Journal of Sustainable Development; Vol. 17, No. 1; 2024
ISSN 1913-9063 E-ISSN 1913-9071
Published by Canadian Center of Science and Education

Urban Land Use Trend and Drivers over the Last Three Decades in Addis Ababa and Impacts to the Sustainable Land Management

Engdawork Assefa[1]

[1] Center for Environment and Development, College of Development Studies, Addis Ababa University, Ethiopia

Correspondence: Engdawork Assefa, Center for Environment and Development, College of Development Studies, Addis Ababa University, Ethiopia. E-mail: eassefat5@gmail.com

Received: December 7, 2023 Accepted: January 12, 2024 Online Published: January 15, 2024

doi:10.5539/jsd.v17n1p119 URL: https://doi.org/10.5539/jsd.v17n1p119

Abstract

Developing countries are experiencing a fast urban expansion which is highly impacted the land use land cover, LULC, biodiversity, local climate, and socio economic conditions. Understanding of urban LULC and its consequences is imperative to explore the opportunities that the urban has for sustainable development. The purpose of this study is to examine the patterns of LULC change, the effects of unsustainable land use, and mitigation measures. The study employed mixed methods including Satellite image, GIS techniques, and social survey. To further refine the study, secondary data from both published and unpublished materials were also used. The transfer of green space to built-up regions during the past three decades is evidence that the patterns of land use changes have become unsustainable. From 1986 to 2017, there has been a substantial quantity of deforestation (4467 ha of forest lost), and reduction of grassland (6314 ha) while built-up land has gone up by 9876 ha. The city's inefficient plans, along with the growing population, are the primary causes of the unsustainable LU. The city has experienced negative effects from unsustainable land use namely: flooding (areas susceptible for flooding increased by 69.5%), urban heat islands (the land surface temperature has increased by 3.8^0C), and carbon sequestration (at least 616, 044 C not sequestered and so released). On the other hand, a number initiatives have been implemented, albeit sporadically, to improve sustainable land use. Thus there is a need for policy makers and urban land use mangers to take into account empirical knowledge while planning.

Keywords: green legacy, sustainability, unsustainable land use, urbanization, urban environment

1. Introduction

Global urbanization is growing at a rate never seen before, with developing nations—primarily in Africa and Asia—seeing the fastest growth (Gao & Neil, 2020). About 10% of the world's population lived in cities in 1900; by 2020, that number had increased to 55% (4.27 billion), and by 2036, it is expected to reach a predicted 62% (5.4 billion) (UN, 2018a). Urbanization has an impact on land use and land cover change, LULCC, hydrological cycles, atmospheric dynamics (which account for 70% of GHG emissions), ecological processes, energy usage, and GHG emission, (which is around 70% of global emissions) and are therefore regarded as the hotspot of environmental problems on a worldwide scale (Grim et al., 2008). Land cover land use change is the most discernible and permanent effects of urban land expansion which have led to a variety of environmental, economic, and social changes (Gao & O'Neill, 2020; Grim et al., 2008). These in turn have an impact on the availability and quality of freshwater, local climate change habitat fragmentation, and biodiversity loss (Grim et al., 2008; McDonald et al., 2011; Arcanjo & Monteiro, 2023). Therefore, one of the major issues affecting the inclusive, secure, resilient and sustainable human settlement is the change in urban land use and cover. The challenges facing urban sustainable development can be identified by examining the ways that land use trends, patterns, and dynamics impact on sustainability (Zhou, 2008). Furthermore, studies of this nature suggest potential solutions that capitalize on the opportunities provided by practices and activities aimed at enhancing sustainable land management.

Ethiopia - the second most populous country in Africa – has also experienced an unparalleled rate of urban growth since the last three decades (CSA, 2013). The proportion of the urban population though small but increased at alarming rate for instance the population residing in urban in 1960, 1970, 1980, 2000 and 2010 account for 10, 13, 15, 18, and 20% of the total population respectively (CSA, 2013; UN-Habitat, 2018; World-Bank, 2015). When

compared to other Sub-Saharan Africa countries, Ethiopia has a greater rate of urban growth—roughly 5% annually (CSA, 2013; EMoUDH, 2015; UN, 2018b). Several studies have also indicated that Ethiopia's urban growth will continue in the future (EMoUDH, 2015; World-Bank, 2015).

All major cities in Ethiopia, mainly regional capital cities have also exhibited the unprecedented urban growth particularly in the last 30 years (Terfa et al., 2019). Between 1984 and 2014, Mekelle's built-up areas grew by approximately 663%, from 531 hectares in 1984 to 3524 hectares in 2014 (Fenta et al., 2017). Between 1957 and 2009, BairDar recorded an overall annual increment of 31%, from 279 ha in 1957 to 4830 ha in 2009 (Haregeweyn et al., 2012) while Adama city the built up areas increased by 600%_ from 8.80 sq.km in 1984 to 51.3 sq.km in 2017 (Manikandan, 2019). Hawassa's urban growth was unprecedented, especially in the last few years. From 509 ha in 1972 to 812 ha in 2003 and 2722 ha in 2006, the urban area was increased. That represents a 67% rise between 2003 and 2006 (Admassu, 2015). The built up area of Hawasaa was also increased by 24% from 1973 to 2015 (Gashu & Gebre-Egziabher, 2018).

A wide range of studies of the various cities of Ethiopia have also reported that the pattern of the land use land cover changes demonstrated that an increase of built-up areas, slums, urban sprawl, and barren land as well as a tremendous decline of cultivated land, woodland and forest land (Admassu, 2015; Fenta, et al., 2017;Gashu & Gebre-Egziabher, 2018; Manikandan, 2019) This in turn resulted in irregularity and dispersion of urban growth representing strong evidence of urban sprawl. Thus in Ethiopia the direction and rate of land use land cover changes of the urban centers is unsustainable. The dominance of slums are resulted in poor disposal of garbage, contamination of both air and water, and inappropriate use of land, and destruction of ecological systems, all of which are significant concerns for sustainable development in Ethiopia (Maktav & Erbek, 2005; Simwanda et al., 2019). Hence, cities in Ethiopia have an immediate need for policies and strategies that are feasible in order to promote sustainable land use and land management (Pieterse & Haysom, 2015). In order to solve these issues, urban planning and development should involve or embody sustainability which targeted to integrate ecological conservation and governance with urban planning.

Since the Bruthland Commission on the Environment, Ethiopia has included the Sustainable Development Agenda and Goals into its plan and made numerous efforts to bring them to fruition (FDRE, 2010) because sustainability is essential to establish a balance between short-term profit and long-term resource preservation. Ethiopia has fully embraced national ownership to implement the 2030 Agenda and its sustainable development goals (SDGs) as an essential component of its national development framework, having accepted the Agenda with strong government commitments and endorsement from the House of People Representatives. Ethiopia included the Sustainable Development Goals (SDGs) into the Growth and Transformation Plan (GTP II), which ran from 2015 to 2020, and the Ten-Year Perspective Plan, which ran from 2019/2020 to 2029/2030. The span of the SDGs' implementation timeframes corresponds to the two plans that came after it. The 17 goals and 169 targets that make up the SDG 2030 are, for the most part, connected to the national vision and the ten-year development goals. The majority of SDG goals and targets that are in line with Ethiopia's internal features and the country's development vision have been attempted to be integrated. The nation is dedicated to accomplishing the SDG objectives, and pertinent sections of the ten-year development plan have appropriate indicators (Waza, 2022). Ethiopia has developed plans for each industry that would be impacted by climate change. The few areas in which the Ethiopian government shows its commitment to addressing climate change include climate resilient agriculture, climate resilient industry, and climate resilient forestry (NAPA, 2017). In addition, every year millions of seedlings are planted as part of a green legacy initiative to fight climate change. Two noteworthy initiatives that are worth mentioning are Ethiopia's National Adaptation Plan and the Climate Resilient Green Economy (CRGE) (NAPA, 2018; Paul & Weinthal, 2019; Golrokhian, 2016).

The country's efforts to realize and implement sustainable development have also been concentrated in urban areas, which have inspired and engaged these centers (Conway & Schipper, 2011). In order to address this, a number of plans, initiatives, and tactics—such as urban greening, green legacy, and urban sustainability—have been developed and put into practice (FDERE, 2015; Worku, 2015). The implementation methods encompass a range of strategies, including community engagement, civic society engagements, and necessitating the cooperation of numerous international organizations and non-governmental organizations (Worku, 2015). However, the majority of the time, the country's plans have been crippled or characterized by extremely poor implementation due to a lack of accountable institutions for carrying out the objectives and a lack of precise and comprehensive mechanisms for achieving the objectives at the local and regional levels (Paul & Weinthal, 2019). As a result, program implementation levels have remained extremely low. Furthermore, Moreover, the urban land use and land cover changes which is rampant in the country accompanied with the urban growth is one of the major factor that affect the urban sustainable development (World Bank, 2015).

Thus, understanding of the challenges sustainability and how sustainability plays out its role at urban contexts, temporal, and spatial scales have a significant implication for institutional and governance responses to unsustainable land use, and to enhance sustainable urban land use (Jennings, 2016). For the effective achievement of sustainable urban land use and land management, the land use patterns of change should be incorporated into urban planning. The provision of evidence based knowledge plays an indispensable significances for land use planners, policy makers, and land managers for sound decision making on the sustainable land use. Nevertheless, the majority of earlier research (Terfa et al., 2019; Manikandan, 2019) has been sparingly focused on sustainable urban land use and development. Instead, it has primarily focused on the growth or expansion of cities and has shown the rate and magnitude of changes in built-up areas. Additionally, they have not dealt with the roles that plans and other initiatives play in promoting sustainable urban land use and development. For land use planners, policy makers, and land managers to make wise decisions on sustainable land, the availability of evidence-based knowledge is essential.

In light of the aforementioned discussion, this study is designed to map and analyze the patterns, trends and drivers land use land cover over the course of three decades in Addis Ababa, with an emphasis on the implication for urban sustainable land management. The study has the following specific objectives a) to map and assess the pattern and trends of land use land cover 2) exploring the driving forces of the changes of land use land cover, and 3) assessing the effects of unsustainable land use and the initiation and mitigation measures of unsustainable land use.

Ethiopia's hub for production, consumption, finance, the intersection of ideas, financial flows, and products flows is Addis Ababa (UN Habitat, 2017). Furthermore, Addis Abeba serves as the hub for politics, governance, cultural unification, diplomacy, and civil society organization not only to Ethiopia but also for the entire Africa, where the Africa Union's headquarter is located. Addis Abeba is a typical capital city of the Sub-Sahara African (SSA) that has experienced a rapid growth of urban given the large number of population increase and economic growth (AACPPO, 2017). Like any capital city of the SSA, AA is marked by a prevailing economy and the subsequent population migration from rural and other urban areas. The subsequent impact of which is overcrowding and congestion, urban poverty, poor living conditions as well as pollutions. Thus it is typical to investigate the patterns and drivers of land uses and sustainable land management in Addis Ababa.

