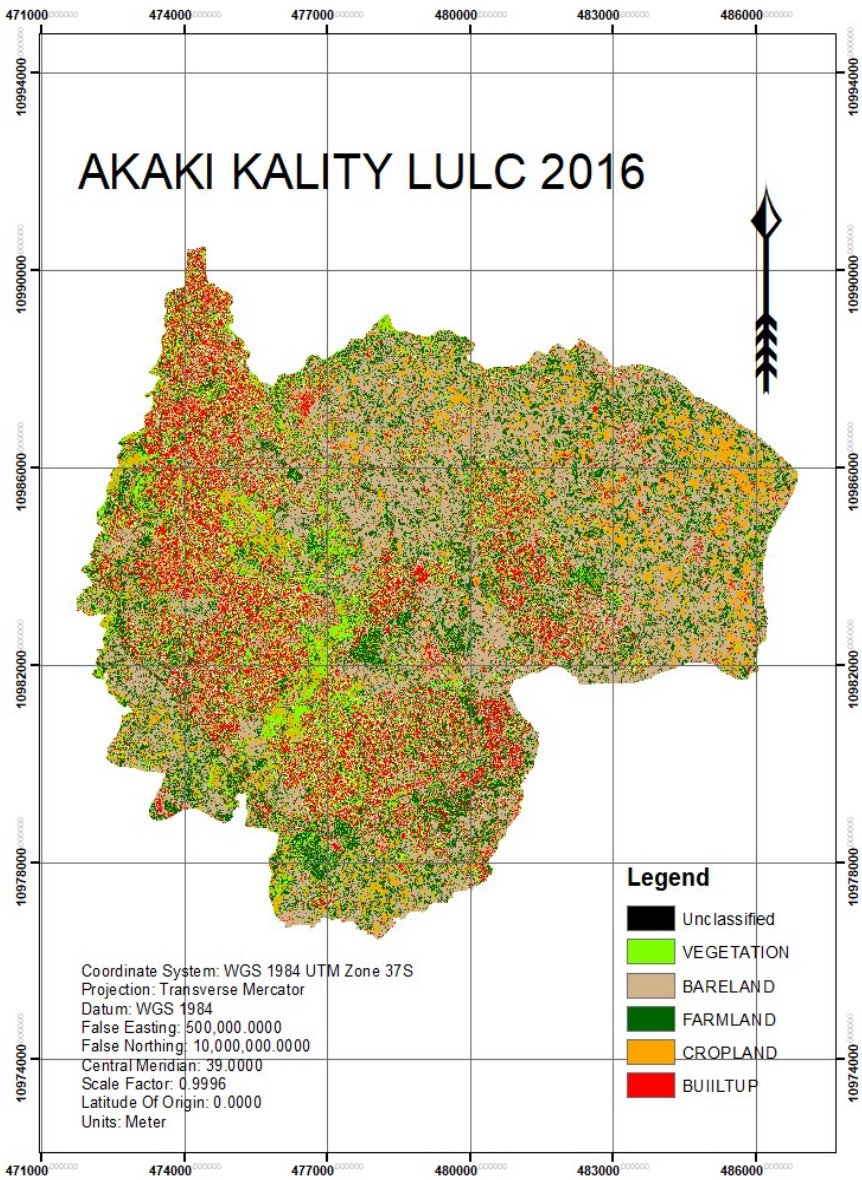


Figure 8 LULC 2006

Source satellite image of year 2006 and processed by ERDAS

The land use land cover classification for the year 2016 is produced and introduced as follows, vegetation inclusion is 20.34 % from the absolute region, settlement is 23.37 %,cropland 10.02 %, barren land is 19.37 % and agriculture is 26.9 % which diminishes how much that of the year (2006)



Source satellite image of year 2016 and processed by ERDAS
Figure 9 LULC 2016

The land use land cover characterization classification for the year 2022 is produced and introduced as follows, vegetation inclusion is 17.19 % from the absolute region, settlement is

48.19%, cropland 10.03 %, barren land is 13.61 % and agriculture is 10.98 % which diminishes how much that of the year (2022)

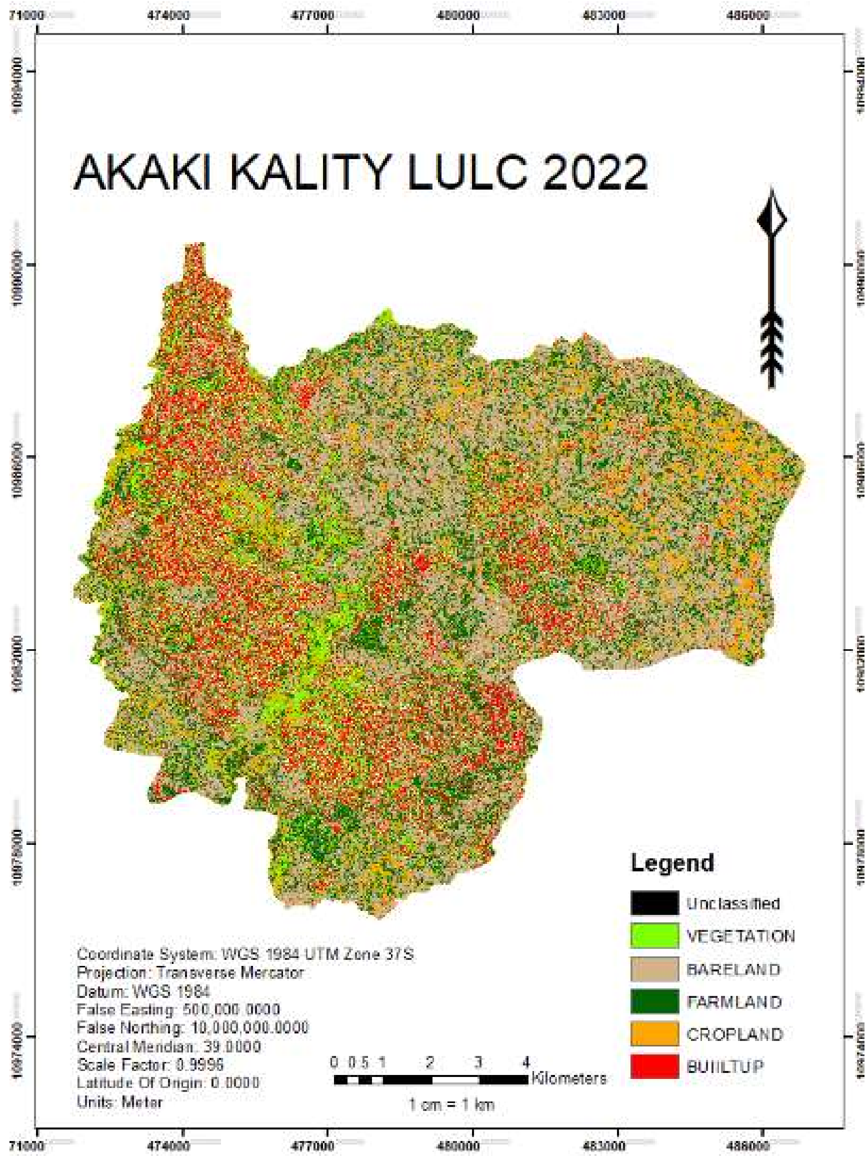


Figure 10 Land use land cover classification map of 2022

Source satellite image of year 2022 and processed by ERDAS

The land use land cover classification category for the year 2006-2016 is generated and presented as follows, vegetation coverage is decreased in 1.9 % from the total area, settlement is 8.8 % huge increment compared with the year of (1996, 2006 & 2016), bare land or open area (grass land) is 0.44 % decrease and agriculture area is 6.45% which is very decrease and small the amount of that of the (1966,2006 & 2022) that means it is consumed and dominated by Settlement or built-up area.

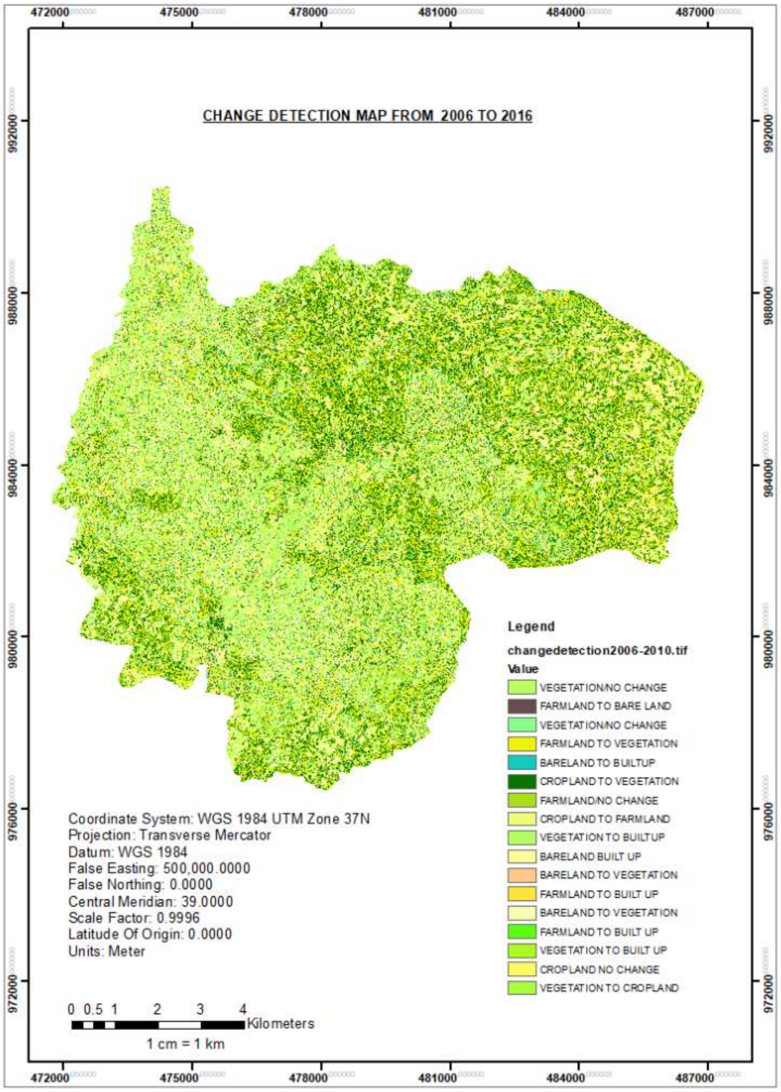


Figure 11 Change detection map 2006 up to 2022

Source satellite image of years 1996 to 2022 and processed by ERDAS

4.2 Results of area coverage land use category in tabular form

As we can see the land use land cover change inclusion region for the many years chosen report from the table five land class result is different in a given different example years. As per the result in the primary year (1996) Farmland is high region inclusion and settlement is tiny covered, also (2006) again Rural is the main and vegetation following, rather than settlement timberland region is reduced. In 2016, the outcome is somewhat different from the results of 1996 and 2006; settlement and vegetation are on a similar level, yet the horticulture region is declining. At last, in 2022 a sensational change is occurring that implies a high inclusion of settlement and immense loss of horticulture inclusion as it is displayed beneath. The aggregate sum of land use land cover order for every class region in hectares and rate from the year 1996-2020

