Fudan Journal of the Humanities and Social Sciences (2024) 17:73–113
https://doi.org/10.1007/s40647-023-00392-y

ORIGINAL PAPER

Public Perception on the Role of Urban Green Infrastructure Development and Land Use Management in Rapidly Urbanized Countries: The Case of Hawassa City, Ethiopia

Mefekir Woldegebriel Tessema[1] · **Birhanu Girma Abebe**[1]

Received: 22 November 2022 / Accepted: 31 August 2023 / Published online: 8 January 2024

Abstract

Urban green areas are essential elements of cities and contribute to the quality of life in numerous ways by maintaining and regulating the environment. However, increased urbanization and development have placed urban green areas under extreme pressure, while unplanned urban growth has resulted in the loss of urban landscape and ecosystem. This study's objective was the public perception on the role of urban green infrastructure and land use management. The 385 sample households were selected by using random sampling method. Descriptive and econometric analyses were used for analyzing both quantitative and qualitative data by using SPSS version 25. Among the major factors influencing the urban green infrastructure by respondents perception were education, income, family size, sex of respondent, marital status, type of employment, ownership of house, participation on public involvement, and frequency of visit to nearer planning which are significant variables in the model. Individuals visited the given green structure at least twice a week, and those not done it were 47.9% and 52.1%. The amount of individuals who visited it twice a week in positive perceivers was 64%, and the amount of those who have not done it was 36%. The Chi-square value of 10.9 was very big and telling us that the frequency of visit was determinant factor of perception. It is vital to keep in mind that while the built-up area and the agricultural areas are rising due to urbanization, the core-ecosystem land is being "eaten" as a result of the past and present land uses inside the administrative limits, as well as the services they provide. In the last 6 years, the rate at which the most precious ecosystems are disappearing has tripled. The population, which reflects the demand for these services and benefits, is still growing, putting more strain on the environment. The recommendations include: Public involvement in urban green space planning and development was determinant and core variable of the study. The government of the town administration should prepare the meeting. The result showed a high correlation between urban green planning and land use changes.

Extended author information available on the last page of the article

Keywords Public perceptions · Land use/land cover changes · Green infrastructure · Recreational areas · Hawassa city

1 Introduction

The world is becoming increasingly urban, and the number of population living in cities is also growing rapidly. United Nations, Department of Economic and Social Affairs forecasted that in 2030 more than 60% of the world's population would be living in cities (UNDESA 2014). Currently, cities occupy only 2.7% of the Earth's surface but are responsible for 75% of total energy consumption and 80% of greenhouse gas emissions and have generally hurt natural resources (Gret-Regamey et al. 2013). To combat this urbanization-imposed challenges, urban green infrastructures are becoming a popular strategy in different parts of the world. Urban green infrastructure is a broad term, defined as the combined structure and connectivity of recreational parks and other types of green spaces that deliver multiple benefits for the urban environment (Jennings et al. 2016; Wolch et al. 2015).

The benefits of urban green infrastructure have been cited in the literature. In general, it has social (Kaczynski and Henderson 2008), economic (Anguluri and Narayanan 2017) ecological (Mohamed and Zhirayr 2013), as well as planning benefits (Attwell 2000; Baycan-Levent et al. 2009). From the social point of view, it improves social cohesion and interaction (Tabassum and Sharmin 2013); provides places for physical activity; contributes to the social well-being and the health of the community. Thus, at present days, urban green infrastructure is embraced by many cities of developed nations to have the aforementioned benefits and create a sustainable urban environment (Foster et al. 2011).

Cities are an important habitat for an array of physical, economic, social, political, and cultural capital (UN-HABITAT 2016). Given this importance, it is significant to think carefully about the nature, operation, and form of cities particularly in respect to the challenging issue of sustainability, and cities; however, today stand in the face of grave danger in the form of uncurbed urbanization and climate change. As a result of this phenomenon, they are facing problems like biodiversity and natural habitat loss, air pollution exceeding safe limits, and urban flooding (UCCRN 2014).

Worldwide mobility restrictions have been implemented to stop the COVID-19 virus from spreading. These limitations presented managers of Urban Green Spaces (UGS) with hitherto unheard-of difficulties, including (1) interpreting confusing, constantly changing national and sub-national rules, (2) creating protocols to control access to UGS, and (3) putting those protocols into practice, disseminating them, and enforcing them. The fact that over 90% of COVID-19 cases occur in urban settings (United Nations 2020) complicates matters further. As a result, demand for access to UGS increased during COVID-19 as people's awareness of the importance of UGS in promoting social cohesion and health increased among residents globally (Sainz-Santamaria and Martinez-Cruz 2022).

Generally, land use/land cover changes (LULCC) and urban green infrastructure serve to beautify the city environment, purify the air, and provide a place for residents to relax and enjoy (Blanco et al. 2009). As (Dahmann et al. 2010) reported LULCC and green infrastructure are diverse, varying in size, vegetation cover, species richness, environmental quality, and proximity to public transport, facilities, and services (Fuller and Gaston 2010). LULCC and green infrastructure, if properly planned, managed, and well connected with its surrounding area, can improve the urban environment by enhancing community development, and social cohesion, and attract tourism investment also increasing the sustainability of urban development (Milton 2002).

LULCC and urban green infrastructures are important to maintaining the existence of habitat, biodiversity, infiltration of water, subsurface and underground water, fresh air, and normal noise (Holm 2000). If the storm water needs to be absorbed by the soil, plants play a crucial role in slowing down the speed of the runoff. So that con-contaminated/toxic surfaces & rainwater can be treated in the soil. This scientific analysis should be indoctrinated in the mind of citizens (UN-HABITAT 2014). Some studies have suggested that from the total urban land areas, 10% of tree cover is necessary to create an ecologically sustainable city (Qureshi et al. 2010).

Responding to these challenges such as unprecedented urban growth lies innovative development of green infrastructure, which not only ensures resilience but also includes environmental and well-being benefits (United Nations 2015). However, it is equally significant to manage the development of green infrastructure to deliver an effective and efficient transition to a sustainable urban form that further enhances urban resilience to multiple social, economic, and environmental stressors (Girma et al. 2019). Findings show that perception is a momentary event in which a person perceives his or her environment, for example, by using the senses such as seeing, hearing, or touching. While another study, by Faehnle et al. (2014), stated that the interpretation process is guided by peoples' deeply held values about what is good and what is not good. Local communities' perceptions can also contribute to building scientific information on LULCC and green infrastructure development and planning. Moreover, perception is considered a learned phenomenon that influences thoughts and actions (Krajterostic et al. 2017).

Local community perception of the use of LULCC and urban green infrastructure is crucial to designing appropriate development and management strategies, especially in poor countries that are highly vulnerable to the impacts of global warming and climate change (Qureshi et al. 2010). When we come to Africa, particularly Ethiopia, the study and development of urban green infrastructure is very limited. As a result, the researcher does not know the existing condition of LULCC and urban green infrastructure, what factors contributed to these gaps, and to what extent people are using the existing LULCC and urban green infrastructure. Many studies have been done earlier regarding the development of urban green space (Bizuayehu Telelew 2018) determinants of green area management under urban landscape in Bahir Dar, (Samson 2010) assessment of urban green infrastructure in Addis Ababa, (Gebeyehu 2014), and assessment of green area development in Addis Ababa, (Gashu and Gebre-Egziabhe 2019) local communities' perceptions and use of urban LULCC and urban green infrastructure in two Ethiopian cities Bahir Dar and Hawassa.

Important data from LULCC research are needed for the planning and management of urban green infrastructure (Yang et al. 2014). According to earlier research (Miller and Hobbs 2002), conventional urban environment investigation was not deemed to be green infrastructure. However, the LULCC and urban green infrastructure give city dwellers a chance to engage with the outdoors both visually and physically. Any metropolitan region with a green infrastructure network is significant because it aims to provide inhabitants with the best possible experience characteristics and mitigate the drawbacks of living in an urban constructed environment (Mansor et al. 2012). Additionally, a more full knowledge of the connections between land use and green infrastructure change necessitates that the underlying mechanisms, patterns, and processes of land conversion as well as the reaction of the urban environment be taken into account throughout official decision-making processes (Zhang et al. 2013).

Urban planners and decision makers may thoroughly assess the effects of various land development scenarios, giving them a scientific foundation on which to base future planning and green infrastructure regulations. In terms of green infrastructure, the spatiotemporal analysis of LULCC can aid in comprehending the dynamics of the changing environment of green infrastructure, serve as the foundation for sustainable development, and offer a key piece of knowledge needed for policy making and planning (Hu et al. 2008; Teferi et al. 2016). This study emphasizes the critical connections between LULCC and urban green infrastructure. According to previous studies (Kambites and Owen 2006; Tzoulas et al. 2007; MoUDH 2015), one form of LULC that is a linked network of multi-functional, predominately unbuilt places that supports ecological and social activities is known as "green infrastructure". The structure and purpose of green infrastructure services change as a result of changes in land use and land cover types (Lei and Zhu 2017).

When the researcher came to Hawassa city, the total planned area of the city was 15,800 hectare from this planned land use and 655.4 hectare was planned for green infrastructure, but currently 52.64 hectare are developed and the rest 602.76 hectare was undeveloped. As already indicated, the view of communities about urban green infrastructure for sustainable development in the city was not well understood. So far, the existing condition of LULCC and urban green infrastructure is not known, and the determinants of community perception have not been researched. That is why the researcher is inspired to conduct the study and the research can be expected to assess the determinants of local community perception, assessing the existing condition of green infrastructure and LULCC in the study area. So, the investigation of this research was focused on these issues. Maintaining a balance among the economic, social, and biological ecosystems is becoming more and more important as LULCC moves towards rapid urbanization (Song et al. 2016). The objective of this study is to examine LULCC and green infrastructure, as well as its planning and development.

2 Materials and Methods

2.1 Study Area Description

Hawassa city rests in the southern region of Addis Ababa, Ethiopia. Geographically, the city stretches 275 km along the Addis Ababa-Moyal international highway, and is embedded between Tikur-wuha River on the Alammura Mountain on the South, Chelelaka-marshy on the East and Lake Hawassa on the West (EDRI 2017). The city of Hawassa has an average elevation of approximately 1690 m above sea level and extends on a partially flat plain in the rift valley (Hawassa City Municipality 2020).

Hawassa city borderland geographical coordinates extend approximately between Latitude: 7° 03′ 43.38″ North and Longitude: 38° 28′ 34.86″ East covering a total area of 15,800 hectare. The borderland contains eight woredas within Oromia National Regional State Shashemene, Arsi Negele, Kofele and Siraro and Southern Nations Nationalities and People's Regional (SNNPR) Hawassa Zuria, Shebedino, Dale, and Boricha (Hawassa city Municipality 2020).

Currently, there are many recreational facilities in the city and its hinterlands. Those available recreational facilities which are found in the city are lodges, an international airport, international stadiums, public libraries, seashore boating, fish markets, etc. Wabeshebele Hotel is also one recreational area found in Wondo-genet woreda. It has many recreational facilities like hot springs and a park. Many people from the study region always come to refresh themselves in this area on weekends. This indicates that there is a strong linkage between the city and its hinterland in terms of recreational facilities.

One of the main attractions for tourists to a city is its urban greenery, cleanliness/sanitation, and accessible public space (comparative advantage). To preserve and further improve the city's culture and reputation for cleanliness and sanitary conditions, the city administration should place a priority on creating and managing new and existing urban greenery as well as public space.

Development and promotion of the hospitality and tourism services sector: Private sector businesses and investors received targeted incentives and concerted efforts to ensure that the city offers high-quality but affordable hospitality services so that it is a pleasant, affordable destination for both domestic leisure travelers and foreign business travelers.

The city's structural design suggests creating a buffer zone on the coasts of Lake Hawassa for environmental protection reasons. The development of recreational, environmentally friendly transportation infrastructure is observed. It is suggested that bike and walking/jogging paths be built along the buffer zone on the city's side of the Lake to enhance the city's tourism attractions and to encourage healthy lifestyles among its citizens. The suggested lanes might extend from the protected park/forest near the city's northern entrance, Tikur-wuha, all the way to the bottom of Tabor Hill. In addition to being able to walk and jog along the shores of the lake, the city's residents, tourists, and visitors could rent bikes along the trek/lane for small fees from, say, a youth cooperative that maintains the trek/lanes or any other entity that would provide such rental services. In addition, it is proposed that an econ-friendly cable car line be built to provide ordinary and leisure transport from the top of Tabor Hill up to the top of Alamura Hill.