The last fifty years in particular have seen a significant increase in the nation's socioeconomic, demographic, and political dynamics. During this period of time, for instance, there have been four government or regime changes namely Monarch, Derg, Ethiopian People Revolutionary Democratic Front, EPRDF and the incumbent government, Prosperous Party. The change of the government has also been accompanied with change in the ideologies, unrest, and conflicts. This has brought a remarkable dynamics on the land use and land management practices and policies. During the time of the transition, the country exhibited land grabbing, informal settlements, large scale of deforestation which is also exacerbated by loose law enforcement. The global trends on economy, climate change, political conditions and technological advancement are also very apparent during this period of time that they have impacts in Ethiopia as well. This time is therefore, the period where there is change of the landscape is more apparent and significant in Ethiopia.

2. Methodology

2.1 Description of the Study Area

Addis Ababa is located in between 8º55´ and 9º05´ North latitude, and 38º40´ and 38º50´ East longitude. The City established in 1887 and has shown a great geographical expansion to the area of about 54,000ha (AACPPO, 2017). Figure shows the location of the study area including the ten sub-cities of Addis Ababa.

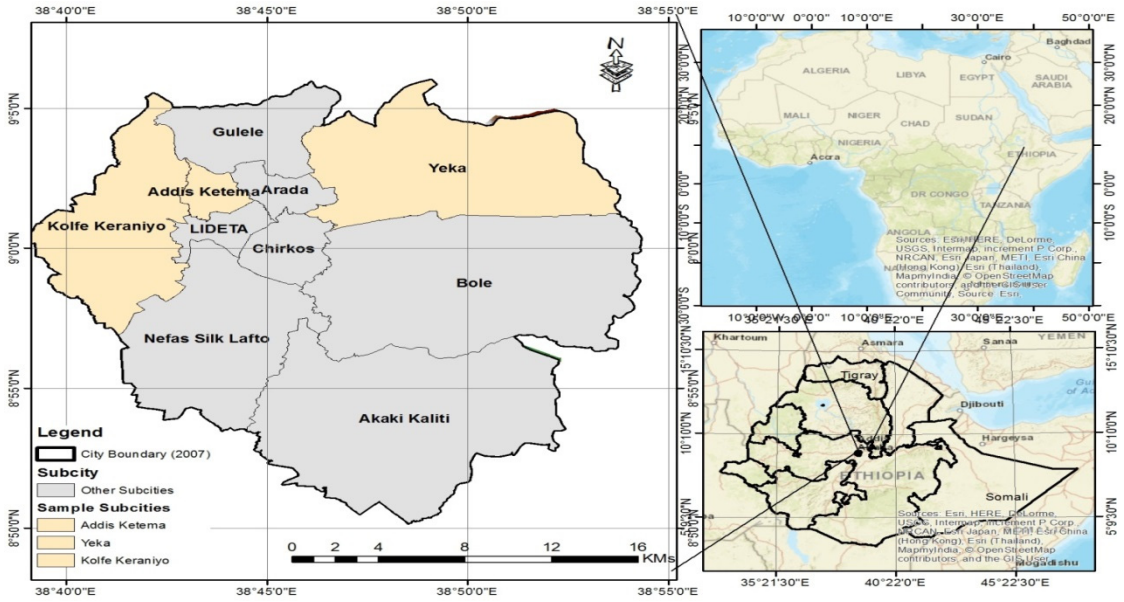

Figure 1. Location map of the study area

2.2 Methods

This study was conducted utilizing an integrated methodology that combined social survey with Remote Sensing and GIS tools. In order to investigate the causes of the changes in urban land cover and land use, as well as the effects of these changes, household surveys were conducted. One hundred and sixty-six household were selected from the representative sub cities. Twenty three households are selected from Addis Ketema, 40 from Yeka, and 43 from Kolfe-keranio utilizing a proportionate approach based on size. A random Woreda was selected from each sub city. Consequently, Woreda 6, 11, and 9 were selected for the corresponding subcities of Yeka, Kolfe-keranio, and Addis-ketema. To ensure that the population was biased-free, a straightforward random sample procedure was used to choose the households.

2.3 Satellite Image Analysis

In this study, the remotely sensed satellite data specifically the Landsat satellite images from the United States Geological Survey (USGS) was downloaded and used mainly to assess the LULCC of Addis Ababa through producing time series LULC maps for the past 30 years: 1986, 2000, and 2016. The image taken in 1986 was Landsat TM 7 whereas the images taken for 2000 and 2016 was Landsat 8 ETM+ which indicates the sensor types used in each image. Since they were taken during the dry season, every images utilized in this study was bright and almost entirely free of clouds. Furthermore, GPS was utilized to gather ground truth data from the field in order to validate the LULC classified information. ERDAS Imagine 2014 and Arc GIS 10.8 software's were used for satellite image processing, image classification and LULC change analysis.

Image Pre-Processing: is often defined as the image preparation and processing procedures that are used to correct image distortion from which arise from imaging systems, sensors, and observing conditions. Geometric rectification and atmospheric correction were carried out following the download of the Landsat data. Furthermore, sub-setting was done according to Area of Interest (AOI).

Image Classification: defined as a technique of extracting information from the image based on the reflectance value of an object. The class can be grouped into a thematic layer of having similar urban LULC in the image. In this study, a hybrid classification technique comprising unsupervised and supervised classifications was used to classify the 1986, 2000, and 2016 images.

Accuracy Assessment: Following image classification, each class of land cover's accuracy in classification was evaluated using a minimum of fifty sample points combined with high-resolution satellite images from Google Earth. The confusion/error matrix was developed using these sample points for each LULC class, and the connection between reference pixels and classified land use and land cover maps was determined. Because it compares two categorization products statically and takes non-diagonal elements into account, this study used khat statistics. K has a value between 0 and 1, where a value of 1 denotes perfect agreement and a value of less than

what would be predicted by chance, respectively. To calculate the classification accuracy as a percentage, this value is commonly multiplied by 100. This is altered to what was examined when the LULC mapping for the specified times has been completed.

Lastly, as shown in Table 1, six categories for land use and land cover were identified within the study area.

Table 1. Description of land use/land cover classes identified in the study area

Land Use/Cover	Description
Forest	Represents areas that are covered with dense trees.
RHT	Represents areas covered by trees of good ornamental values planted and grown along major roads, hotel and school compounds etc.
Grassland	This is the area covered by grass species with no or little vegetation cover.
Cropland	This represents areas used for rain fed crop cultivation. Some irrigated land along the river course also considered as crop lands.
Bare land	Part of the area with no or very little vegetation cover
Built-up area	Represents areas covered by buildings and other infrastructures like roads, parking lots, factories etc.

3. Results and Discussion

3.1 Spatio-temporal Distribution of Land Use Land Covers

The types of the LULC is identified in the urban areas during 1986, 2000 and 2016, include built-up areas, forest cover, road side and homestead tree, grass land, cropland, bare land and built up area (Table 2). Three maps of land use/cover which shows the spatial and temporal distribution of each land cover classes produced for the 1986, 2000 and 2016 (Figure 2, 3 and 4). The area coverage of each land use classes in 1986, 2000 and 2016 is summarized Table 2. With this regard, majority of the study area were covered by crop land (30.7%) and built up area (34%) in 1986 and 2000, respectively. On the other hand, the percent cover of bare land was minimal both in 1986 and 2000. The dominant land use land cover in 2016 was built-up land and followed by crop land which accounts 19.1 %.

The city is spread across a variety of topographic types, from plains to mountains. The first part of the settlement was established on the mountain and then moved to the low-lying land. Currently, the northern edge of the study areas is where forest land cover is most prevalent, with minimal distribution occurring on the river buffer. Cropland is located in the southern and south eastern edges of the study area. While the built-up area is spread to the different direction mainly following the transport roads which radiates to the four direction namely north, south, east and west. However, the pattern is currently changing as the land use and land cover of the city has undergone a massive change, particularly over the last 30 years.