Land use category	1996		2006		2016		2022	
	Area_ha	% age	Area_ha	% age	Area_ha	% age	Area_ha	% age
Vegetation	4296.41	34.8	2511.2	20.34	1785.2316	14.46	2511.2	20.34
Settlement	1217.32	9.86	2885.3	23.37	1667.9446	13.51	2885.3	23.37
Water	1239.54	10.04	1237.1	10.02	2.4692	0.02	1237.1	10.02
Bare land	680.10	5.51	2391.4	19.37	1711.321	13.86	2391.4	19.37
Agriculture	4912.47	39.79	3321.1	26.9	- 1591.3994	12.89	3321.1	26.9
Total	12,346	100	12346.0	100			12346.0	100

Table 7 LULC classification of 1996_2022 Area in hectares and percentage

Source: satellite image of years 1996 to 2022 and processed by ERDAS

Accuracy Assessments Results

ACCURACY TOTALS					
Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
----------	----------	----------	-------	---------	-----
Unclassified		---	---		
	2	0	0	---	---
BARELAND	80	83	76	95.00%	91.57%
	---	---			
VEGETATION	19	23	17	89.47%	73.91%
	---	---			
FARMLAND	20	20	17	85.00%	
		---	---		
	0	0	0	---	---
BUILTUPS	39	33	32	82.05%	96.97%
		---	---		
	10	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
CROPLAND	16	17	16	100.00%	94.12%
Totals	186	186	158		
Overall Classification Accuracy =	84.95%				
	----- End of Accuracy Totals -----				

Table 8 ACCURACY TOTALS OF YEAR 2006

The accuracy assessment of the land use land cover (LULC) map of Akaki Kality sub-city for the year 2006 was performed using a confusion matrix. The LULC map was derived from SPOT image using support vector machine algorithm. The LULC classes included barren land, farm land, vegetation, built-up and crop land. The overall accuracy of the LULC map was 84.95% and the

Conditional Kappa for each Category.	

Class Name	Kappa
----------	-----
Unclassified	
BARELAND	0.852
VEGETATION	0.7095
FARMLAND	0.8319
	0
BUILTUPS	0.9617
	0
CROPLAND	0.9356
----- End of Kappa Statistics -----	

Table 9 KAPPA COEFFCIENTS OF YEAR 2006

This paragraph is an accuracy assessment of the land use land cover (LULC) classification of Akaki Kality sub-city in Ethiopia for the year 2016. The LULC classification was based on satellite imagery analysis using ArcGIS software. The LULC classes included barren land, farm land, vegetation, built-up and crop land. The overall accuracy of the classification was 94.93% and the overall kappa statistics was 0.92, indicating a high agreement between the classified map and the reference data. The accuracy assessment showed that the LULC change in Akaki Kality sub-city was mainly driven by urban expansion and farmland conversion .

The accuracy assessment of the land use land cover (LULC) map of Akaki Kality sub-city for the year 2006 was performed using a confusion matrix. The LULC map was derived from SPOT image using support vector machine algorithm. The LULC classes included barren land, farm land, vegetation, built-up and crop land. The overall accuracy of the LULC map was 98.4% and the overall kappa statistics was 0.796. These values indicate a high agreement between the LULC map and the reference data. The LULC map can be used for various applications such as urban planning, environmental monitoring and land surface temperature analysis.

ACCURACY TOTALS					
Class	Reference	Classified	Number	Producers	Users
Name	Totals	Totals	Correct	Accuracy	Accuracy
----------	----------	----------	-------	---------	-----
Unclassified	0	10	0	---	---
BARELAND	80	83	76	95.00%	91.57%
VEGETATION	81	79	77.45%	97.53%	
FARMLAND	47	46	46	97.87%	100.00%
BUILTUPS	99	328	299	100.00%	91.16%
CROPLAND	21	22	21	100.00%	95.45%
Totals	651 651	618			
Overall Classification Accuracy = 94.93%					
	----- End of Accuracy Totals -----				

Table 10 ACCURACY TOTALS OF YEAR 2016

KAPPA (K^) STATISTICS	

Overall Kappa Statistics = 0.9283	
Conditional Kappa for each Categoı	

Class Name	Kappa
----------	-----
Unclassified	0.9864
VEGETATION	0.9707
BARELAND	1
FARMLAND	1
CROPLAND	0.953
	0
BUIILTUP	0.8365
----- End of Kappa Statistics -----	

Table 11 KAPPA COEFFCIENTS OF YEAR 2016

This paragraph is an accuracy assessment of the land use land cover (LULC) classification of Akaki Kality sub-city in Ethiopia for the year 2016. The LULC classification was based on satellite imagery analysis using ArcGIS software. The LULC classes included barren land, farm land, vegetation, built-up and crop land. The overall accuracy of the classification was 94.95% and the overall kappa statistics was 0.92, indicating a high agreement between the classified map and the reference data. The accuracy assessment showed that the LULC change in Akaki Kality sub-city was mainly driven by urban expansion and farmland conversion .

4.3 Change detection

Understanding that change detection is the identification of variation in land use land cover category based on the observation of a specific area in a different time by using multi-temporal data sets from satellite images. In the study, this method was used to analyze classified images for each year (1996 and 2006), (2006 and 2016), and (2016 and 2022)

4.3.1 Land use land cover change between 1996 and 2006

Based on output below the LULC change from 1996 to 2006 for settlement is increasing by 4.71% and on the opposite Vegetation and agriculture is reduced by 12. 56 % and 6.44 % respectively as shown in the following

	1996		2006		Change 1996_2006	
	Area_ha	% age	Area_ha	% age	Area_ha	%age
vegetation	4296.41	34.8	2745.8	22.24	1550.6576	12.56
Settlement	1217.32	9.86	1798.8	14.57	581.4966	4.71
Cropland	1239.54	10.04	1238.3	10.03	1.2346	0.01
Bare land	680.10	5.51	2445.7	19.81	1765.643	14.3
Agriculture area	4912.47	39.79	4117.4	33.35	795.0824	6.44
Total	12,346	100	12346.0	100		

Table 12 LULC of 1996_2006 Change detection Area in hectares and percentage

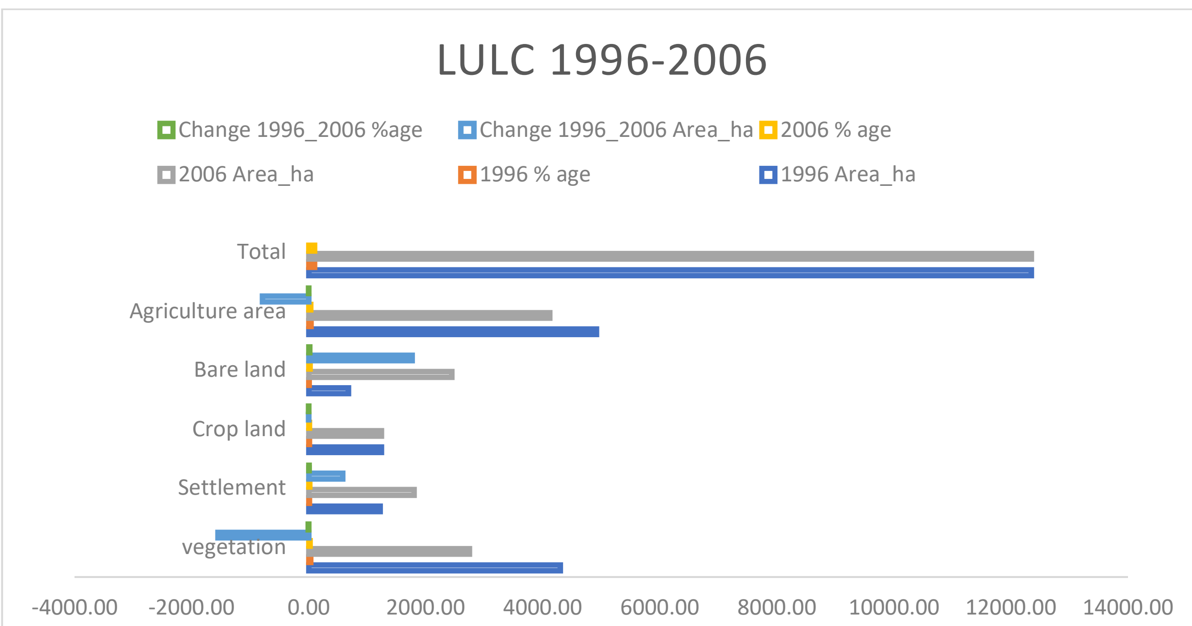


Figure 12 Graphs of LULC 1996-2006

4.3.2 Land use land cover change between 2006 and 2016

Accordingly depending on output below, the LULC change from 2006 to 2016 for settlement is increasing by 8.8 % and on the contrary Vegetation and agriculture is reduced by 1.9% and 6.45 % respectively as shown in the following table

