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Environmental Impacts of Urban Growth in Akaki-Kality Sub city, Addis Ababa, Ethiopia

The thesis submitted to the Ethiopian Institute of Architecture Building Construction and City Development Addis Ababa University in partial fulfillment of the degree of masters of Science in urban planning

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Approval Sheet

EiABC, Addis Ababa University

This is to certify that the thesis prepared by Truesaw Kead Engdaw entitled: Urban Growth Impact on Environment in Akaki Kality Sub city, Addis Ababa, Ethiopia, which is submitted in the partial fulfillment of the requirements for the Degree of Master of Science in urban planning, complies with the regulations of the University and meets the accepted standards concerning originality and quality.

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Declaration

I, the undersigned, declare that this thesis is my own and original work and has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly acknowledged, following the scientific guidelines of the University.

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ABSTRACT

This research is aimed to analyze land use/land cover dynamics of Akaki Kaliti sub city with their driving factors, and related environmental impacts. Spatial analysis were done majorly by using different time series satellite images that were compiled from land sat 5,7 and 8, and the supervised image classification of Arc GIS 10.4 and ERDAS IMAGINE 15 software programs were applied. Other non-spatial environmental impacts were addressed with the aid of primary data collected from households using structured questionnaire and other secondary data that were collected from Ethiopian National Metrology Agency. Similarly, Land Surface Temperature change done with Arc GIS. The 1996-2021 land uses/ land cover result analysis shows bare land decreased from 40% to 24%, which were mostly changed to construction; vegetation and forest, decreased from 43% to 23%; water bodies have shown only about 2% change and built up area increased from 10% to 46 %. Major driving factors for the increment of human induced land uses in the study area were population Growth; GDP growth and Governmental policy such as, industrialization policy and condominium-housing program. In order to minimize anthropogenic induced impacts on the urban environment in the country, government should revise investment policy and balance investment flow between inter regional and create job for youths in regional towns that can potentially reduce rural urban migration and the demand for urban land. Additionally, developing enough infrastructures to regional towns and foster private investors to invest their capital to regional towns. Moreover, vertical developments should be encouraged.

Keywords: *Environment Impacts; Government Policy; Land use/Land cover; Urbanization; urban growth model*

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ACRONYMS

AABOF	Addis Ababa Bureau of Finance
AACPDC	Addis Ababa City Plan and Development Commission
AAEPA	Addis Ababa Environmental Protection Authority
AAHDB	Addis Ababa Housing Development Bureau
AAIB	Addis Ababa Industries Bureau
AAILIC	Addis Ababa Integrated Land Information Center
AALADB	Addis Ababa Land Administration and Development Bureau
CSA	Central Statistics Agency
E	Land Surface Emissivity
EIA	Environmental Impact Assessment
ENMA	Ethiopian National Metrology Agency
FDRE	Federal Democratic Republic of Ethiopia
GTP	Growth and Transformation Plan
HDP	Housing Development Program

IP	Industry Policy
LST	Land Surface Temperature
LULCC	Land Use Land Covers Change
NDVI	Normalized Difference Vegetation Index
USGS	United State Geological Survey
UTM	Universal Transverse Mercator
VP	Vegetation Proportion
WGS	World Geodetic System

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CHAPTER ONE: INTRODUCTION

1.1 Background of the study

Urbanization characteristics , pronounces a shift in a population from one dispersed across small rural settlements in which agriculture is the dominant economic activity towards one where the population is concentrated in larger, dense urban settlements characterized by industrial land service activities (UN, 2011).

Urbanization processes is determined by continuous population growth, reclassification of rural localities into urban centers and migration of people from rural areas towards towns. In 2008, for the first time in history, more than half of the world's population was living in towns and cities. Nevertheless, not all regions of the world have reached this level of urbanization (UN, 2012).

The growth of towns and cities are rapid conditions from time to time and results nearly 66 percent of globe population will live in the towns and cities are in small suburban sites in 2050. Rapid urban growth brings threats for natural resources and exacerbate rural land changed to buildup area, deforestation and depletion of ecology (UN, 2014).

Urbanization rate of Asia is faster than from all continents and more than 1.1 billion people are living in urban areas and this condition leads to physical expansions of metropolitans and urban boundaries (Hugo, 2006; McGee and Robinson, 2019).

The governments of developed nation have enough potential to handle urbanization process by infrastructures, finance and other mechanisms help to manage urban growth. But, developing countries' governments have weak government structures and they have limited capacity of infrastructures, finance and legal framework to handle the rapid urban growth trends (Putra and Baier, 2008).

Particularly to Ethiopia, to say a place urban there are 3 basic criteria which are listed by lease proclamation No721/2011.

1. The place should contain more than 2000 people
2. Half of the population, who are living in that place, should be engaged in non-agricultural activities.
3. The place should has municipality

1.2 Statement of the problem

Urban expansion also affect sustainable and long lasting development, loss of greenery and open spaces, fragmentation of land, destruction of flora and fauna, degradation of ecosystem, ground water recharge potential etc. furthermore, soil fertility, water permeability, biodiversity loss of damaged in irreversible way. Soil closing with impervious material like building, blacktopped road, concrete accounts devastating change in water flow pattern and water induces hazard (Batty et al., 2003; EEA, 2006; Jat et al., 2008).

Land use change is the second most dangerous influence on climate change beside the release of greenhouse gases. Urbanization is leading to significant land use changes in Africa since the continent is undergoing rapid urbanization and population growth in recent decades. Addis Ababa is one of the fastest growing cities in the continent of Africa. Therefore detection of land use change is very important to identify its impact on climate and sustainable land use management of the city. The study used Landsat images to generate land use/land cover change map for the city (Berhanu, 2019).

Akaki Kality Sub city has experienced rapid land use and land cover changes in the past three decades. This has been due to increased pressure on land, caused by Increased Condominium sites; industry zone as a result the sub city has high number of industries (AAILIC, 2014).

In Akaki Kality sub city 25,267 plots of land and total area of 12,400 hectares of land are found based of the data of atlas map of the Akaki kality sub city 2014. Among the total amount of land in Akaki Kality sub city 45 percent of the land is built up area and the rest of the land which accounts 55 percent the sub city is non-built area (AAILIC, 2014).

Akaki kality sub city is one of the most industrialized sub cities which covers higher portion of the city industries. The same is true Akaki kality sub city covers high ratio of urban expansion due to development of condominium houses, real estates and has high land use and land cover changes extended up to now (Ayenew .E, 2017).

Since Akaki kality sub city is industry zone the numbers of industries are growing through time. In 2003, there were 272 small, medium and large industries in Akaki-

Kality industrial zone alone. Between 2003 and 2004 a total of 89 new industrial establishments were recorded in Akaky – Kality Industrial Zone (AAILIC, 2005).

Currently in Akaki kality sub city there are 362 micro industries, 168 small industries 212 medium Industries, 320 high industries and totally 1062 industries are available in the sub city which is big difference when we compare from 2003 which is 272. On the other way condominium housing development also another big factor for the change of land use land cover within 16 years from 2005 until 2021 there were 13 condominium sites were constructed and had big impact on natural environment level (AAIB and AAHDB, 2021).

land use land cover change is always dynamic change and never stop one a time because since human being is living in this planet land use land cover change is continue phenomenon so to get updated land use land cover change result and to recommend appropriate solution frequently research is necessary.

1.3 Objective of the Study

1.3.1 General Objective

The general objective of this research is to explore the Environmental Impacts of Urban Growth in Akaki-Kality Sub city, Addis Ababa

1.3.2 Specific Objectives

1. To analyze land use/land cover change between 1996-2021 of the Akaki Kality Sub-city
2. To identify the driving factors of the land-use/ land cover change
3. To assess the impacts of the land use/land cover change on environment

1.4 Research question

1.4.1 General research question

How can the rapid urbanization of Akaki Kality Sub city's land use/land cover changes and related environmental impacts be analyzed, and what methodology can be proposed to mitigate the impacts?

1.4.2 Specific research questions

- How to analyze land use/land cover changes of the Akaki Kality Sub-city from 1996 to 2021?
- What are the driving factors of the land-use/ land cover change?
- What effects did the change in land use/land cover changes have on the environment?

1.5 Scope of the study

1.5.1 Geographical scope

The research covers geographically in Addis Ababa city administration Akaki Kality Sub city focused wereda 06 and 07.

1.5.2 Thematic scope

The thematic scope of the study focused on land use land cover change using satellite images by down loading from American Geological Survey and using supervised image classification, driving factors of land use land cover change, effects of land use and land cover change on environment, urban expansion, nature of urban expansion, gaps of rules and regulation from implementation, industrials zones and expansion areas, industrial challenges and the environmental change of the study area.

The research used metrology data to triangulate the data which was gathered by questionnaire and produce land surface temperature map with GIS software and systematic questionnaires was applicable using residents which are living near to ten sub city toilet waste dump area and round leather industries.

1.5.3 Temporal scope

The researcher select year 1996 because in this year the city administration approved new legal line map and give recognitions for illegal built houses and this situation play significant role for land use land cover change and to investigate it. On the other hand in

this period Addis Ababa government structure was divided into different zones and it may have little differences from the current sub city government structure of Addis Ababa.

The other research periods were 2005 and 2011 similarly in 2005 the city Administration also approved new line and give land title deed certification for illegal built houses this situation also aggravate new informal houses construction and increased land use land change. the rest year which is 2011 the new program in Addis Ababa which is formulate cadastral land registration by proclamation and this case again has effect on land use land cover change and the researcher get the chance to access governmental approved reference data.

The last research period was 2021 and used the old boundary map of Akaki kality sub city to narrate land use land cover classification in the result part even if there is new boundary for the sub city because of my thesis period was from 1996 to 2021 and new the sub city boundary was classified in 2022.

1.6 Limitation of the study

During the study there was lack of documented and firsthand information, lack of collaboration for the researcher from private and governmental organization get research data.

To get relevant information the researcher would take different mechanisms for industries, for government organization officials and professionals, for residents other

responsible individuals and organization. During these cross check and impartial data gathering process technology may be inaccessible, organization and individuals may not be neutral to give me the information as it and the collected data may be distinct each other's.

Internet was my big challenge for my study. For 3 consecutive months internet was absent and it was difficult to down load satellite image from United Nation Geological Survey and it consumed my time and delay my thesis.

1.7 Significance of the study

The research contributes mainly for the following issues

This research may serves as reference for further researchers especially to study about land use/land cover dynamics and rate of land use and land cover changes in the study area. The study can indicate the level of land use ratio in the study area and change this research would be play vital for policy makers to design better resource management directions especially for urban land manager and policy makers.

The research would be contributes not only the analyzing land use land cover changes but also investigations about environmental impacts related to urbanization. So this research may create ideas to fill gaps of the city administration planning authorities and environmental protections rules and policies.

The research may give constructive solutions how to create healthy urbanizations with less environmental risk in the recommendation part of the research. The research shows

mechanisms how to integrate urbanization with environmental friendly because urbanization is continuous phenomenon which is not yet stop by policies. The research gives solutions how to manage land properly.

1.8 Structure of the paper

This thesis would be organized by five chapters. The first chapter covers background of the study, statement of the problems, objectives, scope of the study, research questions, significant of the study and organization of the paper. The second chapter covers literature review of the thesis, description of the study area, urbanization, suburbanization, cities and mega cities. The third chapter covers the methodologies which the researcher uses which mechanisms to study the given area and topics. The fourth chapter covers the data analysis and presentation of the research, results and discussions and the last fifth chapter covers the findings of the research and shows recommendation for responsible bodies based on the findings and the available results.

CHAPTER TWO: LITERATURE REVIEW

2.1. Definition of terms

The definition of urban varies from country to country, and with periodic reclassification, can also vary within one country over time, making direct comparisons difficult. Depending on the metric used such as population size, population density, or administrative criteria, nonagricultural employment; the size of an urban center can vary widely from country to country. For example, in Ethiopia an urban center contains more than 2000 people, whereas areas in Benin must have more than 10,000 occupants to be classified as urban (Cohen, 2006).

In Australia, urban areas are defined as population clusters of 1,000 or more people, with a density of at least 200 persons per km² (ABS, 2001). According to Statistics of Canada, an urban area in Canada is an area with a population of at least 1,000 people where the density is no fewer than 400 persons per km² whereas in china, it is higher than 1,500 persons per km², in India if one place to say town it will have a minimum of 5,000 people. So there are no uniform criteria worldwide to categorize towns based on their population number (Canada, 2007).

2.1.1 Urban Growth

The increase number of people who live in towns and cities is known as urban growth. The speed of urban population growth depends on the natural increase of the urban population and the population gained by urban areas through both rural-urban migration

and the reclassification of rural settlements into cities and towns. It is the demographic process and increasing of both number of population and urban physical expansion (Unicef, 2012).

Urban growth is a broad and elusive concept that can be subdivided into various types such as sprawling or compact, dispersed or clustered, continuous or leapfrog, spontaneous or self-organizing, planned or organic (Wu, 2000)

Urban growth can be defined as a system resulting from the complex interactions between urban social and economic activities, physical ecological units in regional areas and future urban development plans. This interaction is an open, non-linear, dynamic and local process, which leads to the emergence of global growth patterns. The urban growth process is a self-organized system (Allen, 1997b).

Urbanization comes up with the cost of growth of population in urban areas, with the impact on environment. Urbanization concept comes together with specialization, economic development and industrialization. Urbanization can also be referred to territorial response to economic growth in the country (Sharma, 2003).

2.1.2 Urbanization

The term "urban growth" refers to the total increase in the number of people who live in towns and cities. The pace of the growth of urban population depends on the natural increase of the urban population and the population gained by urban areas through both

net rural-urban migration and the reclassification of rural settlements into cities and towns (UNICEF, 2012).

The term "urban expansion" indicates the spatial or physical enlargement of built-up areas. Bourne (1996) defined urban land expansion as one of the main indicators to measure the intensity of urbanization. He claimed that urban land expansion is the most easily identifiable characteristic of the process in the spatial dimension.

Urbanization process of land conversion from non-built- up land use categories to built-up developed land over time. It is possible for a city to experience urban growth without expansion if this growth is absorbed within existing settlement boundaries (Ewing, 1994).

Urbanization is also a social process which involves the changes of behavior and social relationships as a result of people living in urban area. Essentially, it involves the complex change of life styles which result from the impact of cities on society (Bhatta et al., 2010).

Urbanization is normally used in a broader sense and it refers to the physical growth of urban areas from rural areas as a result of population immigration to an existing urban area. Urbanization is also defined as 'movement of people from rural to urban areas with population growth equating to urban migration'. Important to realize that, the urbanization process indicates that not simply population growth rather it is change of economy, political, social and culture of living (Datta, 2010).

2.1.3 Urban sprawl

It is the horizontal expansion and scattered settlement of people in the periphery of the towns. Urban sprawl is happen in non-planned towns. Urban sprawl is characterized by a scattered population living in separate residential areas, with long blocks and poor access, often over dependent on motorized transport and missing well-defined hubs of commercial activity (Unicef, 2012).

Urban sprawl defines as a certain form of urban development that described by low-density, leapfrog, commercial strip expansion and discontinuity (Ewing, 1997; Downs 1999; Galster et al., 2001; Malpezzi and Guo, 2001)

The term "urban expansion" indicates that physical urban growth shows the spatial or physical enlargement of built-up areas. Urban land expansion is one of the main indicators to measure the intensity of urbanization. He claimed that urban land expansion is the most easily identifiable characteristic of the process in the spatial dimension (Ewing, 1994).

Urbanization is serious problems for developing and developed nations and it is current issues for scholars and politician, USA, urban sprawl is now at the top of the political agenda .Urban sprawl has been criticized for its inefficient use of land resources and energy and large-scale violation on agricultural land. These impacts threaten the principle of sustainable development (Dieleman et al., 2002).

2.1.4 Urban development

Urban development is the process of emerging of different suburban and the rise of great cities and their growing spatial influence initiated a change from largely rural to predominantly urban places and patterns of living that has affected most countries over the last two centuries. Currently not only do large number of people live in or immediately adjacent to towns and cities, but whole segments of the population are completely dominated by urban values, expectations and life styles (Bhatta, 2010).

Urban development results in various land uses with different levels of social, economic and environmental values. This is a higher dimension of heterogeneity, indicated in the attributes of spatial objects. Understanding the dynamic process of urban development must be based on the linkage with the decision-making process as the final users makers. The ability to realistically represent the behavior of the key actors depends on the level of aggregation at which actors and their behaviors will be represented in the model. Real decision-makers are a diffuse and often diversified group of people who will make a series of relevant decisions and trade-offs over a period of time (Cheng.J, 2015)

2.1.5 Sustainable urban form

Sustainable development refers to “development that meets the needs of the present without compromising the ability of the future generations to meet their own needs” (World Commission on Environment and Development, 1987). The existing of all the above-mentioned problems caused by urbanization indicates our cities are not sustainable

(McGranahan&Satterthwaite, 2003). Urban sprawl which is caused by rapid urban growth is problem for land use and land cover and for sustainable development.

A sustainable city must “accomplish a balance among environmental safety, economic development, and social wellbeing” (Wu, 2010). Urban sustainability consists of minimizing the consumption of resources and land, optimizing urban form to facilitate urban flows, protecting both human health and ecosystem, ensuring equal access to resources and services, and maintaining cultural and social diversity and integrity (Alberti& Susskind, 1996; Spiekermann& Wegener, 2003). However, developing sustainable cities is a difficult task because cities are the centers of socioeconomic developments, the main sources of major environmental problems, and the living place of nearly half of the world population (Wu, 2008)

There is a general agreement that for achieving urban sustainability, urban settlements shall to be livable, economically sustainable, socially sustainable and ecologically viable as well as should have official frameworks to distribute social justice, long-term vision and permanent services. Cities nature or structure is causes of environmental problems (Beatley and Manning, 1997; 1999; Newman and Houghton, Kenworthy, 1989).

The sustainability urban form has significant but complex relationship one another. The costs and negative environmental impacts of urban sprawl have been widely studied and documented. The particular concerns over urban sprawl is the inefficient utilization of energy, Urban sprawl is therefore regarded as one of the main challenges for sustainable development and spatial planning (Bhatta, 2010).

2.1.6 Implications of Urban Growth

Urban growth has both advantages and disadvantages, the advantages include reduced transport costs and time wastages, exchange of ideas, educational facilities, sharing of natural resources, higher standard of living and more opportunities for people. The disadvantages of urban growth are cause of warming; flood or excess rainfall, drought, deforestation, land use and land cover change, high accumulation of carbon dioxide, water and weather condition pollution, air pollution and others problems are happened (UN, 2014).

The manufacturing and light industries are found in developing countries and these industries are developed by developed countries with foreign investment. The mass relocation of labor-intensive, less technology-dependent and environmentally hazardous industries in the developing countries is an important phenomenon. The management authorities are forced to use limited natural resources and to provide basic amenities such as water, sanitation, transportation etc., in adequate amount to the residents and industries. Poor access to decent, secure, affordable land and housing is one of the major problems of fast urban growth (UN, 2014).

The ecological risks in mega-cities such as the pollution of air, water and soils are also obvious (Hardoy et al., 2001). The stationary sources of air pollution such as power plants, industrial activities, and residential and commercial buildings along with mobile sources such as vehicles which are poorly maintained and use poor fuel quality and

inadequate traffic management is emerging problem due to urban growth in developing countries.

Rapid and unplanned urban expansion causes a number of serious threats to urban biospheres, including: (i) deforestation, (ii) loss of both flora and fauna; (iii) changes in micro-climates; (iv) loss of fertile arable land (v) soil degradation, and related problem (vi) groundwater pollution (on which many low-income urban dwellers depend for water supplies) (United Nations Human Settlements Program (UN-HABITAT), 2010). Although, urban growth is inevitable, all these above mentioned issues are also need to be paid attention and resolved during this process of urbanization.

The urban environment standard is deteriorating from time to time with the big cities reaching to its saturation points and unable to cope with the increasing pressure on their infrastructure. Increasing pollution of water and air has degraded ecosystems. A continuous encroachment and transformation of ecosystems from woodlands, grass lands, coastal areas, wetlands and water bodies into urban concrete jungles further degrade those (Nagendra et al, 2012).

2.2 Theoretical Review of Land Use Land Cover Change

The terms 'land use' and 'land cover' are sometimes used interchangeably, each has a separate meaning. Land cover is the bio-physical layer covering the earth surface, while land use represents the human utilization of the land cover. Land cover includes earth's land surface distribution of vegetation, water, desert and ice as well as the biota, soil,

topography etc. in the immediate subsurface, and it also includes human activity areas, such as settlement, mine exposure etc. (Lambin, et al., 2003; Oumer,2009).

Land use indicates the human consumption of land on other hand the land cover indicates the physical form of the land (baulies, 1997). Land use change is the result of a complex web of interactions between bio-physical, political and socioeconomic forces over space and time (Briassoulis, 2006).