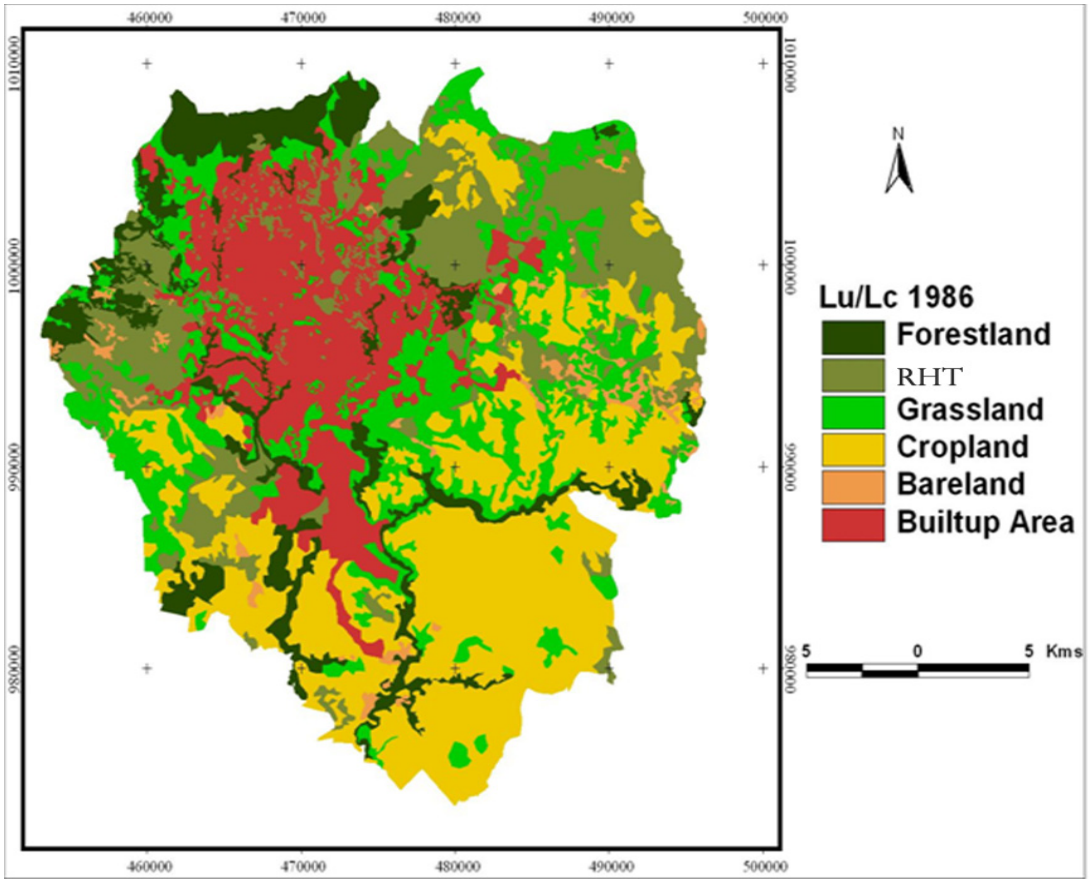

Figure 2. Land use/land cover map of Addis Ababa in 1986

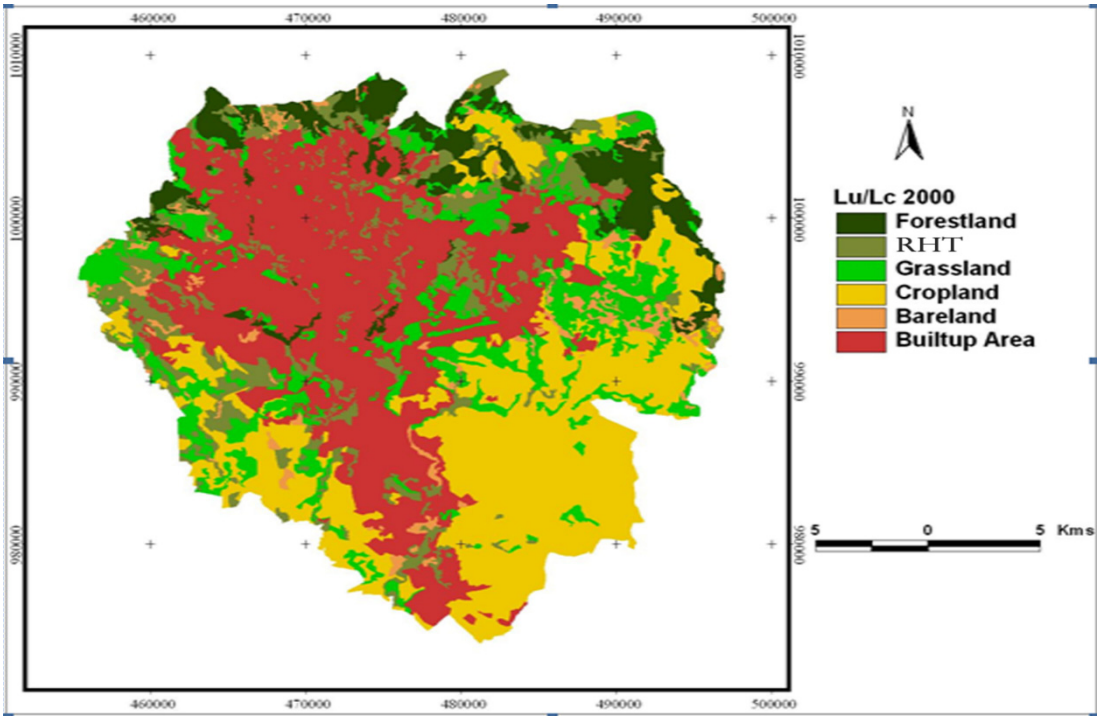

Figure 3. Land use/land cover map of Addis Ababa in 2000

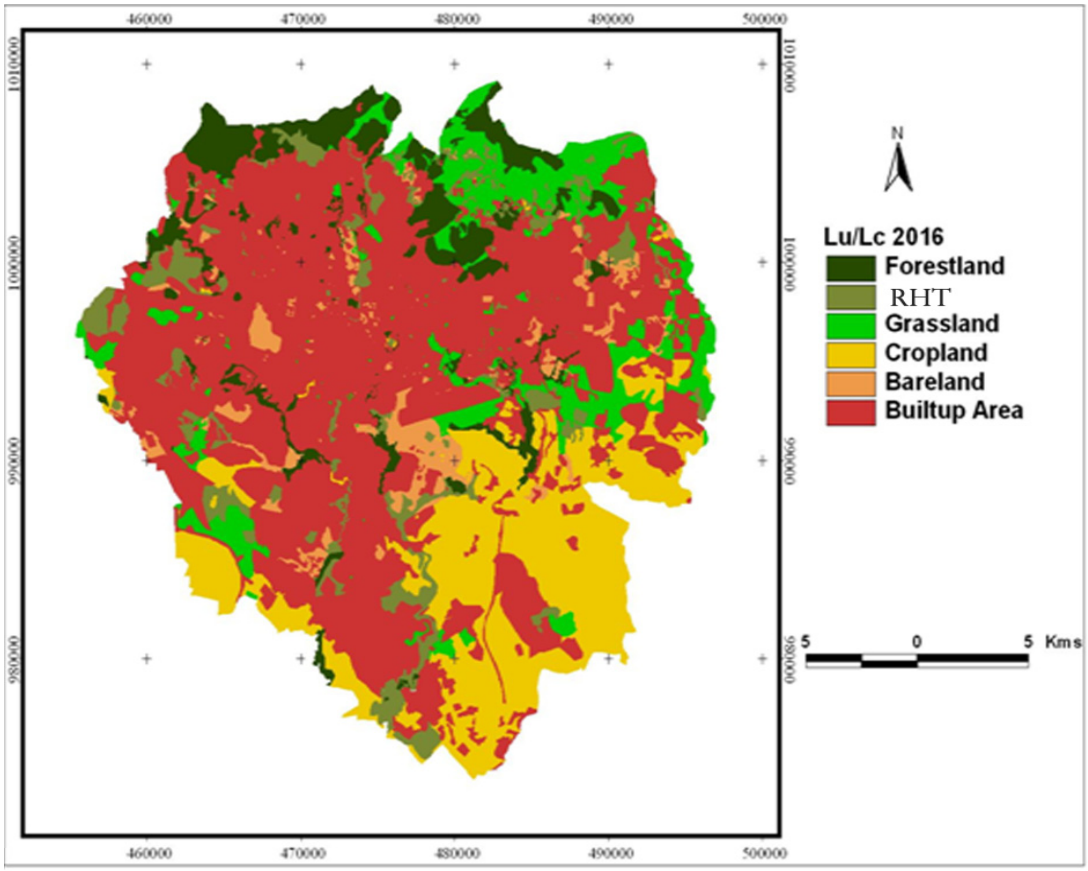

Figure 4. Land use/land cover map of Addis Ababa in 2016

Table 2. Percentages of land use/land cover in Addis Ababa (1986 – 2016)

Land use Type	1986		2000		2016	
	Area(ha)	Area (%)	Area(ha)	Area (%)	Area(ha)	Area (%)
Forest	6015.1	11.4	4491.3	8.5	4357.7	8.3
RHT	9383.0	17.8	5792.0	11.0	3567.9	6.8
Grassland	10550.1	20.0	7752.5	14.7	5004.2	9.5
Cropland	16152.5	30.7	15111.4	28.7	10042.4	19.1
Bare land	1124.0	2.1	1638.7	3.1	2134.9	4.1
Built-up area	9473.3	18.0	17912.0	34.0	27589.3	52.4
Total	52698	100.0	52698	100.0	52696	100.0

3.2 Patterns and Trends of LU

In 1986, built-up area was the third largest land cover next to crop lands and grass land with an area of 18% (9473.3 ha) and bare-land was the smallest land cover with an area of 2.1% (1124 ha). In the next reference year (2000), the area coverage of the built-up area reached to 34% (17912 ha) while the area of bare-land has been changed to 3.1% (1638.7 ha) which insignificant change. Furthermore, built-up area dramatically increased to 52.4% (27589.3 ha) in 2016 and bare-land class was increased only by 1% and reached to 4.1% (2134.9 ha) (Table 3, 4, and 5).

The change of the LULC from 1986 to 2000 is summarized in figure 5 and table 3. Accordingly, expansion of built-up area over the time interval from 1986 to 2000 is summarized in Figure 5. Hence, 5.4% (960.5 ha) of forest land, 9.9% (1769.9 ha) of RHT, 18.3% (3278.2 ha) of grass land, 16.8% (3017.2 ha) of crop land and 0.3% (61.6 ha) of bare land were transformed in to built-up area.

Table 3. Land use/cover change (1986-2000)

Land use Type	Persistence		Gains		Losses		Net Change	
	Area (ha)	Area (%)	Gains (ha)	Area (%)	Losses (ha)	Area (%)	Area (ha)	Area (%)
Forestland	1548.1	25.7	2943.2	13.72	-4467.0	-20.8	-1523.8	-7.1
RHT	2526.8	26.9	3265.2	15.22	-6856.1	-32.0	-3590.9	-16.7
Grassland	4236.1	40.2	3516.4	16.39	-6314.0	-29.4	-2797.6	-13.0
Cropland	13046.5	80.8	2064.9	9.625	-3106.0	-14.5	-1041.1	-4.9
Bare land	1062.5	94.5	576.3	2.686	-61.6	-0.3	514.7	2.4
Built-up	8824.9	93.2	9087.1	42.36	-648.5	-3.0	8438.7	39.3
Total	31244.9	59.29	21453.0	100	-21453.0	-100	0.0	0.0

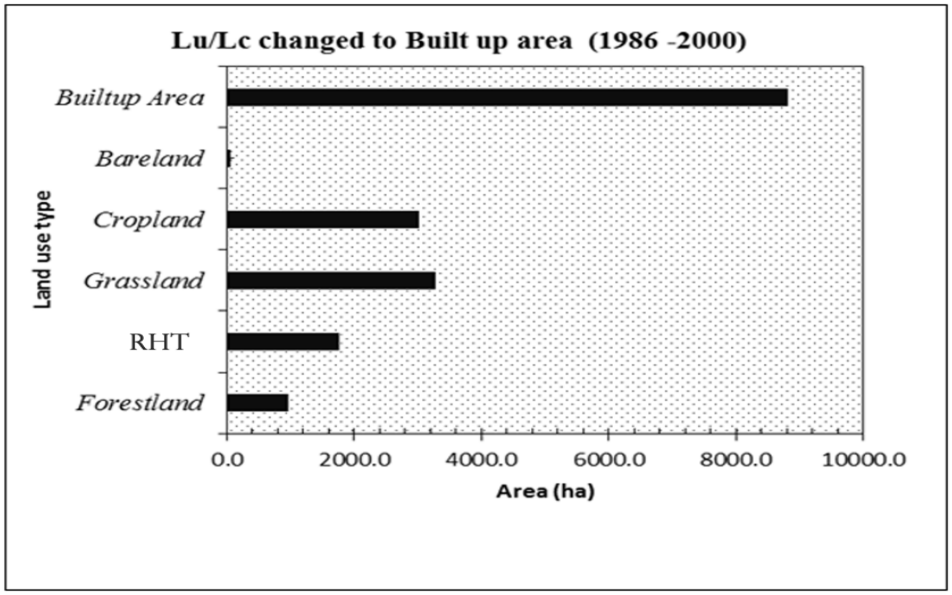

Figure 5. Land use categories changed to built-up areas (1986-2000)

As shown on the table 3, all land use classes has shown a negative net change of their respective area. This indicates that transformation of those land use systems to other land use systems, mostly to Built-up area and bare lands. Unlike to the other land use systems, built-up area and bare-land are the only land use systems which showed a positive net overall change in all the three time intervals. This positive net change indicates as there is transformation of other land use systems to bare-land and built-up area. As shown in Table 5 and assuming constant rate of change in each year, the annual rate of expansion of built-up area and bare land are 6.4% (603.9 ha) and +3% (33.7 ha) respectively.