Land use category	2006		2016		Change 2006_2016	
	Area_ha	% age	Area_ha	% age	Area_ha	%age
vegetation	2745.8	22.24	2511.2	20.34	234.5740	1.9
Settlement	1798.8	14.57	2885.3	23.37	1086.4480	8.8
Cropland	3.7	0.03	2.5	0.02	1.2346	0
Bare land	2445.7	19.81	2391.4	19.37	54.322	0.44
Agriculture area	5352.0	43.35	4555.7	36.9	796.3170	6.45
Total	12,346	100	12346	100		

Table 13 LULC of 2006_2016 Change detection Area in hectares and percentage

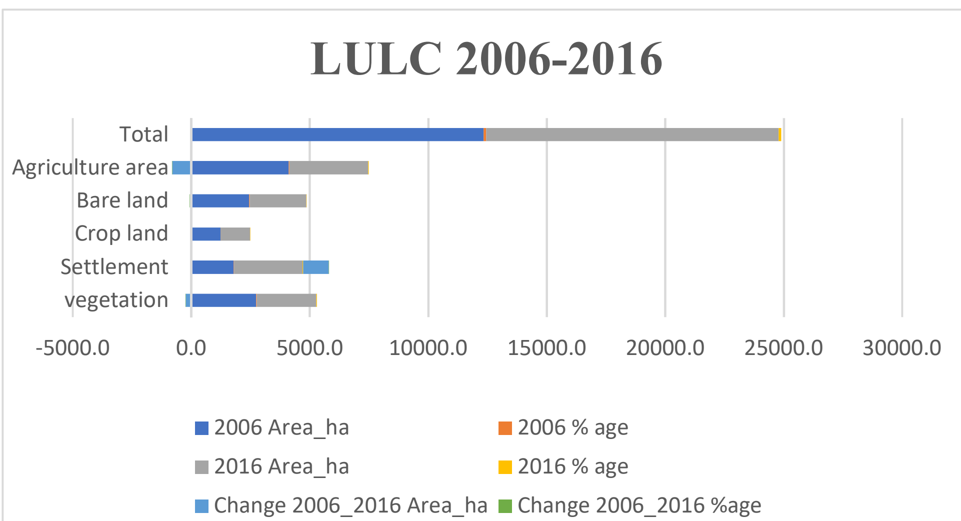


Figure 13 Graphs of LULC of 2006_2016 Change detection Area in hectares and percentage

4.3.3 Land use land cover change between 1996 and 2022

As we can see from the result below, the Land use Land Cover change from 1996 to 2022 or change detection for 26 years in total the settlement is increasing by 38.33 % which is a big change and fast urban expansion, on the contrary Vegetation is reduced to12.61 % and agriculture is decreased by 33.81 % that means agriculture area is consumed by the settlement shown in the following table.

Land use category	1996		2022		Change 1996_2022	
	Area_ha	% age	Area_ha	% age	Area_ha	% age
vegetation	4296.41	34.8	2511.2	20.34	1785.2316	14.46
Settlement	1217.32	9.86	2885.3	23.37	1667.9446	13.51
Crop land	1239.54	10.04	1237.1	10.02	2.4692	0.02
Bare land	680.10	5.51	2391.4	19.37	1711.321	13.86
Agriculture area	4912.47	39.79	3321.1	26.9	1591.3994	12.89
Total	12,346	100	12346.0	100		

Table 14 LULCof 1996_2022 Change detection Area in hectares and percentage

Source: satellite image of years 1996 to 2022 and processed by MS. Excel

4.4 Settlement class total area Dynamics change from1996 up to 2022

The degree of expansion is an important indicator that can show the dynamic change or rate of spatial expansion in the given period of time. Hence, the rate of spatial expansion of settlement area between two years can be calculated by the following formula:

$[(A_2 - A_1 / A_1) * 1/\ T_2\text{-}T_1] \times 100$

Where DC is the dynamic change rate of urban expansion, $T_1$and T_2 are specific time period A1 is settlement area at a time T_1 and A_2 is settlement area at a time T_2.

Thus, the dynamic change settlement area from the year 1996 up to 2022 is calculated as

Thus, the dynamic change settlement area from the year 1996 up to 2022 is calculated as

$$DC\ (1996\text{-}2022) = \left(\frac{5949 - 1217}{1217} * \frac{1}{2022-1996}\right)*100$$

DC (1996-2022) =14.95 %

The dynamic change settlement area from the year 1996 up to 2006 is calculated as

$$DC\ (1996\text{-}2006) = \left(\frac{1798.8-1217}{1217} * \frac{1}{2006-1996}\right)*100$$

DC (1996-2006) =4.77%

The dynamic change settlement area from the year 2006 up to 2016 is calculated as

$$DC\ (2006\ 2016) = \left(\frac{2885.8 - 1798.8}{1798.8} * \frac{1}{2006-2016}\right)*100$$

DC (2006-2016) =6.04 %

This indicates that the A_2 area dependent variable in which the dynamic change of urban settlement depend on .

The above result clearly shows the increases its spatial extent by 4.77 % from 1996_2006, 6.04 % from 2006_2016 and 14.95 % from year 1996-2022 though the era in which vast amount of agricultural or barren land is converted to settlement were from 2016 to 2006, forecasting dynamic change in settlements in Akaki Kality sub city would be highly dependent on the neighboring zones since the new amendment on June 2022 for Addis Ababa master plan shows the new demarcation of Addis Ababa To be bounded by hard boundary which is highway or ring road for the entrance of Addis Ababa from Adama express road. Though the new demarcation left the sub city with almost zero expansion area, even if there is no expansions area for the future there is definitely intra or within sub city barren land with area of 11004 hectare shown in fig14 the white shaded area to be used as only available lands for industry and residential.

Significance of studying settlement dynamic change

Studying settlement dynamic change in Ethiopia is crucial for understanding the country's social, economic, and political development. It helps us to identify patterns of migration, urbanization, and rural-urban linkages, which are essential for planning and policymaking. By examining settlement change, we can gain insight into the distribution of resources, access to services, and the impact of environmental factors on settlement patterns. Additionally, it can help us to understand the challenges and opportunities that arise from rapid urbanization, such as informal settlements, urban sprawl, and environmental degradation. Ultimately, studying settlement dynamics enables us to develop strategies for sustainable development and inclusive growth in Ethiopia. The rate of spatial expansion is significant because it helps us understand the growth of urban areas and the impact of urbanization on the environment. It is also useful for predicting future growth patterns and planning for sustainable development. The rate of spatial expansion can be calculated using various methods such as remote sensing, GIS, and statistical analysis.

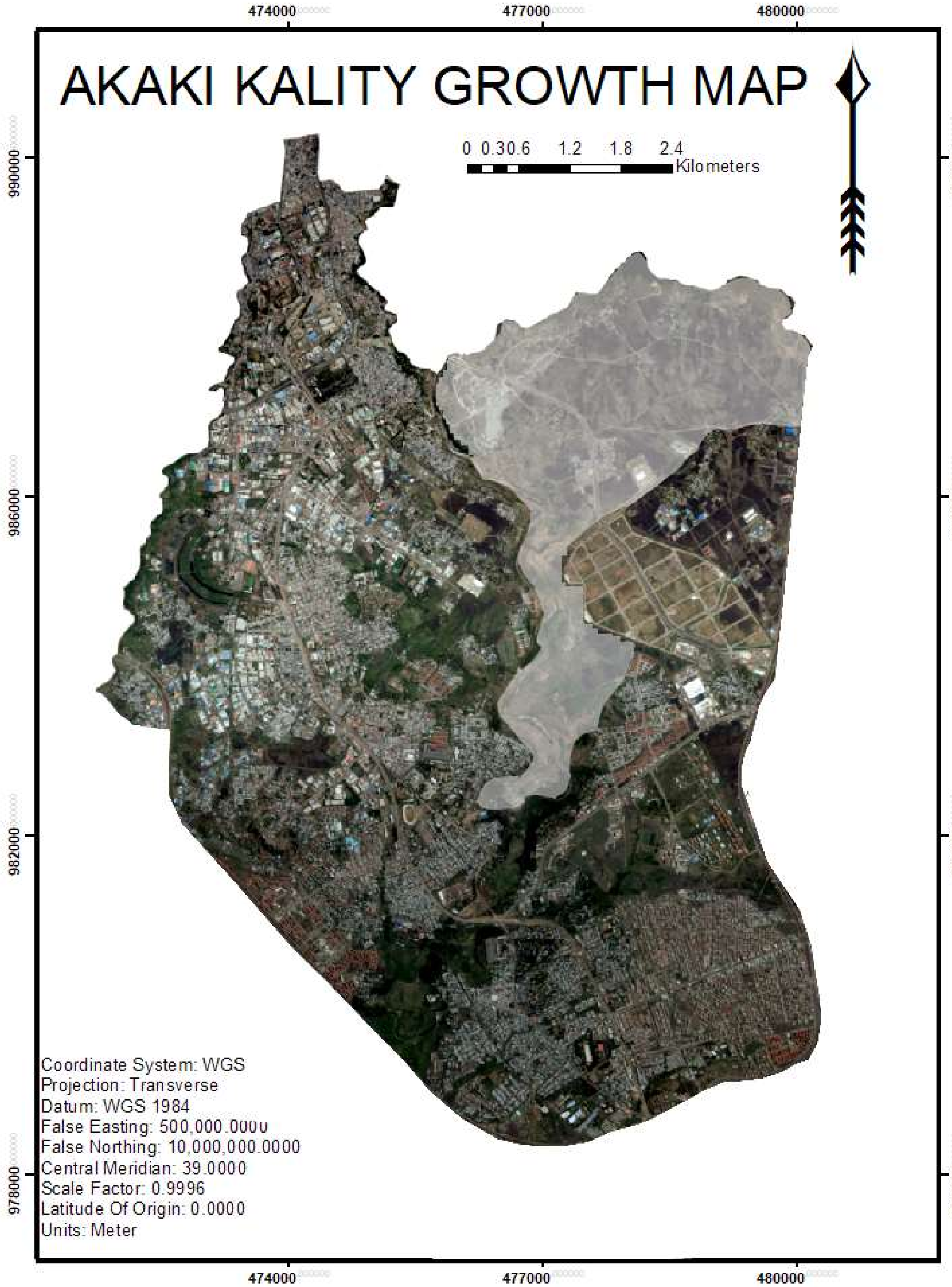


Figure 14 Map of Available plots for future growth

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

As we look back on the period from 1996 to 2022, it is clear that the Akaki Kality sub city experienced significant urban sprawl. The population of the area grew rapidly, leading to an increase in demand for housing, infrastructure, and services. This led to the development of many new neighborhoods, as well as the expansion of existing ones. The main concern of the study were to analyze, detect and evaluate the spatial composition as well as fast emerging expansion of Akaki kality subsidy using the application of remote sensing, ERDAS IMAGINE and GIS tools in order to achieve the goals almost three decades of years 1996,2006,2016 and 2022were selected. The significant changes of classes were distinguished in 1996 up to 2022: farmland to vegetation, bare land to built up, cropland to vegetation, cropland to farmland and farm land to build up