Land use land cover affects one another and it is a complex process and it is most important environmental concern at worldwide level, which is caused by natural processes, effects of climate change, and the mutual interactions among environmental and social factors at different spatial and temporal scales (Valbuena, Verburg and Bregt 2008).

Land use and land cover change (LUCC) is commonly grouped in to two broad categories: conversion and modification. Conversion refers to a change from one cover or use category to another. Modification, on the other way, represents a change within one land use or land cover category due to changes in its physical or functional attributes (Meyer and Turner, 1994).

Land use is the projection of complex urban socio-economic activities on a land system. The structural and functional characteristics of land use reflect the outcomes of socioeconomic processes ((Kronert et al., 2001).

Land use, Land cover change vary with the purpose of the application and the context of their use. The land cover is the biophysical state of the earth's surface and immediate subsurface, while land use indicates the man modification of the land and land-cover type (Skole 1994, Briassoulis 2006).

Land-use-change patterns are the result of the complex interaction between the human and the physical environment. Case studies of the determinants of land-use change can help to analyze which theory is appropriate in a particular region and stimulate the development of new theoretic understandings. In this paper an empirical method is presented to analyze the pattern of land-use change that allows a wide range of factors, from different disciplines, to contribute to the explanation of land-use change (Lambin et al, 2001).

Land-use change can be described by the complex interaction of social and structural factors associated with the demand, technological capacity, social relations affecting demand and capacity, and the nature of the environment in question (Turner et al, 1990).

A theory of land-use change needs to conceptualize the relations among the driving forces of land-use change, their moderating processes and activities, and human behavior and organization. Although no single all-compassing theory of land-use change exists, different theories can help us to analyze aspects of land-use change in tangible cases, their synthesis being essential. Mapping and monitoring land cover have been widely recognized as an important step to better understand and provide solutions for social,

economic, and environmental problems (Adb El-Kawy et al., 2011; Dewan& Yamaguchi, 2009b; Foody, 2002).

Remote sensing has become an increasingly powerful and effective tool for monitoring and managing of land cover (Zhang & Zhu, 2011). Compared with more traditional mapping methods such as field survey and basic aerial photointerpretation, land cover mapping has the advantages of low cost, large area coverage, repetitive data, digital format, and accurate geo-referencing procedures (Jensen, 1996; Yuan et al., 2005). Land use information products from satellite images have become an essential database for land cover management and urban planning. Particularly, in developing countries, remote sensing is able to provide fundamental and cost effective land cover information that is not available from other sources (Dewan& Yamaguchi, 2009b; Miller & Small, 2003).

These relate to the availability of data from high spatial resolution satellites such as Quick bird, IKONOS, Rapid Eye, and Geo Eye, as well as high spectral resolution satellites such as Landsat (TM & ETM+), ASTER. The increasing availability of satellite imagery with significantly improved spectral and spatial resolution has played a significant role in more detailed land cover mapping. Meanwhile, the rapid development of image process technologies has provided more powerful tools for satellite processing and analysis. It is now possible to monitor and analyze urban growth in a timely and cost-effective way (Deng et al., 2009).

An important task of satellite image processing is to develop image data analysis approaches suitable to a particular application. The classification of land cover types

from satellite images is probably the most important objective of digital image analysis. It is a process of categorizing pixels in an image to one of land cover classes. The fundamental basis of remote sensing image classification is the spectral characteristics of earth surface features. While it is relatively easy to generate a land cover map from remote sensing image, it is difficult to make it accurate (Zhang & Zhu, 2011).

In the past few decades, different classification systems have been proposed to conduct the remote sensing image classification. Traditional multispectral classification methods make use of spectral information of different surface objects. Supervised and unsupervised multispectral classifications are the two main spectral recognition methods. Supervised classification aims to allocate pixels based on their similarity to a set of predefined classes that have been characterized spectrally (Foody, 2002).

Supervised classification examines known pixels in an image and aggregates in to land cover classes based on their relative spectral similarity.

The unsupervised classification examines the unknown pixels in an image and aggregates them into land cover classes based on their relative spectral similarity. The advantage of unsupervised classification is that it is automated and does not require a priori knowledge of the study area (Lillesand et al., 2004).

These traditional classification methods have been widely used for remote sensing application and have generated fairly good results for a wide variety of images. However, there are some challenges in obtaining accurate land cover information in urban areas. A major difficulty in urban remote sensing processing is attributed to the high heterogeneity

and complexity of the urban environment in terms of its spatial and spectral characteristics (Deng et al., 2009; Lu et al., 2011; Setiawan et al., 2006).

Misclassification problems are often found in the land cover maps generated from traditional methods. According to the literature review, there are two major factors that are responsible for the misclassification problem. One of them is the mixed pixel problem which results from the occurrence of more than one land cover type in one pixel (Fisher, 1997; Lu & Weng, 2004).

This is particularly true for transitional pixels between land cover types. As a result, the spectral information obtained at the mixed pixel is a mixture of the spectral values of several different land cover types. The other factor is the close spectral similarities between different land cover types (Foody, 2002; Liberti et al., 2009).

In recent years, many efforts have been made to improve urban land cover classification accuracy. A survey of the existing literature suggests that three major methods can be identified.

2.2.1 Making more efficient use of spectral information

Spectral information is the most readily available information in a satellite image. Considerable efforts are being made to develop new spectral classification methods. A number of spectral indices were developed to aid the interpretation of remote sensing images by detecting slight changes between different land cover types (Jones et al., 2011). It is based on the different band reflectance for the same material. For example the

most commonly used Normalized Difference Vegetation Index (NDVI) (Jamali et al., 2014; Setiawan et al., 2006), Ratio Vegetation Index (RVI) (Zhang & Zhu, 2011), Leaf Area Index (LAI) (Jones et al., 2011).

In addition, Principal Component Analysis (PCA) enables redundant data to be compacted into fewer bands. These bands of PCA data are not related and not dependent, and are more interpretable than the source data (Rajani&Rajawat, 2011; Zhang & Zhu, 2011). Tasseled Cap Transformation (TCT) can convert the original bands of a RS image into a new set of bands that are helpful for vegetation mapping (Dymond et al., 2002; Li &Thinh, 2013).

Land cover in urban environment is a direct combination of three mechanisms: vegetation, impervious surface, and soil. The model provides a potential framework to deal with classification problem in urban area. Several studies used the model to map land cover/land use in urban areas and demonstrated the usefulness for the classification in urban areas (Li &Thinh, 2013; Lu &Weng, 2004; Ward et al., 2000).

2.2.2 Incorporation of multisensory data and ancillary spatial information

Another basic strategy for improving the classification accuracy is to mix more information with remote sensing images. Generally, two types of data are used in information fusion. The first way is the integration of multi-temporal and multi-resolution data (Du et al., 2013; Gluch, 2002). The other way is to integrated original image with some other geographic data to improve accuracy of classification results, for example,

Digital Elevation Model (DEM), zoning information, administrative boundaries, etc. (Dewan& Yamaguchi, 2009a; Liberti et al., 2009)

Image

Image classification which is normally performed on multispectral images, which means images with more than one spectral band, automatically categorizes the entire image pixels into various land cover classes based on their similar digital number values (Lillesand, et al., 2008).

The satellite sensors record the variation in the electromagnetic radiation from each part of the earth surface and assign it with a distinct value for each spectral band. The range of digital number varies from sensor to sensor and depends on the radiometric resolution, which is attributed to the sensor's sensitivity to various level of incoming energy (Ayele, 2011)

2.2.3 Increasing use of spatial information

Most of image classification methods are based on the statistical analysis of each separate pixel (Agüera et al., 2008). These methods have a good performance when images have relatively low spatial resolution (Wang et al., 2004). However, the spectral variability increases within the same land cover type in the high spatial resolution images. In order to solve this problem, different systems have been tried that take into account the spatial information, which includes image texture, feature size, shape, etc. (Agüera et al., 2008; Puissant et al., 2005). Because spatial based classification involves a more complex

decision process, they tend to be much more computationally intensive than spectral based classification (Lillesand et al., 2004).

Change detection is the process of identifying differences in the state of a feature or phenomenon by observing it at different times (Singh, 1989).

- 1) Detect the geographic location of change;
- 2) identify the type of change;
- 3) Quantify the amount of change.

Change detection is useful in many applications related to land use and land cover changes, such as shifting cultivation and landscape changes (Serra et al., 2008), land degradation and desertification (Adamo & Crews-Meyer, 2006; Liberti et al., 2009), urban landscape pattern change, timely and accurate change detection of land cover provides a better understanding of relationships and interactions between human and natural phenomena. Change detection involves the analysis of multi-temporal datasets to quantitatively assess the temporal effects of the phenomenon.

There are several ways of processing methods the use of satellite imagery for determining land cover change in urban environments. Martin (1989) divided the methods for change detection into two classes: pixel-to-pixel comparison and post-classification comparison.

The first method conducts the pixel-to-pixel comparison of multi-temporal images without classifying the data. This method applies various algorithms, including image

differencing (Sohl, 1999) and image ratio (Nelson, 1983), to single or multiple spectral bands, vegetation indices (Guerra et al., 1998) or principal components (Fung & Ledrew, 1987), directly to multiple temporal images to generate change maps. Prior classification is not necessary for the comparison and errors from classification can therefore be avoided. However, the results of these methods could not provide information about the land cover conversion matrix.

The post classification comparison method is used to compare two or more separately classified images of different dates to yield land cover change maps, in which not only the amount and location of change but also the nature of change can be identified (Howarth & Wickware, 1981; Singh, 1989). In addition, this method can minimize the problems associated with multi-temporal images recorded under different atmospheric and environmental conditions (Lu et al., 2004). A major pitfall, however, the accuracy of change maps is strongly dependent on the accuracy of individual classification results (Yuan et al., 2005).

2.3 conceptual Review

Urban growth form has been studied in the contexts of urban planning, urban economics, urban geography, and urban sociology (Seto & Fragkias, 2005). The classic Von Thünen (1875) model of land use recommends that the configuration of urban and rural land use reflects transportation costs, land-value of productive activities and market prices. The spatial patterns of urban areas provide a better understanding of the urban growth process and its impact on environment (Luck & Wu, 2002).

The question then is how to quantify and express changes in urban spatial patterns. Landscape metrics are already commonly used to measure the shape and pattern of vegetation in landscape ecology (Gustafson, 1998). Landscape metrics were developed in the late 1980s and incorporated measures from both information theory and fractal geometry based on a categorical, patch-based representation of a landscape (Herold et al., 2003).

Patches are defined as homogenous regions comprising a specific background property of interest such as “urban” or “rural” (Dietzel et al., 2005). Landscape metrics are used to quantify the spatial outlines of individual patches, of covers belonging to a common class, and of the entire landscape consisting of all patches. Change of landscape patterns can be detected and described by the landscape metrics, which categorize complex landscape into identifiable patterns and reveal some ecosystem properties that are not directly observable (Antrop & Van Eetvelde, 2000; McGarigal et al., 2012; Schindler et al., 2008; Tian et al., 2014). Spatial metrics characterize urban form, whereas in ecological landscape studies, landscape metrics are explicitly related to ecological functions (Luck & Wu, 2002).

2.3.1. Urban Growth Boundary

An urban growth boundary creates division between urban areas and rural areas and preserves farmer lands. In this regards, several jurisdictions and executive agencies provide the terms “urban limit line”, to use of blue line or green line as real physical

border to separate rural and urban use of blue line or green line as real physical border to separate rural and urban areas (Jabareen, 2006; Johnson, 2001; Hirt, 2007).

The concept of urban growth boundaries has been used for first time in United States that is valuable to debate “Portland’s urban growth boundary” development. Hence, in the 1970s urban growth boundary has been implemented in Portland which brought out several positive characters for this city such as growing density, encourage an suitable mix of actions that let walking as an attractive alternative in cores of cities, decreased use of automobiles and support other forms of communities transport system, pedestrian preferably with environments (Jabareen, 2006; Johnson, 2001; Hirt, 2007).

2.3.2 Compact City

Before promoting the sustainable development concepts and agenda, the notion of a “radiant city” was proposed by Le Corbusier’s as answer to the issues of Victorian city. This idea allowed creation of tower blocks to lodgment high population densities inside wide-open spaces. In the following of this idea, Dantzing and Saaty in 1973 proposed the idea of compact city. The vision of this idea was for enhancing the quality of urban life without the expense for the future generation.

compact city involves plenty of methods and approaches that goal to create and provide compactness and density as solution to avoid many issues of the modernist cities design and planning Compact development recommends density of the built areas and increase of the activities, effective land use planning, mixed land-use, and appropriate transportation systems (Breheny & Gent & Lock, 1993).

Compact city policies have been designed to high density settlement, mixed land use Narrow Street, minimum individual car availability, and maximized community transport services and to minimize the loss of open countryside and compact city model is very recommendable model for city core areas (McConnell and Wiley, 2010).

The compact city has been embraced as a counter strategy against the rapid decentralization or urban sprawl that occurred in most western countries after the World War second, compact urban development consist of urban infill, moderately higher densities in existing centers of major restructuring of cities (Elkin et al., 1991).

Commission of European Communities in 1990 advocates intensely the “compact city” as an approach that makes urban environment more ecologically sustainable and develops quality of urban life (Laghai, 2010). Hence, compact city is a high-compactness, mixed-use city with narrow streets and well defined borders (Williams, Burton, and Jenks, 2000).

2.3.3 The Eco-City

The eco-city is a model of development that includes an extensive range of urban environmental suggestions to achieve urban sustainability. This model encourages the environmental agenda and highlights ecological management through a set of official and policy tools. Besides, the specific notions of the eco-city are “greening and passive solar design”. Furthermore, eco-city in terms of compactness and other notions is imagined as a “formless” city.

An eco-city should be creating conducive environments for living and for work designed public spaces and mixing green areas and subjects of cultural heritage to provide different surroundings (Mayerhofer&Skala, 2005).

Besides, sustainable and proper infrastructure contributes to the well-being, welfare and safety of residents and their identification with the eco-city (Jabareen, 2006; Mayerhofer&Skala, 2005).

Urban form includes a number of physical characters and non- physical feathers involving “size, shape, scale, density, land uses, building types, urban block layout and distribution of green space”. Besides, in this part five comprehensive and inter-related fundamental elements include “density, accessibility and transport infrastructure, housing/ building type, land use and layout” as make up urban form have been classified. However, these fundamental elements of urban form have direct influence on sustainability and human manner (Dempsey et al., 2010).

2.4 Driving factors of urban growth

There has been an increasing interest in identifying and understanding the effects of the driving factors on urban land cover change because this knowledge is crucial not only for the development of spatial models, but also more important for effective urban planning and management strategies (Dubovyk et al., 2011; Thapa& Murayama, 2010; Wu & Zhang, 2012).

Urban growth can be described by the complex interaction of behaviors and structural factors associated with the demand, technological capacity, social relations, and the nature of the environment (Lambin et al., 2001; Verburg et al., 2004a). However, there are no standard driving factors that are responsible for urban growth.

Gross domestic product and population growth are the main drivers' factors of urban growth. The growth of urban population and economy create urban land demand. More urban land will be required to satisfy further growth of urban population and economy in the future. The population variable was represented by the population density of district-town administrative units because the overall population for the whole study area is more related to the demand of urban land, has less effect on urban growth allocation(Cheng,2014).

2.4.1 Natural factors

In urban atmosphere, natural factors are correlated with the suitability and costs of a location for development. Topography often determines the location of new urban area because flat areas are preferable for urban development and mountains area are less preferable for urbanization (Li et al., 2013a).

Certain location of land which is compatible for urban area may not suitable for crop production may not has a specific soil characteristic that determines the production of agricultural vegetation. The good quality of agricultural land is not suitable for urban development in order to sustain future food supply (Li &Yeh, 2000).

Land use land cover change may happens with natural phenomenon such as flood, volcanic eruption, drought, fire and forest are factors that bring land use land cover changes naturally directly or indirectly (Mather,1986).

2.4.2 Socioeconomic factors

Socioeconomic factors are the most important factors of urban growth. A wide range of urban growth studies are based on socioeconomic theory. According to urban economists there are three primary driving factors that contribute to the urban growth: population growth, rising household incomes, and accessibility improvement (Mieszkowski& Mills, 1993).

As a whole, increasing the population of urban settlements or cities is the main and foremost reason of expansion of urban areas throughout the world. Hence, there is no doubt that growing of population is an indisputable fact and majority of this population are becoming urbanized. In this regards, can be noted rapid expansion of cities is and result high rate of land use land cover change dominated by two factors: immigrations and the natural population growth (Bhatta, 2010 &Günay, 2007).

Absence of low cost legal housing is one of the driving factors of urban expansion which means people who are impossible to have legal housing means they are going to handle illegal housing technics and by taking bare lands and construct illegal houses and this leads to land use land cover change of the area. So it is the causes of land use and land cover changes. For instance, in a well-balanced real estate market, the median household income could officially afford the median price of housing option, while those with lower

wage-earner than the median household income could not afford to buy the median home. As a result, a shortage of affordable housing in cities drives people to set their residences out of the communities in the countryside with informal way of landing (Bhatta, 2010).

Urban area should expand to large area of space to fulfill for the need of land source for housing, service delivery organizations like schools, health centers, offices and water and sanitation institutions services, road construction (Geoghegan et al., 1997; Mertens et al., 2000). Other than census based socioeconomic variables, suitability and accessibility are also strongly affects urban growth (Hu & Lo, 2007; Linard et al., 2013). The improvement accessibility indicates faster and more convenient travel and lower commuting costs. Verburg et al. (2004a) pointed out that “the influence of the socioeconomic conditions in the region can be best characterized by the access that a location has to these facilities.

2.4.3 Spatial policies, as factors of land use land cover of change

Policy variables affect the urban growth because they serve as to encourage or discourage development. From a practical point of view, the policy variables are expressed by spatially explicit layer designating the specified areas (Cheng, doctorate dissertation Dortmund December, 2014).

Spatial policies at national or regional level have significant impacts on land cover change (Dieleman& Wegener, 2004). They define the legal regulations for future land uses (Barredo et al., 2003). In particular, spatial policies can affect the urban

development in two aspects. One it is to serve as an accelerating factor to promote more new development in areas planner or proposed for development (Cheng & Masser, 2003), and the other is as a constraint to limit the development within a specific region, for example, the conservational or protected areas (Long et al., 2012; Verburg et al., 2004).

Evidence of urban planning shows that gradually growing cities have real and foreseeable stages of development. After constructing new houses, people demands for having appropriate life style such as new schools, health centers, administration offices and the primary infrastructure is increased. The new housing developments are built and occupied, the new residents realize they need new schools and improvements in the roads, sewers, and water supplies servicing the new housing; the expanded infrastructure then attracts more housing at higher densities (Heimlich and Anderson, 2001).

Lower level governments have nominal policy instruments to appreciate coming growth facing them, and there has generally been a lack of acceptable planning policies and programs before population growth overcomes them. In some cities, authorities use exclusive zoning regulations; this means separation of land uses. Zoning ordinance and regulations created isolated island fabrics of each type of development (Günay, 2007).

2.4.4 Neighborhood factors

The neighborhood factor is related with the Tobler's (1970) first law of geography. Land cannot be developed independently at each individual location; land cove patterns nearly always show spatial autocorrelation caused by a number of attraction and repulsion forces (Overmars et al., 2003). It is especially important to consider the neighborhood effect due

to the fact that urban development can be regarded as a self-organizing system (Verburg et al., 2004b).

A large number of studies illustrated that locations are more likely to be converted to urban area if they are places which are surrounded by more urban land. A neighborhood is a set of one or more locations that are within a specific distance and have a relationship to the particular location. A neighborhood is the region that serves as an input to assess the neighborhood effect in the transition rules. This effect is calculated as a function of a cell's own state and the state of the cells within its neighborhood. The neighborhood configuration determines the distribution and number of neighborhood cells that will affect the evolution of each central cell (Ménard & Marceau, 2005).

Neighborhood factors are introduced to consider the possible effects of spatial interrelation and neighborhood characteristics by different approaches. For instance, the proportion of urban land and some other land cover types in the neighborhood of a cell (Braumoh & Onishi, 2007; He et al., 2008; Hu & Lo, 2007; Long et al., 2012).

2.5. Environmental effect of land use land cover changes

When we discuss about urban land use and land cover dynamics, driving forces may include urbanization, energy consumption and the congestion transport sector. Pressures consist of solid and liquid waste, gas emission, alteration of natural hydraulic and sediment flux and loss of habitat. On the other way, estate of the environment composed of air quality, water quality, and state portable water with high concentration of metals and suspended solids. Impacts which are air pollution, drinking water pollution, sound

pollution, land fragmentation, atmospheric temperature and rain fall change in ecosystem and climate are indicators of environment and the study covers these elements (Sekovski et al., 2012).

Water bodies and wetlands play a significant role in the global carbon cycle, containing about 12% of the global Carbon pool. Thus, this prevalent depletion of wetlands has become a vital concern, given the current state of global warming and climate change as well as ongoing high demand of water use (Sahagian&Melack, 1998).