The dynamics of these two land covers with in the three time intervals is summarized. From 1986 – 2000; bare land gains 2.68% 576.3 ha loses -0.3% (648.5 ha) and net change was 2.4% (1010.9 ha). But built-up area gains 42.36% (9087.1 ha), loses -3% (655.1 ha) and the net change was 39.3% (8438.7 ha). For the second time interval, 2000 – 2016, Bare land gains +9.63% (2066.5 ha) loses -7.3% (1570.3 ha) and shown a net change of +2.3% (496.2 ha). Also built up area gains +57.74% (12387.7 ha), loses -12.9% (2763.7 ha) and net change of +44.9% (9624 ha). Similarly, from 1986 – 2016, bare-land gains +9.74% (2089.8 ha), loses -5% (1078.9 ha), and net change of +4.7% (1010.9 ha). The gain, loss and net change of the built up area also +87.5% (18771.2 ha), -3.1% (655.1 ha) and +84.4% (18116.1 ha) Table (3, 4, and 5).

The loss of area from bare land and built-up area is very small in each time interval as compared with loses in other land use classes. Bigger loss of area from built-up area from 2000 – 2016 was found with value -12.9%

(2763.7 ha). This area is quite big area. The best reason for this loss can be growing of trees in between built-up areas and when they develop sufficient canopy cover, they will have a tendency to cover built-up area and change the reflectance to vegetation.

Table 4. Land use/cover change (2000-2016)

Land use Type	Persistence		Gains		Losses		Net Change	
	Area (ha)	Area (%)	Gains (ha)	Area (%)	Area (ha)	Area (%)	Gains (ha)	Area (%)
Forestland	1959.3	51.0	3145.5	14.66	-1884.8	-8.8	1260.7	5.9
RHT	1038.7	16.0	2283.8	10.65	-5436.8	-25.3	-3153.1	-14.7
Grassland	1466.2	19.0	3100.6	14.45	-6259.5	-29.2	-3158.9	-14.7
Cropland	7955.6	52.6	2086.7	9.727	-7155.6	-33.4	-5068.9	-23.6
Bare land	68.4	4.2	2066.5	9.633	-1570.3	-7.3	496.2	2.3
Built-up	15137.4	84.6	12387.7	57.74	-2763.7	-12.9	9624.0	44.9
Total	27626	52.42	25071	116.9	-25070.8	-117	0.0	0.0

Table 5. Land use/cover change (1986-2016)

Land use Type	Persistence		Gains		Losses		Net Change	
	Area (ha)	Area (%)	Gains (ha)	Area (%)	Area (ha)	Area (%)	Gains (ha)	Area (%)
Forestland	2034.3	33.8	2323.4	10.83	-3980.6	-18.6	-1657.2	-7.7
RHT	1194.8	12.7	2373.1	11.06	-8188.2	-38.2	-5815.1	-27.1
Grassland	1586.3	15.0	3417.8	15.93	-8963.6	-41.8	-5545.8	-25.9
Cropland	7428.8	46.0	2613.6	12.18	-8722.5	-40.7	-6108.9	-28.5
Bare land	45.1	4.0	2089.8	9.741	-1078.9	-5.0	1010.9	4.7
Built-up	8818.1	93.1	18771.2	87.5	-655.1	-3.1	18116.1	84.4
Total	21107.3	40.05	31589.0	147.2	-31589.0	-147	0.0	0.0

Likewise, from 2000 – 2016, the amount of individual land use/cover transformation in to built-up area is summarized in Figure 6. Numerically, 5.3% (956 ha) of forest land, 15.7% (2815.1 ha) of plantation, 16.8% (3015.6 ha) of Grass land, 26.7% (4776.8 ha) of crop land and 4.6% (824.1 ha) of bare land were transformed to built-up area.

To summarize, in the overall 30 years period, 1986 – 2016, larger amount of change has been occurred. For instance, 10.2% (1835.4 ha) of forest land, 24.7% (4427.3 ha) of plantation, 30.6% (5475.9 ha) of grass land, 35.3 of crop land and 4% (714.6 ha) were transformed to built-up area (Fig. 6). The land use transformation from all other land use types to built-up areas over the time intervals 1986 - 2000, 2000 - 2016, and 1986 - 2016 were made known as 9087.3 ha, 12387.6 ha and 18771.3 ha respectively (Figure 2, Figure 3 and Figure 4). The change matrix (Tables 3, 4, and 5) presents all the transformations from one land use/cover to other land use/land cover type.

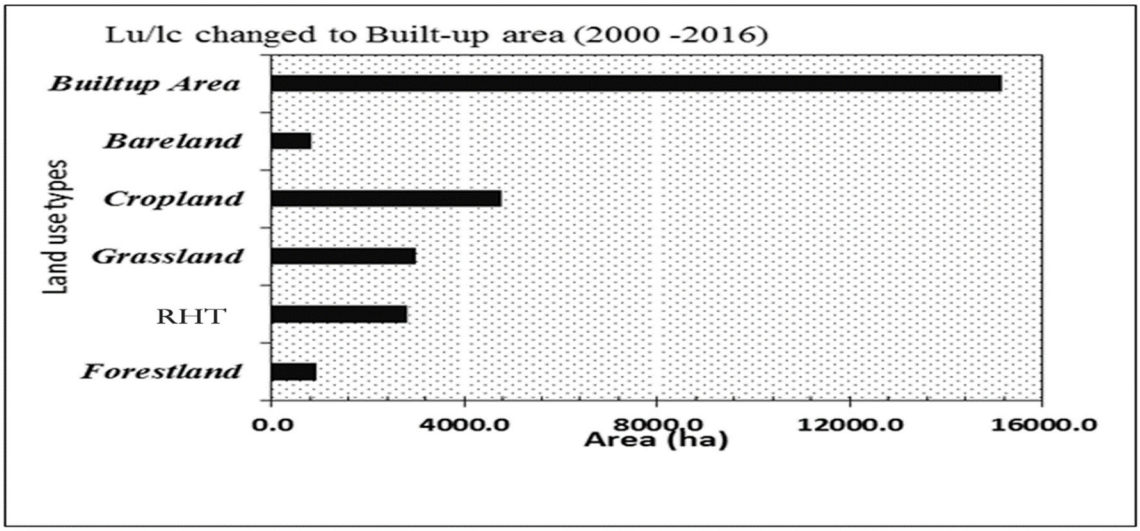

Figure 6. Land use categories changed to built-up area (2000 – 2016)

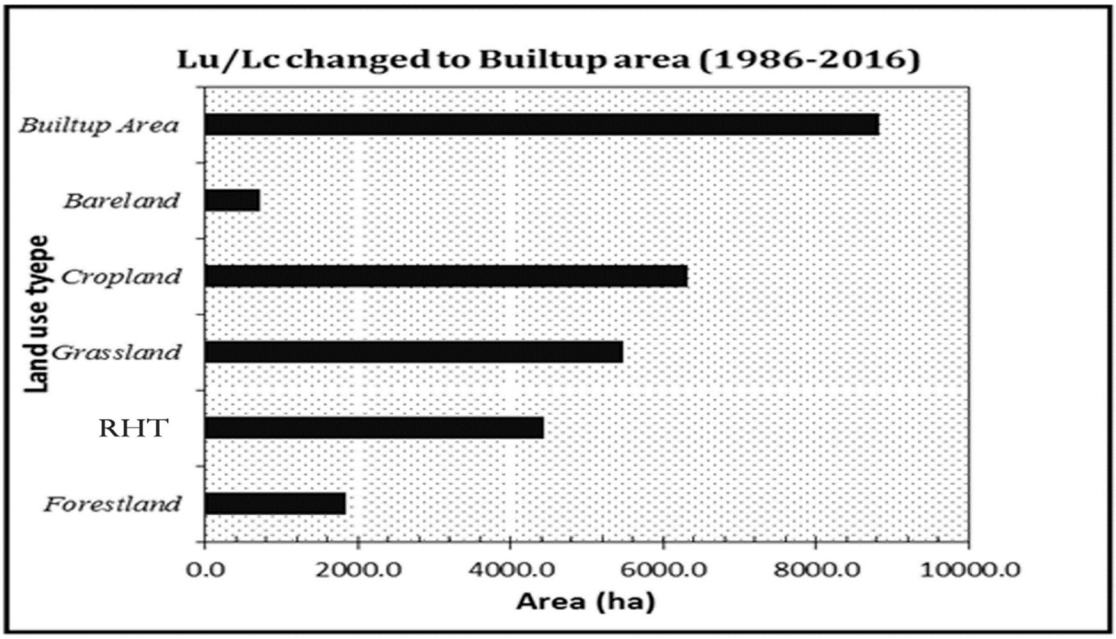

Figure 7. Land use categories changed to built-up area (1986 – 2016)

3.3 Factors for Urban Unsuitable Land Use

In Addis Ababa, urban land use is not sustainable due to several factors. The main factors identified by the household survey are rapid urbanization due to the population growth and inadequate planning and management play stand the most prevailing factors. These factors have led to the overuse of natural resources, environmental degradation and social inequality. The detail of each of this factor is discussed here below:

3.3.1 Urbanization and Population Pressure

In the last couple of decades Ethiopia, particularly the capital city Addis Ababa is under the rapid growth and development (Table 6, and 7). This raid development brings high intensity of urbanization. According to the data from CSA (2013) the rate of urbanization of Addis Ababa is around 8%. The population of the city rapidly increased, from 1980s to 2010s, the need for residential areas for those peoples also increases, which means the infrastructure and investment development grows rapidly with high intensity compared to the late 1980s. As the

city's population is increasing highly, land becomes more extreme to accommodate excessive population. The growth rate of Addis Ababa population will also continue to remain high with annual growth rate of 3.8%

Table 6. Addis Ababa estimated population (1935-2007)

Year	Total population in Addis Ababa	Average annual growth rate
2007	3,384,569	3.8
1994	2,112,737	3.3
1984	1,423,111	3.0
1978	1,167,315	7.6
1967	633,530	7.1
1961	443,728	4.0
1952	327,000	13.4
1935	100,000	2.1

Source: Mahiteme, 2007; CSA, 2013

Obviously, these additional people have created tremendous stress on the urban utility services and other amenities of urban life. This on the other hand resulted adverse effect on the urban environment and valuable green areas and forests has been transformed in to the built-up areas. There it can be said that population pressure is the main constrain in greening process in Addis Ababa. Due to population pressure, the city has been expanded and rapidly covered with built up. With this spatial development of the city, wide roads and other paved areas replaced the unpaved areas, natural depressions, and agricultural land. In many cases, open areas and vegetated areas were filled up for development works not in any planned manner. This leads to green area reduction in alarming rate.

Table 7. Percentage urbanization in Ethiopia, 1984 to 2007

Particulars	1984	1994	2016
Urban population	11.2	13.8	16.2
Share of Addis Ababa	31.9	28.8	22.9
Urban growth rate	---	4.8	3.9
Population growth rate	2.9	2.8	2.6

Source: Edward, Sue (ed.), 2010; Spaliviero & Cheru, 2017

It is illustrated that during the last 30 years green areas has been shrunk and transformed into other types of land use mainly residential and commercial uses. Here when the urbanization rate is high, there are greater conflicts between urban green areas and other land uses for different purposes. One of these land uses which creates conflict with green areas in Addis Ababa is the need for investment and development for business activities. The interview from Ministry of urban development housing and construction also revealed that due to the rapid urbanization of Addis Ababa, urban green areas have been consumed by industrial, commercial, residential and infrastructural developments. The experts underlined that in Addis Ababa, the consequences of rapid urbanization on the development of green areas is alarming.