However, this rapid growth also brought with it several challenges. Many of the new developments were built without proper planning or infrastructure, leading to issues such as traffic congestion, inadequate water supply, and poor sanitation. Additionally, the rapid growth of the area has put a strain on the natural environment, with deforestation and land degradation becoming increasingly common.

Looking ahead, it is clear that addressing these challenges will be crucial to ensuring that the Akaki Kality area can continue to grow sustainably. This will require a focus on urban planning, infrastructure development, and environmental protection, as well as a commitment to addressing the needs of the area's growing population. With the right policies and investments, there is no doubt that Akaki Kality can continue to thrive and grow in the years to come.

5.2 Recommendation

Based on analysis undertaken in this study there are enormous challenges to be addressed in years to come Addressing these challenges requires a coordinated effort from the government, private sector, and civil society to develop and implement sustainable urban planning strategies that consider the needs of the growing population, the environment, and economic development some of the recommendation are. Specifically, by preparing intervention plan, this suggestion also could alleviate urban expansion challenges;

- Large plots and compounds in institution were problems for surrounding community as well the society couldn't get proper services if this plot got developed this plot could benefit both of the stake holder and the community example for such plots are telecommunication compound in Woreda 02, in Woreda 05, religious institution almost in all Woredas, medium and small enterprise in Woreda 10.
- Housing developers both individuals and real estate owned also means of problems to surrounding and peripheral because any building under construction or forgotten building by owner for long time caused serious security issues to residents of woreda 1 housing cooperative owners because such left-over construction houses being home for illegals.
- Akaki Gebeya is a well-known market located in the center of old Akaki town, which used to be covered by agricultural crops and forests before the rapid urbanization and industrialization of the subcity. Today, in modernized Addis in which the only metropolitan city in Ethiopia could not handle such old market so there should works be done to modernize old Akaki market into new highly moderate and suitable market in sub city
- The result of the study shows the expansion of settlement is fast in the town, especially in the last twenty six years with growth rate of 38 %. This causes unmanageable and fast urbanization of the town it may continue in the coming decades.
- The expansion of the town seems like horizontal towards edges of town in every direction without monitoring and planning. Therefore, planners should consider and give emphasis to vertical development of the town.

By implementing these recommendations, the Akaki Kality urban sprawl can become a more livable, sustainable, and resilient community that meets the needs of its residents and contributes to the overall development of Ethiopia.

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APPENDIX 1

GROUND TRUTH

GPS sample data taken from field for ground truth

Pt. No	Easting(X)	Northing(Y)	Remark
1.	483292	985826	Cropland
2.	481714	985759	Cropland
3.	485790	985261	Cropland
4.	483477	986794	Cropland
5.	481444	986467	Cropland
6.	479661	986372	Cropland
7.	480761	987386	Cropland
8.	479800	985962	Cropland
9.	482092	986780	Cropland
10.	479593	985980	Cropland
11.	479060	986161	Cropland
12.	478988	985832	Cropland
13.	479636	987098	Cropland
14.	479622	984503	Cropland
15.	480295	985322	Cropland
16.	481632	983633	Cropland
17.	484171	983056	Cropland
18.	476254	984986	Cropland
19.	482063	987062	Cropland

20.	483557	981933	Cropland
21.	484401	979216	Cropland
22.	484526	978671	Cropland
23.	482685	978604	Cropland
24.	482691	979049	Cropland
25.	482437	980868	Cropland
26.	481204	985251	Cropland
27.	483602	985632	Cropland
28.	477356	987322	Cropland
29.	477879	985659	Cropland
30.	478126	984750	Cropland
31.	479057	984456	Cropland
32.	473621	978951	Cropland
33.	474239	979818	Cropland
34.	473909	981268	Cropland
35.	473078	981864	Cropland
36.	473232	982974	Cropland
37.	475408	981666	Builtup
38.	476094	981844	Builtup
39.	475945	981755	Builtup
40.	476302	982147	Builtup
41.	475680	981217	Builtup
42.	475406	981497	Builtup

43.	475881	981656	Built-up
44.	476080	982155	Built-up
45.	476291	979826	Built-up
46.	478337	979724	Builtup
47.	477240	979230	Builtup
48.	477593	979984	Builtup
49.	477556	978884	Builtup
50.	476804	979772	Builtup
51.	474952	982755	Builtup
52.	474842	983113	Builtup
53.	475110	983631	Builtup
54.	475343	983466	Builtup
55.	475362	983277	Builtup
56.	474765	983613	Builtup
57.	475195	982625	Builtup
58.	474065	983608	Builtup
59.	473611	983898	Builtup
60.	473944	984112	Builtup
61.	473569	984678	Builtup
62.	473530	984344	Builtup
63.	473703	984284	Builtup
64.	474159	983538	Builtup
65.	474387	984467	Builtup

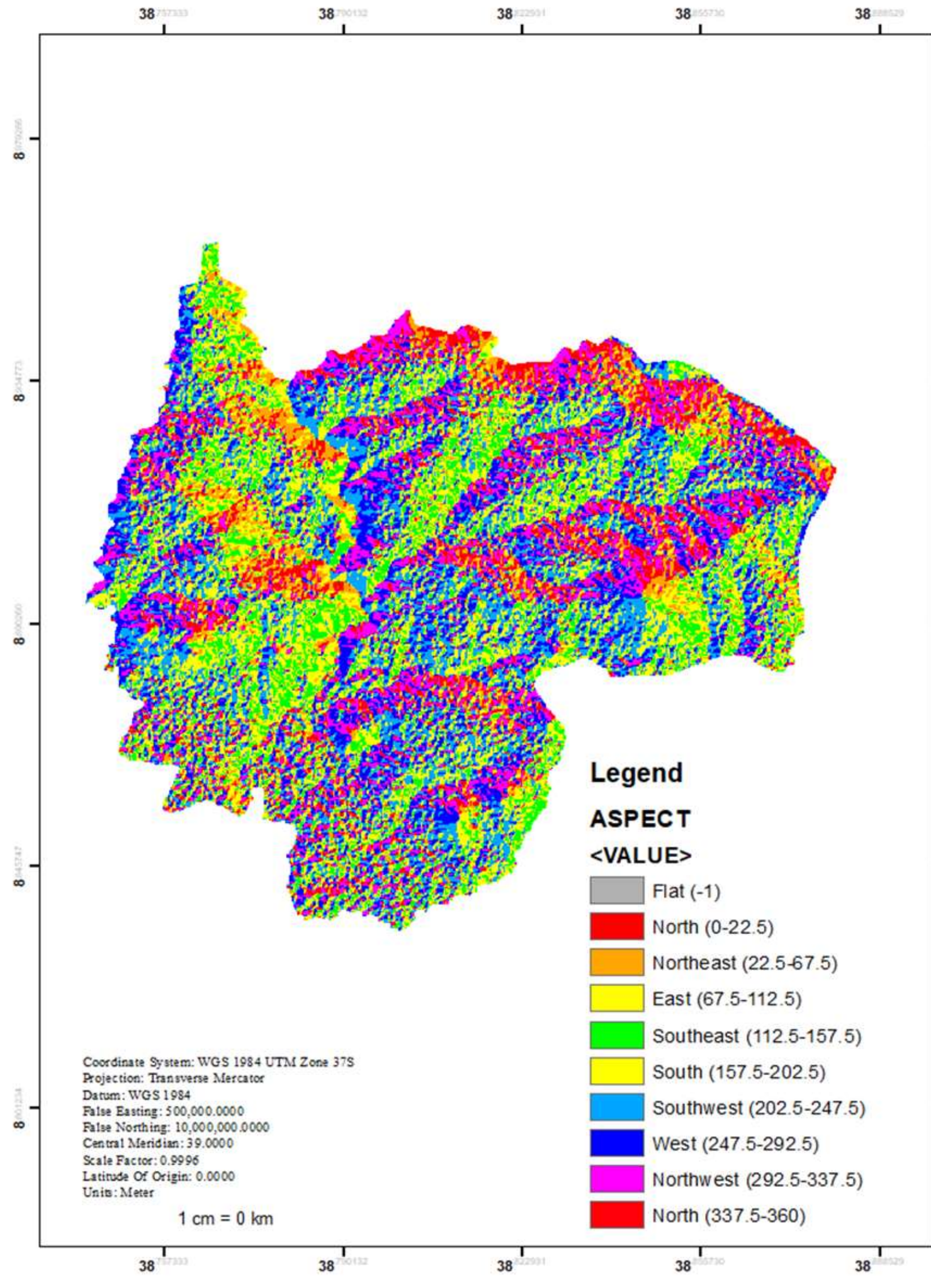
66.	474952	984224	Builtup
67.	475013	984147	Builtup
68.	474188	984889	Builtup
69.	474412	984764	Builtup
70.	473778	985496	Builtup
71.	473605	985389	Builtup
72.	473588	985598	Builtup
73.	473807	985849	Builtup
74.	473284	985504	Builtup
75.	473518	985764	Builtup
76.	474242	986232	Builtup
77.	474636	986272	Builtup
78.	474646	985862	Builtup
79.	475049	986483	Builtup
80.	474657	986686	Builtup
81.	475062	986686	Builtup
82.	474536	986582	Builtup
83.	474364	986042	Builtup
84.	477668	979595	Builtup
85.	478182	979848	Builtup
86.	477560	980064	Builtup
87.	477127	979764	Builtup
88.	477920	980786	Builtup