When population number increases, it would look rational to attach the water problems to population increases, growing water demand and degradation of water sources. Nevertheless, the reasons may be multiple and land-use/cover change seems to form part of such an explanation (Brandon and Bottomley, 1998; Chen, 2000; Diouf and).

Land-use and land-cover change (LULCC) play a significant role in adjusting the water body flow regime of the river basins. There are many connections between the land surface characteristics and the water Changes in the vegetation cover tend to affect the degree of infiltration, run-off, water (Namrataet .al, 2004)

Among different factors land use land cover change is one of the most serious factors the increasing of land surface temperature and Different researchers agree with that land-use change and unplanned use of land resources lead to be raised land surface temperature. Different studies have studied that spatially there are correlations with changes as reflected in the characteristics of individual land-use classes or categories (Oluseyi et. al., 2011).

CHAPTER THREE: METHODS AND MATERIALS

3.1 Research design

The first research question which is analysis of Land use land cover change dynamics of the sub city was responded using the four years satellite images by downloading satellite images from United State Geological survey (USGS) and did land use land cover classification results using supervised image classification to produce land use land cover maps of the sub city.

The second research question which is investigate the causes of land use land cover change was examined using different city administration bureau such as central statistics Agency to prove the population change from 1996 to 2021, Addis Ababa plan and development commission to prove the GDP growth of city, Addis Ababa industry bureau to study the government spatial policy especial industry development and final Addis Ababa housing development bureau to investigate the condominium housing development program.

The research used to answer the third research question which is assessment of environmental impact of urban growth used national metrology Agency data, to prove the temperature change of the sub city, the rainfall levels and humidity change of the sub city, by prepare structured questionnaire for residents and field observation to answered air pollution, sound pollution, drinking water pollution, health problems and to show the land surface temperature change of the sub city using Ark GIS software.

3.2 Site selection criteria

The study area is selected purposely because, first Akaki-kality sub city has many industries and fabrics from the rest of 10 sub cities which are found in Addis Ababa, it is vulnerable for pollutions. The second reason for the selection of study area is there are high urban expansion and high rate of land use and land cover change rates are there. The third reason for chaos of Akaki kality sub city weather condition is very warm so to study the above issues the site is selected and the researcher is going to study the area.

The next reason for the selection of the study area was both wereda 06 and wereda 07 are polluted weredas. wereda 06 covers different leather industries are and wereda 07 contains toilet waste removal area and both this two weredas residents raised appeal towards the city high level leaders including the city mayor and the Akaki kality sub city Environmental Protection Authority branch office recorded me to select wereda 07 and wereda 07 for my study area.

3.3 Description and characteristics of the study area

Akaki Kality sub city has 11 weredas/destricts and among the eleventh weredas/destricts wereda 09 is the largest wereda and it covers 2,948 hectares area and it is 23 percent of the total sub city area. On the other hand wereda 03 is the smallest wereda which covers 236 hectares or 1.9 percent of the sub city total area (AAILIC, 2014).

Based on the Central Statistics Authority (CSA) projections of July 2013, the population of the Akaki Kality Sub city is estimated to reach 205,385 out of which 100,513 are male and 104,872 are female. The Sub city has a population density of 1,653.7 per square kilometer. The population is engaged and led their life with factory workers, civil servants, daily laborers, merchants, commercial workers, farmers and others (Addis Ababa Integrated Land Information Center, 2014).

Akaki kality sub city also one the sub city which has higher expansion due to population new formal and informal settlement like squatters and farmers are incorporate in the city. The other case is the industries and fabrics have high portion of the land the sub city results high expansion.

3.3.1 Location

The study area is located in the South Eastern part of Addis Ababa which is one of the tenth sub cities and so-called Akaki-kality sub city, this part of the city is the most rapidly expanding and growing in Addis Ababa due to massive housing programs for residential purpose, industrial expansion and other infrastructural activities. The study area lies between 38° 45' E-39 S 45'45'' (Kinfе, 2018)

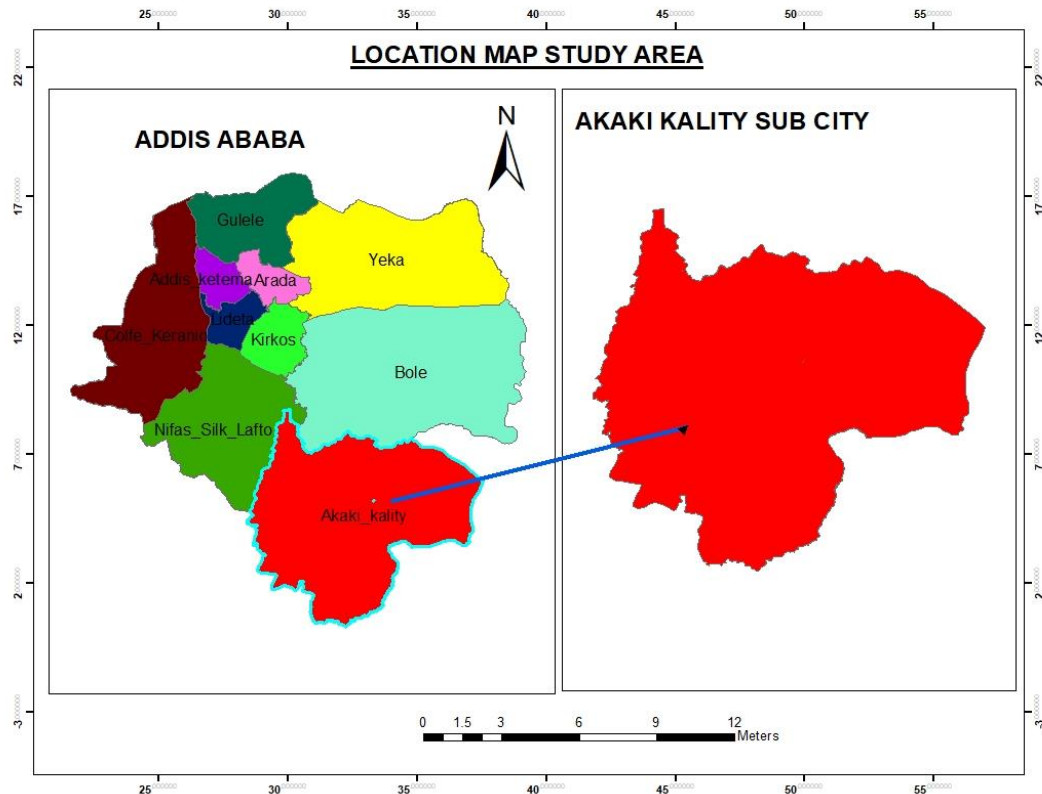


Fig 3.1 Location map of Addis Ababa and Akaki Kality sub city

3.4 Sampling methods and sampling size

3.4.1 Sampling methods

The research used systematic sampling methods by select woredas/districts which are industries and fabrics exposed for air pollution and difficult for living areas. Because in these area the people who are living there are facing the challenges directly or indirectly and the researcher gets tangible and truth information and in addition to the research found recommendations to solve the residents' problems.

The researcher has chosen 1996 year satellite image primary because of the immediate year when the federal democratic republic of Ethiopia (FDRE) has consolidated power and formulates different rules and policies for Addis Ababa city and the existing cloud free satellite image much closer to the 1997 the demographic and census data of the city. Secondly, the year is selected as a result of the city was formulated title deed certification based on satellite source line map for owners and this condition is good opportunity for the research to get authorized and legal spatial data. The third reason to the 1996 year is that the FEDRE government formulated the current Ethiopian constitution, organized regions and two city administration including Addis Ababa.

The other year which is selected by the researcher is 2005, because of the under listed reasons: The other big event of year 2005 is the national election of government and due to this there were dynamic political, social and economic changes in the city of Addis Ababa. In this year, there was a political unrest following election in the country wide, largely in Addis Ababa City, and large number of informal land holding were emerged and the city government has also legalized them. The other reason is that the researchers wanted to relate country level population census which was conducted after 2 years considering the 2007 big number of population variation in the country level and in the city wide.

The other governmental policy in 2005 in Addis Ababa is condominium housing development program for low and middle income people is launched in 2005 in the first time in Ethiopia and in Addis Ababa and this program has its own effect for urban expansion in Addis Ababa and in Akaki Kality sub city.

The third year is the 2011. This year is selected purposely, because there is a high resolution satellite image developed by a Germany Company called 'Hansa luftblt' for the purpose of digital land registration or Cadaster mapping. This image has authorized by the city administration and based on it legal line map and base maps are developed and still these maps are valid to issue the legal ownership certificate for property owners, to develop master plans and for legal cadaster or digital land registration.

The last and the fourth target year satellite image which is taken as source of information is the 2021 satellite image. The purpose to use this year is to get recent information regarding to the urban expansion in the study area and the dynamics of land use land cover changes and corresponding environmental impacts.

Further reason in the year 2021 as before the fifth national election is taken place and governmental power is transited from Ethiopian people democratic liberation front to prosperity party and this change may have its own effects on urbanization, new land owner have taken land informally and change the land use change.

The other general and prevail reasons for the selection of the above years is the master plan preparation periods, which are more or less within two years before or after the selected years. So, this is additional opportunity for the researchers to validate and compare different information from various sources.

3.4.2 Sampling size

The research sample takes from woreda 07 by recommendation of Akaki Kality sub city environmental protection authority branch office. The sample area is selected by the Addis Ababa city administration toilet removal dump area and the whole city level toilet waste material is accumulated around this sample area and the residents have reported their opposition in different times for the sub city environmental protection office. So based on the recommendation of the sub city the research took place this sample area and based on woreda data totally in the village lives here 120 people around this area and had been questioned 92 individuals were selected randomly by questionnaire.

Equation: 3.1

$n = \frac{N}{1 + N(e)^2}$ Yemane (1967) with 95 % confidence level

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

Where

n = Sample size

e = 5% error margin

N = 120 total population

$n = \frac{120}{1 + 120 * 0.05^2}$

n = 92

The second research sample woreda/district 06 also recommended by the sub city environmental protection authority branch office with repeated opposition for the sub city office by the residents and the research took 222 sample individuals were select randomly by woreda data for questioner among 500 total people who are living around this close to leather and tire industries area..

Equation...3.2

$n = \frac{N}{1 + N(e)^2}$ Yamane (1967) with 95 % confidence level

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

Where

n= Sample size

N= 500 total population

e=5% error margin

$n = \frac{500}{1 + 500 * 0.05^2}$

n=222

3.5 Data type

3.5.1 Primary Data

Primary data were collected by field observation, structured questioners, interviewing the private company owner and institutions, governmental organization/offices and professionals who are working in different sectors.

The relevant information about the effects of land use/land cover changes and further environmental impact for livings, and to show the poor integration between the urban expansion and the environmental protection were collected through interviewing, by key informants the residents near industries and the most affected.

3.5.2 Secondary data

The secondary types include all documents for the project development process, published and unpublished research works, Environmental impact assessment documents, urban planning and management documents, and working documents related to the research objectives. Additionally, to illustrate the land use and land cover changes of the Akaki Kaliti sub city, temporal satellite images from 1996 to 2021 having 30m pixel size were used.

The existing projects, related published and unpublished researches, urban planning and management documents were collected from the ministry of urban development and construction, working documents from governmental organizations and private industries and other related administration organs. Governmental office regulation, directives and implementation plans were applied to fill the information gaps of the primary data and also helped to assess the gaps between the rules and their employment.

The satellite images of different years were collected from the United States Geological Survey (USGS) Earth explorer of Land sat 5, land sat 7 and land sat 8 images in Tiff formats. The downloaded images were from spatially referenced in the Universal Transverse Mercator (UTM) projection with datum World Geodetic System (WGS) 1984

UTM zone 37N .The Satellite images preprocessing, supervised image classification and other means of image processing were done using Ark GIS and ERDAS IMAGINE 15 software.

Addis Ababa Environmental Protection Authority was used data for checking of the environmental impact assessment for projects before industries was developed and it's follow-up after industries development. Addis Ababa Plan and Development Commission data was used to prove the structure plan implementation status according to land use land cover and to prove the level of Addis Ababa GDP.

Addis Ababa Land Development and Administration Bureau used to examine the total area of condominium and industries development. Addis Ababa Housing Development Bureau used to examine the aim of condominium housing program and its legal framework regarding to condominium. Addis Ababa Industry Bureau used to study the industries distribution, levels and their functions. National Metrology Agency data used to study the temperature, rainfall and humidity variations of 1996,2005,2011,2021.

Different land sat sources were used to cover the Satellite images of the specified years. Land sat 5 for 1996, land sat 7 for 2005 and for 2011 finally land sat 8 for 2021 satellite images also used to detect land use land cover change and proved temperature change measure.

Table 3.1 Character and acquisition of land sat data

sensor	Acquisition period	resolution	Path/row	producer
1996 land sat 5 TM	15/11/1996	30m	170/052	USGS
2005 land sat 7 ETM+	1/12/2005	30m	170/052	USGS
2011 land sat 7 ETM+	20/1/2011	30m	170/052	USGS
2021 land sat 8 OLI/TIRS	10/12/2021	30m	119	USGS

3.6 Data Collection Methods

.The researcher used systematic questionnaires, interviews, field observations, previously recorded organization data, and other methods to demonstrate that urban growth is a cause of warm; flood or excess rainfall, Temperature, land use and land cover change, water and whether condition pollution, sound pollution ,air pollution and others problems.

Separate participation with men, women, and youth from affected individuals and villages to obtain neutral and reliable information from the victims' society. Perhaps the data were collected in order to get the concerned body, either individually or as a group, and at the office or institution level.

The researcher also used professional workers who are working in Addis Ababa in environmental protection authority and village committee regarding to the face of toilet dump and leather industries waste removal area.

3.7 data analysis, image classification and Accuracy assessment

3.7.1 Data analysis

The data analysis tools of the thesis were Microsoft Excel, Erdas IMAGINE 15 and Ark GIS 10.4 for the land use land cover analysis. Satellite images were analyzed to identify land use/ land cover change, patterns of land use and land cover changes using of the study area. Change detection was applied to show which land uses were converted to which land use.

The environmental effect of urban expansion or land use land cover change on temperature were proved by using the 1996 and 2021 satellite image through generating NDVI, vegetation proportion, land surface emissivity and using temperature brightness, wave length and speed of light.

Environmental pollution such as sound, water, air were identified using systematic questionnaire for residents or villages living near to the target research area, field observation and key informant interviews among societies.

Temperature, rain fall and humidity variation were assessed using the data obtained from the national metrology agency of Ethiopia for the selected research years, which are 1996,2005,2011 and 2021.

ArcGIS 10.4 software was applied to analyze the land use/ land cover changes over time, AutoCAD 7 was used to calculate condominium site areas, ERDAS IMAGINE 15

software were also used to map the study area's natural feature and continuous urban expansion.

3.7.2 Image classification

Image classification refers to the extraction of differentiated classes or themes, usually land cover and land use categories, from raw remotely sensed digital satellite data. Image classification using remote sensing techniques has attracted the attention of research community as the results of classification are the backbone of environmental, social and economic applications (Weng, 2012).

Following the land cover classification, change detection analysis will be used to analyze patterns of land cover change during the study period. Change detection is the process of identifying differences in the states of an object by observing it at different times (Singh, 1989). Image differencing, principal component analysis and post classification detection are the most widely will be used methods for change detection.

Satellite images were downloaded from land sat 5, land sat 7 and land sat 8, composite different color band were done, geo-referencing or map correction were made, extraction of the study area from the big portion were conducted, interpretation of features and classifying as built up area, bare land, forest and vegetation and water bodies were done.

Digital image classification in remote sensing is the detection and clustering of similar image pixels into the same information categories which are produced from several spectral bands of a satellite image (Campbell, 2002; Paiboonvorachat, 2008).

The accuracy was assessed using the sample signature of land use cover classification for each category of land use classes based on image pixel assessment by columns and rows and calculating the sample of rows and columns and dividing its total pixels.

3.7.3 Accuracy assessment

The research used the land use land cover classification result validation using ground truth by taken 58 points and calculate user accuracy, procedure accuracy and over all accuracy sample years .

My accuracy assessment sample years are 1996 which is my primary study period and 2021 which is my last study period. Between these period there are 25 years and within this long period the satellite image quality level may be has big difference has classification accuracy effect so to check this quality Accuracy assessment is done for year 1996 and year 2021 respectively

3.8 Data presentation and interpretation

The data is presented through tables, graphs, charts and also by using relative measures, such as percentages. Moreover, maps and images would be prepared and presented.

The theoretical and descriptive information are presented using narratives. The facts and findings that are difficult to express by tables, graph, images and mappings were expressed by relating to theories.

Land use models were deployed to show time series land use/land cover changes, climatic change in terms of the variation in the distribution of precipitation, Temperature, humidity and identify causes characterized with the fastest urbanization rate.

CHAPTER FOUR: RESULTS AND DISCUSSIONS

These chapter present findings in terms of land use/ land cover changes and parallel environmental effects of land cover and land use changes of Addis Ababa city administration in Akaki Kality sub city within the 25years. The below stated aspects of the study shows the pattern and trend of land use and land cover dynamics as well as indicators of the environmental implications of the changes.

4.1. RESULTS

4.1.1. Land use land covers dynamics of Akaki Kality

4.1.1.1. Land use/ land cover dynamics of Akaki Kality sub city in 1996

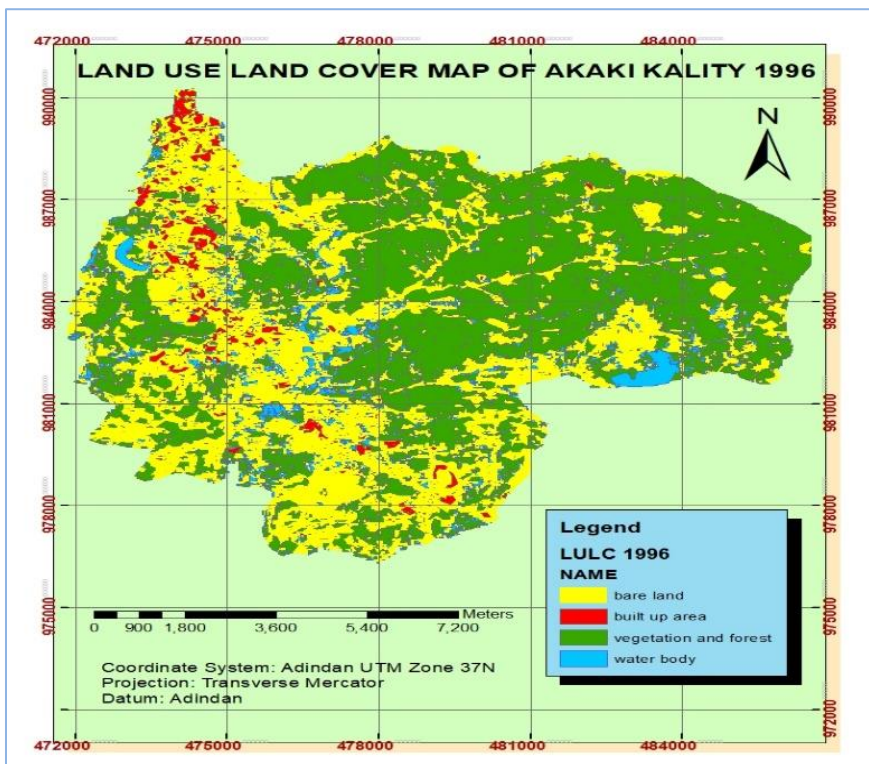


Fig 4.1 Land use/ land cover of the Akaki Kality in 1996

Table 4.1 Percentage of the Land use/ land cover of the Akaki Kality in1996

Land use/Land cover classes	Total area (ha)	Percentage (%)
Bare land	4,960	40
Built up area	1,240	10
Vegetation and Forest	5,332	43
Water bodies	868	7
Grand Total	12,400	100

The land use/ land cover of Akaki Kality sub city during 1996 shows the sub city had the largest coverage of vegetation and forest which is 43%and followed by bare land which accounts 40% of the total area of the sub city. The built up area covered 10 percent and the water body, which accounts 7 % which is the smallest.