Facilitate development and promotion of tourism into Sidama hinterland and culture: In collaboration with pertinent authorities/government offices of the larger Sidama region and other stakeholders, the City Administration shall support and facilitate the development of the tourism potential of Sidama to attract an increasing number of domestic and international tourists to the region who would be almost by default spending part of their visit time in Hawassa city. In addition, the development and management of additional cultural recreational facilities and public spaces within the city itself would also increase the attractiveness of the city for foreign and domestic tourists. These efforts shall include supporting the establishment and development of culturally themed artistic, recreational, and hospitality (e.g., restaurants, lodges) facilities in the city.

Protect and facilitate the development of Burqito hot springs: In addition to protecting developing and properly managing the existing popular tourist attractions such as the lake itself, Tikur-wuha protected forest, Amora-gedel fish market, Grand-gudumale, Alamura, and Tabor hills and King Haile Selassies' seasonal palace at Kuttuwa, the City Administration shall protect and promote the development of the Burqito natural hot springs. These have been traditionally used by the local communities for recreational and their purported medicinal properties. The proposal here is to modernize and protect the area from damage and contamination and modernize it for not only maintaining the traditional use of the hot springs but also as one of the tourist attractions of the city.

What is key from a planning point of view are that different kind of ecosystems (cultivated fields, grasslands, forests) provide ecosystem services of different types and with different extent of effectiveness. Even more practically, it is possible to identify a linkage between land uses and ecosystem services provisioning. Identifying this linkage and being able to assess the ecosystem services provided by specific land uses, can enable planners and decision makers to make land use decisions that can maximize the provision of specific services that are crucial for the city of Hawassa.

2.2 Climate of Hawassa City

The average mean monthly rainfall in Hawassa city is 89.60 mm, whereas the annual mean annual rainfall is 1075 mm. (Maximum mean rainfall occurs in April.) The amount of rainfall decreases from west to east. Based on the rainfall coefficient values, months in the water year are classified as dry months (January, February, November, and December), distinctly rainy months (March and October), and big rainy months (April, May, June, July, August, and September). The area receives an adequate sunshine hour of 100 to 200 h per month from March to October and 200 to 300 h every month in the dry season. The average daily temperature of Hawassa city is 20.3 °C. The maximum daily temperature reaches up to 30.07 °C in March, and the minimum temperature drops to 10.44 °C in November (Hawassa City Municipality 2020).

3 Research Design

An adequate study design is necessary to accomplish the stated research objectives (research questions). This research used a mixed design that incorporates both qualitative and quantitative methodologies because it was challenging to achieve the objectives using a single research strategy. Due to the significance of this research approach for source triangulation and interpretation (to minimize the weaknesses of one method by making up for them with the strengths of another since they are complementary).

The required materials and software packages include: GPS and reconnaissance survey for data collection, QGIS, ARCGIS version 10.3 for image processing and analysis, and SPSS (statistical package for social sciences) and descriptive statistics for the analysis of the driving forces, local community perception toward the change.

3.1 Sampling Techniques

The sampling procedure was a combination of purposeful and random sampling techniques. The first step was a purposeful selection of Kebeles and sub-villages that are located in study areas. The second stage was the simple random sampling of households from the list of villages. To facilitate this final stage, lists of names of households in each selected village were obtained from the Local Kebele Chairpersons or any other key informants such as the field extension officers and technical support organizations operating in the study areas. The names were assigned numbers and using a table of random numbers, a total of households were selected to be interviewed (Table 1).

Amount of accuracy required and characteristics of the target population (Kothari 2004). The total household population, as indicated above, was 16,640; therefore, the sample size of household heads was determined by using the following formula as the number of population was greater than 10,000, thus = $n = z2pq/d2$, where the level of acceptable margin of error was 5%. If the population is $N > 10{,}000$, the sample size was as follows:

$n = z^2pq/d^2 =$,Where $n =$, the desired sample size

$Z =$, confidence level $(95 = 1.96)$

$P =$, estimated characteristics of study population (0.5)

$q = 1 - p = 1 - 0.5 = (0.5)$

$d =$ level of statistical significance which was set margin of error (5%) which taken for this research(0.05)

Therefore, assuming that the size of the targeted population was greater than or equal to 10,000 the sample size of the study was, $n = z^2pq/d^2$ $n = (z = 1.\ 96, p = 0.5, q = 0.5, d = 0.05)$; subsequently, the product was, $(1.96)^2(0.5)(0.5) = 385\ (0.05)^2$.

Since the total population, households of the study were 16,640 which were greater than or equal to 10,000. According to the formula that developed by Kothari

Table 1 Summary of variables

S.N	Variables	Description	Measurement	Variable type	Expected sign
1	AGE	Age of household head	Measured in Years and put in to ranges	Continuous	–
2	SEX	Sex of household head	1 = male, 0 = female	Dummy	–
3	EDUCLEV	Education level of household head	Measured in number and put in to ranges	Continuous	+
4	FAMLY	Family number	Measured in number and put in to ranges	Continuous	–
5	INCOME	Total income of the household head	Measured in number and in to ranges	Continuous	+
6	MARITAL	Marital status of respondents	0 = Married, 1 = Single, 2 = Divorced, 2 = Widowed	Dummy	–
7	EMPELOYE	Type of employment of the respondents	0 = Employed by government, 1 = others	Dummy	+
8	DISTANCE	Distance from the nearest green infrastructure	Measured in km and put in to ranges	Continuous	–
9	AWERNESS	Awareness level of respondent on GI	0 = no awareness on green infrastructure concepts 1 = has	Dummy	+
10	FREQUENT	Frequency of visit to green infrastructure	1 = If the respondent has visited any type of green infrastructure at least once a week. 0 = not	Dummy	+
11	HOUSE	Ownership of house	0 = no own house 1 = Has his own house	Dummy	+
12	TYPE	Type of green infrastructure	1 = If the type of green infrastructure visited by respondent was green parks open spaces plaza and festival site. 0 = not	Dummy	+
13	PARTCEPT	Public participation in GI dev.t and planning	0 = the respondent participated in green infrastructure development and planning 1 = not	Dummy	+

(2004), if the sample size of the population is "greater than 10,000," the desired sample size was the result of the above formula; therefore, the study sample size was 385 people.

3.2 Methods of Data Analysis

Data were collected from both primary and secondary sources, analyzed, summarized, and presented using quantitative and qualitative methods of data analysis because of the objectives of the study and the nature of the data. More specifically, the quantitative data were gathered through closed-ended questions and were analyzed using descriptive statistics (frequency and percentage), standard deviation, and mean to identify the status of household housing, determine respondents' housing problems, and alleviate housing problems. The quality data from different sources were analyzed contextually and gave a factual description of the problem of housing. On the other hand, the qualitative data were collected through Focus Group Discussion (FGD), and key informant interviews were analyzed qualitatively (by narration/discussion). Econometric regression analysis was used to estimate the relationship between the dependent and explanatory variables. Finally, to make the findings easily understandable for the reader tables, figures, charts, photographs, and maps and different pictures were used, with the help of Statistical Package for Social Science (SPSS) version 25 (Fig. 1).

The land use/land cover (LULC) detection was based on quantitative analysis, and the analysis of the driving forces of the change was performed using qualitative analysis. Therefore, to see any changes that take place within these selected periods, the study year is selected due to reasons like; what was the land use/land cover pattern. To accomplish image and data analysis, QGIS version 3.2 and ArcGIS 10.3 were both utilized. With a combination of reference material and personal experience of the study area, the technique relies on maps from various times to identify changes. The Global Positioning System (GPS) for currently operational LULC is included in the reference data.

3.3 The Binary Logit Econometric Model

The binary logit econometric model was used to analyze factors affecting the perception of the local community on the use of green infrastructure. The logit model was used in a binary choice (positive perception versus negative perception) of outcomes. Factors included in the model are exogenous, i.e., currently taken as given by the households. The model provides empirical estimates of how change in these exogenous variables influences the probability of local community perception in urban green infrastructure development (Nkonya et al. 1997). Thus, a logistic function including odds ratios was used to derive coefficients of explanatory variables likely to influence local community perception of the use of urban green infrastructure. For this analysis, the status of perception was the dependent variable and thirteen selected factors were the independent variables.

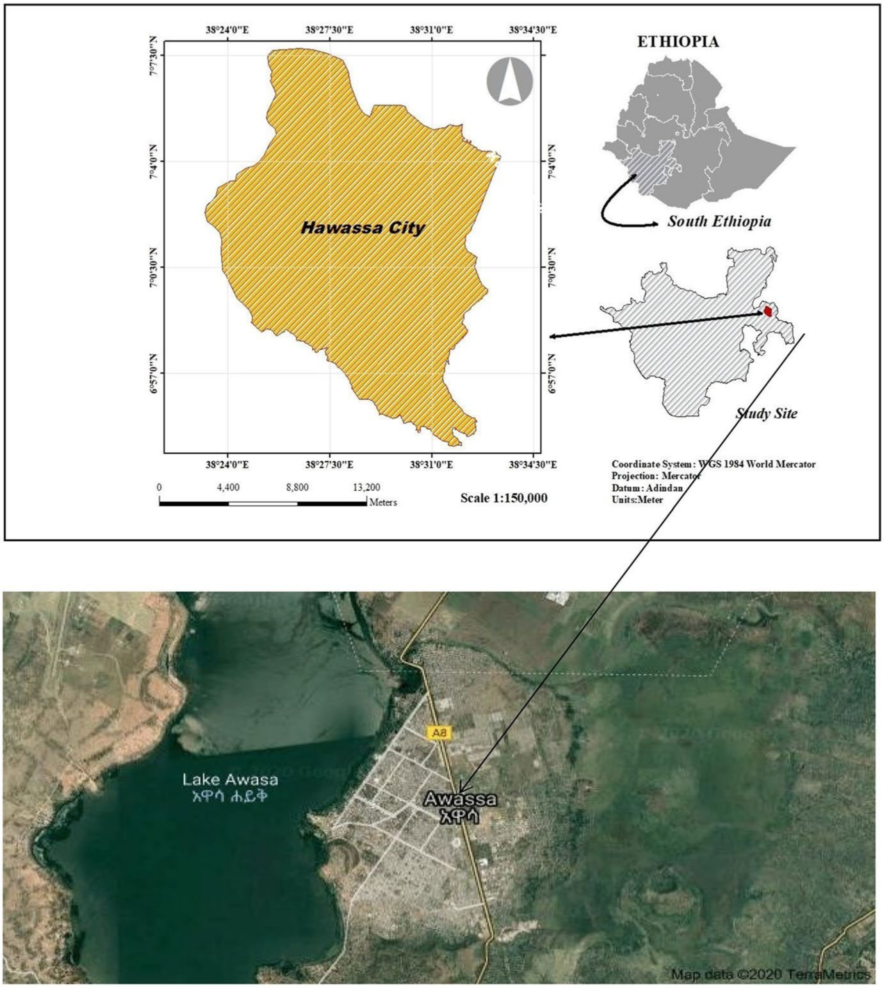

Fig. 1 Location of study area. Source: US Geological Survey (USGS) (http://glovis.usgs.gov)

Since the dependent variable of this study was the assessment of local community perception and use of urban green infrastructure for sustainable development, dichotomous, the value of 1 was assigned to positive perceivers and 0 was assigned to negative perceivers in the econometric model.

Following Gujarati (1995), the functional form of logit model is specified as follows:

$$P_i = E\left(Y = \frac{1}{xi}\right) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x_1)}} \quad (1)$$

For the case of exposition (1)

$$P_i = \frac{1}{1 + e^{-zi}} \tag{2}$$

The probability the given respondent is negative perceiver is expressed as by (2), while the probability of positive perceiver is;

$$1 - P_i = \frac{1}{1 + e^{zi}} \tag{3}$$

Therefore, we can write;

$$\frac{P_i}{1 - P_i} = \frac{1 + e^{zi}}{1 + e^{-zi}} \tag{4}$$

Now ($P_i/1-P_i$) is simply the odds ratio in favor of perception. The ratio of the probability that respondent was perceiver to the probability of that it was negative perceiver. Finally, taking the natural log of Eq. (4) we obtain: -

$$L_i = \ln\left(\frac{P_i}{1 - P_i}\right) = Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n \tag{5}$$

where P_i = is a probability of being positive perceiver they range from 0 to 1.

Z_i = is a function of an explanatory variables (x) which is also expressed as:

$$Z_{\mathrm{i}} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_n X_n \tag{6}$$

$\hat{I}^2_{o}$, is an intercept, and $\hat{I}^2_1$, $\hat{I}^2_2$, $\hat{I}^2_n$ are slopes of the equation in the model.