89.	477834	980507	Builtup
90.	476709	979962	Builtup
91.	477428	980479	Builtup
92.	478579	979492	Builtup
93.	477245	979385	Builtup
94.	476754	979180	Builtup
95.	475588	981504	Builtup
96.	474484	985262	Builtup
97.	476865	978239	Bare land
98.	476952	977883	Bare land
99.	483021	982406	Bare land
100.	482894	983135	Bare land
101.	482389	984093	Bare land
102.	481337	983285	Bare land
103.	480595	983709	Bare land
104.	481409	984235	Bare land
105.	483154	983009	Bare land
106.	480136	982092	Bare land
107.	482238	981950	Bare land
108.	482844	982342	Bare land
109.	482341	981778	Bare land
110.	481831	982708	Bare land
111.	482787	983736	Bare land

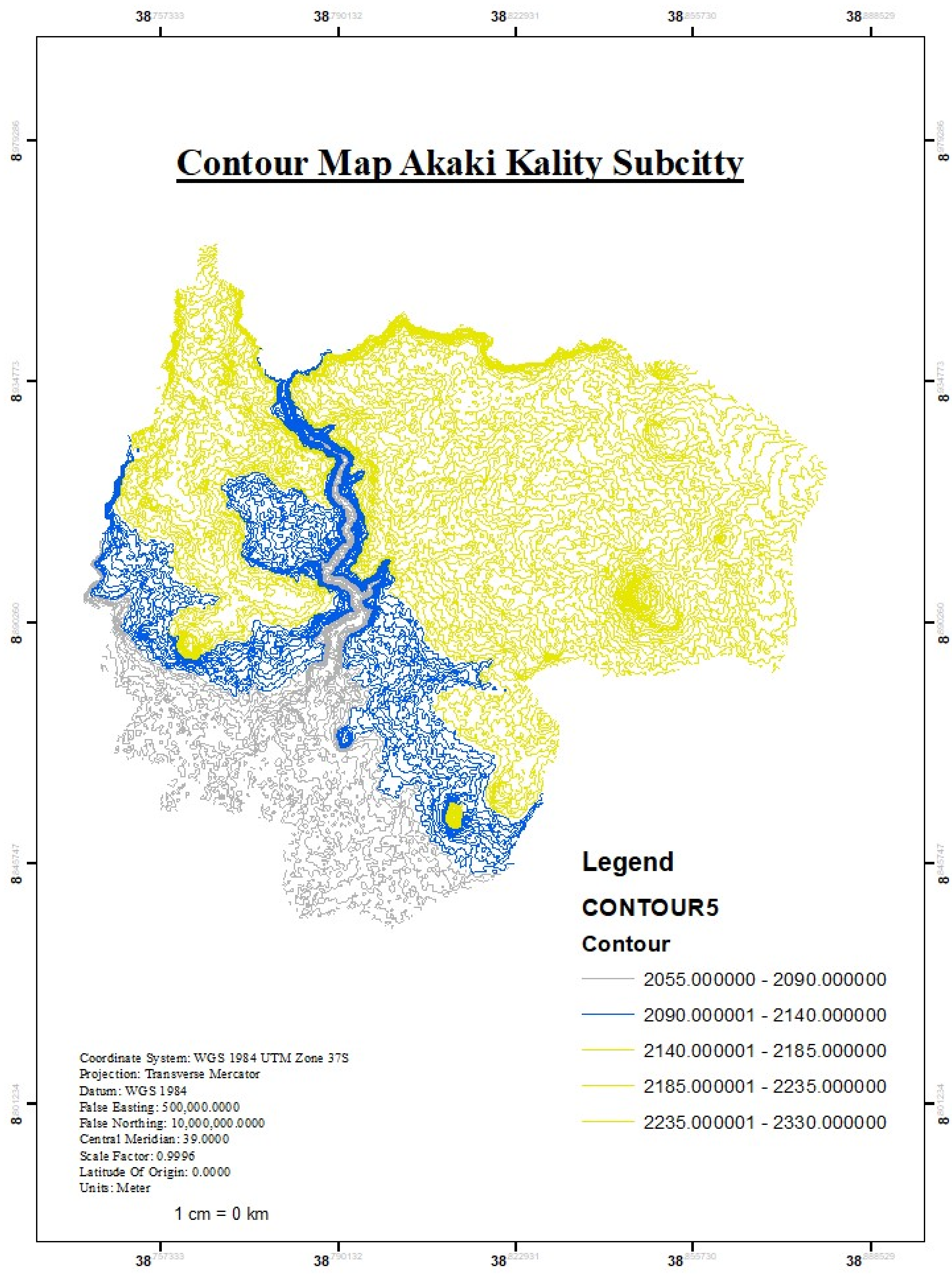
112.	480854	984128	Bare land
113.	479047	983390	Bare land
114.	479019	982903	Bare land
115.	478517	982535	Bare land
116.	476834	982895	Bare land
117.	477408	982287	Bare land
118.	476374	982554	Bare land
119.	475560	982477	Bare land
120.	475219	982575	Bare land
121.	475193	982023	Bare land
122.	474731	981435	Bare land
123.	474655	981359	Bare land
124.	474396	981131	Bare land
125.	474373	980901	Bare land
126.	474792	980475	Bare land
127.	474366	981867	Bare land
128.	474396	981670	Bare land
129.	474025	981642	Bare land
130.	474968	981838	Bare land
131.	475298	980691	Bare land
132.	476284	978334	Bare land
133.	473742	983174	Bare land
134.	472814	984049	Bare land

135.	473991	983074	Bare land
136.	473171	983719	Bare land
137.	472315	983349	Bare land
138.	472767	983874	Bare land
139.	476963	982255	Vegetation
140.	477282	982625	Vegetation
141.	476491	981056	Vegetation
142.	477586	983408	Vegetation
143.	477516	983788	Vegetation
144.	472768	986091	Vegetation
145.	475799	980772	Vegetation
146.	472340	985212	Vegetation
147.	475431	987774	Vegetation
148.	477003	984436	Vegetation
149.	472935	979982	Vegetation
150.	476684	982165	Vegetation
151.	473179	984965	Vegetation
152.	473841	979828	Vegetation
153.	475987	984596	Vegetation
154.	479356	980133	farmlands
155.	473706	977821	farmlands
156.	479235	980887	farmlands