4.1.1.2 Land use/ land cover dynamics of Akaki Kality sub city in 2005

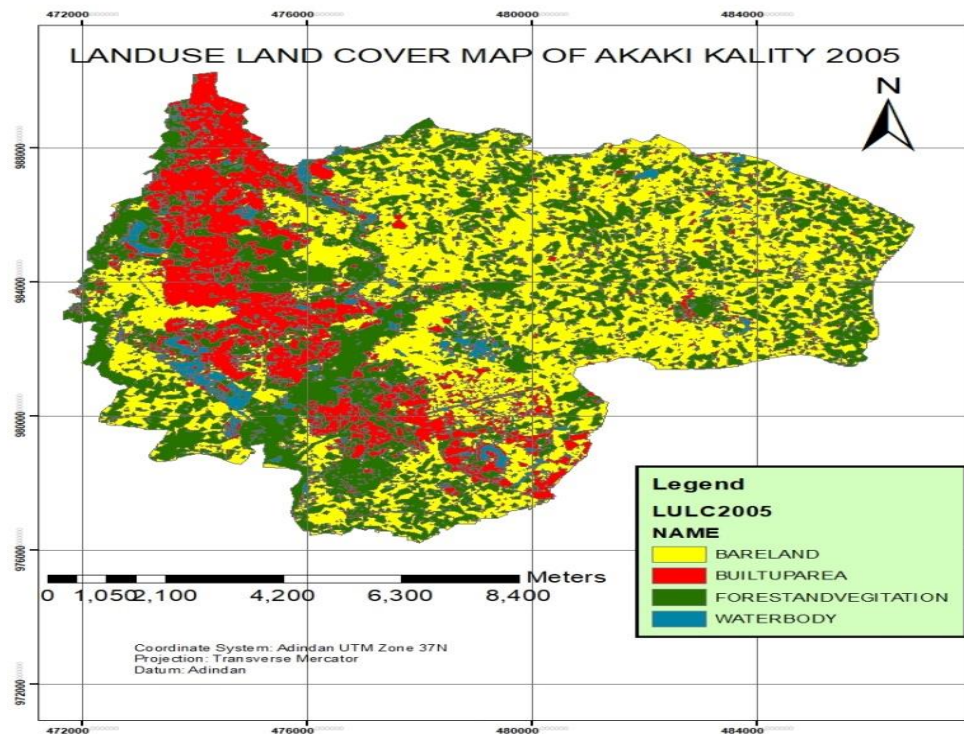


Fig 4.2 Land use land cover classification map in 2005

Table 4.2 land use land covers classification of 2005

Land use/Land cover classes	Total area (ha)	Percentage (%)
Bare land	4,340	35
Built up area	3,224	26
Vegetation and Forest	4,092	33
Water bodies	744	6
Grand Total	12,400	100

The land use/ land cover of Akaki Kality sub city during 2005 shows the sub city had the largest coverage is bare land which is 35% and vegetation and forest is the next largest

coverage which is 33%. The built area covered 26% and the water body accounts only 6 %, which is the smallest.

From the above classification result between 1996 to 2005 there is 5% or 620 hectare bare land was changed to built-up likewise vegetation and forest was lost 10% or 1,240 hectare and built-up area was gain 16% or 1984 hectare land and this implies that weather condition warming environmental pollution, imbalance rainfall, imbalance humidity and environmental degradation will be happen.

4.1.1.3 Land use land cover dynamics of Akaki Kality sub city in 2011

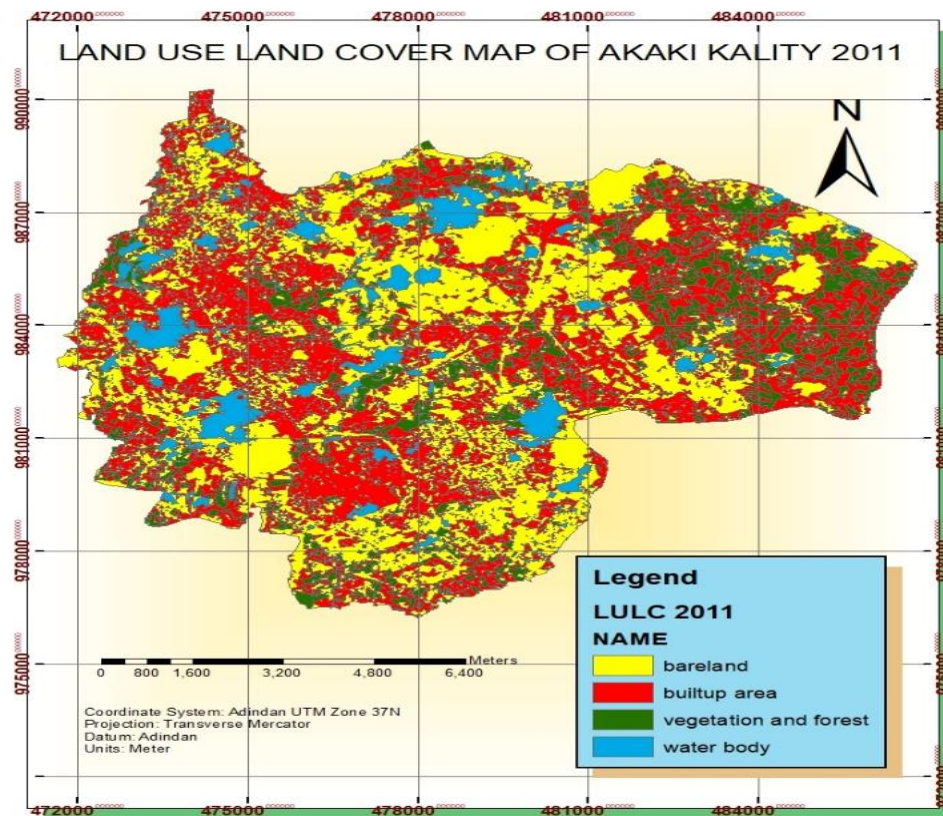


Fig 4.3 Land use land cover classification map in 2011

Table 4.3 land use/ land covers classification of 2011

Land use/Land cover classes	Total area (ha)	Percentage (%)
Bare land	5,084	30
Built up area	3,720	41
Vegetation and Forest	2,976	24
Water bodies	620	5
Grand Total	12,400	100

The land use/ land cover of Akaki Kality sub city during 2011 shows the sub city had the largest portion of bare land which is 41% and built up area had the second larger portion which is 30% vegetation and forest had 24% and water body coverage of 5%.

From the above classification result between 2005 and 2011 loss of 5% or 620 hectare bare land was changed to built-up area likewise vegetation and forest was lost 9% or 1,116 hectare and built-up area was gain 14% or 1,736 hectare land and this implies that weather condition warming environmental pollution, imbalance rainfall, imbalance humidity and environmental degradation will be happen.

4.1.1.4. Land use land cover dynamics of Akaki -Kality sub city in 2021

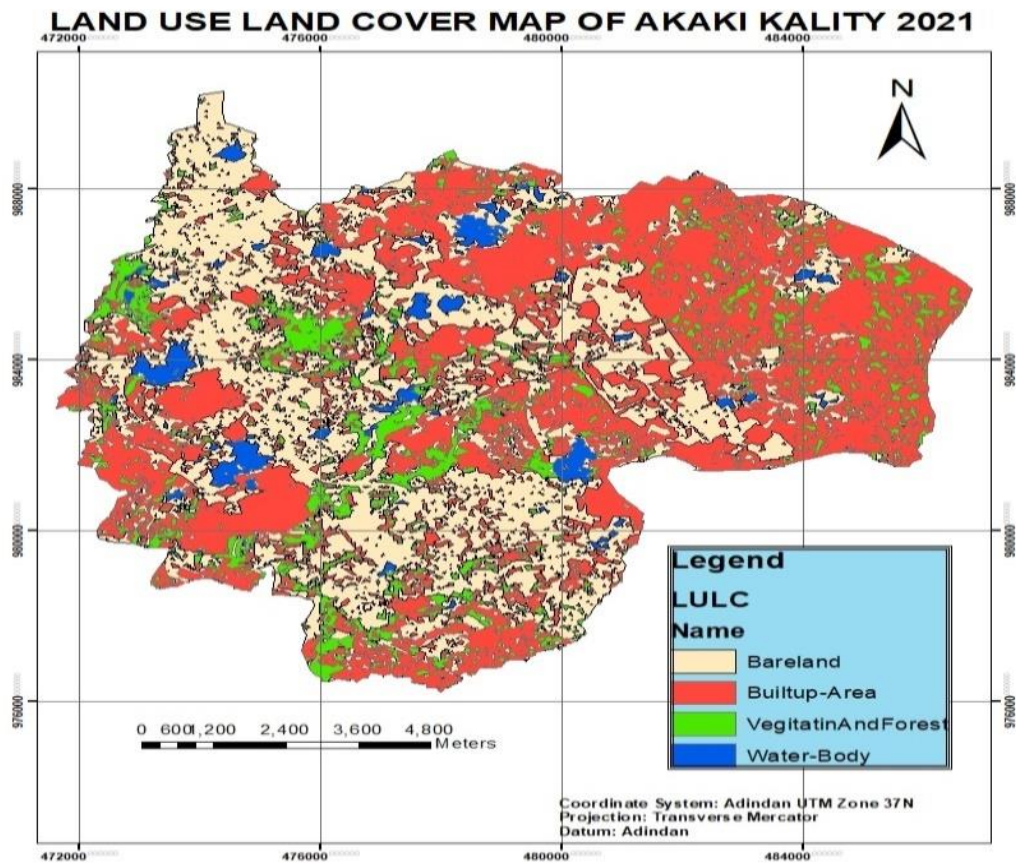


Fig 4.4 Land use /land cover classification map in 2021

Table 4.4 land use/ land covers classification in 2021

Land use/Land cover classes	Total area (ha)	%
Bare land	2,976	24%
Built up area	5,704	46%
Vegetation and Forest	2,852	23%
Water bodies	868	7%
Grand Total	12,400	100%

When we see the land use analysis of 2021 built up area has the largest coverage which is 46% and the second largest portion was bare land which account 24% and vegetation and forest has 23% and water body has only 7% which is the smallest.

Between 1996 and 2021 the land use/ land cover analysis indicates the bare land decreased from 40% to 24 % which mostly changed to construction, and the built up area changes from 10% to 46 %, which means it increased by 36 % or 4,464 hectare. The other land use/land cover, which has shown the big difference between 1996 and 2021, was vegetation and forest, which decreased from 43% and 23%, the water bodies has shown only about 2 % variation within the 25 years from 1996 to 2021.

Table 4.5 Summary of the land use/ land covers classification of the Akaki Kality Sub city in four time series

Land Use Land Cover Classes	Years							
	1996		2005		2011		2021	
	Area (ha)	Percentage (%)	Area (ha)	%	Area (ha)	%	Area (ha)	%
Built-up Area	1,240	10	3,224	26	5,084	41	5,704	46
Bare Land	4,960	40	4,340	35	3,720	30	2,976	24
Vegetation and Forest	5,332	43	4,092	33	2,976	24	2,852	23
Water Body	868	7	744	6	620	5	868	7
Total	12,400	100	12,400	100	12,400	100	12,400	100

4.1.1.5. Accuracy assessment

4.1.1.5.1. Accuracy Assessment of map of 1996

The overall accuracy of 1996 was 74 % the maximum procedure accuracy was 75.6% but the minimum procedure accuracy was 71.4% which were built-up area and water body respectively while the maximum user accuracy was 94.6% and the minimum user Accuracy was 57.7% which were bare land and water body respectively. On the other hand the year Kappa coefficient was 22.5%.

Table 4.6 accuracy assessment of map 1996

		reference map						Users accuracy
		Vegetation and forest	Bare land	Built-up Area	Water	Total	omission	
Classification map	Vegetation and forest	22	7	0	6	35	0.371	0.629
	Bare land	0	35	2	0	37	0.054	0.946
	Built-up Area	8	0	25	0	33	0.242	0.758
	Water	0	5	6	15	26	0.423	0.577
	Total	30	47	33	21	131		
	Omission	0.267	0.255	0.242	0.286			
	Procedure accuracy	0.733	0.745	0.758	0.714			
	Over all accuracy	0.740						
	Radom accuracy	0.258						
	Kappa coefficient	0.225						

4.1.1.5.2. Accuracy Assessment of map of 2021

The 2021 classification map overall accuracy was 86.7% the maximum procedure accuracy was 97.7% and the minimum procedure accuracy was 67.85% vegetation and forest and bare land respectively. Likewise the maximum user accuracy was 100 % for water body and built-up area and the minimum user accuracy was 85.7% which was vegetation and forest. On other hand 2021 kappa coefficient was 80.8%.

Table 4.7 Accuracy assessment of classification map of 2021

		Reference map						users accuracy
		Bare land	Built-up Area	Vegetation and Forest	Water Body	Total	omission	
Classification map	Bare land	19	0	1	0	20	0.050	0.95
	Built_up Area	7	30	0	0	37	0.000	1.00
	Vegetation and forest	2	3	42	2	49	0.143	0.86
	Water Body	0	0	0	7	7	0.00	1.00
	Total	28	33	43	9	113		
	Omission	0.32	0.091	0.0232	0.222			
	Procedure accuracy	0.68	0.909	0.977	0.777			
	Over all accuracy	0.87						
	Radom accuracy	0.31						
	Kappa coefficient	0.81						

4.1.2. Driving factors of land use land cover change

4.1.2.1 Population Growth

The growth of population number is one of the most influential causes for urbanization and land use/ land cover changes for most of the urban areas globally. Likewise in Addis Ababa, population is one of the causes of its expansion and the increased built up area in the study area.

The 1994 Ethiopian census shown the population of Addis Ababa city was 2.09 million and in 2007 increased to 2.75.million which means the population number of the city grew by 31% (CSA, 1994&2007). Particular to the study area, between 1994 and 2007 census, the population of Akaki Kality sub city increased from 139,260 to 330, 396 .

Table 4.8 Population growth of the Addis Ababa city and Akaki Kality sub city from 1994 to 2021

No	Year	Addis Ababa population		Akaki kality
		Million	Growth rate	Population in thousand
1	1996	2,189,000	2.10	144,474
2	2005	2,634,000	2.05	173,844
3	2011	3,263,000	4.38	215,358
4	2021	5,006,000	4.42	330,396

Between 1996 and 2005 the population of Addis Ababa city increased by 445,000 which means about 49,444 people added to the city annually. In the same period, the populations of the Akaki Kality sub city increased by 29,370 and 2,937 new people were added to the sub city annually.

From 2005 to 2011 the population of Addis Ababa grew from 2,634,000 to 3,263,000 and in the same period the sub-city the population increased by 41,514 people.

Moreover, between 2011 and 2021, within 10 years, the population of Addis Ababa grew from 3,263,000 to 5,006,000 means 1,743,000 people increased in the city level, and the population of the Akaki Kality increased from 215,358 to 330,396, about 115,038 more people.

As a result, from 1996 to 2021, in 25 years, the Akaki Kality sub city population grew by 185,922. Therefore, these people need additional land for residence and other social services that increased the built up spaces and rate of urbanization in general (CSA, 1996&2007).

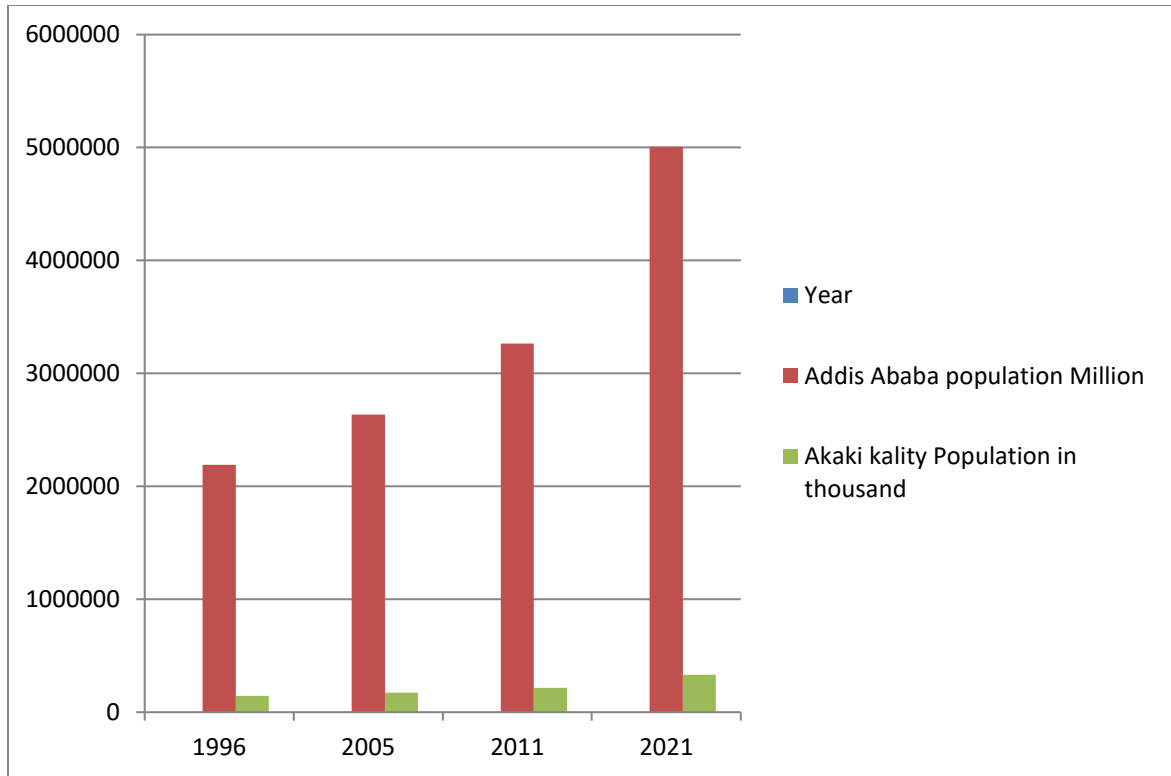


Fig 4.5 population graph of Addis Ababa and Akaki Kality sub city from 1994 to 2021

4.1.2.2. GDP growth of the city

Between 1996 to 2005 years the GDP of Addis Ababa city increased by 40,813,040,202 birr. This numbers indicate about 4,534,782,244 birr increased annually in the city level and Akaki kality sub city's GDP was 2,693,660,654 birr, within these9 years about 299,295,628 birr increased annually.

From 2005 to 2011, the city's GDP was 100,435,255,342 birr and with 16,739,209,223.667 birr increment annually, and at the sub city level within the same period, the GDP was 6,628,726,852 birr and 1,104,787,808.667 birr increment annually.

In the third phase of the study period, from 2011 to 2021 the GDP of Addis Ababa was 610,363,467,110.69 birr and 40,283,988,830 birr at the sub city level respectively.

Addis Ababa city administrations gross domestic product increased from time to time. In 1996 the city GDP was 50,971,975,497.51 birr and after 25 years in 2021 the city GDP grew to 802,583,738,151.69 birr which is nearly 16 fold. This economic growth of the city is lead to high investment and job creation for people and it is the causes of migration from regions to Addis Ababa to get job that brings to high urbanization and expansion at the sub city level (AABOF, 1988to2021).

Table 4.9 GDP of Addis Ababa and Akaki Kality sub city

No	year	Addis Ababa GDP	Akaki kality GPD
1	1996	50,971,975,497.51	3,364,150,382.836
2	2005	91,785,015,699.51	6,057,811,036.134
3	2011	192,220,271,041.00	12,686,537,888
4	2021	802,583,738,151.69	52,970526718.012

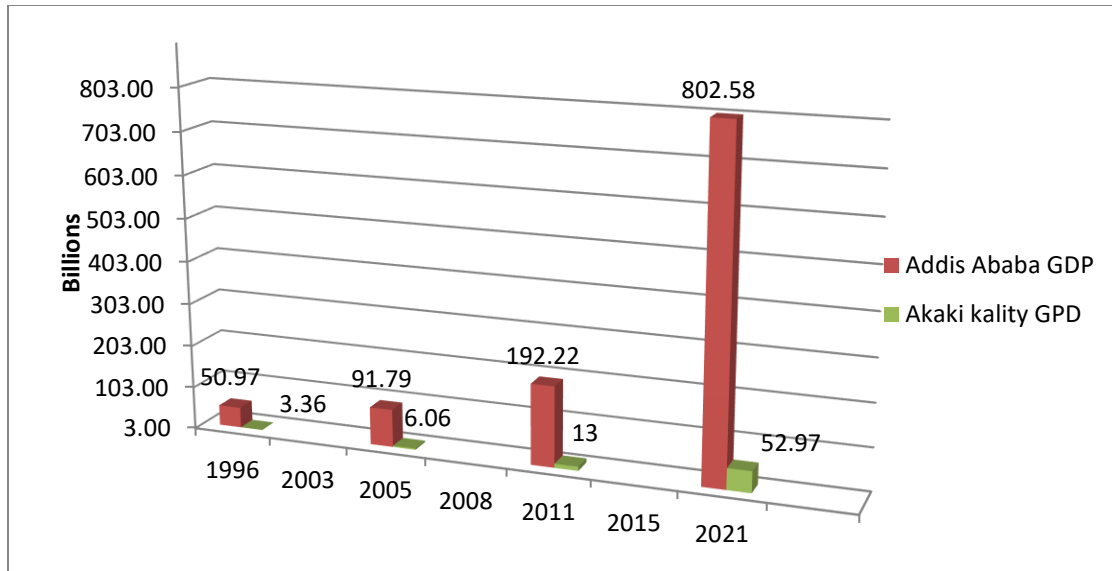


Fig 4.6 GDP growth from 1996 to 2021 of city and sub city

4.1.2.3. Governmental Policy

4.1.2.3.1. Industrial development

According to the 2010/11 CSA report, there are 2,170 medium and large scale industries established in Ethiopia out of which more than 40% are located in Addis Ababa. The other national regional states have the following share: 23% in Oromiya, 11% in Amhara, 11% in SNNP, 9 % in Tigray, 3.23% in Dire Dawa, 1.01% in Harari, 0.6% in Somali, 0.37% in Afar, 0.09% in Benshangul and 0.05% in Gambella regional states.