L_i = is log of the odds ratio, which is not only linear in X_i but also linear in the parameters.

X_i = is vector of relevant respondent characteristics.

If the disturbance term (U_i) is introduced, the logit model becomes

$$\mathrm{Z_i} = \beta_{\mathrm{o}} + \beta_1 \mathrm{X_1} + \beta_2 \mathrm{X_2} + \ldots + \beta_{\mathrm{n}} \mathrm{X_n} + \mathrm{U_i} \tag{7}$$

3.4 Variables and Hypothesis

3.4.1 Dependent Variable

The dependent variable was an assessment of the local community's perception of the use of urban green infrastructure in the study areas. In the dependent variable, community participation is dummy. It measures whether the communities participate (contribute or engage in cash or in-kind) not in sustainable urban green infrastructure activities and takes the value 1 if the members of the community participated in urban green infrastructure activities and 0 if not. The binary logistic regression was used to explore the relationship between the dependent and the independent variables. Binary logistic regression was appropriate for categorical dependent variables and it can help to examine several variables simultaneously. In addition, it is flexible and was widely applied to different variables that had different characteristics (Landau and Everett 2004). The pattern of association between the response and explanatory variables was assessed by perceived correlation, which was also used to evaluate the presence or absence of multi-collinearity among the explanatory variables.

3.4.2 Independent Variables

Independent variables are variables that affect the dependent variable and are not changed by the other variables. But they cause changes in dependent variables. The independent variables for this study were identified based on the review of different literature and carefully identified only those that affect the local community's perception of the use of urban green infrastructure considered by the study.

To reduce bias, considering relevant variables that were included in the binary logit was very vital. However, empirical evidence and different theories were used to identify variables that affect communities' perception of the use of urban green infrastructure considered by the study. Based on this, the variables including household's personal and demographic variables, economic variables, institutional variables, and social variables were identified as independent variables for this study. The following independent variables were explained most probably to influence the local community perception and use of urban green infrastructure in the study area.

3.4.2.1 Definition of Independent Variables and Their Hypothesized Relations with Perception

I. Demographic Variables

1. *Age (AGE)*: It is a continuous variable and measured in number of years. Age of respondents can generate or erode confidence. With age, the age of the respondents influences whether the respondent benefits from the experience of an older person, or has to base its decision on the risk-taking attitude of a younger person. There also may be significant difference in the distribution of household age of the sampled households between positive perceivers and negative perceiver respondents. In other words, as the age of the household increases, the probability of positive perception decreases because, with age,

respondents can become more risk averse and then tend to be reluctant to green infrastructure. Therefore, in this study, it is hypothesized that age of household is more likely to affect local community perception on use of green infrastructure negatively/positively (Hillsdon et al. 2006; Aziz 2012; Zhou and Rana 2012; Molla et al. 2017).

2. *Sex of the household (SEX)*: It is the maleness and femaleness of the household. It is a nominal variable used as a dummy, which takes a value of one if Male, and zero if Female. Gender difference is found to be one of the factors influencing. It was hypothesized that the males have more favorable perceptions of green infrastructure than females (Jim 2013; Molla et al. 2017).
3. *Education level (EDUCLEV)*: It is defined as the number of schooling in years maintained by the respondents. It is a continuous variable. It enables respondents to have access to new information and idea. Based on his study, household head's educational level was thus expected to influence the probability of positive perception on use of urban green infrastructure. Many evidences reveal that those individuals with better educational status are more willing to participate in urban green infrastructure development and use of green infrastructure than less educated (Verlic et al. 2016).

II. Socio Economic Variables

1. *Total annual income* Income was the amount of money that a respondent earns per month using the domestic currency of Ethiopian Birr. It is the total annual income of the respondents. It was hypothesized that the households with higher income have high chance to think and perceive positively toward the green infrastructure.
2. *Marital statuses of respondents* Marital status of respondents was hypothesized to affect the perception of green infrastructure. It has a positive relationship with perception. Likewise, a study conducted in Italy by Sanesi and Chiarello (2006) showed that marital status significantly affects the patterns of green infrastructure use. Similarly, Bedimo-Rung et al. (2005) indicated that the frequency of visits to green infrastructure by married respondents is directly correlated with periodic timing, i.e., the greater the gap between potential leisure opportunities, the higher the observed involvement. The duties that married individuals occasionally accept, however, made this appear logical (Sanesi and Chiarello 2006).
3. *Type of employment the respondent engaged* It was perceived hypothesized to influence the perception level of respondents towards green infrastructure. It refers to the type of employment the respondent was engaged in to earn income for livelihood.

4. *Ownership of house* The chance of individuals becoming the owners of house has the influence on the perception toward the green infrastructure. It measures the house tenure of the respondent (Sikorska et al. 2017).
5. *Family numbers* Family number was hypothesized to influence the perception toward the green infrastructure. It is a continuous variable that is determined by house hold size.

III Institutional Variables

1. *Awareness level of respondent on green Infrastructure* Awareness level of the respondents was hypothesized to affect the perception of individuals toward the green infrastructure. It is the level of awareness of the respondent about green infrastructures. It was coded "1," if a respondent has awareness about green infrastructure concepts and types and "0," if not.
2. *Public participation in green infrastructure development and planning* It refers to participation by the respondent in green infrastructure development and planning in the form of maintenance and protection, financial support, technical support, etc. It was coded "1," if a respondent participated in green infrastructure development and planning and "0," if not studies have shown that participation is concerned with the involvement of users in the maintenance and future planning of green infrastructure (Syme et al. 2001).
3. *Distance from the nearest green infrastructure* It was put forward that people's attitudes towards urban green infrastructure were influenced by the typical distance between their homes and the closest green infrastructure location.

IV Biophysical Variables

1. *Frequency of visit to green infrastructure* Is the number of visits by the respondent to any type of green infrastructure? It was hypothesized to affect the perception of individuals toward the green (Lafortezza et al. 2009).
2. *Type of green infrastructure* It refers to the type of green infrastructures a respondent visited. A value of "1" was given if the type of green infrastructure visited by respondent was public parks, open spaces, sport fields, and a value of "0" was assigned if the type of green infrastructure visited by respondent was other than the ones mentioned in Molla et al. (2017).

4 Results

4.1 Family Number

The family number was hypothesized to influence the perception of the green infrastructure. As shown in Table 2, the total average family number of respondents was 5.2 with a standard deviation of 1.6. The mean and standard deviation for

Table 2 Family number

Family number	Positive perceivers	Negative perceivers	Total
Mean	5	5.74	5.2
Standard deviation	1.32	1.65	1.6
Maximum	8	8	8
Minimum	2	2	2

t-value = 41.2

P = 0.065*

*Significant at less than 10% probability level

Table 3 Summary of the result of dummy explanatory variables

S. N	Dummy variables	x^2 values	*P*-value
1	Sex of respondent	3.35	0.087
2	Marital status of respondent	14.8	0.076
3	Type of employment	3.2	0.014
4	Ownership of house	3.42	0.044
5	Awareness for green infrastructure	1.62	0.191
6	Participation public involvement	12.14	0.000
7	Frequency of visit to green infrastructure	10.9	0.001
8	Type of green infrastructure	0.37	0.84

positive perceived respondents were 5 and 1.32, respectively. Also, for negative receivers, the mean and standard deviation were found to be 5.7 and 1.65, respectively. The *t*-value of 41.2 also shows the relationship between family numbers and the perception of respondents. There was a mean difference between positive and negative perceived which showed the presence of a relationship between the perception of green infrastructure and family number.

4.2 Summary of Descriptive Statistics

The summary of the descriptive analysis part of this study brings the findings from descriptive or quantitative analysis, and the qualitative results analysis (FGD, and personal interviews, and researchers' observation). In the descriptive analysis part, 13 independent variables were hypothesized to affect the dependent variable which means perception and use of green infrastructure.

Tables 3 and 4 represent the summary of the hypothesized continuous and discrete variables included in the model. Out of the total eight dummy variables, five variables were significant. That is, the sex of respondents, marital status, and type of employment, ownership of house, participation, and frequency of visits to green infrastructure were significant at less than 1.5 and 10% probability levels. The rest

Table 4 Summary of the result of continuous explanatory variables

S.N	Continuous variables	Mean	Std	*t*-value	*P*-value
1	Age	41.9	10.9	1.84	0.13
2	Education level	0.6.23	4.4	17.92	0.092
3	Income	6289	2797	29	0.052
4	Distance from nearest green infrastructure	0.45	0.2	1.58	0.1
5	Family size	5.2	1.6	41.2	0.065

of the dummy variables such as awareness about green infrastructure and the type of green infrastructure found near to the respondent are not significant variables.

4.3 Summary of the Descriptive Statistics (Continuous Variables)

From five continuous variables, three of them revealed significant effects on the perception of green infrastructure. That is, all three significant variables (education level, income, and family size) were significant at a 10% level of significance. The rest of the two continuous variables like distance from the nearest green infrastructure and age of respondents were not significant.

4.3.1 Public Participation in Green Infrastructure Development and Planning

Table 5 shows that those who participated in public involvement in planning and development from positive perceivers were 62.9% and those who do not participate were 37.1%. The reverse also was true of negative perceivers. The Chi-square value of 12.14 was a significant number. Therefore, public participation involvement in green infrastructure development and planning has a relationship with perception.

4.3.2 Frequency of Visit to Green Infrastructure

As indicated in Table 6, individuals visited the given green infrastructure at least twice a week and those not done it were 47.9% and 52.1%. The number of individual also who visited it twice a week in positive perceivers was 64%, and that of those who did not do it was 36%. The Chi-square value of 10.9 was very big telling us that.

4.3.3 Type of Green Infrastructure

Out of the total respondents in the study area, about 48.5% and 51.5% responded that there were public parks and the like green infrastructures and other than those green infrastructures, respectively. The Chi-square value of 0.37 was a very small

Table 5 Public participation in green infrastructure development and planning

Participation	Positive perceivers		Negative perceivers		Total	
	No	%	No	%	No	%
Not participated	76	37.1	115	64.1	83	49.7
Participated	129	62.9	65	35.9	84	50.3
Total	205	100.0	180	100.0	167	100.0

$x^2 = 12.14$ P-value = 0.000***

***Significant at less than 1% probability level

Table 6 Frequency of visit to green infrastructure

Frequency of visit	Positive perceivers		Negative perceivers		Total	
	No	%	No	%	No	%
Not visited	73	36.0	70	38.5	87	52.1
Visited	131	64.0	11	61.5	80	47.9
Total	205	100	180	100	167	100

$x^2 = 10.9$ P-value = 0.001***

***Significant at less than 1% probability level

Table 7 Type of green infrastructure

	Positive perceivers		Negative perceivers		Total	
Type of green infrastructure	No	%	No	%	No	%
Other than green infrastructure	106	51.7	87	48.7	81	48.5
Public park	99	48.3	92	51.3	86	51.5
Total	205	100.0	180	100.0	167	100.0

$x^2 = 0.37$ P-value = 0.84

Not significant

and nonsignificant number. Therefore, the type of green infrastructure that an individual visited has no relationship with perception (see Table 7).

A city's competitiveness grows if it is livable, clean, suitable, and attractive to residents, visitors, and tourists. The qualified, devoted, and professional officials who work day and night to achieve the goals of making the city more competitive and attractive are responsible for this attractiveness and competitiveness. Because of their multifaceted nature and need for diverse personnel for their development and administration, green spaces. Without competent and dedicated personnel, greater awareness, adequate funding, or a current strategy, nothing worthwhile can be accomplished.

Table 8 Family number

Family number	Positive perceivers	Negative perceivers	Total
Mean	5	5.74	5.2
Standard deviation	1.32	1.65	1.6
Maximum	8	8	8
Minimum	2	2	2

t-value = 41.2 P = 0.065*

*Significant at less than 10% probability level

The majority of the land within Hawassa city's administrative limit remains undeveloped. The entirety of the undeveloped land is made up of a variety of ecosystems (or biological units) that offer a wide range of services and advantages, including flood mitigation, air purification, CO2 storage, food production, and wood providing. Ecosystem services refer to the services that ecosystems offer. The fact that diverse types of ecosystems (cultivated fields, grasslands, woods, etc.) deliver ecosystem services of various types and to varying degrees of effectiveness is important from a planning perspective. Even more accurately, a connection between land uses and the provision of ecosystem services can be found. Planners and decision makers can maximize the provision of certain services that are essential for the city of Hawassa by identifying this linkage and being able to evaluate the ecosystem services given by different land uses.