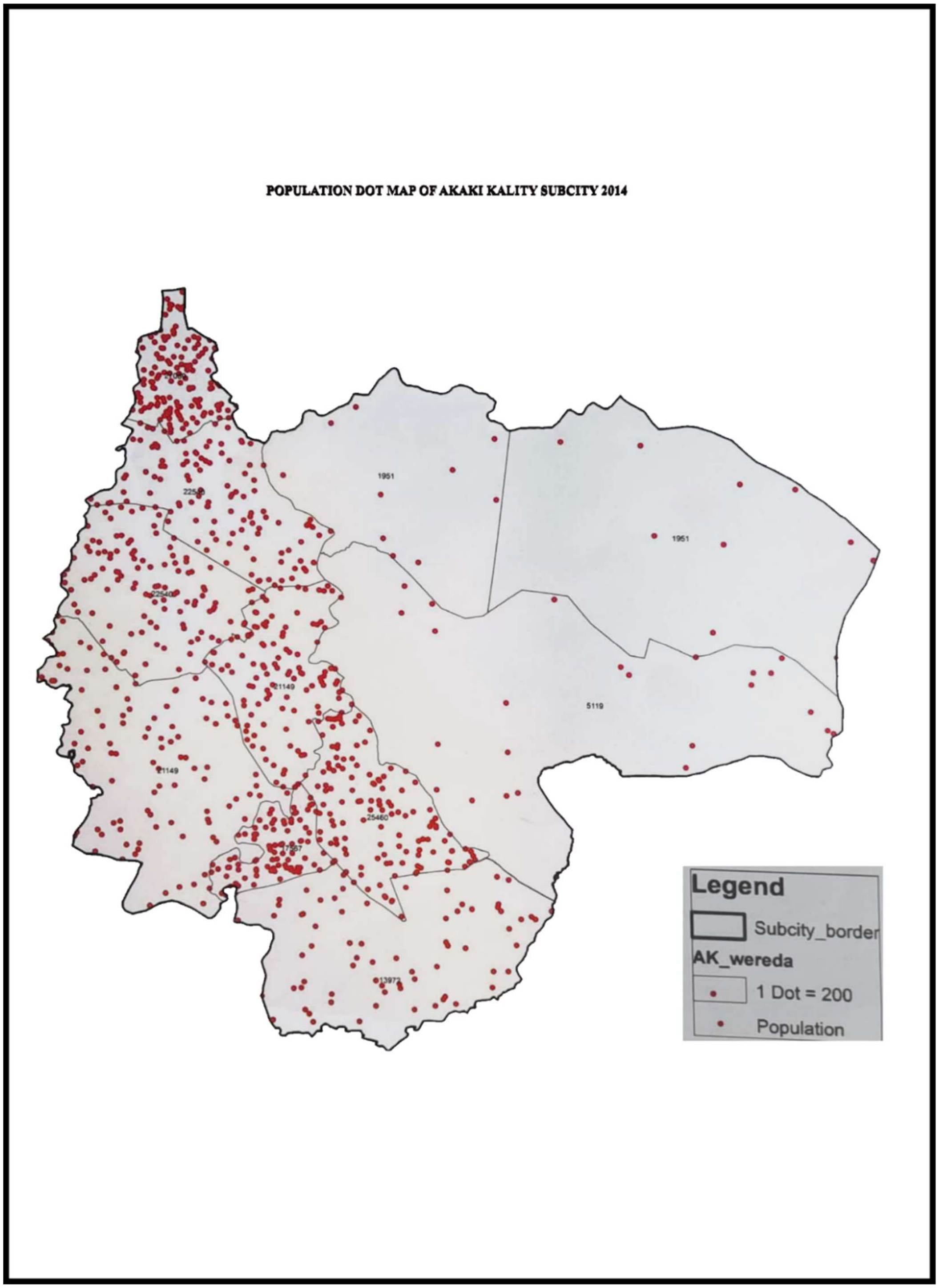
APPENDIX 2



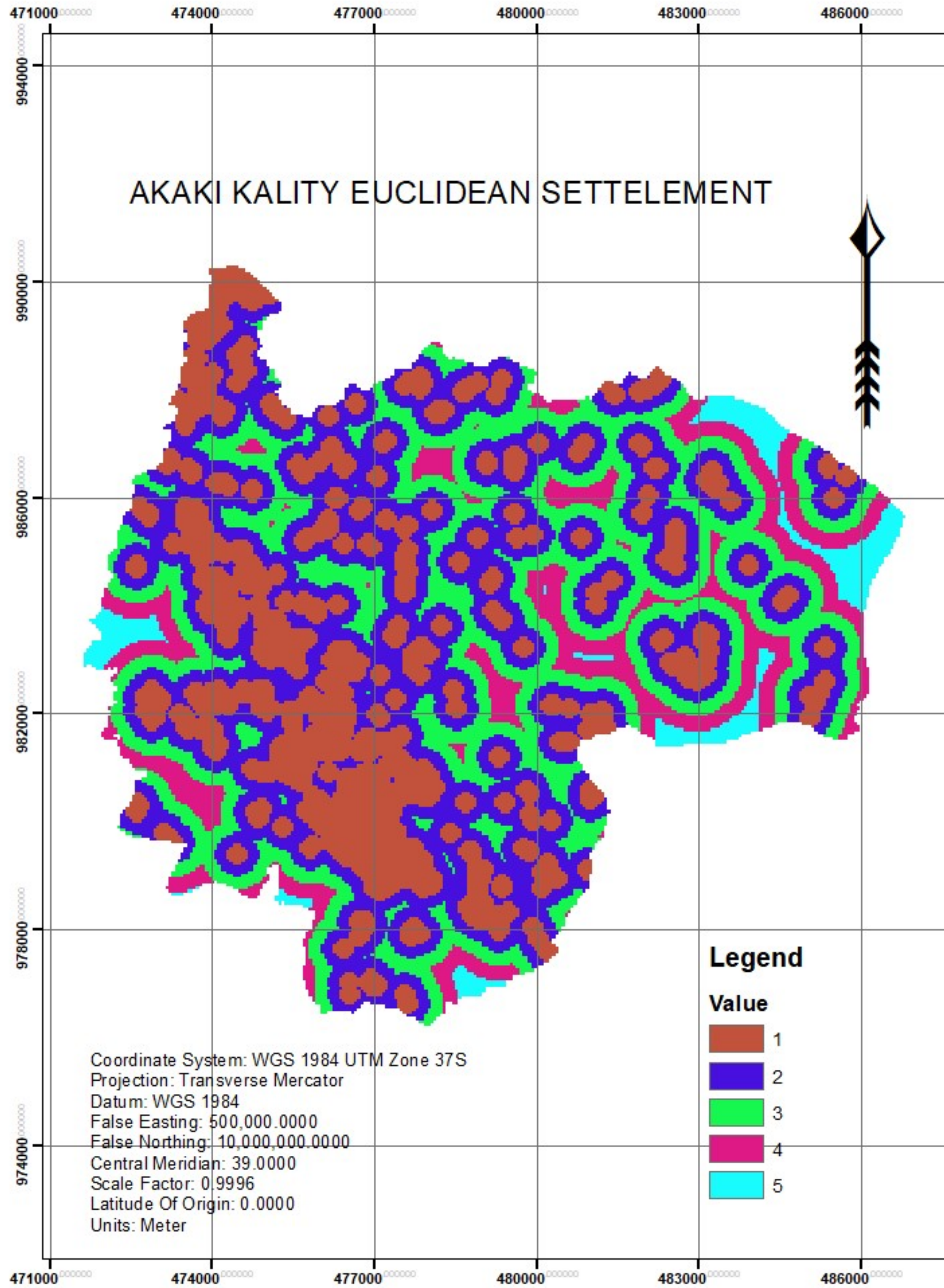
15 *ASPECT map Akaki Kality*



16 Contour map of Akaki Kality

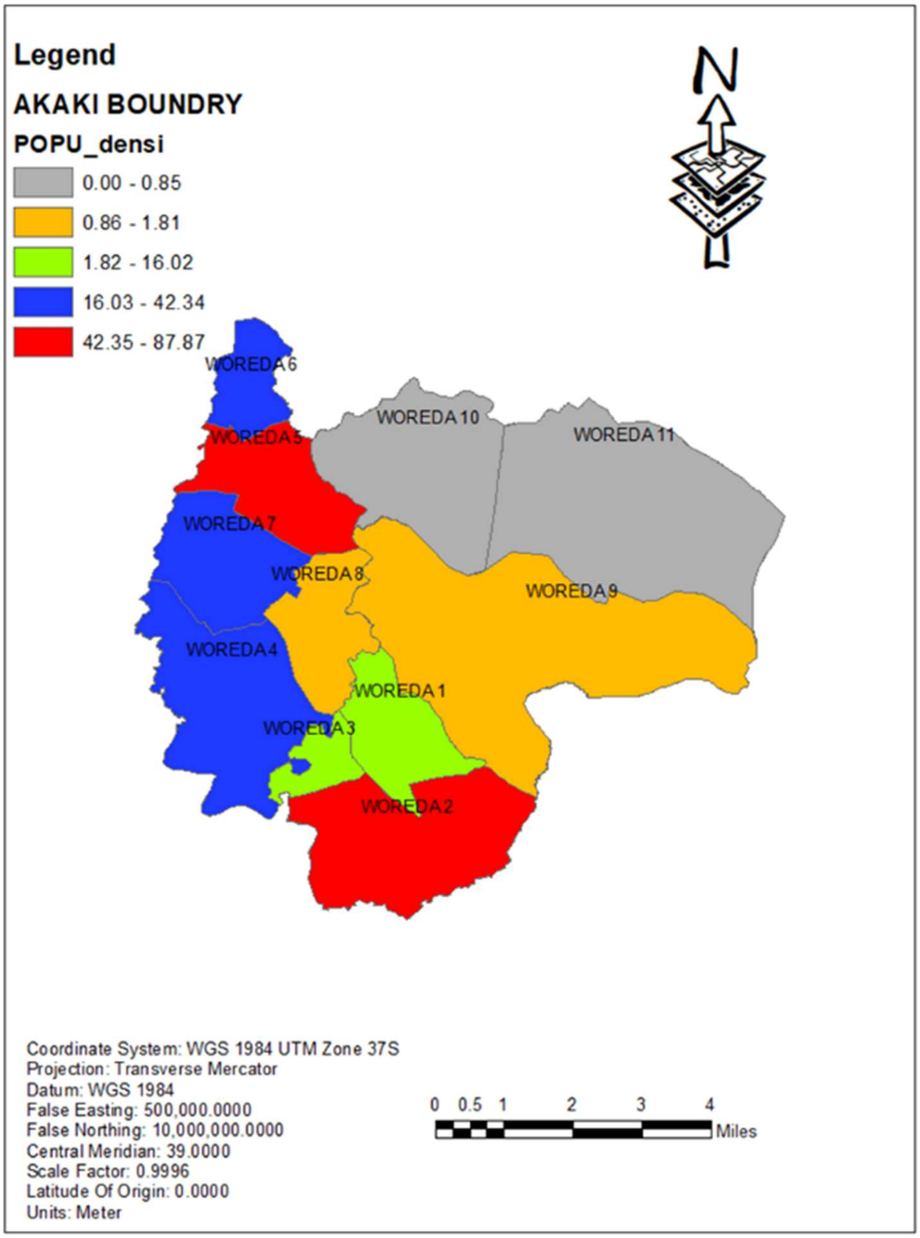


17 Population Dot Map of Akaki Kality

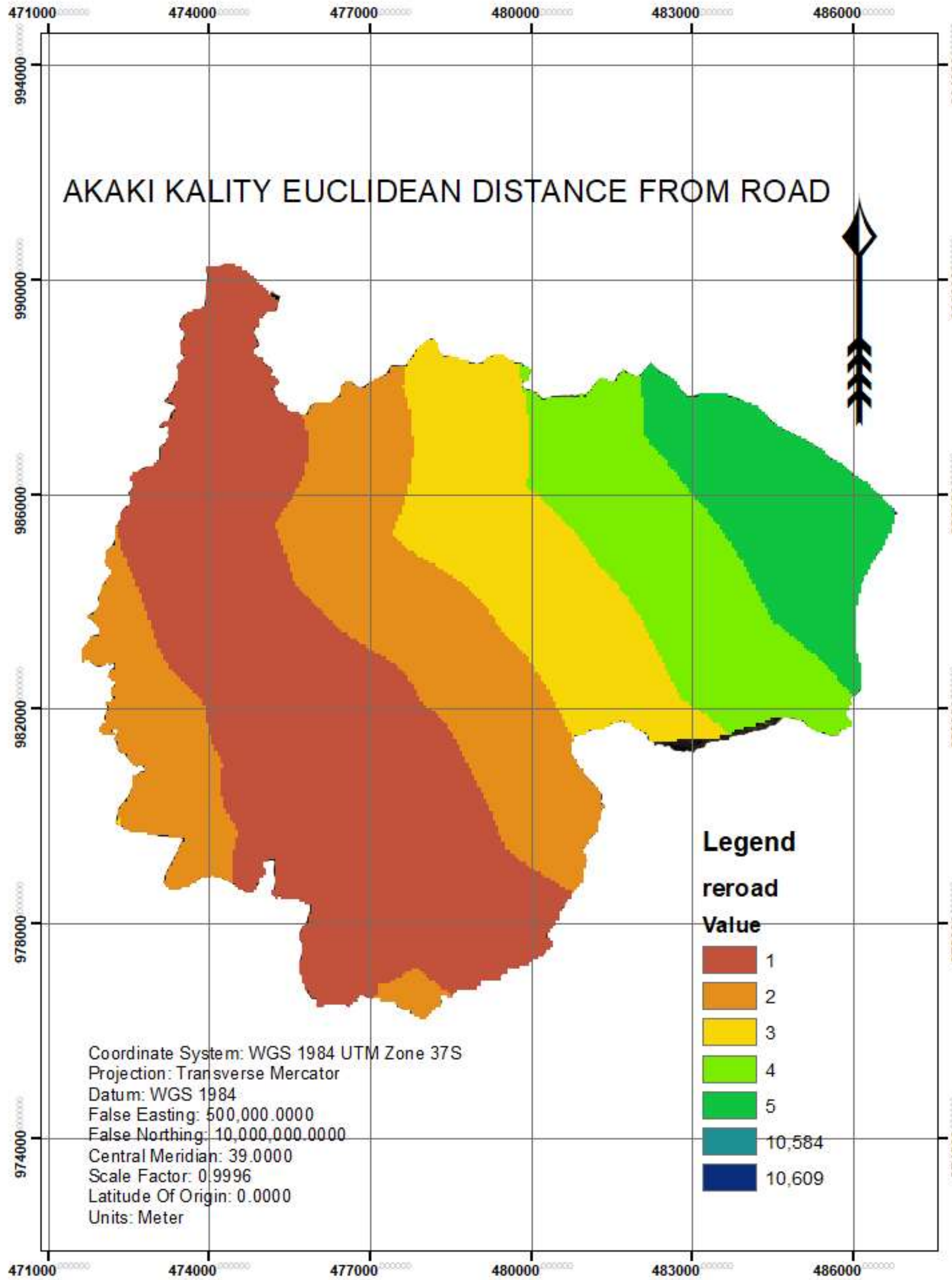


18 Akaki Kality Euclidean settlement

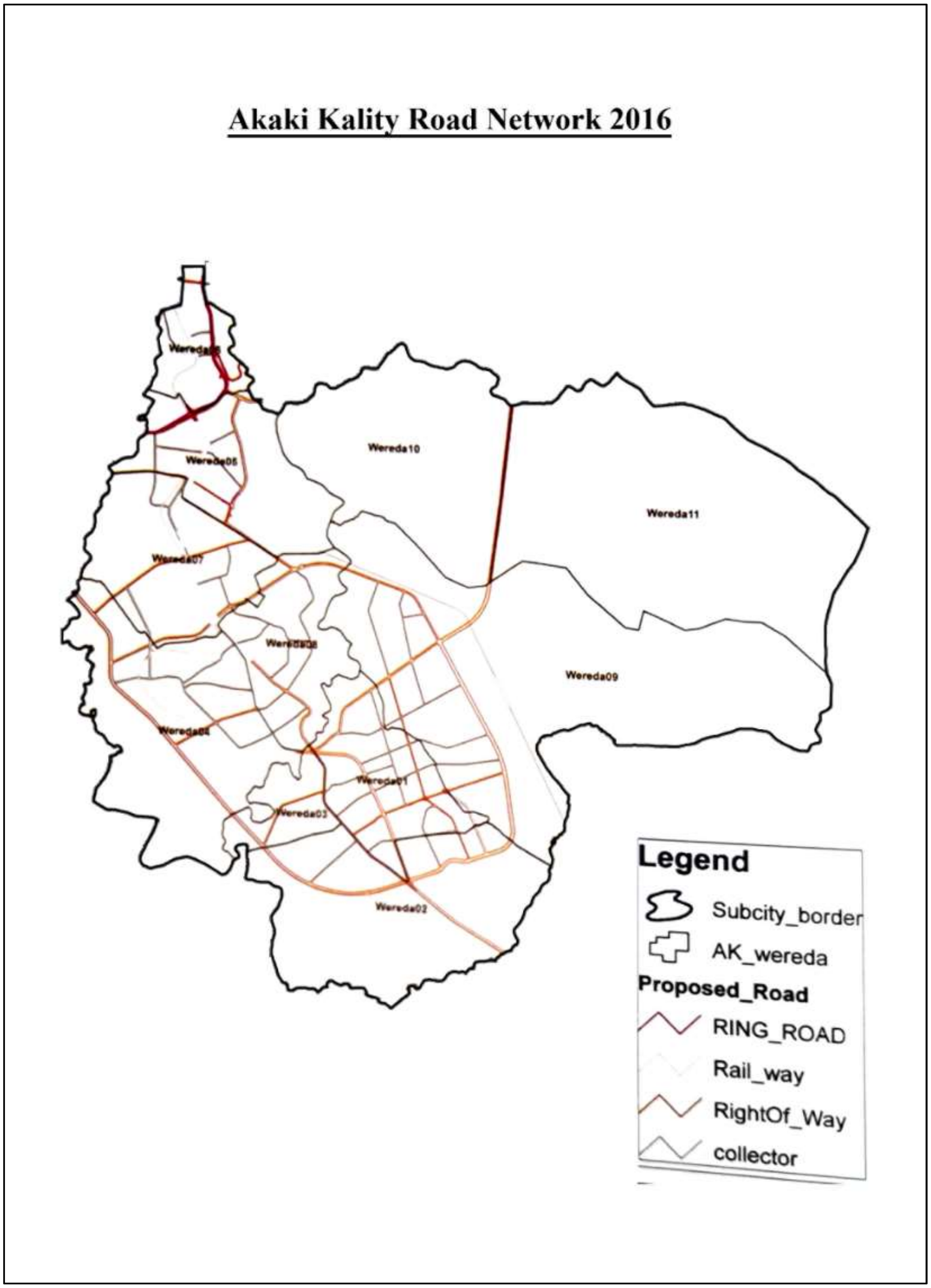
POULATION DENSITY MAP BY WOREDA (2007 CSA)