Most of the urban trees, both exotic and local species that were grown to enhance the greenery of the city and also protect the natural environment have been destroyed or degraded due to rapid population growth of the city. In addition to that most of the open space and green areas changed to commercial and building areas as well as for dumping of wastes and changed to small market places. As it is also seen from the RS and GIS analysis in the last 30 years the green areas are on high diminishing rate and depleted. The study by different researcher such as Shi, (2013) has also found similar findings.

Perception of respondents on the role of population pressure on green area management and development as shown in the table 8, majority of the respondents strongly agree for most of the statements that indicate the role of population pressure on green area development and management. For instance, majority of the respondents (71.7%)

perceived that lack of awareness on communities was making it difficult to develop green areas. Similarly, 81% of the respondents believed increasing population in Addis Ababa had a major role for loss of green areas.

Table 8. Perception of respondents on the role of population pressure on green area development and management

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1. Increasing population in Addis Ababa is the reason for loss of green areas.	48.1	33	4.7	9.4	4.7
2. Temporal and spatial urban expansion and densification has been decreasing the available green areas in the last 30 years.	37.7	32.1	10.4	11.3	8.5
3. Poor urban – rural nexus was resulting in poor planning, development and management of green areas	33	31.1	0	19.8	16

3.3.2 Poor Implementations of Government Policies

Policies refer to rules and regulations formulated for the implementation of the intended objectives. Policies related with the development and management of recreational parks and street trees in the study sub city suffer from implementation problem. In the past, there were no clear planning, policy and strategy in Addis Ababa regarding green area development and management. However, these days there were plans and strategy concerning green areas and greenery in the city. The supreme law, Environmental policy, National Growth and Transformation development strategy, Climate resilient green development initiatives, CRGE (2011), can be mentioned among the policies and legislations that support the regions and municipalities to focus on greener development and management. However, the implementation of these policies and plans to the ground is very poor. The study identified that preparation of policies and plans were not involved major stakeholders including the community being the major factors which hinder the implementation of plan to the ground. The result of the interview with key informants revealed that there is negligence of the authorities for implementation of regulations. Besides, in Addis Ababa, there is a clear working procedure which forces individuals to have open space for green vegetation in individual's compounds during the collection of building license and during construction (Regulation No.17/2004, "The Addis Ababa City Government Building Permit Regulations" (2004). However, this is not fully implemented during construction and the allotted open space often is not developed and even if trees are planted they are not well taken care off.

In addition, the key informant's underlined low priority to green areas by authorities was a key factor for poor implementation of government policies. Green areas were found not to be among the top priorities of the Addis Ababa city authorities. The study found that from the interview of key informants and observation there was limited attention to environmental protection and green areas that sufficient land is not allotted and the allotted ones were utilized for other opposite land uses like construction purpose are among the serious challenges of green areas caused from poor implementation of policies and plans. For instance "Menaleshe Tera" which is found in Adis Ketema sub city was market area in reality, but in the land use plan of Addis identified it as a Park. According to Saporiti, (2006) outcome on developing countries where many public parks were found to only exist on paper but not implemented on the ground.

Table 9 presents perception of respondents the on the poor implementations of government policies related to green area management and development. As shown in the table, majority of the respondents strongly agree/agree for most of the statements that indicate poor implementation of government policy affects the development and management of green areas. For example, majority of the respondents (73.5%) perceived that poor implementation of government policy was making it difficult for Addis Ababa to have well managed green areas. Similarly, 84 % of the respondents believed that low priorities that have been given to green areas affect its development and management.

Table 9. Perception of the respondents on the poor implementations of government policies related to green area management and development

		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1.	Condominium developments have been taking Addis Ababa's green areas	34	26.4	8.5	20.8	10.4
2.	Real-estate developments have been taking part for the reduction of green areas in Addis Ababa.	34.9	35.8	6.6	17.9	4.7
3.	Industry/factory developments have been taking big part for the reduction of green areas in Addis Ababa	42.5	32.1	6.6	14.2	4.7
4.	Poor implementation of government policy was making it difficult for Addis Ababa to have well managed green areas	44.3	29.2	7.5	11.3	7.5
5.	Lack of government policy and legislation was making it difficult for Addis Ababa to have well managed green areas	39.6	23.6	5.7	17	14.2
6.	Low priority have been given to green areas in the city of Addis Ababa	41.5	42.5	0	9.4	6.6
7.	Land policy of urban areas in Addis Ababa was making it difficult for the developments of green areas	29.2	27.4	0	22.6	20.8
8.	Illegal settlement on urban green areas have not been controlled by responsible government body	44.3	38.7	0	10.4	6.6

3.4 Effects of Land Use Pattern

The patterns of land use and cover of Addis Ababa, as we discussed in the preceded topics, has undergone unprecedented land use land cover changes (Table 3, 4, and 5). The conversion of agricultural, woodland, and other grasslands, along with similar areas, mostly into built-up areas, is considered a substantial modification in the usage of urban land. Thus, the change such as deforestation, devoid of the green areas and grass land is the manifestation of the unsustainable land use which in turn have detrimental effects on flooding, urban heat islands, biodiversity loss, adverse economic and social impacts and negative impacts on the Sustainable Development Goals, SDG. The urban residents of Addis Ababa are also aware of the adverse effects of urbanization or urban expansion as revealed by our previous studies (Getachew et al., 2021; Weldeghebrael, 2021). The study by Getachew et al., 2021, stated that the about 57% of the respondents have high level of environmental knowledge.

3.4.1 Flooding

Flooding ***is*** a natural hazard that occurs when water overflows its normal boundaries and inundates land that is normally dry. Urbanization has a great impact on flooding through increased runoff and peak discharge and reduced floodplain storage (Feng et al., 2021). In Addis Ababa, flooding is a serious problem and its recurrence is increasing in recent time (Birhanu et al., 2016; Beshir & Song 2021; Mohamed & Worku, 2021). In the city, areas which were susceptible to 25 mm or more direct runoff in 1984 was 34.5% whereas by 2020 it was increased to 69.8% (Beshir & Song, 2021). The same authors have also shown that the overall highly flooded areas were increased by more than 100% in 2020 as compared to 1984. The effects of the flooding have also been quite severe, as seen by the 647 deaths that occurred in 2000 and the over 200,000 people who lost their homes as a result of the August 2006 severe flooding (Jalayer et al., 2014). The flooding that occurred in September 2017 was also caused five people death, several injuries, and left 230 homeless (Beshir & Song 2021).

Nevertheless, the city's precipitation trend from 1976 to 2015 did not show a statistically significant increase (Beshir & Song, 2021). Among other things, one of the primary causes of floods is the loss of the urban forest's and other vegetation cover, which served to prevent excessive amount of water from surface runoff. According to

DPPC, about 40% of the flooding and landslides is attributed to loss of green spaces in Addis Ababa. Beshir and Song (2021) have also revealed that there is a decrease in infiltration and an increase in surface runoff with the removal of forest. The surface flow with the current poor infrastructure leads to increased flooding hazards. Moreover, flood is exacerbated by the increase of the surface runoff amount due to building that produce large amount of roof water.

This phenomena is also aggravated by the poor design and building of the waterways. The waterway is usually lacks maintenance and it aggravates the flooding during the rainfall season and during the periods of erratic rainfall (Zemecha, 2022). The issue of the recurrence of the severe flood in various Ethiopian cities has also been documented by our joint research at Hawasa city (Zemecha, 2022) and by other cities like Adama (Bulti et al., 2021), Diredawa (Billi et al., 2015).

3.4.2 Urban Heat Island

Research on Addis Ababa's urban heat islands, UHI, conducted by (Moisa & Gemeda, 2022; Worku et al., 2021; Worku, 2021) also revealed an increase in land surface temperature, LST. The findings of Worku's (2021) study showed that, between 1985 and 2015, the land surface temperature rose by 3–8 °C. The primary causes of the increase in UHI over the past few decades have been changes in land use and land cover, specifically a decrease in green space and an increase in built-up regions (Moisa, & Gemeda 2022; Worku et al., 2021). This is also supported by a number of studies, which show that the decrease in vegetation cover and the increase in built-up areas, lead to the impervious surface areas which become the primary cause of the rise in LST in Jima, Ethiopia (Moisa et al., 2022), Benin City (Ayanlade & Howard, 2019), Calgary and Edmonton cities (Ejiagha, 2022), and Abuja (Isioye et al., 2020)

3.4.3 Biodiversity Loss and Adverse Impacts on Carbon Sequestration

One of the major and most pressing environmental issues of the present tie in Addis Ababa is the decline and loss of biodiversity. The most important tree species that covered Addis Ababa in the past include Juniperus procera, Olea europaea subsp. cuspidate, Hygenia abyssinica, Hypericum revolutum, and H. quartinamum, Podocarpus falcatus, Acacia abyssinica and A. negril, Erica arborea (Technical Report, 2022). However, at the turn of last century nearly most of the trees in and around city, were removed. This is mainly due to the high demands of wood for construction and fuel wood coupling of the increase demand of land for settlements and agricultural expansion (Fetene & Worku, 2013; Woldegerima et al., 2017). This in turn resulted in loss of genetic resources, severe soil erosion, and water table flooding of the city. Soil degradation is severe particularly in mountain areas such as Suluta which also affect the water quality and amount from which major supply of water comes from (Fetene & Worku, 2013; Woldegerima et al., 2017). Due to their provision of clean water, pure air, soil creation, and protection, the loss of biodiverisy has a significant impact on biological raw materials and economic value. Thus, the loss resulted in the reduction in ecosystem services including provision and control (de Bie CAJM, 2000)

Moreover, the removal of tree has also an adverse impacts on the carbon sequestration as forest cover is the important source for carbon sequestering. It has estimated that one ha of dense, medium and open forest types forest cover in Addis Ababa sequester 293tons/ha, 142tons/ha and 132tons/ha respectively (Woldegerima et al., 2015). With the same taken, the loss of the one ha carbon resulting in the release of the 132 to 293 tons of carbon. As this study reported that the for the last three decades about 4467 ha of forest was removed for the purpose of built-up and for other purpose. This implies that 616,044 to1,308,832 amount of the C were not sequestered instead released to the atmosphere. In this regard deforestation is contributing to an addition of carbon to the atmosphere and affecting the clean air.

The study by Makoni (2020) has also depicted that loss of green spaces in Addis Ababa aggravates air pollution, which has increased by 62% between 1974 and 2018. Air quality in Addis Ababa is also affected by widespread use of charcoal and wood for cooking purposes(UN-Habitat, 2017).