Monitoring and evaluation of development projects have positive results on the projects being implemented by somebody/organization/government. Once an activity is implemented, it needs immediate follow-up for sustainability and being alive. Ignoring the development activities after implementation opens the door for the damaging of the activities rather than continuing. This indicates that there was not enough follow-up by the sector which may make the development of urban green infrastructure less rapidly in an area. This may cause damage to the plants being planted in the previous time, making void an area and needing replanting of seedlings at the original/previous/ land rather than planting in the new land for widening/ diversifying/ the area coverage of green infrastructure in the area.

4.4 Family Number

The family number was hypothesized to influence the perception of green infrastructure. As shown in Table 8, the total average family number of respondents was 5.2 with a standard deviation of 1.6. The mean and standard deviation for positively perceived respondents were 5 and 1.32, respectively. Also, for negative perceptions, the mean and standard deviation were found to be 5.7 and 1.65, respectively. The t-value of 41.2 also shows the relationship between family numbers and the perception of respondents. There was a mean difference between positive

Table 9 Summary of the result of dummy explanatory variables

S.no	Dummy variables	x^2 values	*P*-value
1	Sex of respondent	3.35	0.087
2	Marital status of respondent	14.8	0.076
3	Type of employment	3.2	0.014
4	Ownership of house	3.42	0.044
5	Awareness for green infrastructure	1.62	0.191
6	Participation public involvement	12.14	0.000
7	Frequency of visit to green infrastructure	10.9	0.001
8	Type of green infrastructure	0.37	0.84

Table 10 Contingency coefficient for the dummy variables of binary logit regression

Dummy variables	SEX	MRT	EMPLO	HOUS	AWER	PTCP	FRQV	INFRA
SEX	1	0.32	0.13	−0.062	−0.033	−0.036	−0.107	−0.119
MRT		1	−0.164	−0.339	0.127	0.193	0.177	−0.164
EMPLO			1	0.130	−0.206	−0.177	0.033	0.130
HOUS				1	−0.413	−0.078	−0.021	−0.413
AWER					1	0.263	0.224	0.263
PTCP						1	0.21	0.43
FRQV							1	0.16
INFRA								1

and negative perceptions which showed the presence of a relationship between the perception of green infrastructure and family number.

Tables 9 and 10 represent the summary of the hypothesized continuous and discrete variables included in the model. Out of the total eight dummy variables, six variables were significant. That is, the sex of respondents, marital status, and type of employment, ownership of house, participation, and frequency of visits to green infrastructure were significant at less than 1.5 and 10% probability levels. The rest of the dummy variables such as awareness about LULCC and green infrastructure and the type of green infrastructure that was found near to the respondent are not significant variables.

4.5 Summary of Descriptive Statistics

The summary of the descriptive analysis part of this study brings the findings from descriptive or quantitative analysis, and the qualitative results analysis (FGD, personal interviews, and researcher's observation). In the descriptive analysis part, 13 independent variables were hypothesized to affect the dependent variable which means perception and use of green infrastructure.

4.5.1 Determinants of the Perception and Use of Green Infrastructure

The dependent variable was the dichotomous choice variable with two categories (0 for negative perceptions of green infrastructure and 1 for positive perceptions of green infrastructure). With the application of the binary logistics regression (BLR) model, the explanatory variables that were hypothesized as influencing the status of perception of respondents were regressed. The analysis was performed by using a statistical software package called "SPSS" version 21.

The contingency coefficient, which measures the association between various dummy variables based on the Chi-square, was computed to check the degree of association among the dummy explanatory variables or the existence of the multi-collinearity

4.5.2 Multi-collinearity Diagnosis

The determinants of the perception and use of green infrastructure by respondents and data collected from selected respondents were subjected to fit into logistic regression analysis. The statistical software used for analyzing the data was SPSS 21 for Windows. Before running the logistic regression model, both the continuous and discrete explanatory variables were checked for the existence of a multi-collinear problem. The problem arises when at least one of the independent variables is a linear combination of the others. The existence of multi-collinearity might cause the estimated regression coefficients to have the wrong signs and smaller *t*-ratios that might lead to wrong conclusions

Two measures are often suggested to test the presence of multi-collinearity. These are variance Inflation Factor (VIF) for association among the continuous explanatory variables and contingency coefficients for dummy variables. The technique of VIF was employed to detect the problem of multi-collinearity among the continuous variables. According to Gujarati (1995), VIF can be defined.

$$\mathrm{VIF}(x) = \frac{1}{1 - R^2}$$

where R^2 is the square of multiple correlation coefficients that results when one explanatory variable (x_i) is regressed against all other explanatory variables. The larger the value of VIF. ($xiR^2{}_i$) the more "troublesome" or collinear the variable x_i is. As a rule of thumb, if the VIF of a variable exceeds 10, there is a multi-collinearity problem. The VIF value displayed in Table 10 has shown that the continuous explanatory variables have no serious multi-collinearity problem.

Table 11 Variance inflation factor (VIF) for the continuous explanatory variables

S.N	Continuous variables	Tolerance	Variance inflation factor (VIF)
1	Age	0.89	1.114
2	Education level	0.935	1.07
3	Income	1	1
4	Distance from nearest green infrastructure	0.93	1.07
5	Family size	1	1

Similarly, contingency coefficients were computed to check the existence of multi-collinearity problem among the discrete explanatory variables.

The contingency coefficient is computed as: $C = \sqrt{\frac{x^2}{n+x^2}}$.

Where C = Coefficient of contingency, x^2 = Chi-square random variable and

N = Total sample size. The decision rule for contingency coefficients is that when its value approaches 1, there is a problem of association between the discrete variables.

Based on Table 10, the dummy variables were co-related. The contingency coefficient, which measures the association between various dummy variables based on Chi-square, was computed to check the degree of association among the dummy explanatory variables or the existence of the multi-collinearity problem. The decision rule for the contingency coefficient states that its value of 0.75 or above indicates a stronger relationship between the explanatory variables.

As shown in Table 11, the values of the VIF for the five continuous variables were found to be small (that means a value less than 10), indicating that the data have no serious problem of multi-collinearity. As a result, all seven continuous variables were retained and encoded into binary logistic regression analysis.

4.6 The Model Output

In the preceding section, variables characterizing the respondents and their differences among the positive and negative perceived groups were identified. However, in the logistic model analysis, we emphasize considering the combined effect of variables between positive and negative perceived respondents in the study area. Therefore, the emphasis was on analyzing the variables together, not one at a time. By considering the variables simultaneously, we can incorporate important information about their relationship.

Thirteen variables were hypothesized to explain the factors affecting the perception of green infrastructure. Out of these, nine of the variables were found to be significant, while the remaining four were nonsignificant in explaining the variations in the dependent variable among sample respondents.

Table 12 Parameters estimation of binary logistic regression on the perception status of households in Hawassa City, 2020

Explanatory variables	B	S.E	Wald	Odds ratio (Exp(B))	Sig
AGE	−.030	.020	2.297	.971	.130
SEX	761	.444	2.933	.467	.087
EDUCLEV	150	.089	2.847	1.162	.092
INCOME	000	.000	3.770	1.000	.052
MARTAL	−2.711	1.526	3.156	.066	.076
EMPLOYE	−1.084	.441	6.046	2.955	.014
HOUSE	916	.455	4.050	.400	.044
AWERNESS	−535	.410	1.707	.585	.191
DISTNCE	1.899	1.155	2.702	6.676	.100
PARTCIPT	2.081	.507	16.840	.125	.000
FREQUENT	1.458	.427	11.644	4.297	.001
TYPE	−.084	.417	.041	.919	.840
FAMLY	250	.136	3.401	.779	.065

***Significant at less than 1% probability level

**Significant at less than 5% probability level

*Significant at less than 10% probability level

Observations: $N=167$

−2Log likelihood 49.74

Model chi-square 151.75

Sensitivity/Correct prediction of positivity 78.7

Specificity/Correct prediction of negativity 79.5

Over all cases correctly predicted 79

The maximum likelihood estimates of the logistic regression model show that the major factors influencing the perception of green infrastructure by respondents were education, income, family size, sex of respondent, marital status, type of employment, ownership of the house, participation in public involvement and frequency of visit to nearer infrastructure. The parameter estimation results presented in Table 12 were discussed in more detail.

For this study, the discussion was focused on the variables, which were significant as given in Table 12. Finding the variables that influence how people in the research area regard green infrastructure is one of the study's specific goals. For the better development of urban green infrastructure, it is important to know if the specific respondent regarded the green infrastructure negatively or positively. The age of respondents, distance, level of awareness, and kind of green infrastructure were less effective in describing how the perception of green infrastructure was determined.

4.7 Land Requirement

Land demand for the planning period, based on the compact medium to high-density planning principle, is about 2000 to 4000 hectare of land. In this regard, the city should prepare and/or provide at least 200 hectare of developed land per year for housing purposes only. Taking demand for housing as a base for calculating demand for other land use types, the city should prepare and/or provide an additional 500 hectare of developed land for these types of land use categories. This accounts for at least one-third of the existing urbanized land of the city. However, the city is not in a position to provide the aforesaid amount of land every year for housing purposes, due to the shortage of land for expansion within its administrative boundary.

The city should fulfill the required land for housing through, inner city redevelopment (200 hectare), expanding to Wondo-tika areas (600 hectare), changing the use of land currently occupied by the agricultural research center for mixed-use residences (122.7 hectare), using the old airstrip for mixed-use housing (17.8 hectare), using areas behind Hawassa industrial park including land sub-divided for re-settlers for mixed-use residence (142 hectare), through land readjustment in the newly included six Local Development Plan areas (600 hectare), infilling Tula town and its surroundings (200 hectare), plot subdivision in the compounds of federal, regional, and zonal government institutions and in private holdings such as Hawassa University, Regional Agriculture Bureau, SOS, and other large compounds of government or private holdings with available underutilized land, etc. (117.5 hectare). This could happen at the time of National Development Plan Preparation, and New Local Development Plan Preparation toward Loge town with the concept of land readjustment (100 hectare).

Land must be prepared and/or made available through a land readjustment process in the regions that are specifically needed for other supporting land use types at the city's periphery. These land use categories include municipal and social land uses, road and transportation infrastructure, and other physical constructions. The following subsections provide the specifics of the land use proposal's many components.

4.8 General Land Use

Currently, 27.61% of the city's land is urbanized in Hawassa. The population and demographic study projected that the city's current population (372,721) will reach 900,710 by 2030. To meet this increasing demand for urbanization, the city should either increase its urbanized land by more than double-fold or should undertake massive redevelopment activities for the next 10 years. The block-based general land use proposal is then categorized into nine major classifications such as housing; commerce and trade; administration; services; manufacturing and storage; recreation and environmental; road and transport; urban agriculture; and special functions. Two types of classifications are made based on the two different boundaries: the planning and administrative boundaries. If the classification is based on the newly delineated planning boundary (of 6528.98 hectare), then housing takes the major share

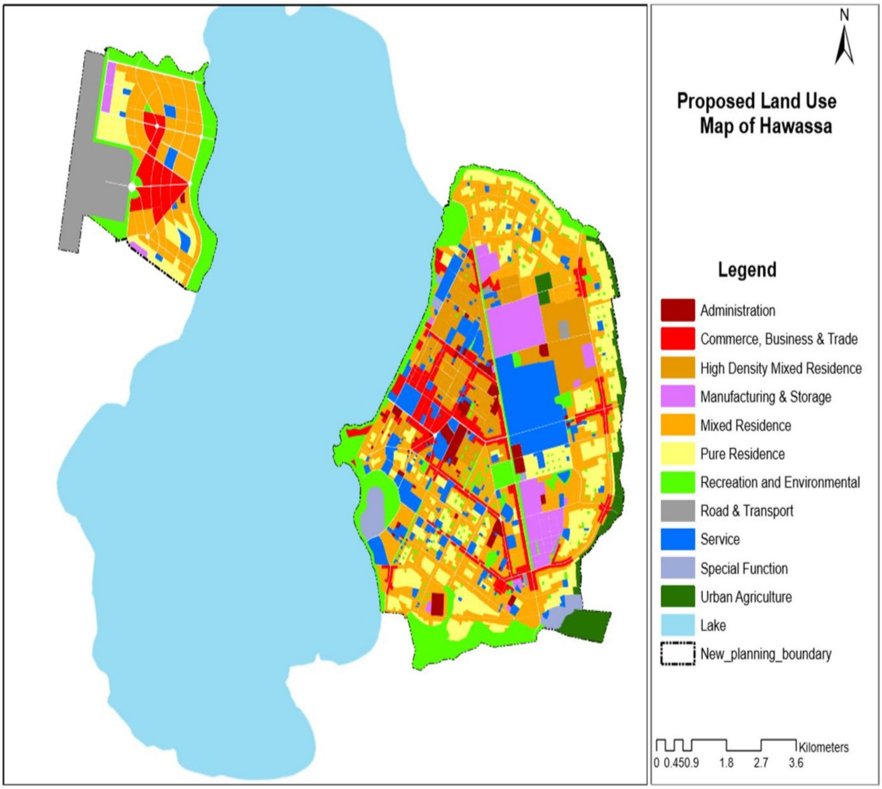

Fig. 2 Land use classification map within the planning boundary. Source: Hawassa city Municipality (2020)

(37.77%) from the proposed land use classification followed by road & transport (23.76%), recreation & environmental (11.67%), service (9.67%), respectively (see Fig. 2).