The city administration and federal governments decided Akaki Kality sub city is the center for industry zone and a number of industries were constructed during the research period.

In 1996, only one industry was in Akaki Kality sub city, in 2005 number of industries were increased to 29, in 2011 the sub city contained 44 industries, in 2021 there were 117 industries and currently there are about 1,062 industries in the sub city ranging from micro enterprises to high level industries(Industry bureau,2023) .

Among 1062 total industries in in the sub city, 176 industries are leather industries which are dangerous for environmental pollution and have had bad smell for the residents especially leather industries which are found in Woreda06 are repeatedly complained by residents and they have reported their complain repeatedly to the city mayor and other federal government officials but still they have not got solutions.

These leather industries have the amount of 16.57 percent of the total Akaki Kality sub city industries and these industries are becoming the most critical industries for air pollution and with their bad smell due to the solid and liquid wastes.

Table 4.10 Industries distribution in different woredas

woreda	Micro industries	Small industries	Medium industries	High industries	Total industries
1	41	11	7	6	65
2	13	6	4	9	32
3	46	9	5	2	62
4	16	6	9	7	38
5	6	17	44	77	144
6	14	27	4	5	50
7	85	26	53	159	323
8	50	14	59	11	134
9	46	21		3	70
10	9	14	12	6	41
11	0	0	0	0	0
12	1	3	15	35	54
13	35	14			49
total	362	168	212	320	1062

When we saw the industries distribution between woredas, woreda 07 has largest (323 total industries), followed by woreda 05 (144 total industries). The third woreda which has large industries is woreda 08 which has 134.

Woreda07 and woreda 05 accounts 44% of the total sub city industries coverage and these woredas are specified as industries zone in the city. On the other hand, among 13 woredas in the sub city woreda 11 has no industry.

Generally the total industries in Akaki Kality sub city covers 1,167 hectare of land which accounts about 9.4 percent of the total land of the sub city and 84 percent of the whole Addis Ababa's industries ratio (AAIB, 2023).

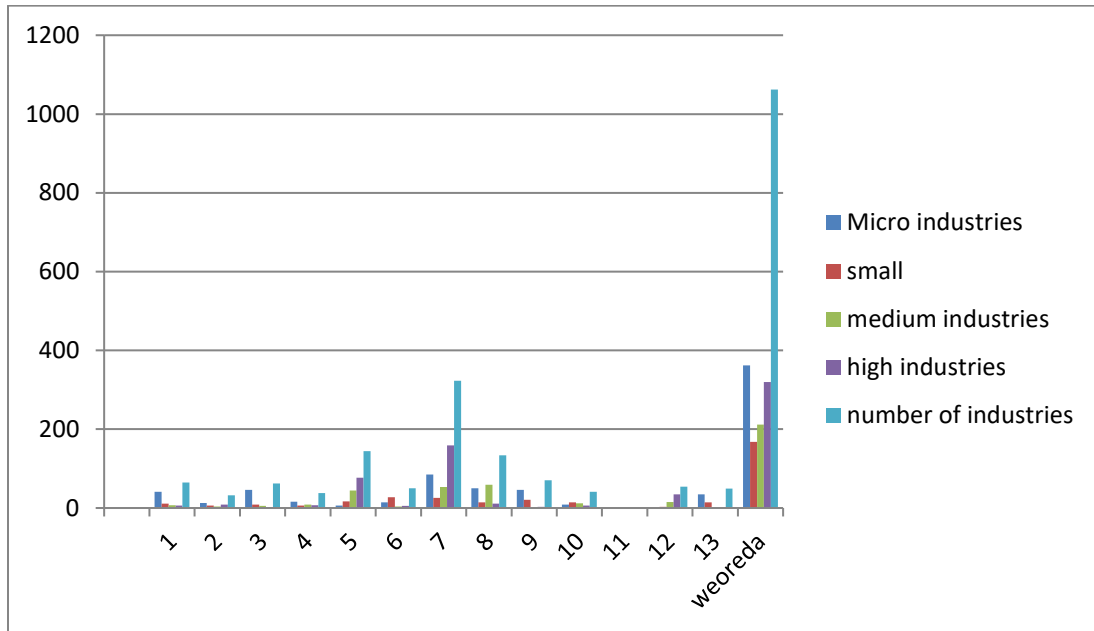


Fig 4.7 Industries distribution of woredas in the sub city

Table 4.11 shows industries name and the area they cover

No	Industry Name	Area by meter square
1	Meta beer Akaki kality	369,000
2	Meloyem general closing power limited company	3279.73172
3	CBB power limited company	3383.353521
4	Tice power Limited Company	4352.598855
5	Bajaba power limited company	3058.221543
6	Alshalom leather product company	1705.893652
7	Alek terrazzo manufacturing power limited company	4653.962777
8	Gaf General trading	2282.387459
9	Guna power limited company	3299.380821
10	Taf international power limited company	3079.395563
11	Ethiopian Sinakis power limited company	2413.054354

4.1.2.3.2. Condominium housing program

Condominium housing program got the first legal framework in 2003 and approved as proclamation no. 370/2003. The program was very huge and planned on 6,000 hectares of land annually with a density of 150-300 households per hectare.

Following the program, 13 condominium sites were constructed in Akaki Kality sub city from 2005 to 2021 and these numbers levels the sub city to second rank next to bole sub city within 16 years.

The biggest condominium site in Akaki Kality sub city covers about 718 hectares of lands and the smallest site covers 0.79 hectares of land. In total, all the condominium

sites in the sub city cover about 1156.69 hectares of land of the 12,400 hectares total area of the sub city, which is about the 9.3% the total area of the sub city.

Thus, condominium housing program is government led policy and it is one of the main causes for the land use/ land cover changes observed between the 2005 to 2021 in the sub city (AABOLA, 2005&2021).

Table 4.12 shows condominium site area

No	Condominium Site Name	Area by hectare (ha)
1	Coye feche condominium	718
2	Gelan number 1 condominium	43.48
3	Gelan number 2 condominium	12
4	Gelan number 3 condominium	88
5	Crown condominium	88.05
6	Tulu dimtu condominium	144.45
7	Kilinto condominium	36
8	Genet menafesha condominium	5.86
9	Kality chefe condominium	14
10	Kality total condominium	2
11	Komet condominium	3.14
12	Cheralya condominium	0.79
13	Kality Gebrael condominium	0.97
	Total area	1,156.69

4.1.3 Impact of land use land cover change on environment

4.1.3.1. Impact of land use land cover change on tap water pollution

Residents requested regarding clean drinking water in the summer season and all the respondents answered that they have got challenges of clean water as the dirty material which have been produced by industries were polluting water bodies through flooding.

People who are leaving near to industries usually boil dirty water for drinking, but still the polluted water and exposed for water borne diseases mostly the poor people have forced usually to buy packed water.

Among the respondents who are living near to leather industry, 95 percent or 298 respondents agreed liquid wastes diffused and remixes to tap drinking water, and 3 percent or 9 respondents are not sure and the rest 2 percent or 6 respondents are disagree of the dirty diffusion to tap water.

Table 4.13 Tap water pollutions quantity

Response	Respondents In percent	Number of respondents
Yes	95	298
No	3	9
Not sure	2	6

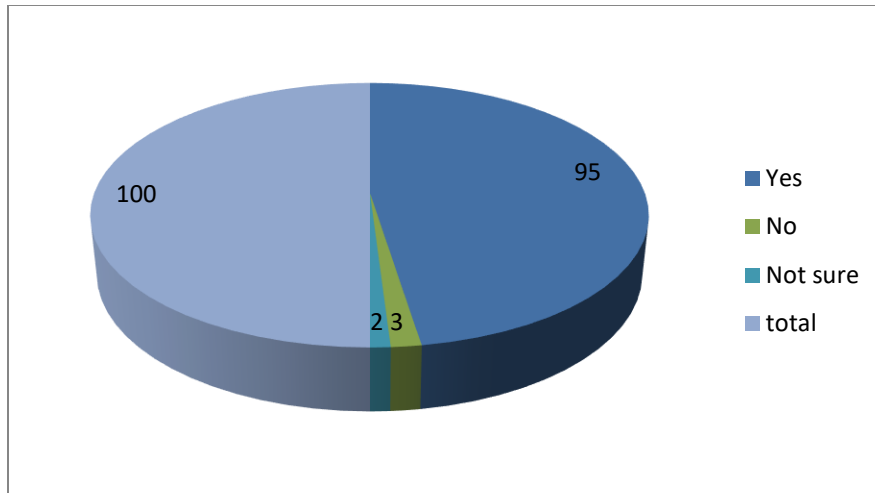


Fig 4.8 Graph showing the response of residents on tap water pollution

4.1.3.2. Impact of land use land cover change on air pollution

The respondents agree as there is a bad smell comes from long distance through wind and cover all area of the respondents, which part of air pollution. According to the respondents, they are exposed to diseases like esophagus diseases, common called and other breathing system diseases.

The respondents also expressed the bad smell brought difficulty to live there and those who can afford usually rent houses in another area and it usually very strong for gusts who wants to visit families and they mostly cannot stay long times due to this bad smell.

Among 314 people participated in this research, 90 percent of them or 283 people were completely agree that liquid waste brought air pollution and a cause for bad smell, and only 31 people or 10 percent of the respondents are agree as the leather industries have minimum effect for their living and no people accept the dame area.

Table 4.14 the air pollution quantity

Response	Quantity (%)	Quantity in number
Maximum	90	283
Minimum	10	31
No	0	0

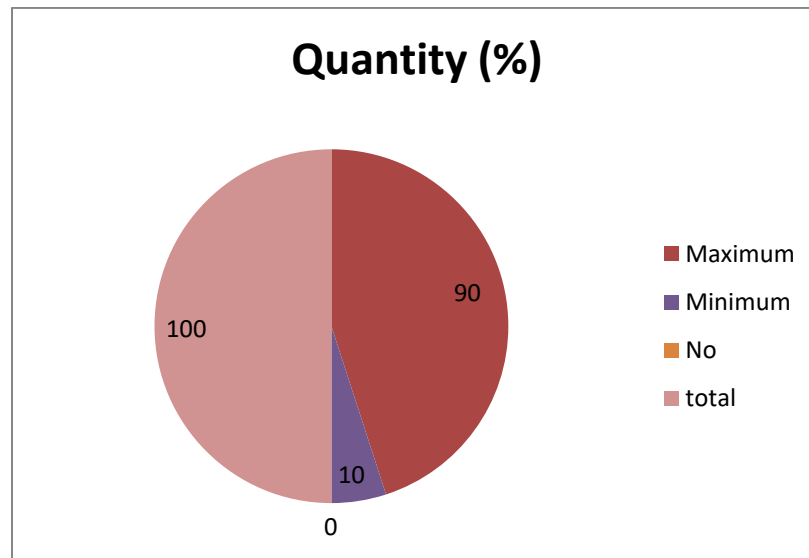


Fig 4.9 Graph of air pollution level in the village



Fig 4.10 Photo shows all city toilet waste sites over flow to village

The above two photographs show the village and the ten sub-cities toilet waste dump area, and this waste moves by flood into the village and pollutes their drinking water, and this is the result of urbanization.

4.1.3.3. Health problem of land use land cover change

The respondents approve that liquid waste disposal dam, which is found near to their living area, is the cause for their health. The residents explain that this dirty dam has caused skin allergy, water-borne diseases like cholera, diarrhea, and common cold, especially children who are under-aged.

Among the residents who participated in this research, 80 percent of the participants or 251 people agree that the dirty water and leather industries are causes for health problems, and 10 percent of the respondents or 31 people are not sure whether it has an impact, and the rest 10 percent of the participants or 31 people disagree that the dirty dam and leather industry near to their village are affecting them.

Table 4.15 Responses on the health issue and the dirty dam

Response	Quantity In percent	Quantity in number
Yes	80	251
No	10	31
Not sure	10	31

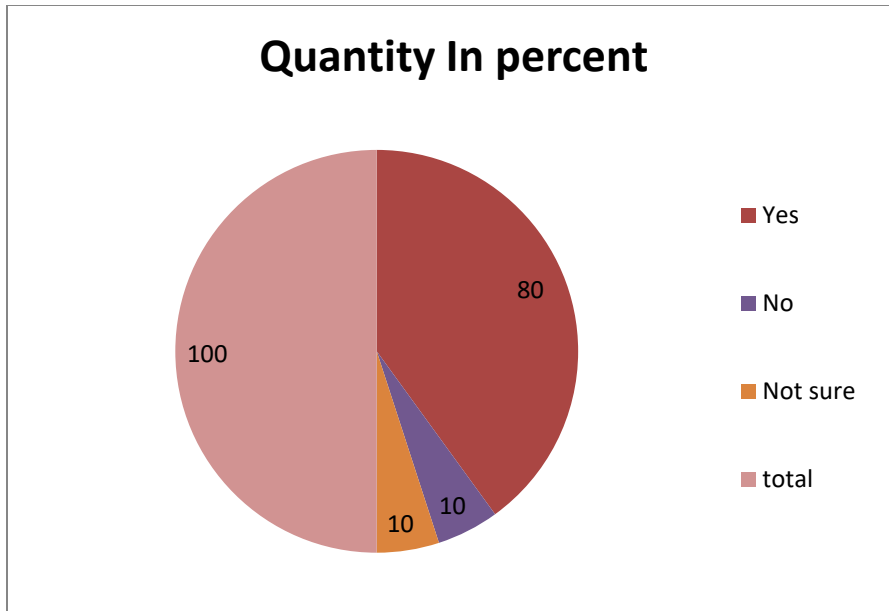


Fig 4.11 Health problem quantity graph

4.1.3.4 Noise pollution of land use land covers change

As the respondents explain during the interview there is a disturbance due to noise at day and night sleeping is a nightmare.

From the total 314 respondents 70 percent or 220 people are explained noise is a big problem for them to live in the area. 20 percent of the respondents are not agreeing the disturbance due to noise and the remaining 10 percent of the respondents are not recognized the noise.

Table 4.16 the noise ratio in the research area

response	Quantity In percent	Quantity in number
yes	70	220
no	20	63
Not sure	10	31

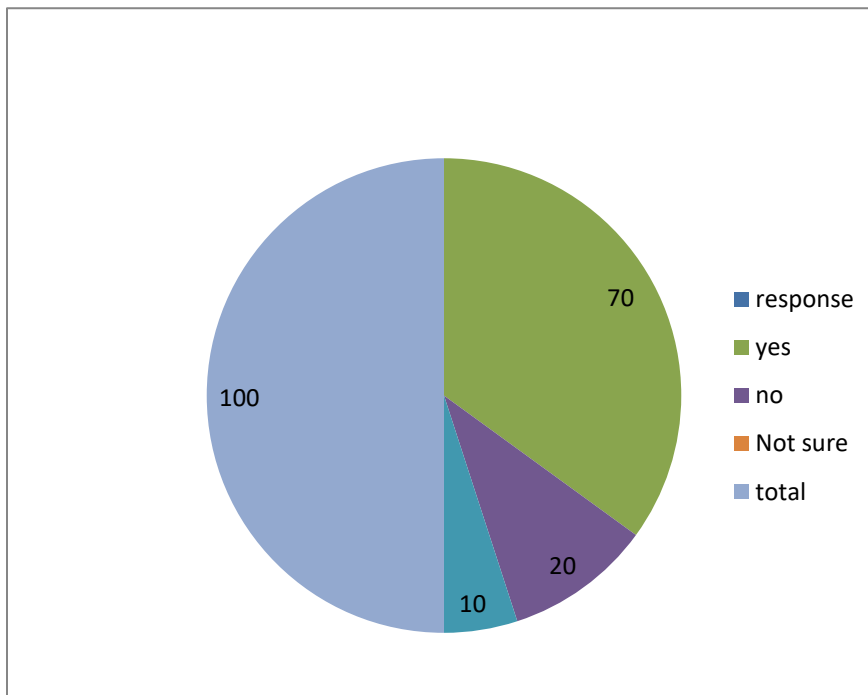


Fig 4.12 Graph of noise level in the study area

4.1.3.5. Source of land for village residents and when they got

The researcher proved that the residents got their land through inheritance and most of the residents are pioneer farmer. Through interview it was identified that about 80 percent

or 128 people of the residents were farmer family. People who were got house by buying from farmer family were only 20 percent or 32 people

When we see the duration of their residence among respondents, 80 percent or 128 people were occupied the area before 1996 and 15 percent or 24 people were start to live in the area between 1996 and 2005, the rest 5 percent or 8 people were come to the area after 2005 through buying house.

Table 4.17 village living years

Period	Respondents' in percent	Respondents 'in number
Before 1996	80	251
1996-2005	15	47
After 2005	5	16

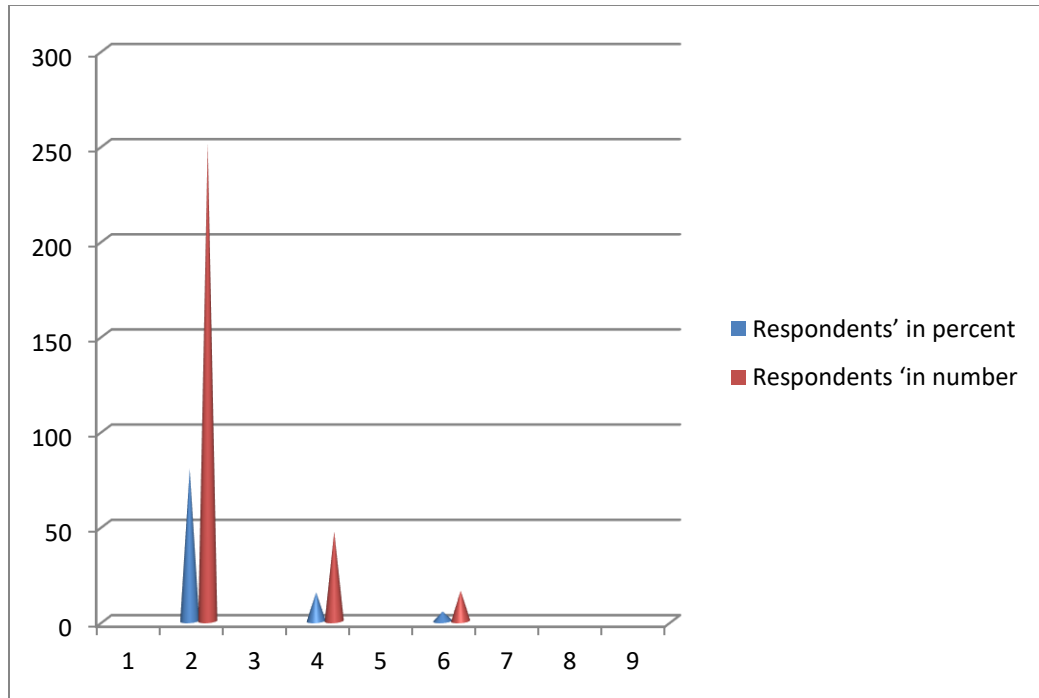


Fig 4.13 graph of living period of residence

4.1.3.6 Temperature situation of the study area from 1996 to 2021

The information of Ethiopian national metrology Agency indicated that the maximum temperature of the study area in 1996 was 26.4 degree centigrade, the minimum was 7.1 degree centigrade and the average temperature during the given year was 16.75 degree centigrade.

In the year 2005 the maximum temperature was 26.6 degree centigrade, the minimum temperature of the area was 8.5 degree centigrade and the average temperature was 17.55 degree centigrade which was raised by 0.2 degree centigrade from the year 1996 years with in 9 years period.

In the third research period, 2011, the maximum temperature was 25.4 degree centigrade while the minimum temperature was 9 degree centigrade and the average temperature during the study period was 17.2 degree centigrade this means temperature was decreased by 1.2 degree centigrade when compared to the 2005 year within 6 years.

In the 2021, the maximum degree centigrade of the study area was 26.4 while the minimum degree centigrade was 9 and the average temperature was 17.7 degree centigrade. This shown that the temperature increased with 1.2 degree centigrade between 2011 to 2021 within 10 years period.