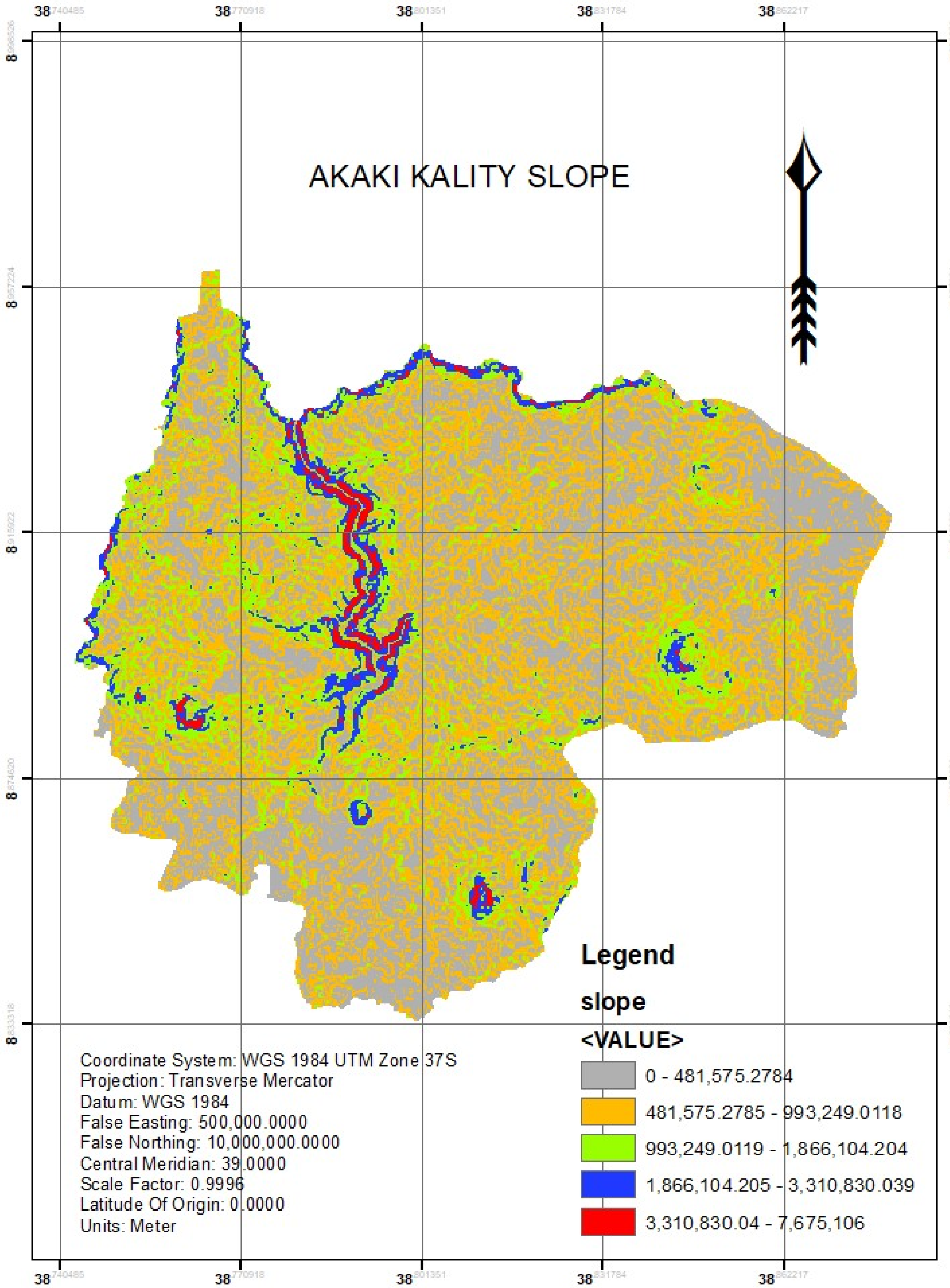
19 *Population Density Map by Woreda*



20 Euclidean Distance from Road



21 *Akaki Kality Road Network*



22 Slope Map of Akaki Kality

Woreda code/name	Number of plots by woreda	Built-up _area by hectares
1	3816	376
2	2671	765
3	1425	119
4	3024	888
5	2359	616
6	2798	280
7	3193	498
8	3914	454
9	1163	929
10	449	476
11	455	157
Total	25267	5558