4.9 Recreation and Environmental Plan

Various recreational land uses (such as open space, formal greens, and sports facilities) and environmental land uses are allotted space under the recreation and environmental land use plan (such as forests, buffer zones, nursery sites, and environmentally fragile areas). The specifics of the two plans are described in the following subsection.

4.9.1 Open Spaces

The open spaces are spaces reserved within the community that serve as meeting or gathering places outside individual plots, accessible by all community members, and have recreational and aesthetic value to the community. The proposal reserves 17.4 hectare of open spaces of which 10.84 hectare is for play lots and 6.56 hectare for playgrounds. The proposal retained the existing play lots and reserved new neighborhood-level plots for play lots and playgrounds specifically in the periphery of the city. Each lot is defined by local roads to avoid encroachment threats from adjacent private holdings. In the old dilapidated settlement areas of the city where redevelopment and land readjustment, play lots and playgrounds were allocated at the time of National Development Plan Preparation.

4.9.2 Formal Green

Recreational elements categorized under formal green include communal green areas, parks, lakes, riverside resort centers, etc. These areas are the areas that contribute to residents' physical and mental aspects, strengthening the community identity, quality of life, and social sustainability. The proposal reserves 157.83 hectare for green areas and 130.85 hectare for parks (Tikur-wuha protected forest/park). Like open spaces, each of the specific land use types is defined by local roads to avoid potential encroachment from adjacent private holdings. In the old and dilapidated settlement areas of the city where redevelopment and land readjustment are taking place, green areas should be allocated at the time of Local Development Plan Preparation (LDPP). Furthermore, the city should rehabilitate the existing and proposed formal green areas and street sides to attract users and to be safe, accessible, and pedestrian friendly.

The recreational green spaces are proposed primarily for access to visual comfort and recreational comfort by taking into consideration the inflow of local and international tourists into the city. The proposal considers the economic benefits of urban green areas such as the creation of job opportunities, providing services to local people and tourists in green areas, employment of people responsible for the maintenance of these areas, etc.

Well-planned green areas and green infrastructures increase the attractiveness of local and international tourists to the city. Urban greenery, cleanliness/sanitation, and accessible public spaces are among the major pulling factors for tourists into the city ("comparative advantage"). Therefore, the City Administration shall prioritize developing and managing existing and new urban greenery and public space; maintaining and further strengthening the culture and brand of cleanliness and sanitation in the city. To realize the strong potential for growth of both local and international tourist inflows, the following recommendations are put forth.

- *Hospitality and tourism services industry development and promotion* Concerted efforts and targeted incentives shall be provided to private sector enterprises and investors to make sure that high-quality but affordable hospitality services are offered in the city to ensure that the city is a pleasant, affordable, and convenient destination for local leisure tourists and international business travelers.

- *Development of recreational, eco-friendly transport infrastructure*
- *The structural plan of the city proposes a buffer zone on the boundary of Lake Hawassa for environmental protection purposes* From the perspective of developing the tourist attraction of the city and promoting healthy lifestyles for the residents of the city, it is proposed that bike and walking/jogging lanes be constructed along the buffer zone on the city's side of the Lake. The proposed lanes could run from the protected forest/park near the northern entrance of the city ("Tikur-wuha") up to the foot of Tabor Hill (Duume Hill). In addition to being able to walk and jog along the shores of the lake, the city's residents, tourists, and visitors could rent bikes along the trek/lane for small fees from, say, a youth cooperative that maintains the trek/lanes or any other entity that would provide such rental services. In addition, it is proposed that an econ-friendly cable car line be built to provide ordinary and leisure transport from the top of Tabor Hill (Duume) up to the top of Alamura Hill (with stops in between as necessary). After technical and economic feasibility considerations, the cable car transportation shall be powered using solar power.
- *Facilitate development and promotion tourism into Sidama hinterland and culture* In collaboration with pertinent authorities/government offices of the larger Sidama region and other stakeholders, the Hawassa city Administration shall support and facilitate the development of the tourism potential of Sidama to attract an increasing number of domestic and international tourists to the region who would almost by default spending part of their visit time in Hawassa. In addition, the development and management of additional cultural recreational facilities and public spaces within the city itself would also increase the attractiveness of the city for foreign and domestic tourists. These efforts shall include supporting the establishment and development of culturally themed artistic, recreational, and hospitality (e.g., restaurants, lodges) facilities in the city.
- *Protect and facilitate development of Burqito hot springs* In protecting, improving, and effectively running the current well-liked tourist attractions (such as the lake itself, Tikur-wuha protected forest, Amora-gedel fish market, Grand-gudumale, Alamura and Tabor hills, and King Haile Selassies' seasonal palace at Kuttuwa), the City Administration shall protect and promote the development of the Burqito natural hot springs. These have been traditionally used by the local communities for recreational and their purported medicinal properties. The proposal here is to modernize and protect the area from damage and contamination and modernize it for not only maintaining the traditional use of the hot springs but also as one of the tourist attractions of the city.

4.10 Functional Green Areas

Functional green areas are areas found in institution grounds, churchyards, and cemeteries. Some of these green spaces could be allocated for recreational purposes; however, their principal purpose is the function they have such as use for education, worship, and cemeteries.

4.10.1 Sport Centers

The sports center's proposal includes a gymnasium, club, circus, ground tennis, and stadium. The space required for the gymnasium, club, and circus is too small to be illustrated in the land use proposal of the structure plan so space for all should be reserved at the time of National Development Preparation (NDP) based on the pre-defined standards of the country. Considering the stadium, the proposal maintains the space allocated for the two stadiums: the old and new stadium. The two stadiums should be surrounded by collector, sub-arterial, or arterial roads. The city should also encourage private sectors to engage in the provision of sports facilities and services.

4.10.2 Linear Green Spaces

Linear green space along the side of major transport routes of the city such as on the right side of the existing main highway (in front of Hawassa University and Hawassa Industrial Park as we run south to north, on the route starting from Shell through Old bus station, St. Gabriel to Piazza, from St. Gabriel to Referral Hospital, from Atote to Wanza, from Wondo junction to Airport, from Tulla to Airport and from Monopol to Tulla) should be provided with linear green spaces planned for recreational and aesthetic purposes. The linear green space covers 146.06 hectare of land.

4.11 Proposed Environmental Plan

The environmental plan consists of forest land, a buffer zone, a nursery site, and environmentally fragile areas such as marshes, lakes, rivers, and ground water potential. The detailed plan of each land use is as follows:

4.11.1 Forest Land

The proposal retained land for forest development on top of Alamura Hill and its surroundings and the southeastern hilly area of the city. It accounts for 304.76 hectare of land. The city should promote the reforestation activity through incentives, to push people from the informal settlements to move their homes and use the land for tree-planting activities only. The city should ensure coordination among the forestry department, Rift-valley River basin office, and NGO's forestry activities, identify priority areas, and start implementing urgently new forestry activities both upstream and downstream.

4.11.2 Buffer Zone

The plan proposed a 50 to 100-m buffer zone along the sides of Lake Hawassa. For practical purposes, a 50-meter buffer is allocated in the already developed section of the lakeside. In this zone, all physical structures should be removed, and the lakeside area should be free and accessible by all residents of the city. For any other future development demand, however, the city should preserve at least a 100-m buffer. In Wondo-tika however, the proposed buffer width extends beyond 100 m. All lakeside buffers of various widths are proposed to have 10-m sidewalks. The buffer has to be considered not only for activities needing a building but also for cattle and urban agriculture. The plan proposes other types of buffer along the sides of the current sanitary fill (20-m width) and proposed sanitary fill (50-m width). In general, the proposed buffer zone covers 151.37 hectare of land.

4.11.3 Nursery Sites

The plan maintained the existing fish nursery site located close to the fish market and allocated 0.263 hectare of land for seedlings along the sides of Tikur-wuha River and Chleleka wetland.

4.11.4 Environmentally Fragile Areas

The plan identified about 20 environmentally fragile areas of 2708.41 hectare within the city's administrative boundary. The plan maintained these areas as protected areas for the sake of preserving the city's biodiversity and ecological value. Lakeside areas of this type are proposed to be possible locations for the creation of artificial wetlands, to limit the pollution of the lake from storm waters, and to limit floods, for the entire proposal of recreation and environmental (Fig. 3).

4.12 Proposed Distribution of Density

The current average density of the city is 12,656 persons per km^2. Its distribution ranges from 1090 persons per km^2 in the predominantly scattered settlement of Tulla subcity, to as high as 31,700 persons per km^2 in the high-density Bahil-adarash subcity of Hawassa. To address this structural difference, an area-specific density distribution is proposed for the next 10 years (Fig. 4).

The average density for Hawassa city for the next 10 years is proposed to be 20,000 persons per km^2. Figure 4 shows five different densities distributed across the city's administrative boundary. As shown in the figure, the major city centers areas such as Piaza, Old market surroundings, Old bus station areas, Shell,

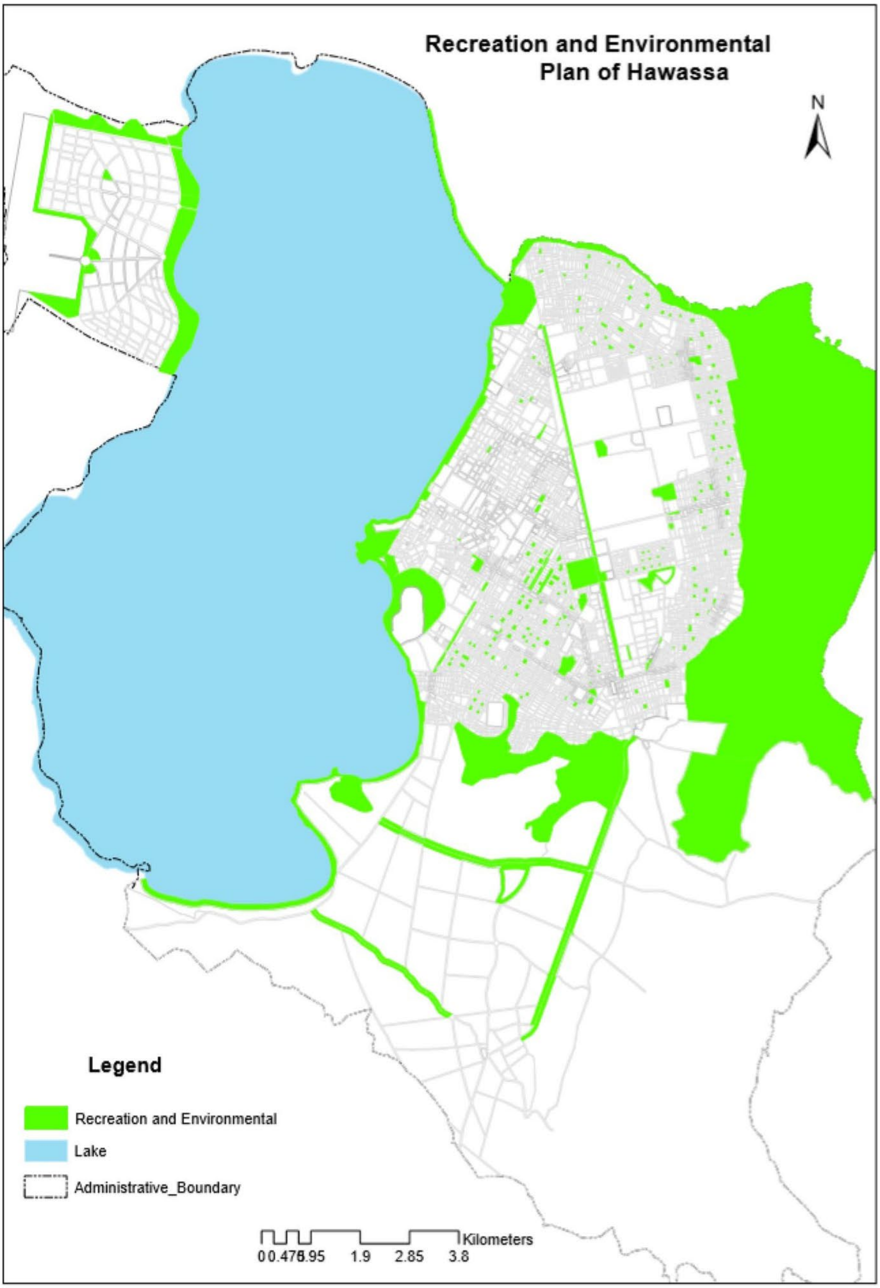

Fig. 3 Recreation and environmental map of Hawassa. Source: Hawassa city Municipality (2020)