Table 4.18 temperature summary

years	Maximum Temperature	Minimum Temperature	Average temperature
1996	26.4	7.1	16.75
2005	26.6	8.5	17.55
2011	25.4	9.0	17.2
2021	26.4	9.0	17.7

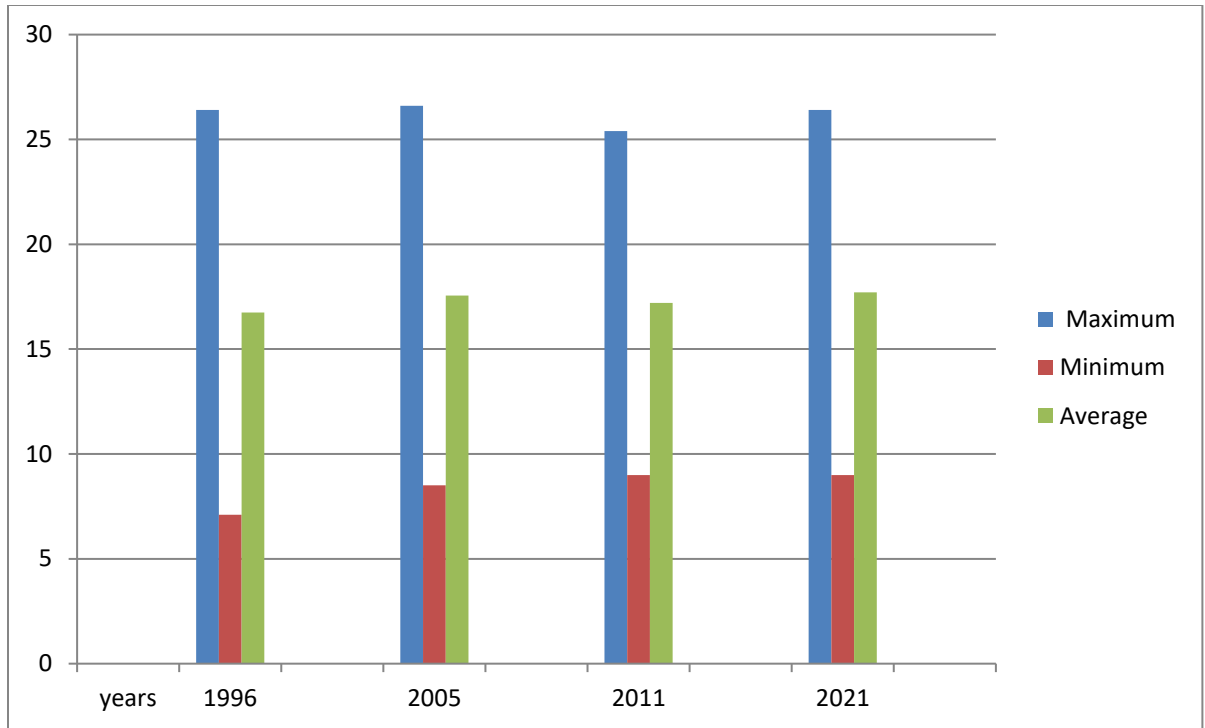


Fig4.14 Graph of temperature variation from 1996 to 2021

4.1.3.6.1 Temperature analysis of 1996

$$L \lambda = \frac{(L_{max} \lambda - L_{Min} \lambda)}{QCALMAX - QCALMIN} * (Band6.TIF - QCALMIN) + L_{MIN} \lambda \dots\dots\dots Eq. (4.1)$$

$$QCALMAX - QCALMIN$$

$$T = \frac{K2}{\ln(k1/L \lambda + 1)} \dots\dots\dots Eq. (4.2)$$

$$\ln(k1/L \lambda + 1)$$

$$C = K - 273.15 \dots\dots\dots Eq. (4.3)$$

Where

$L_{\lambda \text{ MAX}}$ = Radiance maximum

$L_{\lambda \text{ MIN}}$ = Radiance minimum

L_{λ} = Spectral Radiance

$QCALMAX = QUANTIZE_CAL_MAX_Band6$

$QCALMIN = QUANTIZE_CAL_MIN_Band6$

T = Satellite Temperature in Kelvin

K1 = Calibration Constant one

K2 = Calibration Constant two

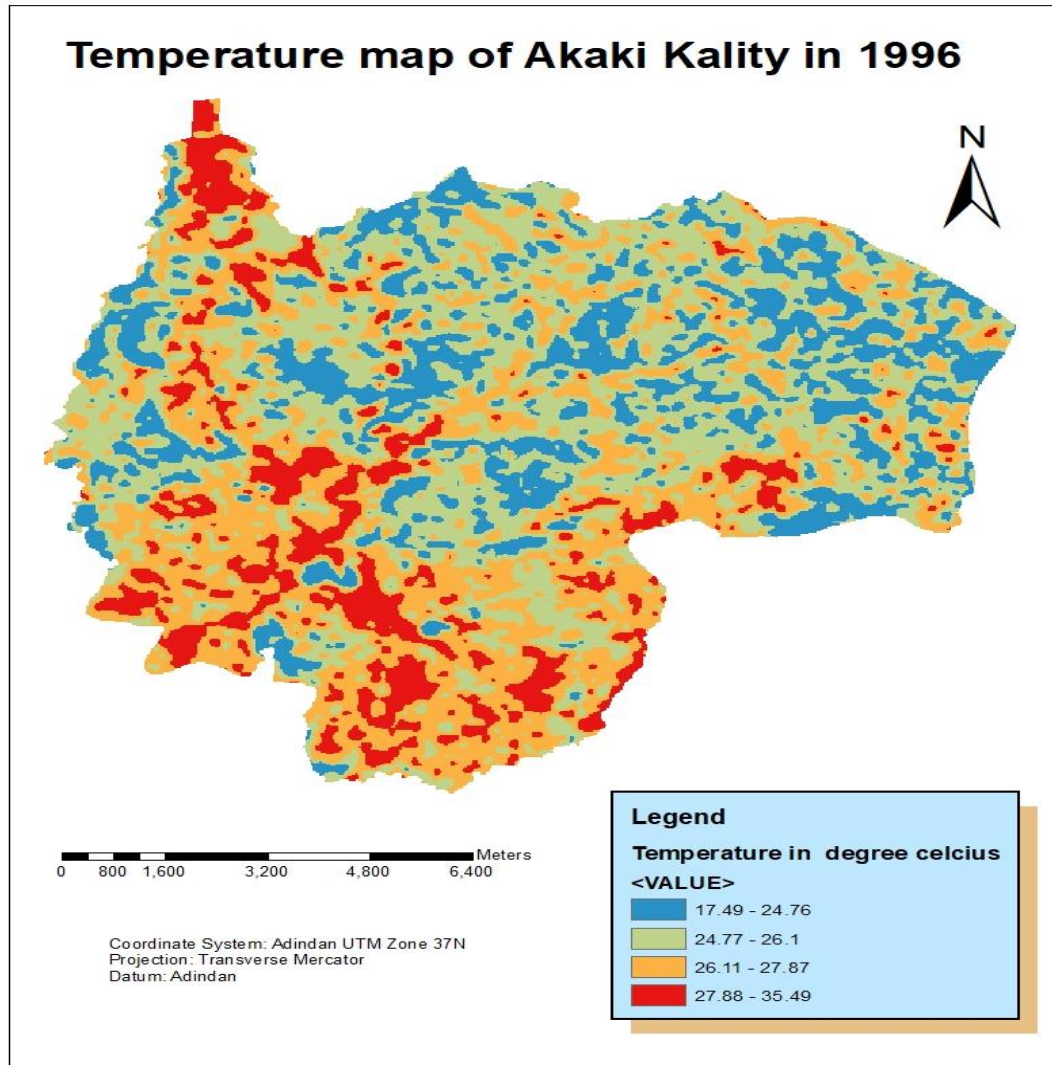


Fig 4.15 land surface Temperature map of Akaki Kality in 1996

The above land surface temperature map indicates that in 1996 the minimum temperature was 17.49 °C and the maximum temperature of the year was 35.49°C and this value varied from metrology records which 26 °C. But the temperature map showed the most area of the map was between 17.49 °C to 27.87 °C. So the metrology value may be the average of all the sub city temperature. This temperature change is the results of bare land

and vegetation and forest are converted to built-up area and for developments of industries which release huge carbon dioxide towards the air and increased temperature.

4.1.3.6.2 Temperature analysis in 2021

$$LST = (BT/1) + W * (BT/14338) * \ln(E) \dots \dots \dots \text{Eq. (4.4)}$$

LST = land surface Temperature

$$BT = K2 / \ln(k1/L\lambda + 1) - 273.15 \dots \dots \dots \text{Eq. (4.5)}$$

Where

BT= brightness atmosphere temperature with band 10

W= wave length

L λ =spectral radiance

K1 = constant band No

K2 = constant band No

$$PV = [(NDVI - NDVI_{min}) / (NDVI_{max} + NDVI_{min})]^2 \dots \dots \dots \text{Eq. (4.6)}$$

PV=vegetation proportion

$$NDVI = NIR - R / NIR + R \dots \dots \dots \text{Eq. (4.7)}$$

NDVI min = minimum normalized difference vegetation index

NDVI max = maximum normalized difference vegetation index

$$E = PV * 0.004 + 0.986 \dots \dots \dots \text{Eq. (4.8)}$$

E = land surface emissivity

Temperature Map of Akaki Kality in 2021

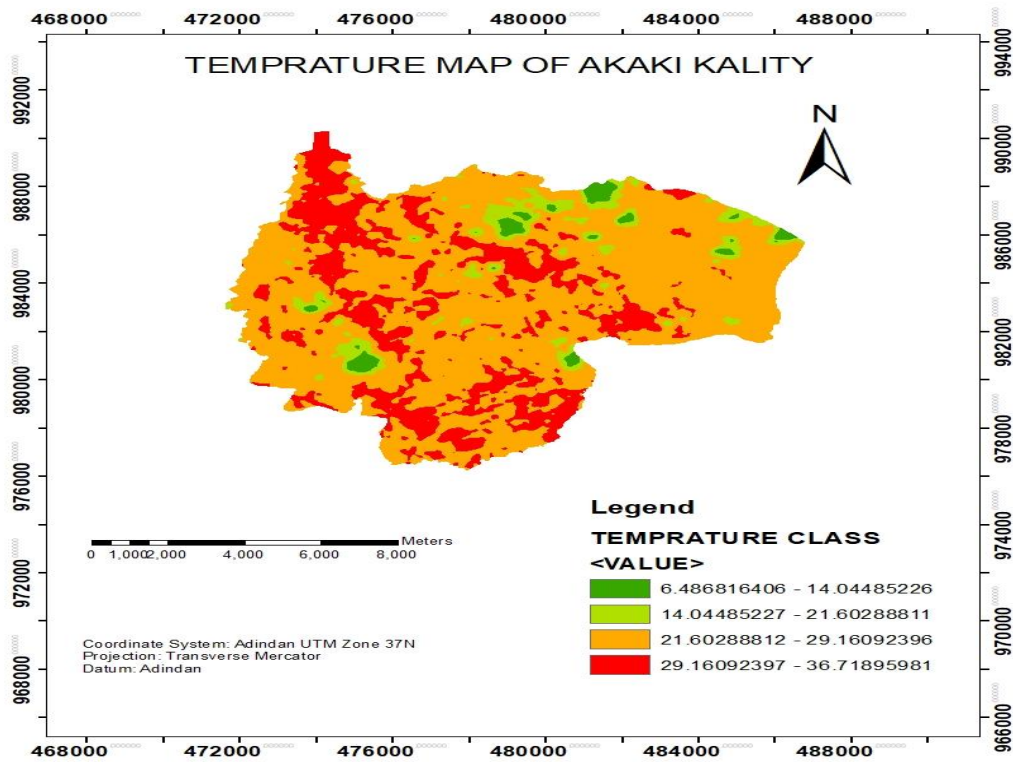


Fig 4.16 land surface Temperature map of Akaki Kality in 2021

The above land surface temperature map indicates that in 2021 the minimum temperature was 6.4 °C and the maximum temperature of the year was 36.7 °C and this value varied from metrology records which 26 °C. But the temperature map showed the most area of

the map was between 21 to 29 °C. So the metrology value may be the average of all the sub city temperature. This temperature change is the results of bare land and vegetation and forest are converted to built-up area and for developments of industries which release huge carbon dioxide towards the air and increased temperature.

4.1.3.7 Humidity condition of the study from 1996 to 2021

Based on the Information of the Ethiopian metrology Agency, in the year 1996 the maximum relative humidity of the study area was recorded 89 and the minimum relative humidity was 43 while the average relative humidity of the area was 66.

In 2005 maximum relative humidity was 88, the average humidity was 58.5 and the minimum humidity of the study area was 29. This shows that the relative humidity of the 2005 has shown decreasing when compared to the 1996.

The third research period 2011 has maximum humidity of 93; minimum humidity of 33 and average humidity was recorded 63. To compare the humidity level of 1996 and 2011 between 15 years the maximum humidity had increased with 4, but still less average humidity.

The fourth research year which is 2021, in this year the maximum humidity was 94, the minimum was 26 whereas, the average was 60. This shown that between 1996 to 2021 within 25 years the humidity variation was from 89 to 94 which is , minimum humidity difference was 18 which was big and the average humidity difference was between 1996 to 2021 was 6 which is decreasing.

Table 4.19 humidity level from 1996 to 2021

years	Maximum humidity	Minimum humidity	Average humidity
1996	89.0	43.0	66
2005	88.0	29.0	58.5
2011	93.0	33.0	63
2021	94.0	26.0	60

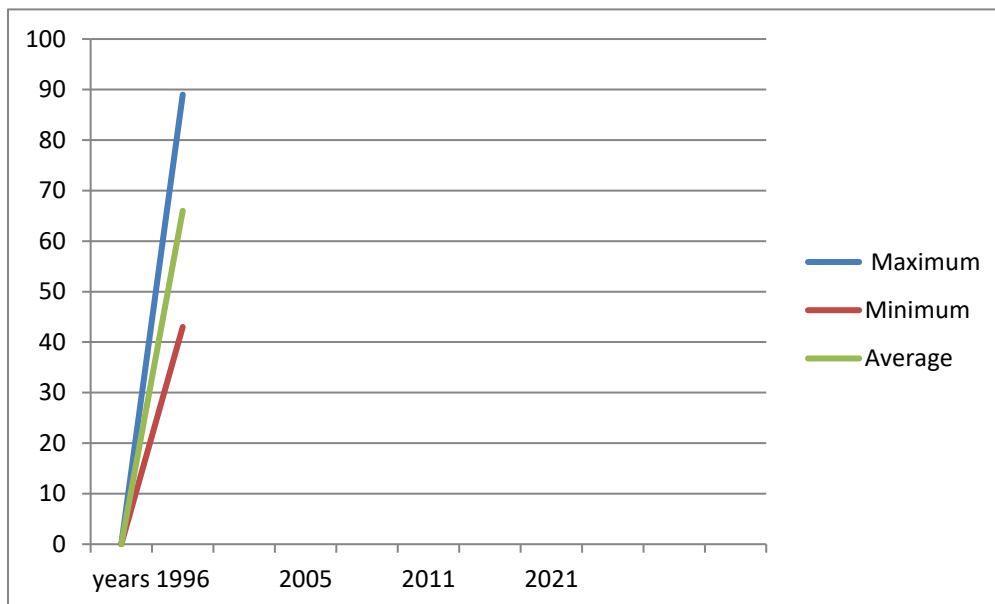


Fig 4.17 Graph of humidity from 1996-2021

4.1.3.8 Precipitation situations of the study area from 1996 to 2021

Based on the information of the Ethiopian metrology Agency, the maximum precipitation of 1996 was 346.3 and the minimum was 15.8 and the average precipitation was

181.05. There is a big variation between the maximum and minimum precipitation in the study area.

In 2005, the maximum precipitation is 248; the minimum was 14.1 while the average precipitation was 131.05 which indicate less precipitation when compared to the 1996.

In the third study year which was 2011, the maximum precipitation was 296.5, minimum value was 3.4 and the average recorded precipitation was 149.95 and when we compare the precipitation value of this year and the 1996 precipitation value the maximum, the minimum and the average variation are 49.5, 12.4, 31.1 respectively.

The last study period was 2021, which is a recent year had maximum precipitation 277.2, the minimum value of the precipitation was 5.2 and the average precipitation was 141.2. When the 1996 year precipitation variation with 2021 year maximum, the minimum and average value had 69.1, 10.6, 39.85 respectively and the precipitation had decreased.

Table 4.20 indicates the precipitation of 1996-2021

years	Maximum Precipitation	Minimum Precipitation	Average Precipitation
1996	346.3	15.8	181.05
2005	248.0	14.1	131.05
2011	296.5	3.4	149.95
2021	277.2	5.2	141.2

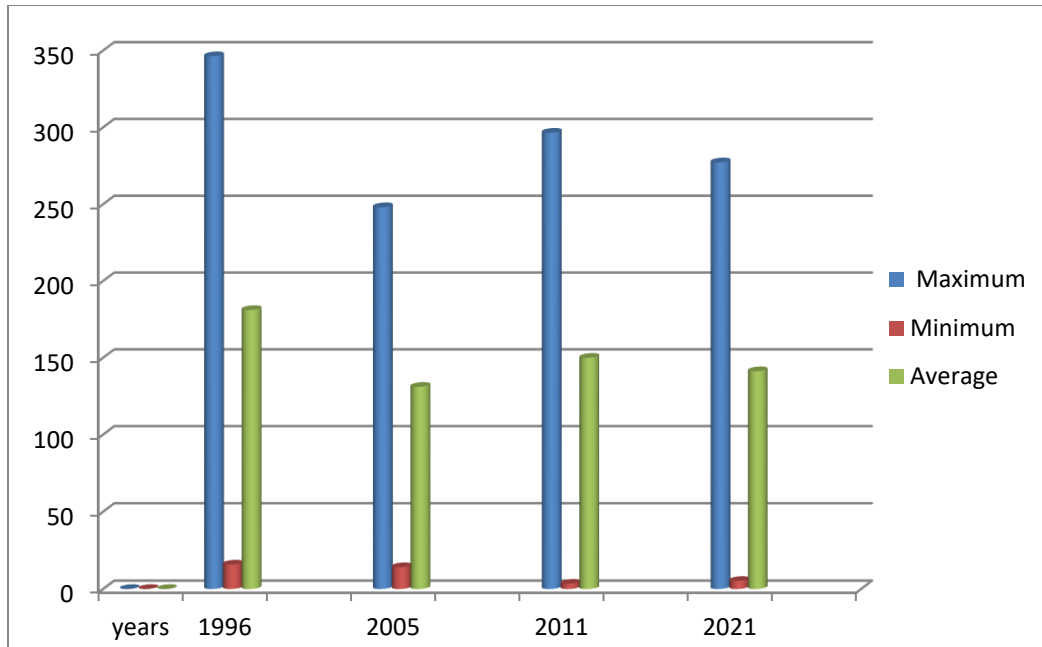


Fig 4.18 Precipitation status of 1996 to 2021

4.1.3.9 Weak governmental attention for environment

The GTP 2010 to 2015 plans shown that the government plan to develop 15,000 hectare land for industries and the industry sector accounts a share of 32 percent from the country economy and create for 3 million job opportunities. This implies that government attention for industries and investment is high but environmental attention is low and existing rules are poorly implemented. That led to losing suitable living environment and people usually exposed too many problems.

According to article four of the Council of Ministers' Industrial Pollution Prevention Regulation No 159/2001, all manufacturers are responsible for the respective inputs and by-products as well as solid and liquid wastes generated. But most of industries

discharged their liquid and solid wastes to water bodies such as rivers and streams without treatment.

4.1.3.9.1 Weakness of financial institution to protect the environment

World Bank and other international financial institution have rule on environmental impact assessment study and it is one of the criteria to give loan and the loan taker institution and individuals must bring environmental impact assessment study to take loan. Other financial institution takes this trend for the sake of environmental hazard protection.

In Ethiopia, Financial institution especially banks has no cultures and directives requiring environmental impact assessment and give loans for investors without environmental impact assessment. This condition pave ways for investor to invest without give due focus to environmental issues and have negative impact for environment.

4.1.3.9.2 Weakness of building permits institution regarding to environment

When investors get their finance from financial institution their next task is construction stage and likewise during construction building permit institution do not set as criteria for environmental impact assessment (EIA) study to give building permit license and investors develop investment without EIA and this situation affects environment directly or indirectly.

The second weakness of the building permits institution which visible in the city in practice is there is no rule to liable the investors and manufacturers how to construct and

by which material they should be construct and preferable material standards should be available by rules.

4.1.3.9.3 Weakness of environmental protection authority

Environmental protection proclamation number declares any institution before establishment should have environmental impact assessment study but in practice people were doing without EIA study. During this time, the Addis Ababa Environmental protection Authority has power to take measurement but small measurements are in the proclamation and do not stop development without EIA study.

The other gap of Environmental protection Authority as institution has no pollution prevention proclamation and rules. As result, when there is pollution the Authority have no clear power to take measurement when there is pollution.

To audit the factories and industries or any investment to check whether they were do their production according to their proposal there is no audit rules. Set by Addis Ababa Environmental protection Authority.

Addis Ababa city Environmental protection Authority has no integration working rules with the other sectors which are directly or indirectly affect the environment, like financial institutions, building permit, water and sanitation authority , industry bureau and trade bureau. This non-integrated works of the AAPEA brings environmental degradation.