15 Built up areas by Woredas

Woreda	Area by Ha.	percentage
W01	604	4.89
W02	1323	10.73
W03	236	1.91
W04	1326	10.73
W05	735	5.95
W06	309	2.50
W07	780	6.33
W08	596	4.83
W09	2848	23.04
W10	1279	10.36
W11	2310	18.73
total	12346	100

16 Area Coverage by Woreda

Slope Class (%0)	Description	Area_Ha	Percentage
< 2	Flat	2346.40	19.00
2-4	Gently slopping	4382.26	35.49
4-7	Sloping	3703.75	30.00
7-10	Strongly sloping	789.39	6.39
10-15	Moderately steep	498.78	4.04
15-21	Steep	300	2.45
21-65	Very Steep	320.86	2.63
Total		12347	100

17 Slope Range of Akaki Kality Sub city

No	Woreda	Area by Ha.	Sub_woreda	#Sefers	#Blocks
1	W01	604	16	48	108
2	W02	1324	28	92	217
3	W03	236	5	22	65
4	W04	1326	9	61	189
5	W05	735	9	53	128
6	W06	309	7	34	94
7	W07	780	19	62	162
8	W08	596	11	57	120
9	W09	2848	9	173	355
10	W10	1279	13	57	158
11	W11	2310	9	24	64
Total		12347	135	683	1660

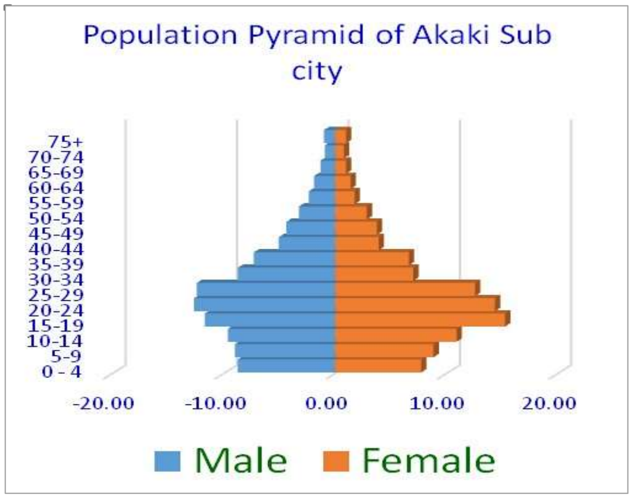
18 List of Administrative of Woredas in Akaki Kality

Age	Male		Female		Both Sexes	
0 - 4	7,511	8.47	7,106	7.77	14,617	8.06
5-9	7,754	8.74	8,143	8.90	15,897	8.77
10-14	8,378	9.44	10,108	11.05	18,486	10.20
15-19	10,637	11.99	14,313	15.64	24,950	13.76
20-24	11,653	13.14	13,367	14.61	25,020	13.80
25-29	11,096	12.51	11,614	12.69	22,710	12.53
30-34	7,688	8.67	6,496	7.10	14,184	7.82
35-39	6,409	7.22	6,101	6.67	12,510	6.90
40-44	4,421	4.98	3,619	3.96	8,040	4.44
45-49	3,810	4.29	3,463	3.79	7,273	4.01
50-54	2,835	3.20	2,643	2.89	5,478	3.02
55-59	2,055	2.32	1,642	1.79	3,697	2.04
60-64	1,654	1.86	1,307	1.43	2,961	1.63
65-69	1,148	1.29	932	1.02	2,080	1.15
70-74	801	0.90	751	0.82	1,552	0.86
75+	864	0.97	951	1.04	1,815	1.00
Total	88,714	100.00	91,488	101.17	181,270	100.00

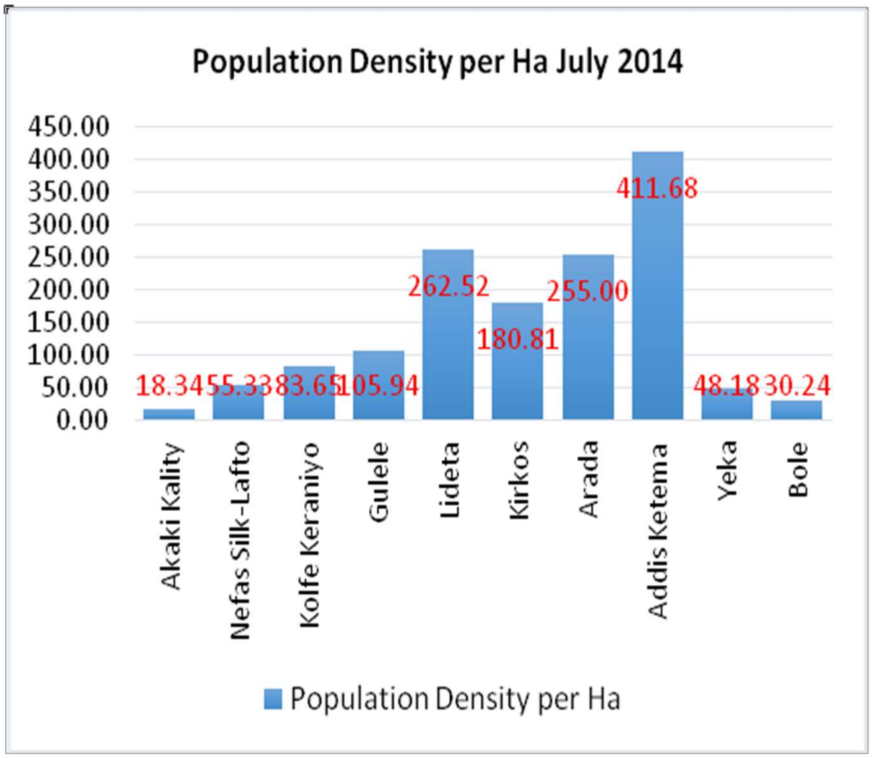
19 Five Year Age groups in Akaki Kality

Woreda	Area & percent		Population &		Population density
	Ha	%	Pop	%	
w 01	603.92	4.89	25,572	14.11	42.34
w 02	1,323.61	10.72	14,033	7.74	10.60
w 03	235.96	1.91	17,644	9.73	74.78
w 04	1,325.63	10.74	21,242	11.72	16.02
w 05	735.46	5.96	22,639	12.49	30.78
w 06	309.54	2.51	27,199	15.00	87.87
w 07	780.34	6.32	22,639	12.49	29.01
w 08	596.18	4.83	21,242	11.72	35.63
w 09	2,847.61	23.06	5,141	2.84	1.81
w 10	1,279.49	10.36	1,959	1.08	1.53
w 11	2,309.96	18.71	1,960	1.08	0.85
	12,347.7	100.0	181,27	100.00	14.68

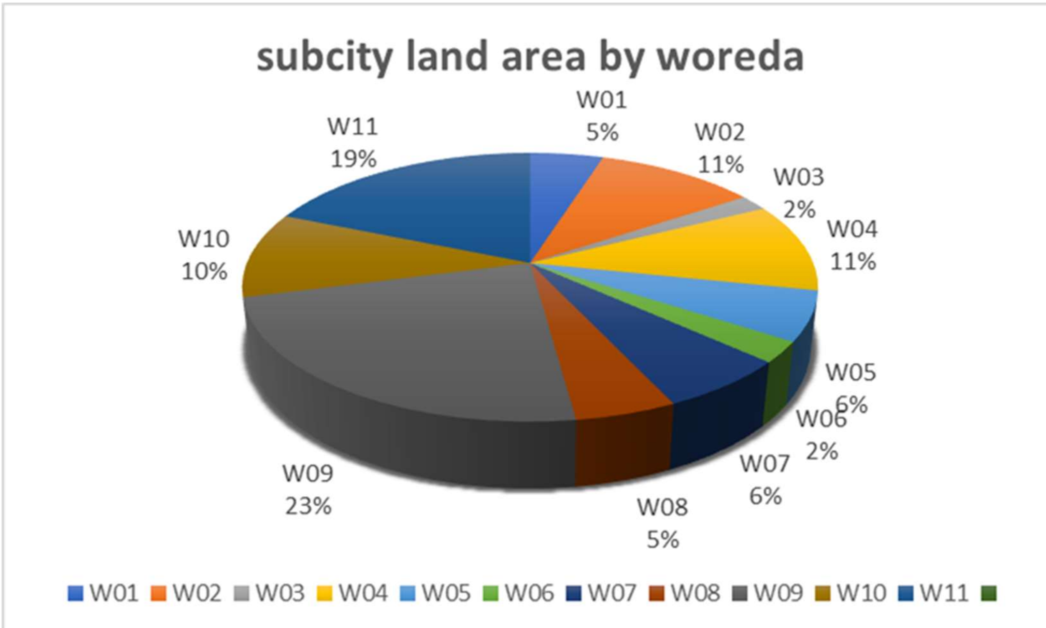
20Population Distribution by woredas



23Population Pyramid of Akaki Kality



24 Population Density Per Ha



25 Akaki Kality Land area by Woredas

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15 Contour map Akaki Kality..64
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