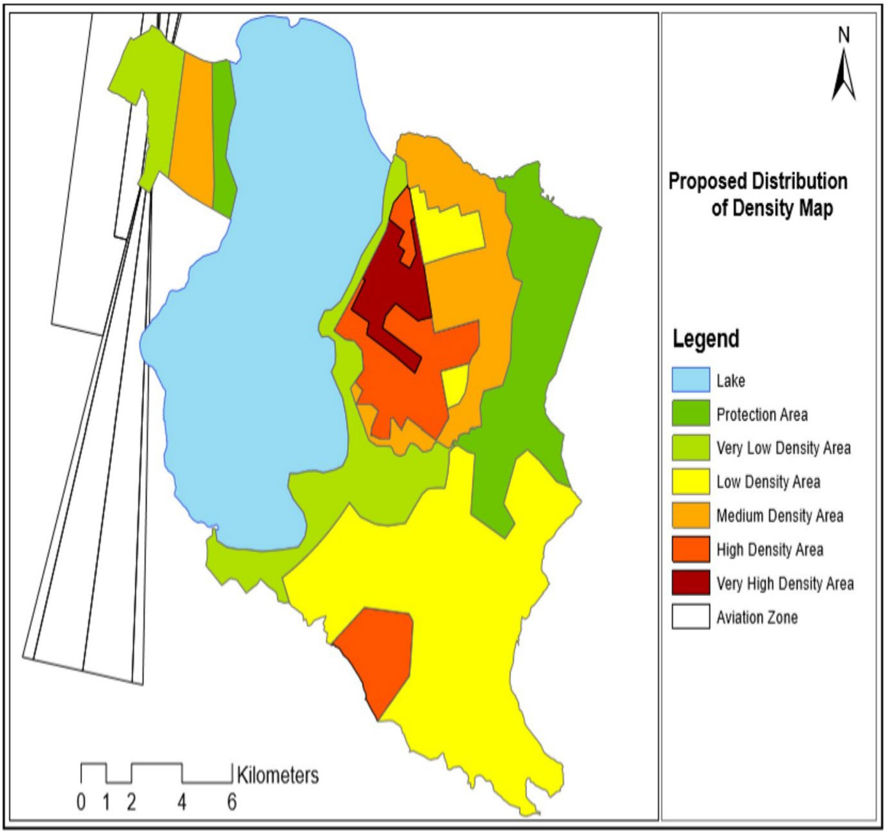

Fig. 4 Proposed distribution of density within the administrative boundary. Source: Hawassa city Municipality (2020)

Turufat, Atote, and areas in front of Hawassa Industrial Park are the most strategic areas that accommodate major commercial activities and employment zones for the residents. It is essential to encourage relatively very high-density residential development in order to provide homes close to these employment zones, and hence, a very high density of at least 30,000 persons per km^2 is proposed for these specific areas. The city will achieve this density through redevelopment that considers the important role of the existing major economic activities of the area, and the higher land value of the surrounding settlements those enable the city to create new commercial and employment hubs for the city.

In the immediate surrounding areas of the major city centers and employment areas, a high residential density of 25,000 persons per km^2 is proposed. In the recent expansion areas of the city such as Dato, Chefe, Monopol, and Wondo-tika, a medium residential density that accommodates 20,000 persons per km^2 is proposed. Most parts of Tula subcity and areas surrounding the lake fall under low and very low-density zones with proposed densities of 15,000 and 10,000 persons per km^2, respectively.

A study by Luck and Wu (2002) recognized that urbanization is one of the most important driving forces behind LULCC in Jinan City (China). According to Kong and Nakagoshi (2006), the policies that have an impact on the growth and control of urban green infrastructure are the driving drivers. However, Byomkesh et al. (2012) noted that among other factors, rapid population growth brought on by rural-to-urban migration, economic development, and a lack of awareness among city managers and residents are the causes of changes in green infrastructure. Improper regulations and rules that fail to protect urban green infrastructure, a lack of financing for their administration and maintenance, and political pressure to stop illegal conversion and leasing of green infrastructure are additional challenges.

5 Discussion

5.1 Green Infrastructures, Natural Services, and Benefits

The majority of the area that is officially part of Hawassa is undeveloped. The entirety of the undeveloped region is made up of several ecosystems (or ecological units) that offer a variety of functions and advantages, including flood mitigation, air purification, carbon dioxide storage, food production, and wood supply. Ecosystem services are the services provided by ecosystems.

Planning must take into account the fact that different types of ecosystems, such as forests, cultivated fields, and grasslands, provide distinct kinds and levels of ecosystem services. Even more plausibly, there is a link between the usage of land and the provision of ecosystem services (ES). By recognizing this connection and having the ability to assess the ecosystem services provided by various land uses, planners and decision makers can maximize the provision of some services that are crucial for the city of Hawassa.

Table 13 Land use and average ES provisioning in Hawassa city, 2005 and 2017

Land use	Average ES prov. For the land use	Area in 2005 (km^2)	Area in 2017 (km^2)	Trend of land use from 2005 to 2017
Built up	0,45	12,2	44,9	↑
Airport	0,06	0,0	4,3	↑
Mineral extraction site	0,25	0,5	0,5	→
Agricultural areas	1,42	89,7	104,4	↑
Pastures/natural lands	1,16	70,8	19,1	↓
Forests/protected	3,22	2,0	2,0	→
Water bodies	2,23	95,1	95,1	→

Source: Hawassa city Municipality (2020)

In addition to the overall decrease of ES, what is relevant to note are shifts in terms of types of ES provided? In this regard, Table 13 shows that, due to land use changes from 2005 to 2017, the most affected category of ES is the regulating ES. This means that the territory is providing less global and local climate regulation, less water flow regulation, less nutrient regulation, and less natural hazard regulation. Because of the increase in agricultural land, many provisioning services increased or kept their values. Recreational services also decreased. This means that, overall, the resilience and the support for human well-being are decreasing and measures should be taken to address these trends.

The lack of proper natural capital to sustain the city not only limits some benefits (recreational areas, nice fish for cooking, valuable landscapes, rich biodiversity) but also implies costs. For example, in recent years, the city of New York, due to the deforestation of hectares of a forest along its rivers, realized that the water of the Hudson became suddenly polluted. The city administration assessed that the construction of a water purification plant to do the same job that the forest cut used to do would have cost five billion dollars. They decided to replant the trees (which implied the costs of the purification plant to obtain the same benefits). In the design of a city and in the decisions taken related to land uses, this should be considered.

Table 13 and Fig. 5 present the result of such computation, where is it possible to see, roughly, that from 2005 to 2017 the built-up and the agricultural land increased, the protected areas (forests) and the lake remained stable, and the natural land (linked to the ES provisioning values for pastures) decreased dramatically. Being forests, the lake, and natural lands the land uses providing the highest amount of ES, the overall ES provisioning decreased from 2005 to 2017 (from 424 to 400 points). In particular, Fig. 5 shows where the highest amount of ES occurs (on a scale from 0 to 5, where to 5 corresponds the land usable to provide the highest amount of ES and 0 is the land use not providing any ES). By mapping the present and past land uses within the administrative boundaries, and by explicating the services they provide, it is important to consider that while the built-up area and the agricultural areas are increasing on urbanization, the core-ecosystem land is being "eaten." The speed at which the most valuable ecosystems are disappearing (together with the services and benefits they provide) tripled in the last 6 years of interval. In the meantime, the population (which represents the demand for such services and benefits) keeps increasing and so does its pressure on the environment.

In addition to the overall decrease of ES, what is relevant to note are shifts in terms of types of ES provided? In this regard, Table 14 shows that, due to land use changes from 2005 to 2017, the most affected category of ES is the regulating ES. This means that the territory is providing less global and local climate regulation, less water flow regulation, less nutrient regulation, and less natural hazard regulation. Because of the increase in agricultural land, many provisioning services increased or kept their values. Recreational services also decreased. This means that overall, the resilience and the support for human well-being are decreasing and measures should be taken to address these trends.

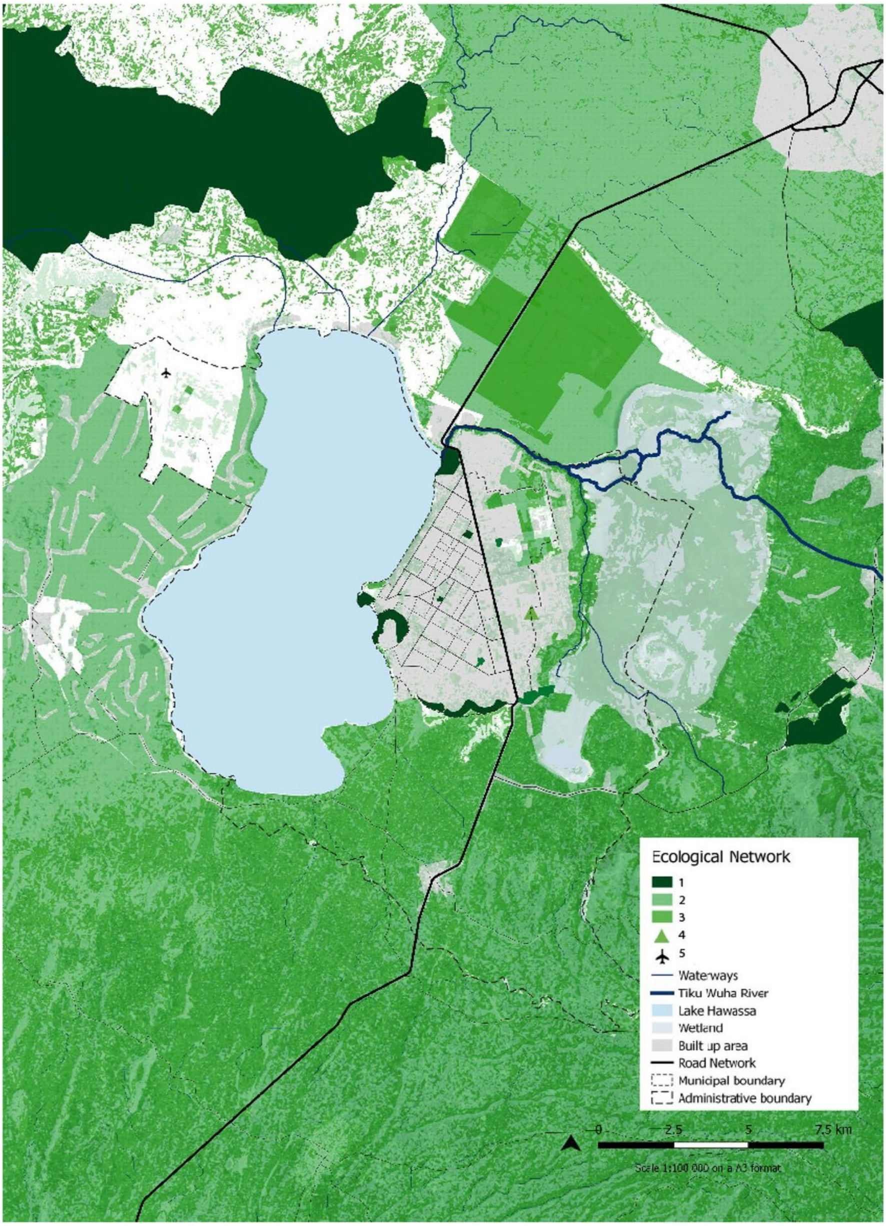

Fig. 5 Ecosystem service map. Source: Hawassa city Municipality (2020)

5.2 Protected Areas, Biodiversity, and Ecological Network

Hawassa city is known within the country for its richness in terms of biodiversity and ecological value. For this reason, and also for the recreational and aesthetic

Table 14 Ecological system (ES) provisioning and trends in Hawassa, 2005 and 2017

(ES)	2005	2017	Trend
Regulating ES			
Global climate regulation	325,5	247,75	↓
Local climate regulation	458,4	428,2	↓
Air quality regulation	99,7	114,4	↑
Water flow regulation	739,75	709,5	↓
Water purification	200,2	200,2	→
Nutrient regulation	463,8	418,8	↓
Erosion regulation	303,4	313,4	↑
Natural hazard regulation	461,8	416,8	↓
Pollination	97,9	112,4	↑
Pest and diseases control	644,6	591,6	↓
Regulation of waste	448,5	522,25	↑
Provisioning ES			
Crops	624,4	638,4	↑
Biomass for energy	844,7	619,7	↓
Fodder	394,2	95,5	↓
Livestock (domestic)	452,5	526,2	↑
Fiber	10	10	→
Timber	10	10	→
Wood fuel	380,4	380,4	→
Fish	475,5	475,5	→
Aquaculture	637,8	533,0	↓
Wild foods and resources	275,1	319,3	↑
Bio-chemicals and medicines	475,5	475,5	→
Freshwater	2,6	2,6	→
Mineral resources	682,5	445,9	↓
Abiotic energy sources	769,5	762,8	↓
Recreational ES			
Recreation and tourism	674,4	667,7	↓
Landscape aesthetics and inspiration	752,9	728,3	↓
Knowledge system	220,6	286,0	↑
Religious and spiritual experience	811,7	709,36	↓
Cultural heritage	374,1	314,4	↓

Source: Hawassa city Municipality (2020)

value of its landscape, within the administrative boundary of Hawassa city, it is possible to identify protected areas.