3.4.4 Economic and Social Effects of Un-Sustainable Land Use

In the past four decades about the 3106 ha of farm land was converted to the built-up areas in Addis Ababa. This has also led to the displacement of the people mainly from the per-urban areas from the farm land. This farm land was the main source of the livelihood and economic activity for the people in the per-urban areas. This land was also the main source of wood for construction and wood. Hence the change of the farm land was highly affected the benefits they get from the land. There are various studies which demonstrated the adverse impacts of the urban expansion on per-urban areas such as income (Kasa et al., 2011), decline of a decline in crop and livestock production (Erasu & Lika, 2022), and negative effects on the livelihood assets (Tufa & Megento, 2022)

People's mobility, social cohesiveness, settlement patterns, and economic activity were all negatively impacted by the plan to alter the land use of the Addis Ababa Center (Weldeghebrael, 2022; AACA, 2009). Government and foreign offices are located in the city's core, which is also an area of considerable economic value. Its high rate of slum concentration is another characteristic. The goal of the government's plan to renovate and reconstruct the Center is to improve the city's image while also generating economic benefits. As a result, a sizable portion of the slums were destroyed, and the land was used to construct hotels and other massive government projects. The details of the process and mechanism of slums demolishing and their consequences are well illustrated in our previous study (Weldeghebrael, 2021).

The residents of the slum were forced to leave by the redevelopment scheme. The impoverished from the slum districts relocated to the peripheral areas of city, where housing costs are significantly lower than in the city center. Additionally, as a result, there was a drop in population density at the center and an increase in population density in peripheral areas of city (Weldegebriel et al., 2021). Additionally, the peripheral areas lack developed social service systems, which means that residents suffer from inadequate social services or inadequate amenities such as banking, transportation, water, power, and health service), as reported by the study (Weldegebriel et al., 2021).

Thus, we draw the conclusion that the distribution of the population and social services have been significantly impacted by the change in land use. The quality of human life is directly affected by social services including schools, electric cities, health care, and water. When it came to the availability of social services, the Center fared better than the surrounding areas. Additionally, the research has shown that there is an uneven distribution of amenities, which has a negative effect on the SDG. Because of this, there have been unsustainable changes in land use, necessitating a review of national policies and plans in order to achieve the SDG.

3.5 Institutions and Initiatives towards Urban Sustainable Land Use

3.5.1 Plans

Urban land development and expansion determine the trends and patterns of the land cover and land use in urban areas. That is, the process of urbanization and growth led to the numerous ways that the land was used for different purposes. The growth or extension of the urban area or city is also influenced by a number of other variables. The factors that have been determined to be the most significant contributors to the city's growth include, but are not limited to, population growth, politics, GDP, capital flow, informal capital flow, transportation constraints, and the effects of various planning initiatives (UN Habitat, 2017). The sustainability of urban land use is therefore determined by urban development and its subsequent process.

The city of Addis Ababa is hardly an exception, having gone through several urban development and policy planning processes that emanated from several regimes, from the birth 1989 to the present. Over this period of time, a broad range of variety of socio-economic and political growth was demonstrated. The state of planning design, and implementation was one of factors attributed to the current development of the city. About ten master plans have been designed and developed for AA growth and expansion. During this period, four regimes of the country have instated the design and formulation of the plans programs, each with its own philosophy, politics, approaches to development, and aspirations.

The pattern of Addis Ababa's land use and cover has grown as a result of numerous initiatives. The city has released roughly ten master plans since its founding and undergone a century of planning procedures (cf. Table 10) (Tufa, 2008; Alemayehu, 2008; Bonsa, 2012; AAPCO, 2017; Kloosterboer, 2019; Weldegebriel, 2023).

Table 10. Master Plans of Addis Ababa and their features over the historic period of time

Plan and Year	Features
(1896_ 1930)_Taitu Plan • Original settlement Plan • 1910- 1920 plan	• Traditional plan of individual clusters (fragmented urban development) for defensive strategy_ camping sites (“Safar”) • Change from camping sites to towards toward infrastructure-based development (e.g. Addis _Djibouti railway).
Italian occupation (1936-41): • The Sketch of Le Corbusier; Guidi, and C. Valle's Master Plan	• Monumental plan which is typical symbolic expression of colonialism. • Attention given to the existing city Hall and the railway station, Kazanchis, Mercato, and Addis Ketema districts.
Imperial regime: 1941_ 1974 • 1940s to 1950s little attempt • Sir Patrick Abercrombie’s plan • Bolton Hennessy and artners’ plan 1960_ early 1970 and • Plan of Luis De Marien	• Neighborhood Plan. Generally, the urban development guided by existing infrastructure • very significant development on infrastructure, such as. Chruchill avenue
Socialist Regime (1974_ 1990): • integrated regional and urban plans by the Hungarian C.K. Polony	• Not implemented by the lack of fund. In general, this period was considered as very slight or no significant urban development except the Meskel public square development
From 1990s to date • Master plan of 1986; Master plan of 2003;Master plan of 2017 (the 10th plan)	• In the beginning it was the like of the preceded period which was marked by the combination of the planned and unplanned ones. The master plans of 1986 and 2003 are known for their coverage of regional and hinterland studies and inclusion of the socio-economic data integrated with physical plans. The current Structure Plan of Addis Ababa (is the 10th ratified plan of the city covering the period 2017-2027

Source: Tufa, 2008; Alemayehu, 2008; Bonsa, 2012; AAPCO, 2017; Kloosterboer, 2019; Weldegebriel, 2023

The aforementioned has made it abundantly evident that historical circumstances, individual characteristics, and planned actions have all had an impact on the development of the city. Despite formal planning attempts that lasted for a century, Addis Ababa's urban development history—which includes the city's typology, structure, land use, and current land use patterns—has an unplanned informal dimension. The city's development is primarily dependent on spontaneous growth and/or expansion with a variety of attributes. On the other hand, the typo-morphology and development structure of the public services and roads are largely determined by the political characteristics of the era. Nonetheless, the Addis Ababa Master Plan of 2003 has provided fresh impetus for more focused and intensive efforts to preserve and enhance Addis Ababa's natural resources and endowments for the for the benefit of present and future generations.

The Master Plan of the 2003 establishes aggressive policy targets for the green sector: almost 22,000 hectares, or 41% of Addis Ababa's total land area, are set aside for the green frame (Table 11).In the plan about 470 ha of the 22,000 ha (41%) of the city's total area set aside for the green sector are used for park development; the remaining 12,160 ha are used for roadside and median tree plantations, 700 ha for the Botanic Garden, 1,140 ha for river

buffers, 7,170 ha for urban agriculture, and 28 ha for urban agriculture. However, the overall plan was not well carried out.

Table 11. Urban green space, GS, and built-up in the two master plans, 2003 and 2017

Urban GS and the built up areas	2003		2017	
	Area /hr	%	Area	%
Urban forest	12,168	23.4	10,301.5	19.7
River and river buffer	1,144	2.2	4,026.5	7.7
Urban agriculture	7,176	13.8	9961	1.9
Urban parks	468	0.9	938.7	1.8
Total GS	20956	40.3	16262	31.1
Built- up areas	30,044	59.7	36,029.2	68.9
Total Area	52,000	100	52,292	100

Source: AACA, 2015

3.5.2 Institutions

In addition, Ethiopia lacks planning organizations, which exacerbates the problem of unplanned expansion and spontaneous urban periphery development. In comparison to the creation of urban plans, the Institute, which is in charge of training skilled labor and creating urban plans in Ethiopia, was founded relatively. National Urban Planning Institute (NUPI), was established in 1987 which was renamed as Federal Urban Planning Institution 2005 and as Federal Urban Planning coordinating Bureau(FUPCB) in 2008. This institute so far achieved important tasks, to mention few among other, the Institute prepared City-Wide Structural Plan, Local Development Plans, and Basic Plan urban plan. City-wide Structural Plan can be implemented with a preparation of Integrated Urban Infrastructure and Service Plan (UTTMP), Urban Transport and Traffic Management Plan (UTTMP), Local Development Plan (LDP), Local Economic Development Strategy (LEDS) and Social Development Strategy (SDS).

Therefore, national government and local governments have different responsibility in the urban planning process of Ethiopia. The above five structural plan implementing manuals prepared by the federal government and by using those manuals, local governments /city administrations/ prepare their own five years municipal Integrated Development Plan (IDP).

However, as different studies reported that documents that these plans were inadequately achieved (such as UN Habitat). When we questioned the officials about the reasons behind the plans' poor implementation (despite multiple attempts to do so), they disclosed a number of barriers including inadequate facilities, a lack of skilled labor, and understaffing. They also reported experiencing a lack of funding and having poor communication or coordination with other relevant offices that are also accountable for the plans' implementation. Moreover, it was discovered that the different plans continued to ignore land cover in particular and environmental issues in general. Future urban development planning should therefore take these different socio-environmental dynamisms and related urban concerns into consideration.

The city has also established a number of organizations and structures for the purpose of putting the policy, programs, plan, and initiative into action in order to achieve the environmental target. The most significant of these organizations in terms of environmental management is Addis Ababa Beautification, Parking and Cemetery Administration, AABPCADA. This institute is in charge of developing municipal parks and managing green spaces along road strips and pedestrians. To promote more ecologically conscious behavior across the city, AABCADA has developed and put into place a variety of measures. The City’s Environmental Planning Agency, or EPA, on the other hand, is responsibile of managing and developing the green spaces and woodlands along the river bank of the city. t The existence of these institutions makes it easier to carry out plans and policies that support management practices and address or lessen the difficulties associated with managing green spaces. However, it was discovered that there are dynamics between the intuitive framework and the deficiency of trained human force.

3.5.3 Initiatives, Strategy, and Activities

Because sustainability is crucial to establish a balance between immediate gain and long-term resource preservation, Ethiopia has incorporated the Sustainable Development Agenda and Goals into its plan and made numerous efforts to see them through to completion (FDRE, 2010). Ethiopia has been adopted and practicing various initiatives and activities since the Bruthland Commission on the Environment. It is also important to note that Ethiopia has gradually changed its policy response to climate change since the UNFCCC was ratified in 1994. The Ethiopian Program of Adaptation on Climate Change and Nationally Appropriate Mitigation Actions was introduced in 2010, while the country's National Adaptation Plan of Action was introduced in 2007. In order to create a resilient and green economy, Ethiopia also adopted the Climate Resilient Green Economy (CRGE) strategy in 2011. The primary goals of the CRGE, which was introduced in 2011, are to safeguard the nation against the negative consequences of climate change and to develop a green economy (CRGE, 2012).

The CRGE initiative recognized 60 projects in addition to four pillars (power, forestry, and agriculture, as well as transportation and buildings). By 2030, GHG emissions are to be kept at 150 Mt CO2e. Among the pillars, forestry is anticipated to provide 50% of the country's capacity for abatement, and the Ethiopian government completely incorporated REDD+ as a crucial component of the country's CRGE (EPA, 2011). The only pillar that was designed specifically for Urban Mitigation programs was the one pertaining to buildings and transportation. The key aim under transportation was to "improve urban transport in Addis Ababa through urban electric rail, and fast and efficient bus transit." The "buildings pillar" (Green City and Buildings) has three primary projects, the most significant of which are "rapid transition to high efficiency light bulbs for residential, commercial, and institutional buildings," "use of landfill gas management technologies (e.g., flaring) to reduce emissions from solid waste," and "reduction of methane production from liquid waste". As a result, the city of Addis has also paid high or appropriate attention to environmental issues (uses, such as green spaces, buffers, and water bodies), which account for 30.5% of the total areas of the urban development that is intended to be completed by 2027.