4.2 DISCUSSION

When my study begins in 1996 the sub city built up area ratio was only 10% which is small and after 25 years in 2021 the sub city built area ratio coverage increased to 46% which has huge portion which means 36% new bare land was changed to built-up area in the sub city. This rapid change of land use to built-up is not the Addis Ababa case alone but also the Bahir Dar town built up coverage also has big change from 1.54% in 1986 to 9.42% in 2010 which shown big change above 9 fold (Atalel.G, 2014).According to Ayele Abebe research the Hawassa built up area was 4.4 % in 2002 and this area increased by 4.72 in 2009 after 7 years (Ayele.A, 2017).

Built up area growth is not Addis Ababa or Ethiopian case it is also global phenomena due to rapid urbanization.in Hyderabad, India in 1989 the built up area increased from 13.32%to 26.92%in 2011 over double growth within 22 years (Wakode, 2016). Asep Kasidi proved that settlement or built up area was increased by 2.45% between 1995 and 1997 within 2 years period in CiTarun water shade area. This shown that large amount of land was changed to built-up from bare land and agriculture area time to time.

The same is true for built up area maximized with time difference proved between 1984 to2010 from 0.64%up to 1.66% nearly 3 fold within 26 years (Paul.S, 2009).Between 1990 to 2000 built-up area ratio was increased from 11.8% to 18.3% according to Renny Chiwa study in2008 Tanzania river basin and this data indicated that 10 years period 7.5% additional built area was increased (Chiwa.R, 2008).

The study which was taken place in Stockholm and Shanghai from 1990 to 2010 in both cities urbanization was expanded continuously especially in Shanghai the built up area was increased up 25% and 11% was expanded in Stockholm Sweden according to the thesis of Jan Haasthis showed that urban expansion or expansion of built-up area was not uniform (Haas.J, 2016).

The thesis which was studied in 2013 in China by Gong the built up area was increased from 26.75% to 60.74% between the year 1993 and 2009 in this study showed that urbanization was continuous change and within 17 years 33.99% new expansion was recorded which was bigger than doubled in China (Gong.F, 2013).

Bare land was one of the land use type which has big change with in the study period, in 1996 the sub city bare land coverage was 40% which is big and after 25 years 2021 the bare land ration decline to 24%.The Peru water shed bare land area decreased from 20.8% in 1988to 16.6 % in 2007 which decreased by 4.2% between 19 years this indicate that decreasing of bare land and growth of built up area is common in different places (Carlos.A, 2007).

Belete Tafese proved from 1998 to 2016 bare land of Adama zuria woreda was decreased from 8.89% to 3.98%within 28 years. My study also proved that the quantity of bare land in Akakai kality was decreased from time to time and found by declined from 40% to 24 % between 1996 to 2021 meaning that 16% of the sub city bare land was changed to built-up area (Belete.T, 2017).

The same trend is found in water shade of Peru the quantity of bare land was decline from time to time and arrived from 20.8 % to 16.6% from 1988 to 2007 within 19 years' time period. in other words Peru water shade area lost 4.2% of bare land from 1988 to 2007 (Carlos. A, 2009).

Bare land reduced among different years when we see the case of Java Indonesia bare land status was decreased from 71,629 Ha to 30.99 Ha between 1972 to 2012 according to Andrea Emma study of Java urbanization and urbanization impact due to expansion of urbanization, industrialization and commercial services (Andrea. E, 2015).

In my study forest area cover declined in high ratio, in 1996 the sub city forest and vegetation was 43% this coverage decreased to 23% in 2021 which means 20% of the sub city forest and vegetation area was lost.

In Pangani river basin Tanzania the forest coverage was 24% in 1990 and this coverage decreased to 12% in 2009 after 19 years the forest area lost 12% (RENNY, CH.2012). Similarly in Kiskatinaw river water shed forest area was 8% in 1984 and 5.5% in 2010 meaning forest area declined by 2.5% and these facts shown that forest area decreased from years to years from different places (Paul, 2013).

In Kenya the forest ratio was down from 36.796% to 22.822% between 1988 to 2010 within 22 years the forest content was lost by 13.974% this amount of forest was changed to urbanization and agricultural lands according to Mwathi.M study in Nairobi Kenya (Mwathi.M, 2016).

In my study the water body change was not significant but in Bah Dar level of water body varies from 2.4% to 1.7% means 0.7% of water body changed to built-up and agriculture area based on Atalel study analysis of urban land and land use and land cover change in Bahir Dar townin 2014 (Atalel.G, 2014).

In kenya between 1988 to 2010 the size of water body was declined from 1.966% to 1.636% and 0.33% amount of water body was lost and shift to built-up and agriculture land use category according to Mwathi.M study in Nairobi Kenya (Mwathi.M, 2016).

When the density of urban area increased the area under water body has decreased between 1989 to 2011 within 22 years the quantity of water body was decreased from 4.42% to 4.14% or 0.28% water quantity was lost according to Hemant Balwantmaster's thesis in Hyderabad, India in 2016 (Hemant .B, 2016).

The amount of water body in Taiyuan, China between 1995 to 2015 decreased from 1.15 % to 1.06% as Fei Ma maters thesis was studied by 2015 which means 0.9 % amount of water was lost by the above listed period according to this thesis urban expansion or urbanization aggravate the wastage of water resources' (Fi .M, 2015).

Population growth was one of the causes for land use land cover change in Akaki kality sub city. During the study period from 1996 to 2021 the sub city population increases from 144,474 to 330,396 which means 185,922 new additional people were added for the sub city and these people consumed additional built up place and was big cause for the change of land use land cover. Population has created demand for several goods and

services which require space leading to change of various land uses and land covers to accommodate new functions at the expense of previous functions (MWATHI.P, 2016).

with the increases of population growth land use land cover change or built up area increased and most other land use type like agriculture land forest and water body are changed to residential, commercial and other services are distribute and consumption of land is high. Degradation of city center is push peoples for desired urban peripheries to get not degradation environment (Koirala.S, 2018)

GDP growth was one of the quoted reasons for land use land cover change for the study area from 1996 to 2021 huge capital change was recorded from 3,364,150,382.836 birr to 52,970,526,718.012 which was 49,606,376,335.176 birr was gained within 25 years in the study period and this huge amount of capital leads for government to create investment policy to change the practice for the sake of job opportunities for the newly coming population from rural urban migration and the new born growing youths. The economic development of the city has led to a boom in the construction industry and subsequent expansion of built-up areas (MWATHI.P, 2016).

When people income was increased people have interest to buy and construct houses to urban periphery rather than city centers or cores and they have vehicle or individual care accessibility and these people periphery interest have pressure for new land use land cover change or expansion of built up area in urban peripheries (Koirala.S,2018)

Economy growth measured in GDP per capita and FDI facilitates the creation of jobs, better education systems, and scientific research attracting massive waves of migrants.

Increased economic growth has also brought about constructions of big malls such as Garden City, shopping mall, and Acacia Mall and brings high land use land cover change (BenBella.E, 2016).

Government policy was the most and highest prevalent cause which utilized huge portion of land from the sub city land especially industries development government program was alone utilized in Akaki Kality sub city 1,167 hectare of land which accounts about 9.4 percent of the total land of the sub city and 84% of the whole Addis Ababa's industries ratio. Industries have high demand of land and industries expanded in countryside and industries require huge size of land by industries nature. Indonesia industries developed at the fresh location and consumed new land due to the factories need road, communication and other necessary infrastructure in Indonesia (Karsidi.P, 2004).

Industrial structure also has a great impact on urban expansion in medium-sized cities. Cities that are dominated by manufacturing industries, economic growth will be accompanied by a large demand for land. Condominium Housing development program was the other program in Akaki kality sub city which was taken large coverage of land in the sub city and cover about 723.759 hectares of land of the 12,400 hectares total area of the sub city, which is about the 5.8% the total area of the sub city. Development of the real estate market has aggravated the loss of agricultural land in urban fringe and rural areas (Ma, 2015).

In other words both industry development and condominium housing development program utilized 42% of new built up area which was added from 10% to 46% the new additional 36% was added within 25 years in the study period in the study area.

Land Use and Land Cover Change (LUCC) is the leading edge and hot topics of global change research. The mutual influence between LUCC and human society acts on the human survival environment and food safety. In the global scope, LUCC plays an important role in the hydrothermal cycle in globe land water cycle (Zhang. F, 2001-2013).

My study also proved that the temperature of the study area increased from 35.49 °C to 36.7°C which means 1.21 °C Temperature was added to the environment from 1996 to 2021 and the study area became warming. Surface Temperature of built up is higher than bare land temperature and bare land temperature is higher than forest area so land use land cover change is one the causes for increment of surface temperature (Belete,2017)

LULC change is one of the decisive environmental phenomena that affect many parts of the earth's systems including climate, hydrology, biodiversity and fundamental sustainability of land resources on the earth. Land use land cover change has a substantial effect on runoff generation, soil erosion and soil fertility loss. The presence of rugged terrain, deforestation, inappropriate land use system and relatively high amount of summer rainfall are major factors which contribute to the high runoff production, (Mustard, 2004).

The study area tap water was affected by the toilet waste and wastes from leather industries of the city which was removed in front of the living village and this situation exposed living people for water borne diseases and out of use for drinking purpose when the study was questionnaires and answered by the village member. Land use change was also cause for air pollution based on the respondents of the study. In idea about the possible sources or urban activities which are responsible for pollution of groundwater. This analysis has directly linked the industrial activities in those specific regions and the pollutants produced and transported to aquifer by those small scale industries or businesses. In many cases in Hyderabad in India, this had made the groundwater unusable for drinking purposes (Wakode, 2016).

Wetlands are a vital component for regional ecosystems. Wetlands play a leading role in the global carbon cycle, containing about 12% of the global carbon pool. Thus, this prevalent depletion of wetlands has become a vital concern, given the current state of global warming and climate change as well as ongoing high demand of water use (Sangermano. et.al Eastman, 2010).When we see the wetland or water body status of the study area within 25 years of the study period 2 percent was changed from 1996 to 2021 and it has its own effect on the quality of atmospheric Temperature resources.

When the thesis was studying 70 percent of the respondents or residents were proved that sound pollution is big problems and disturb during night when people sleep and this problems was became after the industries were developed and land use land cover change was happened. Residential land use has less sound noise and commercial land use has

high sound noise due to industries and high disturbance for overall for environmental noise (Howard, 2012).

This thesis proved in the study area the content of forest and vegetation decreased from 43 percent in 1996 to 23 percent in 2021 and here there was 20 percent or 2,480 hectare loss of vegetation and forest within 25 years. Loss of vegetation and forest leads the high emission of CO_2 and has big contribution for global warming (Galal, 2005).

CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

Urbanization rate in Ethiopia has increased from time to time especially in Addis Ababa; Particularly in Akaki kality sub city it has shown a huge increment from 10 percent in 1996 to 46 percent in 2021. This has been proved by conducting a land use/ land cover changes with Ark GIS software and proved that built up spaces increment was changed from 10% in 1996 to 46 % in the 2021.

The major causes for the increment of human induced land uses in the study area are population Growth; GDP growth and Governmental policy. such as industrialization policy and the condominium housing development program; This research realized that in addition to sound and air pollution, the untreated liquid and solid wastes released from industries like leather factories have largely affected the life of the nearby residents and the sub city at large..

The result of this research also shows the most important environmental elements such as temperature, rainfall and humidity varieties, from 1996 to 2021 following the expansion of built up area mostly led by industries and mass housing developments.

Air pollution, tap water pollution, sound pollution, rain fall or precipitation degradation, humidity level variation was proved by the research with triangulation by metrology data, by respondents participation and using Ark GIS software.

Finally the thesis produced temperature map of the study area showing the increased of urbanization and also increased temperature this was the result of the increment of built-up area increased and the environmental regulating elements like forests, bare land and water bodies have been decreased.

5.2 RECOMMENDATIONS AND FUTURE RESEARCH

- ❖ The government should revise investment policy and balance investment flow between Addis Ababa and regional towns. When investment is distributed to regional towns and create jobs for youths in rural areas urban migration will be reduced and the land demanded for housing and other services in Addis Ababa will be reduced. This due to the fact that one of the causes of rural urban migration is job opportunities.
- ❖ Deliver enough infrastructures to regional towns and foster private investors to invest their capital to regional towns.
- ❖ Government should give enough attention and formulate strong proclamation to safeguard environment and established industries far from residential areas especially leather industries and toilet waste dump area should be established out of the city. The former leather industries which are found in the study area near to the living areas should be changed other services or relocating the nearby residents.
- ❖ Government offices should aware societies for to curb deforestation otherwise it affects the living environment.
- ❖ Environmental impact assessment (EIA) should be done for all projects before implementation.

- ❖ Governmental institutions like water and sewerage, environmental protection, building permit, financial institution and other related bureaus should be done their works with integrated and have common role regarding to environmental protection.
- ❖ The structure plan of Addis Ababa which was studied in 2017-2027 should implement the proposed greenery and should cover 30 percent of the total area of the city. So plantation of trees should be encouraged by responsible bodies.
- ❖ Proper and efficient land management policy should be formulated and implemented to balance the land demand and land resource utilization.
- ❖ Vertical development should be encouraged to minimized the need of extra land for construction and discourage urban sprawl.

Future research

My thesis used satellite images to analysis land use land cover changes the images are not accurate due to cloud in summer season and vegetation and forest, water bodies are more available in the summer but absent in the winter dry season. So it is better further investigation will be done with more accurate satellite images and with authorized data by company to get accurate land use land cover classification findings.

During my study the thesis did not show the future expansion area and the future land consumption so it is better further study to fill this gap and to indicate directions for decision makers for next expansion and land consumption.

The environmental issues are very vast to investigate the thesis tries to answer the question of environmental impact with residents' questionnaire, metrology data and land

surface temperature status was done by taking two different years using Ark GIS software. But still the environmental degradations are requiring extra and different ways to prove it.

When the thesis was study there was difference between the quantities of temperature with metrology data and land surface temperature which is done by Ark GIS software. So future research is necessary to investigate the difference between temperature and land surface temperature.

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PUBLISHABLE MANUSCRIPT

Land use/ Land cover change and their driving factors in Akaki Kality Sub city,

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Abstract

This manuscript identified Land use/ land cover change dynamic and their major driving factors in Akaki Kality, Addis Ababa city. The study deployed satellite images from the land sat 5, land sat 7 and land sat 8 that were downloaded basically from the USGS and processed using Arc GIS 10.4 and ERDAS IMAGINE 15 software with supervised image classification method. It is proved that the land uses/ land cover analysis shows a high percentage of built up area increment from 10% in 1996 to 46% in 2021, which means it increased by 36 % or 4,464 hectare. Whereas, the bare land, vegetation and water bodies have shown a significant decreasing within these 25 years. The major causes for the land use/ land cover change in the study area were the demographic change, the economic growth, and industry and housing related development policies of the country. As a result, there is a need for revising the policies as per the guiding rule for the current high urbanization trends, high human migration, and demand for land that increased horizontal urban expansion. It is also important to balance investment policy and investment flow especially in a way to enhance the regional towns in terms creating better job opportunities for youth.

Keywords: Driving factors; Land use/land cover change; urban development; government policy

1. INTRODUCTION

The process of urbanization, or “urban transition”, describes a shift in a population from one that is dispersed across small rural settlements in which agriculture is the dominant economic activity towards one where the population is concentrated in larger, dense urban settlements characterized by industrial and service activities (UN, 2011).

The definition of ‘urban’ varies from country to country, and with periodic reclassification, can also vary within one country over time, making direct comparisons difficult. Depending on the metric used such as population size, population density, or administrative criteria, nonagricultural employment; the size of an urban center can vary widely from country to country. For example, in Ethiopia an urban center contains more than 2000 people, whereas areas in Benin must have more than 10,000 occupants to be classified as urban (Cohen, 2006).

In Australia, urban areas are referred to as "urban centers" and are defined as population clusters of 1,000 or more people, with a density of at least 200 persons per km² (ABS, 2001). According to Statistics of Canada, an urban area in Canada is an area with a population of at least 1,000 people where the density is no fewer than 400 persons per km² whereas in china, it is higher than 1,500 persons per km², in India if one place to say town it will have a minimum of 5,000 people. So there are no uniform criteria worldwide to categorize towns based on their population number (Canada, 2007).

The process of urbanization is persistent for many decades due to continuous population growth, reclassification of rural localities into urban centers and migration of people from

rural areas towards cities in 2008, for the first time in history, more than half of the world's population was living in towns and cities. Nevertheless, not all regions of the world have reached these levels of urbanization. It is expected that half of the population of Asia will live in urban areas by 2020, while Africa is likely to reach a 50% urbanization rate only in 2035 (UN, 2012).

Urbanization is therefore a global phenomenon. The growth of towns and cities are rapid conditions from time to time and results nearly 66 percent of world population will live in the towns and cities are in small suburban sites in 2050. This rapid urban growth exposed natural resources for threats and disaster conditions. Urbanization changes large agriculture land to urban centers, deforestation were increased, large portion of land for industries, infrastructures and utilities (UN, 2014).

Urbanization rate in Asia is faster than the rest of the world. More than 1.1 billion people live in urban area of the continent of Asia and the urbanization trends in Asian countries are marked by increasing physical growth which extends beyond metropolitan and city boundaries (Hugo, 2006; McGee and Robinson, 2019).

The governments of developed nation are capable enough to handle the urbanization process by infrastructures, finance and other mechanisms help to manage urban growth. But, developing countries' governments have weak structures and they have limited capacity of infrastructures, finance and legal framework to handle the rapid urban growth trends (Putra and Baier, 2008).

Particularly to Ethiopia, to say a place urban there are 3 basic criteria which are listed by lease proclamation No721/2011. These are: (i) the place should contain more than 2000 people. (ii) Half of the population, who are living in that place, should be engaged in non-agricultural activities. (iii) The place should has municipality

The problem identified is related Rapid urbanization associated with improper management urban expansion leads to urban sprawl, pollution, environmental degradation and unsustainable production and consumption patterns (UN, 2014).

The pace of urbanization in developing countries is large compared to the developed countries between 2007 and 2025. The annual rate of urban population in developing regions was projected to be 2.27 percent, and 0.49 percent respectively. This rapid urbanization in developing countries leads to the cause of informal settlement and informal business when the people have no potential to build formal houses and formal business. As a result, 37 percent of the urban population lives under slums, environmental disaster and social risk situations in different developing countries (UN-Habitat, 2008).

Urban expansion also affect sustainable and long lasting development, loss of greenery and open spaces, fragmentation of land, destruction of flora and fauna, degradation of ecosystem, ground water recharge potential etc. furthermore, soil fertility, water permeability, biodiversity loss of damaged in irreversible way. Soil closing with impervious material like building, blacktopped road, concrete accounts devastating change in water flow pattern and water induces hazard (Batty et al., 2003; EEA, 2006; Jat et al., 2008).

Ethiopia is the second-most populous country in Africa and has been experiencing a rapid urbanization which is the result of unplanned and uncontrolled urban expansion that causes scattered urban growth, loss farmland, environmental degradation, physical growth without infrastructures service delivery in Ethiopian cities (Berhanu, 2019).

Urbanization rate of Ethiopia is very high which is 3.6 percent in 2012 based on UN study and this rate will be increased to 36 by 2025. The spatial distribution of urban centers is unbalanced, and there is a large disparity between the levels of urbanization among the various regions (UN, 2012).

Land use change is the second most important anthropogenic influence on climate beside the emission of greenhouse gases. Urbanization is leading to significant land use changes in Africa since the continent is undergoing rapid urbanization and population growth in recent decades. Addis Ababa is one of the fast growing cities in the continent of Africa. Therefore detection of land use change is very important to identify its impact on climate and sustainable land use management of the city. The study used Landsat images to generate land use/land cover change map for the city.

Akaki Kality Sub city has experienced rapid land use and land cover changes in the past three decades. This has been due to increased pressure on land, caused by Increased Condominium sites, industry zone as a result the sub city has high number of industries (Addis Ababa City Land Information Center, 2014).

In 2003, there were 272 small, medium and large industries in Akaki- Kality industrial zone alone. Between 2003 and 2004 a total of 89 new industrial establishments were recorded in Akaky – Kality Industrial Zone (City Government of Addis Ababa, 2005).

Akakikality sub city is one of the most industrialized sub cities which covers higher portion of the city industries. The same is true Akaki kality sub city covers high ratio of urban expansion due to development of condominium houses, real estates and has high land use and land cover changes extended up to now (Ayenew .E, 2017).

In Akaki Kality sub city 25,267 plots of land and total area of 12,348 hectares of land are found based of the data of atlas map of the Akaki kality sub city 2014. Among the total amount of land in Akaki Kality sub city 45 percent of the land is built up area and the rest of the land which accounts 55 percent the sub city is non-built area (AAILIC, 2014).

Thus, the objectives of this research is to analyze land use/land cover dynamics from 1996-2021 of the Akaki Kality Sub-city and to analyze causes of land use land cover dynamics in the study area.