Figure 6 shows the map of protected areas in Hawassa city. These can be divided into three main groups: protected areas inside the planning boundary that are valued for their aesthetic, recreational, and cultural/religious value; protected areas outside the planning boundary that stand as the foundation of the ecological network and

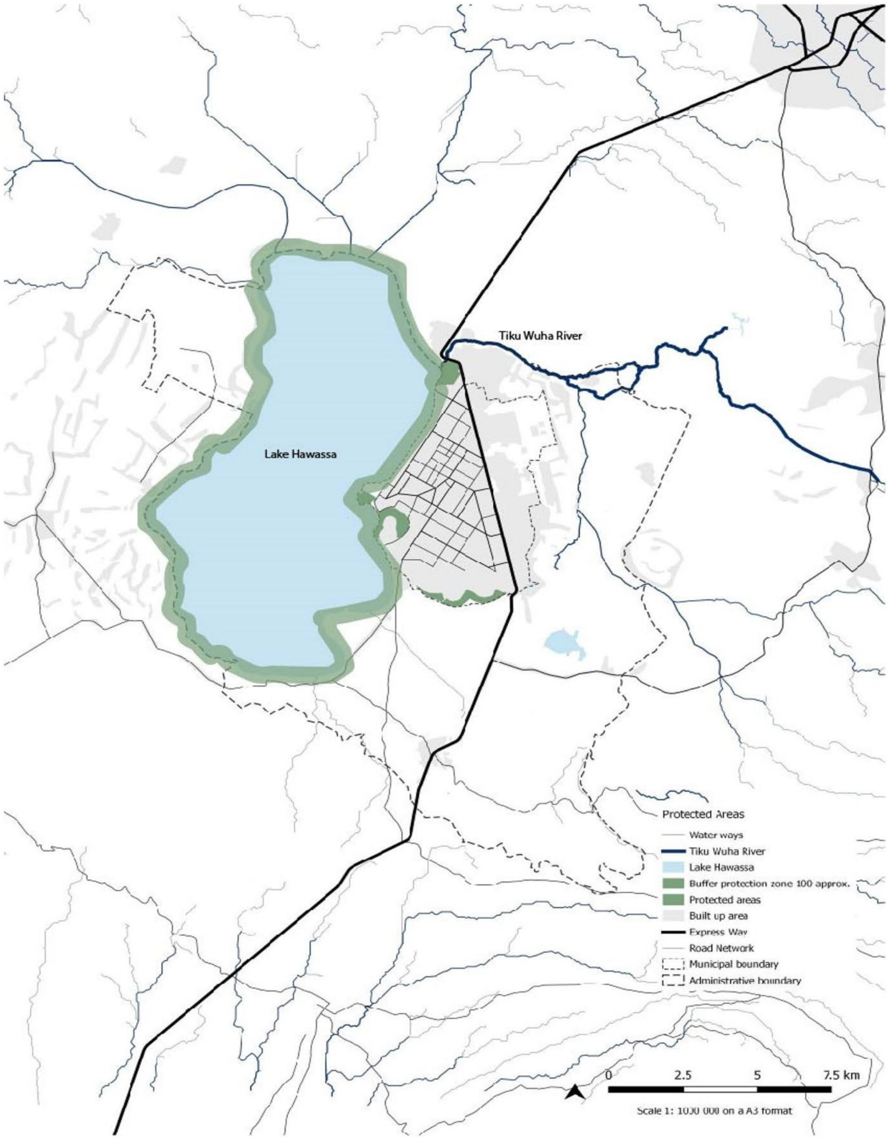

Fig. 6 Protected areas map. Source: Hawassa city Municipality (2020)

the region's natural capital. Unfortunately, even though the buffer is recognized as a protected area by the building code of the city, the policy is not properly implemented. The lack of implementation is due to the fact that the majority of buildings and activities within the buffer were established before the policy neither (which is retroactive) nor due to the informality of the activities that occupied the buffer after the policy was established.

6 Conclusion

The study was conducted in Hawassa city, Southern Ethiopia; the green infrastructure was one of the major targets of the government. The objective of the study was to assess the perception of the use of green infrastructure with the sampled respondents. Green infrastructure in different parts of Hawassa city such as street trees, public parks, and play fields was emerged and was planned for different purposes/ benefits in the community. The major factors affecting the status of people's perception toward those green infrastructures' were not clearly known in the study area. Different sources of related literature were reviewed in order to understand what has been obtained from different related studies. The systematic random sampling method was employed by using probability proportional to size.

Urban open space availability in the city has changed throughout time. There are currently fewer open spaces and green areas in the city with each significant construction. This demonstrates that despite the growing need for recreation in society, the issue of urban green areas has not received more attention in municipal development policies. The urban green zones have been excluded from the structural or development plan that has been put into action. This indicates a significant risk to the growth of urban green spaces in the metropolis.

Descriptive statistics and econometric models were used for analyzing both quantitative and qualitative data by using "SPSS version 21" software. In addition to this, FGD and Key informant interviews were triangulated in order to ensure the validity and reliability of the research. According to the analysis of data, the major factors affecting the status of the local community's perception toward the use of green infrastructure were analyzed by using a binary logit regression model. Raw data were passed through different processes of tests such as *t* test and Chi-square test, and to check for multi-collinearity, VIF (variance inflation factor for continuous variables) and contingency coefficient (for categorical variables) were applied before processing logit model to assess factors affecting local community perception. As the results of descriptive statistics and logit model, it was found that the positive and negative perceptions had a combination of factors personal and demographic, economic institutional and biophysical factors, and other different influencing factors that discourage the positive perception toward the green infrastructure. According to the result of the descriptive statistics, the variables like education level, income, family size, sex, marital status, type of employment, ownership of the house, participation in public meetings, and frequency of were found to be significant determinants of the perception of green infrastructure. The result shows that increasing education level income, family size, sex, ownership of the house, participation in public meetings, and frequency increases the chance of being positively perceived. The chance of being positive perceived decreases with increase in marital status and type of employment. According to the result, the perception status of the town was seen that the majority of the participants were negative perceivers of green infrastructure that needs their thinking change in order to bring the development of green infrastructure. This result was found due to the different variables.

The type of employment an individual engages in determines the perception status. As individual become government employed, the chance to become positive thinker increases. This could be due to mostly the government-employed individuals not freely moving and having no extra income for recreation. Ownership of the house was one of the core variables of the study. As the individual becomes the house owner, the chance to think positively increases. This is due to the fact that homeowners have no burden of freight toward survival and recreating in nearby resources. Participation in public involvement in green infrastructure planning and development was determinant core variable of the study. As an individual participates more and more in public meetings, he/she gets better and additional knowledge of green infrastructure.

Protected areas of Hawassa are known within the country for their richness in terms of biodiversity and ecological value. For this reason, and also for the recreational and aesthetic value of its landscape, within the administrative boundary of Hawassa city it is possible to identify protected areas. Among these, we can distinguish among three main categories: protected areas within the planning boundary that are recognized because of their aesthetics, recreational, and cultural/religious value. A second category is protected areas outside the planning boundary that represent the pillars of the ecological network and natural capital within the region. To conclude, a third type of protected area is represented by the Hawassa Lake and its buffer of 100 m. Unfortunately, even though the buffer is recognized as a protected area by the building code of the city, the policy is not properly implemented. The lack of implementation is due to the fact that the majority of buildings and activities within the buffer were established before the policy (which is not retroactive) and due to the informality of the activities that occupied the buffer after the policy was established.

The amount of urban green infrastructure in the city has been changing over time. Currently, whatever there is a large development, the number of open space and green spaces are decreasing in the city. This shows that the issues of urban green space do not have been given attention in the development of policies of the city, even though society's need for recreation is increasing. This is observed in the structure or development plan of the city as well. Even if most of the proposals in the structural or development plan had been implemented, the urban green space was left out. This shows a serious threat to the future development of urban green areas in the city.

Author contributions Mefekir Woldegebriel and Birhanu Girma contributed to the conceptualization. Mefekir Woldegebriel and Birhanu Girma curated the data. Mefekir Woldegebriel and Birhanu Girma were involved in the formal analysis. Mefekir Woldegebriel and Birhanu Girma assisted in the methodology. Mefekir Woldegebriel and Birhanu Girma contributed to the software. Mefekir Woldegebriel and Birhanu Girma performed the visualization. Mefekir Woldegebriel and Birhanu Girma contributed to writing—original draft.

Funding This research receives no funds.

Data Availability Not applicable.

Code Availability Not applicable.

Declarations

Conflict of interest The authors declare that they have no competing interests regarding this paper.

References

Anguluri, Ramesh, and Priya Narayanan. 2017. Role of green space in urban planning: Outlook towards smart cities. *Urban Forestry and Urban Greening* 25: 58–65. https://doi.org/10.1016/j.ufug.2017.04.007.

Attwell, K. 2000. Urban land resources and urban planning: Case studies from Denmark. *Landscape Urban Plan* 52(2): 145–163. https://doi.org/10.1016/S0169-2046(00)00129-8.

Aziz, N. A. A. 2012. Green Space Use and Management in Malaysia. Frederiksberg: Forest and Landscape, University of Copenhagen (Forest and Landscape Research. https://www.researchgate.net/ publication/267512066

Baycan-Levent, T., R. Vreeker, and P. Nijkamp. 2009. A multi-criteria evaluation of green spaces in European cities. *European Urban and Regional Studies* 16(2): 193–213. https://doi.org/10.1177/0969776408101683.

Bedimo-Rung, A.L., A.J. Mowen, and D.A. Cohen. 2005. The significance of parks to physical activity and public health: A conceptual model. *American Journal of Preventive Medicine* 28(2): 159–168. https://doi.org/10.1016/j.amepre.2004.10.024.

Bizuayehu Telelew. 2018. Determinants of green areas management under urban Landscape Dynamics in Bahir Dar City, Ethiopia. Thesis Submitted to The Center for Environment and Development Presented in Mastersof Arts (Environment and Sustainable Development). Addis Ababa University. http://etd.aau.edu.et/handle/123456789/14944

Blanco, H., M. Alberti, A. Forsyth, K.J. Krizek, D.A. Rodriguez, and E. Talen. 2009. Hot congested, crowded and diverse: Emerging research agendas in planning. *Progress in Planning* 71(4): 153–205. https://doi.org/10.1016/j.progress.2009.03.001.

Byomkesh, T., N. Nakagoshi, and A.M. Dewan. 2012. Urbanization and green space dynamics in Greater Dhaka, Bangladesh. *Landscape Ecological Engineering* 8: 45–58. https://doi.org/10.1007/s11355-010-0147-7.

Dahmann, N., J. Wolch, P. Joassart-Marcelli, K. Reynolds, and M. Jerrett. 2010. The active city. Disparities in provision of urban public recreation resources. *Health and Place* 16(3): 431–445. https://doi.org/10.1016/j.healthplace.2009.11.005.