Over the years, Ethiopia has been implementing various programs within those policy frameworks (Agribilcha, 2022). One among them, and by far the most consequential, has been the Green Legacy Initiative (GLI). The Green Legacy Initiative was initiated in June of 2019, with the goal of creating an Ethiopia that is both environmentally conscious and adaptable to the effects of climate change. It was planned that a total of 20 billion seedlings should be planted over the course of the five years. By the fourth year, Ethiopia has succeeded in planting 25 billion seedlings by mobilizing more than 20 million citizens throughout the nation. The development of more than 120,000 nurseries throughout the country has enabled the creation of more than 767,000 jobs, mostly for women and youth and played an important role in creating environmental awareness (Agribilcha, 2022) The Green Legacy Initiative is a demonstration of Ethiopia’s long-term commitment to a multifaceted response to the impacts of climate change and environmental degradation that encompasses agroforestry, forest sector development, greening and renewal of urban areas, and integrated water and soil resources management. Furthermore the initiative has also targeted to alleviate the problem of food insecurity by planting (in 2022, it was planted about 500 million seedlings of fruit trees) fruit trees such as avocadoes, mangoes, apples and papayas. This has an immense contribution to Ethiopia’s efforts to meet its international commitments such as the Paris Climate Change Agreement, the 2030 Agenda for Sustainable Development, and Agenda 2063: The Africa We Want (Beyene & Shumetie, 2023; Agribilcha, 2022).

Despite the low and declining provision of green and open space caused by massive urban renewal and urban expansion combined with the absence of measures for the waste disposal facilities from industries and other firms, there are however opportunities for the development of green area. Among a number of other things, the most significant ones would be the development of the riversides and the beautification of the cemetery. In Addis Ababa, there are over 70 cemeteries owned by religious institutions while about over ten cemeteries fall under the jurisdiction of the Addis Ababa City Administration which cover more than 122 hectares (AAUBGDB, 2022; Agribilcha, 2022). On the other hand, virtually all of the areas of the graveyard are not adorned with vegetation, are not prepared with appropriate designs, and are not neat. However, the city's plan for the cemetery called for it to be landscaped with grass, stocked with flowers and trees, kept free of trash, and outfitted with electrical service. In addition, there ought to be seating available for customers, waste receptacles, and access roadways. At the moment, the Administration of Addis Ababa's beautification parking and cemetery have been working in this sector to realize the goals, which can be seen as an excellent opportunity for greenery work in Addis Ababa.

The development of the rivers and riverbanks in Addis Ababa is an opportunity as they have for a significant amount of time became a dumping grounds and sewers for wastes that has been collected from the city. An initiative by Prime Minister Abyie Ahmed to develop the riversides from Entoto (north top of AA) to Akakie (south

end of Addis Ababa), which longs or covers about 61 kilometers long, has been launched as Sheger Project in 2019 (ADBP, 2021). The primary purpose of the initiative is to make Addis Ababa greenery, more environmentally friendly and resistant to the effects of climate change. In doing so, to improve the general well-being of the population and to promote tourisms. The Sheger Park Friendship Square was officially opened to the public on September 2020 as part of this initiative. This park has also served as a witness for the Ethiopian government's dedication to CRGE green growth and is an important component of green legacy. Furthermore, Addis Ababa specifically the Sheger project, has also benefited from the recently established green legacy initiative at the national level. By the year 2020, approximately 6 million seedlings had been planted (AAUBGDB, 2022). The plantation spanned (covered) the entirety of Addis, including each and every one of Addis Ababa's neighborhoods.

4. Conclusion

Urban areas of the developing countries are experiencing a fast growing as well they are highly susceptible spot of environmental change. Urban expansion is highly impacted the land use land cover and which in turn adversely affect the biodiversity, local climate, water availability, socio economic conditions. Understanding of the extent of changes of the urban land use land cover and its consequences play very important roles to explore the opportunities that the urban has for the future sustainable development. However, there are limited studies on sustainable dimensions of urban land use and land over dynamics in Ethiopia.

The objective of the study is to examine the status, trends and patterns of the land use land cover and the impacts of unsustainable use on environment, economic and social conditions of the people in Addis Ababa, Ethiopia. Moreover it assesses the initiation and strategies to avert the unsustainable land use and opportunities. This study collects and analyzes data using a variety of methodologies. It mapped and examined the land uses land cover dynamics using satellite imagery and GIS analysis. Moreover, the drivers of land use and land cover change collected using social survey which include –household survey. Secondary data was also collected by reviewing published and unpublished documents and augmented the study.

The results revealed that Addis Ababa has gone through unprecedented land use land cover change over the last thirty year from 1986 to 2017, as the built up areas increased by 9876 ha while the forest, cultivated land, and grass land lost 4467ha, 3106 ha, and 6314 ha respectively. The transfer of green space to built-up regions during the past three decades is evidence that the patterns and land use changes have become unsustainable. The city's inefficient policies and plans, along with the growing population, are the primary causes of the unsustainable land use pattern. The city has experienced negative effects from unsustainable land use over the past thirty years. These include recurrence flooding, the rise of urban heat islands, biodiversity deterioration, carbon sequestration decline, and adverse impacts on socioeconomic effects. However, a number of programs, initiatives, and activities have been implemented, albeit sporadically, to improve sustainable land use.

This study suggests that urban land use planning and policy makers should be based on empirical knowledge. Sustainability issues such as the challenges and opportunities should be integrated in land use planning and adaptation policies and plans, and sustainability dimension adjustment in human systems should be encouraged in response to existing or anticipated unsustainable land use change impacts. Despite the numerous initiatives and programs of the federal and regional governments, it is crucial to focus on the creation of the institutions necessary for the successful implementation of the master plans. In the future, an empirical investigation should be undertaken on the impacts of the recent initiatives of the green legacy in Ethiopia, which has been undertaken since the last five years, and the subsequent land use patterns on the carbon sequestration.

References

Addis Ababa City Administration, AACA. (2015). Climate Resilient Green Growth Strategy and Integrated Climate Change Response Investment Plan Development for Addis Ababa (unpublished technical report).

Addis Ababa City Planning Project Office (AACPPO). (2017). Addis Ababa City Structural Plan, Draft Final Summary Repor (2017-2027), Addis Ababa, Ethiopia.

Addis Ababa Urban Age Task Force. (2022). Green and Blue Infrastructure in Addis Ababa A review of challenges and response strategies. *Technical Report 3.1. Addis Ababa Ethiopia.*

Addis Ababa Urban Beautification and Green Development Bureau (AAUBGDB). (2022). Annual Report.

Admasu, T. G. (2015). Urban land use dynamics, the nexus between land use pattern and its challenges: The case of Hawassa city, Southern Ethiopia. *Land Use Policy*, *45*, 159-175. https://doi.org/10.1016/j.landusepol.2015.01.022

African Development Bank Group, ADPB. (2021). Addis Ababa "Beautifying Sheger" River Development Project Investment Strategy and Infrastructure Plan Investment Strategy and Infrastructure Plan.

Agribilcha, P. L. C. (2022). The Great Green Wall Initiative in Ethiopia-Country Review.

Alemayehu, E. Y. (2008). Revisiting Slums, Revealing Responses: Urban Upgrading in Tenant-Dominated Inner-City Settlements in Addis Ababa, Ethiopia. Oslo: Norwegian University of Science and Technology, Faculty of Architecture and Fine Art, Department of Urban Design and Planning.

Arcanjo, G. W. M., & Monteiro, J. B. (2023). Urban Solid Residues Management: An Analysis from Sobral-CE/Brazil. *Journal of Sustainable Development*, *16*(6), 1-12. https://doi.org/10.5539/jsd.v16n6p12

Ayanlade, A., & Howard, M. T. (2019). Land surface temperature and heat fluxes over three cities in Niger Delta. *Journal of African Earth Sciences*, *151*, 54-66. https://doi.org/10.1016/j.jafrearsci.2018.11.027

Beshir, A. A., & Song, J. (2021). Urbanization and its impact on flood hazard: the case of Addis Ababa, Ethiopia. *Natural Hazards*, *109*(1), 1167-1190. https://doi.org/10.1007/s11069-021-04873-9

Beyene, A. D., & Shumetie, A. (2023). *Green Legacy Initiative for Sustainable Economic Development in Ethiopia*. Ethiopian Economic Association (EEA).

Billi, P., Alemu, Y. T., & Ciampalini, R. (2015). Increased frequency of flash floods in Dire Dawa, Ethiopia: Change in rainfall intensity or human impact? *Natural Hazards*, *76*, 1373-1394. https://doi.org/10.1007/s11069-014-1554-0

Birhanu, D., Kim, H., Jang, C., & Park, S. (2016). Flood risk and vulnerability of Addis Ababa City due to climate change and urbanization. *Procedia Engineering*, *154*, 696-702. https://doi.org/10.1016/j.proeng.2016.07.571

Bonsa, S. (2012). The historiography of Addis abeba: A critique and a discussion of the 'Ethiopian city. *Journal of Ethiopian Studies, 45*, 15–51.

Bulti, D. T., Abebe, B. G., & Biru, Z. (2021). Climate change–induced variations in future extreme precipitation intensity–duration–frequency in flood-prone city of Adama, central Ethiopia. *Environmental Monitoring and Assessment*, *193*, 1-14. https://doi.org/10.1007/s10661-021-09574-1

Conway, D., & Schipper, E. L. F. (2011). Adaptation to climate change in Africa: Challenges and opportunities identified from Ethiopia. *Global Environmental Change, 21*(1), 227–237. https://doi.org/10.1016/j.gloenvcha.2010.07.013

CSA. (2013). The Federal Democratic Republic of Ethiopia Central Statistical Agency Report on Population Projection of Ethiopia; CSA: Addis Ababa, Ethiopia.

de Bie CAJM. (2000). Comparative performance analysis of agro-ecosystems. Doctoral Dissertation, Wageningen University, the Netherlands.

Disaster Preparedness and Prevention Center, DPPC. (2015). Addis Ababa City Risk Profiling Program Report. Disaster Preparedness and Prevention Center.

Edwards, S. (Ed.). (2010). Ethiopian Environment Review No. 1. Forum for Environment, Addis Ababa.

Ejiagha, I. R., Ahmed, M. R., Dewan, A., Gupta, A., Rangelova, E., & Hassan, Q. K. (2022). Urban warming of the two most populated cities in the Canadian Province of Alberta, and its influencing factors. *Sensors*, *22*(8), 2894. https://doi.org/10.3390/s22082894

EMoUDHC. (2015). National Report on Housing and Sustainable Urban Development; Ethiopian Ministry of Urban Development, Housing and Construction: Addis Ababa, Ethiopia.

Erasu Tufa, D., & Lika Megento, T. (2022). Conversion of farmland to non-agricultural land uses in peri-urban areas of Addis Ababa Metropolitan city, Central Ethiopia. *GeoJournal*, 1-15. https://doi.org/10.1007/s10708-021-10553-9

FDRE. (2010). Growth and transformation plan (GTP) 2010/11- 2014/15. Addis Ababa: Ministry of Finance and Economic Development, Addis Ababa: Federal Democratic Republic of Ethiopia.

FDRE. (2015). Federal Government of Ethiopia, Ministry of Urban Development and Construction.Growth and Transformation Plan II, 2015/16 – 2019/20.