2. MATERIALS AND METHODS

2.1 Data Type

2.1.1 Primary Data

Primary data were collected by field observation, structured questioners, interviewing the private company owner and institutions, governmental organization/offices and professionals who are working in different sectors.

The relevant information about the effects of land use/land cover changes and further environmental impact for livings, and to show the poor integration between the urban expansion and the environmental protection were collected through interviewing the residents near industries and the most affected.

2.1.2 Secondary data

The secondary types include all documents for the project development process, published and unpublished research works, Environmental impact assessment documents, urban planning and management documents, and working documents related to the research objectives. Additionally, to illustrate the land use and land cover changes of the Akaki Kaliti sub city, land sat 5 satellite images for 1996 to 2021 having 30m pixel size were used.

The existing projects, related published and unpublished researches, urban planning and management documents were collected from the ministry of urban development and

construction, working documents from governmental organizations and private industries and other related administration organs. Governmental office regulation, directives and implementation plans were considered to fill the information gaps of the primary data and also helped to assess the gaps between the rules and their employment.

The satellite images of different years were collected from the United States Geological Survey (USGS) Earth explorer of Land sat 5-8 images in Tiff formats, and Google Earth. The downloaded images were from spatially referenced in the Universal Transverse Mercator (UTM) projection with datum World Geodetic System (WGS) 1984 UTM zone 37N .The Satellite images preprocessing, supervised classification and other means of image digitizing were done using ArcGIS and Erdas IMAGINE software.

2.2 Data Analysis

The data analysis tools of the thesis were Microsoft Excel, Erdas IMAGINE 15 and Ark GIS 10.4 for the project analysis. Satellite images were analyzed to identify land use/ land cover change, patterns of land use and land cover changes using of the study area. Change detection was applied to show which land uses were converted to which land use.

ArcGIS 10.4 software was applied to analyze the land use/ land cover changes over time, AutoCAD 7, ERDAS IMAGINE 15 software were also used to map the study area's natural feature and continuous urban expansion.

2.3 Image Classification

Image classification refers to the extraction of differentiated classes or themes, usually land cover and land use categories, from raw remotely sensed digital satellite data. Image classification using remote sensing techniques has attracted the attention of research community as the results of classification are the backbone of environmental, social and economic applications.

Following the land cover classification, change detection analysis will be used to analyze patterns of land cover change during the study period. Change detection is the process of identifying differences in the states of an object by observing it at different times (Singh, 1989). Image differencing, principal component analysis and post classification detection are the most widely will be used methods for change detection.

Satellite images land sat 5, land sat 7 and land sat 8, were down loaded from USGS and processed using Ark GIS 10.4 and ERDAS EMIGEN 15 software with supervised image classification and composite different color band were done, geo-referencing or map correction were made, extraction of the study area from the big portion were conducted, interpretation of features and classifying as built up area, bare land, forest and vegetation and water bodies was done.

Digital image classification in remote sensing is the detection and clustering of similar image pixels into the same information categories which are produced from several spectral bands of a satellite image.

3. RESULTS AND DISCUSSION

3.1. RESULTS

3.1.1 Analysis of land use land cover dynamics of Akaki-kality sub city

3.1.1.1 Analysis of land use land cover dynamics of Akaki-kality sub city in 1996

The land use/ land cover of Akaki Kality sub city during 1996 shows the sub city had the largest coverage of bare land which is 43% and followed by bare land forest and vegetation which accounts 40% of the total area of the sub city. The built area covered 10% and the water body which accounts 7 % which is the smallest.

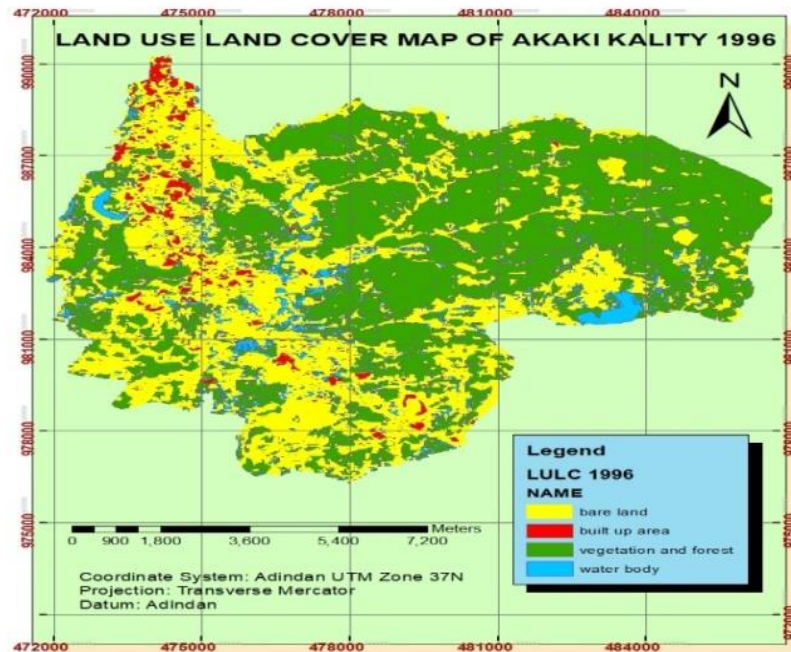


Fig 4.1 Land use/ land cover of the Akaki Kality in 1996

Table 4.1 Percentage of the Land use/ land cover of the Akaki Kality in1996

Land use/Land cover classes	Total area (ha)	Percentage (%)
Bare land	4,960	40
Built up area	1,240	10
Vegetation and Forest	5,332	43
Water bodies	868	7
Grand Total	12,400	100

3.1.1.2 Analysis of land use land cover dynamics of Akaki-kality sub city in 2005

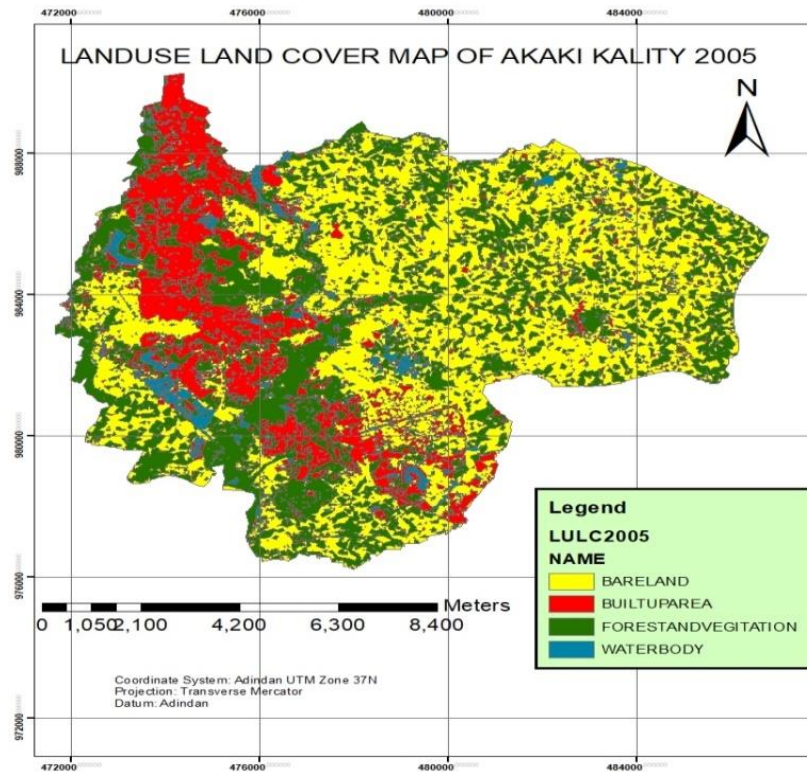


Fig 4.2 Land use land cover classification map in 2005

Table 4.2 land use land covers classification of 2005

Land use/Land cover classes	Total area (ha)	Percentage (%)
Bare land	4,340	35
Built up area	3,224	26
Vegetation and Forest	4,092	33
Water bodies	744	6
Grand Total	12,400	100

The land use/ land cover of Akaki Kality sub city during 2005 shows the sub city had the largest coverage is bare land which is 35% and the second largest coverage is forest and vegetation it accounts 33%. The built area covered was 26% and the water body accounts 6 % is the smallest.

3.1.1.3 Analysis of land use land cover dynamics of Akaki-kality sub city in 2011

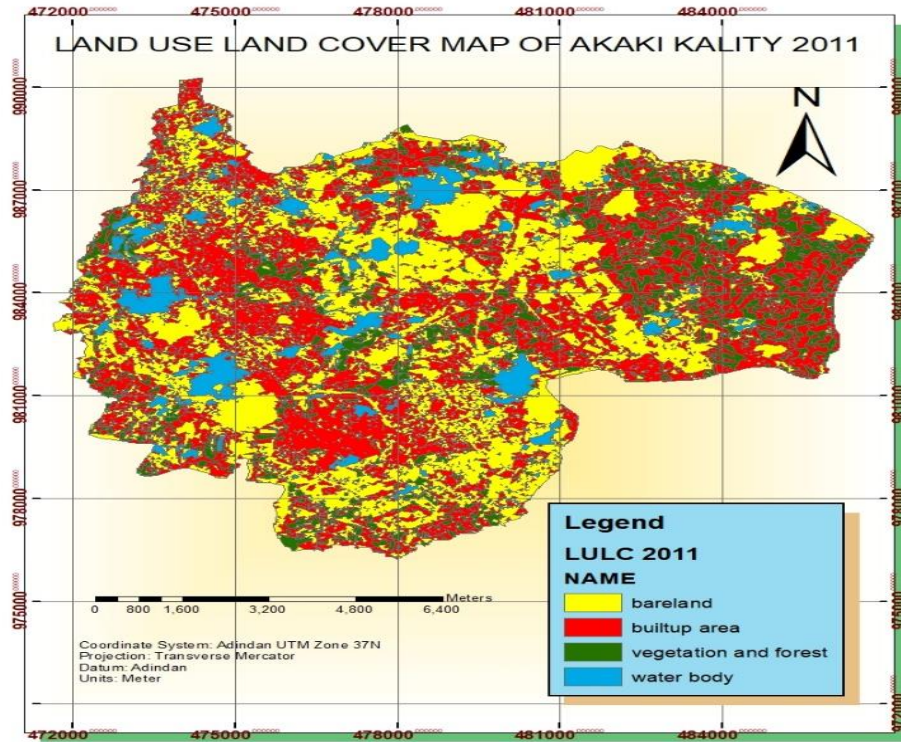


Fig 4.3 Land use land cover classification map in 2011

Table 4.3 land use/ land covers classification of 2011

Land use/Land cover classes	Total area (ha)	Percentage (%)
Bare land	5,084	41
Built up area	3,720	30
Vegetation and Forest	2,976	24
Water bodies	620	5
Grand Total	12,400	100

The land use/ land cover of Akaki Kality sub city during 2011 shows the sub city had the largest portion of bare land, which is 41% and built up area, had the second larger portion which is 30% vegetation and forest had 24% and water body coverage was 5%.

3.1.1.4 Analysis of land use land cover dynamics of Akaki-kality sub city in 2021

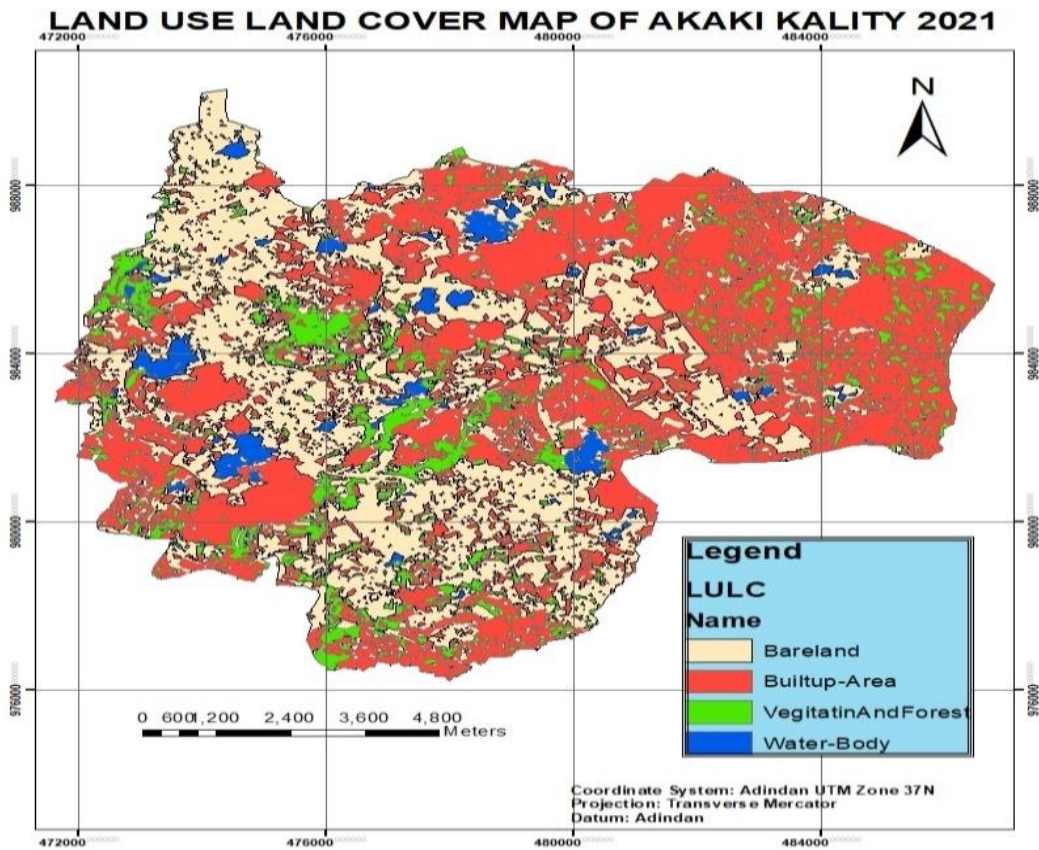


Fig 4.4 Land use /land cover classification map in 2021

Table 4.4 land use/ land covers classification in 2021

Land use/Land cover classes	Total area (ha)	Percentage (%)
Bare land	2,976	24
Built up area	5,704	46
Vegetation and Forest	2,852	23
Water bodies	868	7
Grand Total	12,400	100

Built up area has the largest coverage in 2021 which is 46% and the second largest area was bare land and accounts 24% the third largest portion was vegetation and forest which is 23% and the final smallest portion is water body which was 7 % only.

Between 1996 and 2021 the land use/ land cover analysis indicates the bare land decreased from 40% to 24 % which mostly changed to construction, and the built up area changes from 10% to 46 %, which means it increased by 36% or 4,464 hectare. The other land use/land cover, which has shown the big difference between 1996 and 2021, was vegetation and forest, which decreased from 43 percent and 23 percent. Water bodies have shown only about 2 % variation within the 25 years from 1996 to 2021.

Table 4.5 Summary of the land use/ land covers classification of the Akaki Kality Sub city in four time series

Land Use/ Land Cover Classes	Years							
	1996		2005		2011		2021	
	Area (ha)	Percentage (%)	Area (ha)	%	Area (ha)	%	Area (ha)	(%)
Built-up Area	1,240	10	3,224	26	5,084	41	5,704	46
Bare Land	4,960	40	4,340	35	3,720	30	2,976	24
Vegetation and Forest	5,332	43	4,092	33	2,976	24	2,852	23
Water Body	868	7	744	6	620	5	868	7
Total	12,400	100	12,400	100	12,400	100	12,400	100

3.2. DISCUSSION

When my study begins in 1996 the sub city built up area ratio was only 10% which is small and after 25 years in 2021 the sub city built urea ratio coverage increased to 46% which has huge portion which means 36% new bare land was changed to built-up area in the sub city. This rapid change of land use to built-up is not the Addis Ababa alone case but also the Bahir Dar town has also big change from 1.54% in 1986 to 9.42% in 2010 which shown big change above 9 fold (Atalel.G, 2014).Built up area growth is not Addis Ababa or Ethiopian case it is also global phenomena due to rapid urbanization.in Hyderabad, India in 1989 the built up area increased from 13.32%to 26.92% in 2011 over double growth within 22 years (Wakode, 2016).

Bare land was one of the land use type which has big change within the study period, in 1996 the sub city bare land was 40% which is big and after 25 years 2021 the bare land ration decline to 24%. The Peru water shade bare land area decreased from 20.8% in 1988 to 16.6 % in 2007 which decreased by 4.2% between 19 years this indicate that decreasing of bare land and growth of built up area is common in different places (Carlos.A,2007).

In my study forest area cover declined in high ratio, in 1996 the sub city forest and vegetation was 43% this coverage decreased to 23% in 2021 which means 20% of the sub city forest and vegetation area lost. In Pangani river basin Tanzania the forest coverage was 24% in 1990 and this coverage decreased to 12% in2009 after 19 years the forest area lost 12% (RENNY, CH.2012). Similarly inkiskatinaw river water shed forest area was8% in 1984 and 5.5% in 2010 meaning forest area declined by 2.5% and these facts shown that forest area decreased from years to years from different places (Paul, 2013).

Population growth was one of the causes for land use land cover change in akaki kality sub city. During the study period from 1996 to 2021 the sub city population increases from 144,474 to 330,396 which means 185,922 new additional people were added for the sub city and these people consumed additional built up place and was big cause for the change of land use land cover. Population has created demand for several goods and services which require space leading to change of various land uses and land covers to accommodate new functions at the expense of previous functions (MWATHI.P, 2016).

with the increases of population growth land use land cover change or built up area increased and most other land use type like agriculture land forest and water body are changed to residential, commercial and other services are distribute and consumption of land are high. Degradation of core cities is push peoples for desired urban fringes (Koirala.S, 2018).

GDP growth was one of the quoted reasons for land use land cover change for the study area from 1996 to 2021 huge capital change was recorded from 3,364,150,382.836 birr to 52,970,526,718.012 which was 49,606,376,335.176 birr was gained within 25 years in the study period and this huge capital leads for government to create investment policy change to practice for the sake of job opportunities for the added population. The economic development of the city has led to a boom in the construction industry and subsequent expansion of built-up areas. This has resulted in pressure and need for more land to accommodate the housing, commercial and industrial needs for the increasing city population (MWATHLP, 2016).

When people GDP growth was increased people have interest to buy and construct houses to urban periphery rather than city centers or cores and they have vehicle or individual care accessibility and this people periphery interest have pressure for new land use land cover change or expansion of built up area in urban peripheries (Koirala.S,2018)

Economy growth measured in GDP per capita and FDI facilitates the creation of jobs, better education systems, and scientific research attracting massive waves of migrants. Increased economic growth has also brought about constructions of big malls such as

Garden City, shopping mall, and Acacia Mall and brings high land use land cover change (BenBella. E, 2016).

Government policy was the most and highest cause which utilized huge portion of land from the sub city land especially industries development government program was alone utilized in Akaki Kality sub city 1,167 hectare of land which accounts about 9.4 percent of the total land of the sub city and 84% of the whole Addis Ababa's industries ratio. Industries have high demand of land and industries expanded in countryside and industries require huge size of land by industries nature. Indonesia industries developed at the fresh location and consumed new land due to the factories need road, communication and other necessary infrastructure in Indonesia (Karsidi.P, 2004).

Industrial structure also has a great impact on urban expansion in medium-sized cities. Cities that are dominated by manufacturing industries, economic growth will be accompanied by a large demand for land. Condominium Housing development program was the next program in Akaki kality sub city which was taken large coverage in the sub city and cover about 723.759 hectares of land of the 12,400 hectares total area of the sub city, which is about the 5.8% the total area of the sub city. Development of the real estate market has aggravated the loss of agricultural land in urban fringe and rural areas (Ma, 2015).

4. Conclusion and the way forward

Land use land cover change in Ethiopia have increased from time to time especially in Addis Ababa, Particularly in the Akaki kaliti sub city it has shown a vast change from 1996 to 2021. Between 1996 and 2021 the land use/ land cover analysis indicates the bare land decreased from 40% to 24 % which mostly changed to construction, and the built up area changes from 10% to 46 %, which means it increased by 36% or 4,464 hectare. The other land use/land cover, which has shown the big difference between 1996 and 2021, was vegetation and forest, which decreased from 43 percent to 23 percent. Water bodies have shown only 2 % variation within the 25 years from 1996 to 2021.

These land use lands cover change caused by population growth, GDP growth of the city and special Government policies like industries policy and condominium housing development.

Therefore, based on the finding, this research has forwarded the following recommendations:

- ❖ The government should revise investment policy and balance investment flow between Addis Ababa and regional towns. When investment is distributed to regional towns and create jobs for youths in rural areas urban migration will be reduced and the land demanded for housing and other services in Addis Ababa will be reduced. This due to the fact that one of the causes of rural urban and urban-urban migration is job opportunities.

- ❖ Deliver enough infrastructures to regional towns and foster private investors to invest their capital to regional towns and play vital for job creation.
- ❖ Proper and updated land management policy should be formulated and balance the land demand and land resource utilization.
- ❖ Vertical development should be encouraged to minimized the need of extra land for construction and discourage urban sprawl

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