Ethiopian Development Research Institute (EDRI). 2017. Study on Industrial Park Development: issues, Practices and Lessons for Ethiopia. Research Report 29. Website: http://www.edri.org.et

Faehnle, M., P. BÃ¤cklund, L. TyrvÃ¤inen, J. NiemelÃ¤, and V. Yli-Pelkonen. 2014. How can residents' experiences inform the planning of urban green infrastructure: Case Finland. *Landscape and Urban Planning* 130: 171–183. https://doi.org/10.1080/09640568.2019.1578643.

Foster J, Lowe A, Winkelman S. 2011. The value of green infrastructure for urban climate adaptation the Center for Clean Air Policy. The value-of-green infrastructure for urban climate-Adaptation. Visit www.ccap.org.

Fuller, R.A., and K.J. Gaston. 2010. The scaling of green space coverage in European cities. *Biology Letters* 5(3): 352–355. https://doi.org/10.1098/rsbl.2009.0010.

Gashu, Kassahun, and Tegegne Gebre-Egziabhe. 2019. Spatiotemporal trends of urban land use/land cover and green infrastructure change in two Ethiopian cities: Bahir Dar and Hawassa. *Environmental System Research* 7: 8. https://doi.org/10.1186/s40068-018-0111-3.

Gebeyehu, A. 2014. Assessment of Green area management in Addis Ababa, particular reference Gullele Sub city, MA Thesis, Addis Ababa University. http://etd.aau.edu.et/handle/123456789/5412

Girma, Y., H. Terefe, and S. Pauleit. 2019. Urban green spaces use and management in rapidly urbanizing countries, Ethiopia. *Urban Forestry & Urban Greening* 43: 126357. https://doi.org/10.1016/j.ufug.2019.05.019.

GrÃªt-Regamey, E Celio, T.M. Klein, and U.W. Hayek. 2013. Understanding ecosystem services trade-offs with interactive procedural modeling for sustainable urban planning. *Landscape and Urban Planning* 109(1): 107–116. https://doi.org/10.1016/j.landurbplan.2012.10.011.

Gujarati, D. 1995. *Basic econometric*, 3rd ed. New York: McGraw Hill.

Hawassa City Government. 2020. Hawassa City Government Analysis and Development of Strategic Plan Report (unpublished) the First Five (2016/17–2020/21) and the second Five (2022/23–2026/27) years strategic Plan Hawassa City Planning Project Office.

Hillsdon, M., J. Panter, C. Foster, and A. Jones. 2006. The relationship between access and quality of urban green space with population physical activity. *Public Health* 120(12): 1127–1132. https://doi.org/10.1016/j.puhe.2006.10.007.

Holm, S. 2000. Use and importance of Urban parks. Danish Centre for Forest.

Hu, H., W. Liu, and M. Cao. 2008. Impact of land use and land cover changes on eco system services in Menglun, Xishuangbanna, South west China. *Environmental Monitoring and Assessment* 146: 147–156. https://doi.org/10.1007/s10661-007-0067-7.

Jennings, V., L. Larson, and J. Yun. 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.

Jim, C.Y. 2013. Sustainable urban greening strategies for compact cities in developing and developed economies. *Urban Ecosystems* 16(4): 741–761. https://doi.org/10.1007/s11252-012-0268-x.

Kaczynski, A.T., and K.A. Henderson. 2008. Parks and recreation settings and active living: A review of associations with physical activity function and intensity. *Journal of Physical Activity & Health* 4: 619–632. https://doi.org/10.1123/jpah.5.4.619.

Kambites, C., and S. Owen. 2006. Renewed prospects for green infrastructure planning in the UK. *PlanNing Practice and Research* 21(4): 483–496. https://doi.org/10.1080/02697450601173413.

Kong, F., and N. Nakagoshi. 2006. Spatial-temporal gradient analysis of urban green spaces in Jinan, China. *Landscape Urban Planning* 78: 147–164. https://doi.org/10.1016/j.landurbplan.2005.07.006.

Kothari, C.R. 2004. *Research methodology: Methods and techniques*, 2nd ed. New Delhi: New Age International Publishers.

KrajterOstic, S., C.C. Konijnendijk van den Bosch, D. Vuletic, M. Stevanov, I. Zivojinovic, S. Mutabd zija-Becirovic, and J. Lazarevic. 2017. Citizens' perception of and satisfaction urban forests and green space: Results from selected southeast European cities. *Urban Forestry and Urban Greening* 23: 93–103. https://doi.org/10.1016/j.ufug.2017.02.005.

Lafortezza, R., G. Carrus, G. Sanesi, and C. Davies. 2009. Benefits and well-being perceived by people visiting green spaces in periods of heat stress. *Urban Forestry and Urban Greening* 8: 97–108. https://doi.org/10.1016/j.ufug.2009.02.003.

Landau, S., and B. Everett. 2004. *A handbook of statistical analyses using SPSS*. Boca Raton, FL: Chapman and Hall/CRC Press LLC.

Lei, C., and L. Zhu. 2017. Spatio-temporal variability of land use/land cover change (LULCC) within the Huron river: Effects on stream flows. *Climate Risk Management* 19: 35–47. https://doi.org/10.1016/j.crm.2017.09.002.

Luck, M., and J. Wu. 2002. A gradient analysis of urban landscape pattern: A case study from the Phoenix metropolitan region, Arizona, USA. *Landscape Ecology* 17: 327–339. https://doi.org/10.1023/A:1020512723753.

Mansor, M., I. Said, and I. Mohamad. 2012. Experiential contacts with green infrastructure's diversity and well-being of urban community. *Asian Journal of Environmental Behavioural Studies* 49: 33–48. https://doi.org/10.1016/j.sbspro.2012.07.024.

Miller, J., and R. Hobbs. 2002. Conservation where people live and work. *Conservation Biology* 16: 330–337. https://doi.org/10.1046/j.1523-1739.2002.00420.x.

Milton, K. 2002. *Loving nature: Towards ecology of emotion*. New York: Routledge.

Mohamed, M.S., and V. Zhirayr. 2013. The benefits of urban parks: A review of urban research. *Journal of Novel Applied Science* 2: 231–237. https://doi.org/10.1123/jpah.5.4.619.

Molla, M.B., C.O. Ikporukpo, and C.O. Olatubara. 2017. Utilization patterns of urban green infrastructure in southern Ethiopia. *Journal of Applied Sciences and Environmental Management* 21(7): 1227–1236.

MoUDH (2015) Ethiopia national urban green infrastructure standard, Addis Ababa, Ethiopian.

Nkonya, E., T. Schroeder, and D. Norman. 1997. Factors affecting adoption of improved maize seed and fertiliser in northern Tanzania. *Journal of Agricultural Economics* 48(1–3): 1–312.

Qureshi, S., J.-H. Breuste, and S.J. Lindley. 2010. Green space functionality along an urban gradient in Karachi, Pakistan: A socio-ecological study. *Human Ecology* 38: 283–294. https://doi.org/10.1007/s10745-010-9303-9.

Sainz-Santamaria, J., and Adan L. Martinez-Cruz. 2022. Adaptive governance of urban green spaces across Latin America—Insights amid COVID-19. *Urban Forestry & Urban Greening* 74(2022): 127629. https://doi.org/10.1016/j.ufug.2022.127629.

Samson, D. 2010. Sustainable city fabric for urban slum areas in the case of Bahir Dar, MSC Project Thesis, Addis Ababa University. Study session 5. (2016). Urbanization trends, causes and effects. http://etd.aau.edu.et/handle/123456789/3355

Sanesi, G., and F. Chiarello. 2006. Residents and urban green spaces. The case of Bari. *Urban Forestry and Urban Greening* 4: 125–134. https://doi.org/10.1016/j.ufug.2005.12.001.

Sikorska, D., P. Sikorski, and R.J. Hopkins. 2017. High Biodiversity of green infrastructure does not contribute to recreational ecosystem services. *Sustainability* 9(3): 334. https://doi.org/10.3390/su9030334.

Song, X., K. Chang, L. Yang, and J. Scheffran. 2016. Change in environmental benefits of urban land use and its drivers in Chinese cities, 2000–2010. *International Journal of Environmental Research and Public Health* 13: 535. https://doi.org/10.3390/ijerph13060535.

Syme, G.J., D.M. Fenton, and S. Coakes. 2001. Lot size, garden satisfaction local park and Wetland visitation. *Landscape and Urban Planning* 56: 161–170. https://doi.org/10.1016/S0169-2046(01)00179-7.

Tabassum, S., and F. Sharmin. 2013. Accessibility analysis of parks at urban neighborhood: The case of Dhaka. *Asian Journal of Applied Science and Engineering* 2: 148–160.

Teferi, E., W. Bewket, and S. Belay. 2016. Effect of land use land cover on selected soil quality Indicators in the head water area of the Blue Nile basin of Ethiopian. *Environ Monitoring AssessMent* 188: 1–12. https://doi.org/10.1007/s10661-015-5086-1.

Tzoulas, K., K. Korpela, S. Venn, V. Yli-Pelkonen, A. KÃ¡zmierczak, and J. Niemela. 2007. Promoting ecosystem and human health in urban areas using green infrastructure a literature review. *Landscape and Urban Planning* 81: 167–178. https://doi.org/10.1016/j.landurbplan.2007.02.001.

UCCRN (Urban Climate Change Research Network). 2014. Climate Change and Cities, Center for Climate Systems Research, Earth Institute, Columbia University. http://uccrn.org/files/2015/02/UCCRN-ARC3–2-Midterm-Workshop-Outcome-Report.

UNDESA. 2014. World Urbanization Prospects: 2014 Revision. New York: United Nations Department of Economic and Social Affairs. http://esa.un.org/unpd/wup/FinalReport/WUP2014-Report.pdf.

UN-Habitat. 2014. Urban Patterns for a Green Economy: Working With Nature Hs/047/12e, Isbn (Series): 978-92-1-133398-5, ISBN 978-92-1-132462-4, Nairobi GPO KENYA, www.unhabitat.or

UN-HABITAT. 2016. The world cities report on inequality, climate change, housing and slums, urban governance and legislation, and the urban economy, New York.

United Nations. 2015. Issue brief: Reducing disaster risk in urban settings, ministerial roundtable. World Conference on Disaster Risk Reduction, Sendai, Japan.

United Nations. 2020. The sustainable development goals report 2020 vol. 2030.

Verlic, A., A. Arnberger, A. Japelj, P. Simoncic, and J. Pirnat. 2016. Perceptions of recreational trail impacts on an urban forest walk: A controlled field experiment. *Urban Forestry and Urban Greening* 14(1): 89–98. https://doi.org/10.1016/j.ufug.2014.12.004.

Wolch, J., J. Byrne, and N. Joshua. 2015. Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough. *Landscape and Urban Planning* 125: 234–244. https://doi.org/10.1016/j.landurbplan.2014.01.017.

Yang, J., C. Huang, Z. Zhang, and L. Wang. 2014. The temporal trend of urban green coverage in major Chinese cities between 1990 and 2010. *Urban for Urban Green* 13: 19–27. https://doi.org/10.1016/j.ufug.2013.10.002.

Zhang, H., Z.F. Qi, X.Y. Ye, Y.B. Cai, W.C. Ma, and M.N. Chen. 2013. Analysis of land use/land cover change, population shift, and their effects on spatiotemporal patterns of urban heat islands in metropolitan Shanghai, China. *Applied Geography* 44: 121–133. https://doi.org/10.1016/j.apgeog.2013.07.021.

Zhou, X., and P.M. Rana. 2012. Management of environmental quality. *An International Journal* 23(2): 173–189. https://doi.org/10.1108/14777831211204921rgt.

Mefekir Woldegebriel Tessema is currently studying Ph.D. at Addis Ababa University Department of Urban and Regional Planning, A.AU, Ethiopia. His research interests include Migration/Population studies, Solid waste management, Transport management system, Urban Land use/Land cover change, Urban Expansion/informal settlement/formal settlement.

Birhanu Girma Abebe (Ph.D) is an Associate Professor at Addis Ababa University Department of Urban and Regional Planning, A.AU, Ethiopia. His research interest in urban land use/land cover change Housing, Urban and Mobility Studies, Urban Expansion and Urban land speculation.

Authors and Affiliations

Mefekir Woldegebriel Tessema[1] · Birhanu Girma Abebe[1]

✉ Mefekir Woldegebriel Tessema
wmefekir@gmail.com; Mefekir.woldegebriel@eiabc.edu.et

Birhanu Girma Abebe
mesi.bire@gmail.com

[1] Ethiopian Institute of Architecture, Building Construction and City Development (EiABC), Addis Ababa University, Addis Ababa, Ethiopia