Feng, B., Zhang, Y., & Bourke, R. (2021). Urbanization impacts on flood risks based on urban growth data and coupled flood models. *Natural Hazards*, *106*, 613-627. https://doi.org/10.1007/s11069-020-04480-0

Fenta, A. A., Yasuda, H., Haregeweyn, N., Belay, A. S., Hadush, Z., Gebremedhin, M. A., & Mekonnen, G. (2017). The dynamics of urban expansion and land use/land cover changes using remote sensing and spatial metrics: the case of Mekelle City of northern Ethiopia. *International journal of remote sensing*, *38*(14), 4107-4129. https://doi.org/10.1080/01431161.2017.1317936

Fetene, A., & Worku, H. (2013). Planning for the conservation and sustainable use of urban forestry in Addis Ababa, Ethiopia. *Urban Forestry & Urban Greening, 12*(3), 367–379. https://doi.org/10.1016/j.ufug.2013.03.004

Gao, J., & O'Neill, B. C. (2020). Mapping global urban land for the 21st century with data-driven simulations and Shared Socioeconomic Pathways. *Nature communications*, *11*(1), 2302. https://doi.org/10.1038/s41467-020-15788-7

Gashu, K., & Gebre-Egziabher, T. (2018). Spatiotemporal trends of urban land use/land cover and green infrastructure change in two Ethiopian cities: Bahir Dar and Hawassa. *Environmental Systems Research*, *7*(1), 1-15. https://doi.org/10.1186/s40068-018-0111-3

Getachew, D., Assefa, E., & Seyoum, A. (2021). Factors Affecting People's Environmental Awareness in the Urban Areas: A Case of Addis Ababa, Ethiopia. https://doi.org/10.21203/rs.3.rs-861127/v1

Golrokhian, A., Browne, K., Hardin, R., Agrawal, A., Askew, K., Beny, L., ... Morse, B. (2016). A National Adaptation Programme of Action: Ethiopia's responses to climate change. *World Development Perspectives*, *1*, 53-57. https://doi.org/10.1016/j.wdp.2016.05.005

Grimm, N. B. et al. (2008). Global change and the ecology of cities. *Science 319*, 756–760. https://doi.org/10.1126/science.1150195

Habitat, U. N. (2017). *The State of Addis Ababa.* UN Habitat: Nairobi, Kenya.

Habitat, U. N. (2018). Tracking Progress Towards Inclusive, Safe, Resilient and Sustainable Cities and Human Settlements. SDG 11 Synthesis Report-High Level Political Forum 2018.

Haregeweyn, N., Fikadu, G., Tsunekawa, A., Tsubo, M., & Meshesha, D. T. (2012). The dynamics of urban expansion and its impacts on land use/land cover change and small-scale farmers living near the urban fringe: A case study of Bahir Dar, Ethiopia. *Landscape and urban planning*, *106*(2), 149-157. https://doi.org/10.1016/j.landurbplan.2012.02.016

Isioye, O. A., Ikwueze, H. U., & Akomolafe, E. A. (2020). Urban heat island effects and thermal comfort in Abuja Municipal Area Council of Nigeria. *FUTY Journal of the Environment*, *14*(2), 19-34.

Jalayer, F. et al. (2014). *Probabilistic GIS-based method for delineation of urban fooding risk hotspots.* Nat Hazards. https://doi.org/10.1007/s11069-014-1119-2

Jennings, V., Larson, L., & Yun, J. (2016). Advancing sustainability through urban green space: Cultural ecosystem services, equity, and social determinants of health. *International Journal of environmental research and public health*, *13*(2), 196. https://doi.org/10.3390/ijerph13020196

Karadimitriou, N., Cheru, F., Wondimu, A., Yacobi, H., Eyob, A. E., Belay, F., ... Yoseph, S. (2022). The State of Addis Ababa 2021: Towards a Healthier City.

Kasa, L., Zeleke, G., Alemu, D., Hagos, F., & Heinimann, A. (2011). Impact of urbanization of Addis.

Kloosterboer, M. H. (2019). *The 'new'Addis Ababa: shantytown or global city? An assessment of large-scale inner-city renewal, redevelopment and displacement for the construction of a 'new'Addis Ababa* (Doctoral dissertation, University of Glasgow).

Mahiteme, Y. (2007). *Carrying the Burden of Long-Term Ineffective Urban Planning'an Overview of Addis Ababa's Successive Master Plans and Their Implications on the Growth of the City.* NTNU: Trondheim, Norway.

Makoni, M. (2020). Air pollution in Africa. *The Lancet Respiratory Medicine*, *8*(7), e60-e61. https://doi.org/10.1016/S2213-2600(20)30275-7

Maktav, D., & Erbek, F. S. (2005). Analysis of urban growth using multi‐temporal satellite data in Istanbul, Turkey. *International Journal of Remote Sensing*, *26*(4), 797-810. https://doi.org/10.1080/01431160512331316784

Manikandan, S. (2019). Spatial and Temporal Dynamics of Urban Sprawl Using Multi-temporal Images and Relative Shannon Entropy Model in Adama, Ethiopia. *J. Adv. Res. Geo Sci. Remote Sens*, *5*, 48-57. https://doi.org/10.24321/2455.3190.201801

McDonald, R. I., Green, P., Balk, D., Fekete, B. M., Revenga, C., Todd, M., & Montgomery, M. (2011). Urban growth, climate change, and freshwater availability. *Proceedings of the National Academy of Sciences*, *108*(15), 6312-6317. https://doi.org/10.1073/pnas.1011615108

Mohamed, A., & Worku, H. (2021). Urban land cover and morphometric analysis for flash flood vulnerability mapping and riparian landscape conservation in Kebena River watershed, Addis Ababa. *Applied Geomatics*, *13*(1), 15-28. https://doi.org/10.1007/s12518-020-00318-3

Moisa, M. B., & Gemeda, D. O. (2022). Assessment of urban thermal field variance index and thermal comfort level of Addis Ababa metropolitan city, Ethiopia. *Heliyon*, *8*(8), e10185. https://doi.org/10.1016/j.heliyon.2022.e10185

Moisa, M. B., Merga, B. B., & Gemeda, D. O. (2022). Urban heat island dynamics in response to land use land cover change: a case of Jimma city, southwestern Ethiopia. *Theoretical and Applied Climatology*, *149*(1-2), 413-423. https://doi.org/10.1007/s00704-022-04055-y

NAPA. (2008). Ethiopia's National Adaptation Plan of Action. Addis Ababa.

Paul, C. J., & Weinthal, E. (2019). The development of Ethiopia's Climate Resilient Green Economy 2011–2014: implications for rural adaptation. *Climate and Development*, *11*(3), 193-202. https://doi.org/10.1080/17565529.2018.1442802

Pieterse, E., Parnell, S., & Haysom, G. (2015). *Towards an African urban agenda.* Nairobi: UN-Habitat and Economic Commission for Africa, UN-Habitat.

Sarporiti, N. (2006). *Managing public parks: How public-private partnership can aid conservation.* Washington D. C.: The World Bank.

Shi, W. (2013). *Landscape management for urban green space multifunctionality: a comparative study in Sheffield (UK) and Yuci (China)* (Doctoral dissertation, University of Sheffield).

Simwanda, M., Murayama, Y., & Ranagalage, M. (2020). Modeling the drivers of urban land use changes in Lusaka, Zambia using multi-criteria evaluation: An analytic network process approach. *Land Use Policy*, *92*, 104441. https://doi.org/10.1016/j.landusepol.2019.104441

Spaliviero, M., & Cheru, F. (2017). The State of Addis Ababa 2017: The Addis Ababa We Want. The State of Addis Ababa 2017: the Addis Ababa we want.

Terfa, B. K., Chen, N., Liu, D., Zhang, X., & Niyogi, D. (2019). Urban expansion in Ethiopia from 1987 to 2017: Characteristics, spatial patterns, and driving forces. *Sustainability*, *11*(10), 2973. https://doi.org/10.3390/su11102973

Tufa, D. (2008). Historical Development of Addis Ababa: plans and realities. *Journal of Ethiopian Studies*, 27-59.

Tufa, D. E., & Megento, T. L. (2022). The effects of farmland conversion on livelihood assets in peri-urban areas of Addis Ababa Metropolitan city, the case of Akaki Kaliti sub-city, Central Ethiopia. *Land Use Policy*, *119*, 106197. https://doi.org/10.1016/j.landusepol.2022.106197

United Nations. (2018a). The Speed of Urbanisation Around the World, Department of Economic and Social Affairs.

United Nations. (2018b). *The 2018. Revision of World Urbanization Prospects: United Nation Population Division.* Department of Economic and Social Affairs, United Nations: New York, NY, USA.

Wazza, M. (2022). Ten Years Development Plan of Ethiopia (2021-2030): A Critical Review.

Weldegebriel, A. T., Tekalign, M., & Van Rompaey, A. (2023). Socio-spatial analysis of regime shifts in Addis Ababa's urbanisation. *Applied Geography*, *154*, 102918. https://doi.org/10.1016/j.apgeog.2023.102918

Weldegebriel, A., Assefa, E., Janusz, K., Tekalign, M., & Van Rompaey, A. (2021). Spatial Analysis of Intra-Urban Land Use Dynamics in Sub-Saharan Africa: The Case of Addis Ababa (Ethiopia). *Urban Science*, *5*(3), 57. https://doi.org/10.3390/urbansci5030057

Weldeghebrael, E. H. (2022). The framing of inner-city slum redevelopment by an aspiring developmental state: The case of Addis Ababa, Ethiopia. *Cities*, *125*, 102807. https://doi.org/10.1016/j.cities.2020.102807

Woldegerima, T., Yeshitela, K. and Lindley, S. (2017). Ecosystem services assessment of the urban forests of Addis Ababa, Ethiopia. *Urban Ecosystems, 20*(3), 683-699. https://doi.org/10.1007/s11252-016-0624-3

Worku, G., Teferi, E., & Bantider, A. (2021). Assessing the effects of vegetation change on urban land surface temperature using remote sensing data: The case of Addis Ababa city, Ethiopia. *Remote Sensing Applications: Society and Environment*, *22*, 100520. https://doi.org/10.1016/j.rsase.2021.100520

Worku. H. (2015). Climate Resilient Green Growth Strategy and Integrated Climate Change Response Investment Plan Development for Addis Ababa, Addis Ababa City Government (Unpublished Strategy Document).

World Bank. (2015). *Ethiopia Urbanization Review: Urban Institutions for a Middle-Income Ethiopia.* Washington, DC: World Bank.

Zemecha, T. (2022). Urban growth dynamics, planning, and flooding vulnerability and resilience. The case of Hawassa, Ethiopia. Doctoral Dissertation, Civil Service University, Ethiopia

Zhou, J. (2008). Brief Analysis Countryside Urbanization Sustainable Development. *Journal of Sustainable Development*, 99. https://doi.org/10.5539/jsd.v1n2p99

Acknowledgments

Not applicable.

Authors contributions

Not applicable.

Funding

Not applicable.

Competing interests

The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Canadian Center of Science and Education.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.