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Research article

Assessments of woody vegetation in Addis Ababa city, Ethiopia

Debela Daba Guta* and Birhanu Belay Telake

Gullele Botanical Garden, P. O. Box 153/1029 Addis Ababa, Ethiopia

*Corresponding Author: debeladhaba@gmail.com

Abstract: This study was conducted in Addis Ababa city streets that passes through Gullele, Arada, Yeka, Bole, Kirkos, Nefas Silk Lafto and Akaki Kaliti subcities specifically Gullele (starts from winget round about to Bole Airport by trekking GBG, Addisu gebeya round about through Addisu Gebeya, Semien mezegaja, St. George Church), Yeka and Areda (from 4 kilo through kebena to megenegna bus station), Bole sub city (from meskel round about to bole airports) and The second phases are also three sub cities those are Kirkos, Nefas silk lafto and Akaki kaliti which has been started from Mexico roundabout to sarebet on the way to lafto mall, German round about, mebrat hayl, Nefas silk sub city office, Haile garment, Hana mariam roundabout to kalliti roundabout. The final one was also had three sub cities those were: Gullele, Arada and Yeka starts from 6 kilo to 4 kilo through Kebena to megenegna round about. Data had been collected and recorded using GPS, digital camera and analyzed mainly by using the Microsoft Excel and spread sheet. Totally about 74 species were collected and identified from all the sampling area. The canopy of these the 74 species has been classified into 14 shape style and round is the dominant from the total shape and canopy. The status of the vegetation has been classified as bad, good, very good and excellent and these species were identified from 56 plots by botanical name and local name. The habits of the species are classified as 44 are tree and 30 plants are shrubs. These plants were classified under 40 families and Fabaceae contributed the highest number of species followed by Myrtaceae. From the total list only 4 species has been endemic, 30 are indigenous and 48 have been exotic.

Keywords: Endemic, Indigenous, Exotic**,** Street plants, Canopy Shape.

INTRODUCTION

For the first time in history, the majority of the world's population lives in urban areas (UNPF, 2007). The 20th century was the century of urbanization. Now a day, it is calculated that over half of the world population lives in urban regions while by 2030 the urban population is expected to be doubled. Urban vegetation is fundamental importance for the quality of life on our ever increasingly urbanized societies. Today, the development of green infrastructure is changing the way communities think and making them sustainable in order to improve the quality of life of their current residents and for future generations of residents.

Urban green infrastructure refers to spaces that are located in the urban web which include urban forest, river buffer vegetation, recreational parks, urban agriculture, avenues of trees and other garden area. Green infrastructure is defined in different ways by different authors. McMahon & Benedict (2002) defined green infrastructure as an inter-connected network of water ways, wetlands, woodlands, wild life habitats and other natural areas: greenways, parks and other land conservation, working farms, ranches and forests; and wilderness and other open spaces that support native species, maintain natural ecological processes, sustain air and water resources and contribute to the health and quality of life for communities and people.

More recently Davies *et al.* (2012) defined green infrastructure as parts of urban areas with a mix of street trees, parks, cultivated land, wetlands, lakes and streams. This definition is synonymous with the definition of urban forests. In which, urban forest is defined as trees, forests, green spaces, and related biotic, abiotic and cultural components in and around cities (Carter, 1995). Therefore, green infrastructure and urban forest are regarded as being similar land use types. Hence, in this paper, the terms green infrastructure, green areas and urban forest are used interchangeably.

Urban greens have significant amenity and recreational value contributing towards quality of urban life. It not only provides benefits to ecosystems and people but also to the economy. It is a key component for sustainable growth of communities and a critical public investment (McMahon & Benedict, 2012).

It is observed that politicians, industrial houses, especially in developing country try to grab these green open spaces for creation of concrete jungle. Scientific understandings of how urban forests, river buffer vegetation, recreational parks and street trees benefits people is generally lacking in majority of developing countries. This happens because non-market benefits of such areas are not correctly valued. There is evidence that open space with in town and cities might be more effective in helping adaptation, as it can provide shade, flood storage, improve infiltration rate and reduce run-off. This clearly has implications for policies to encourage infill development (Foster & Lowe 2011).

Addis Ababa is a unique city with land features of mountains and plains. Addis Ababa is the capital city of Ethiopia, located at the eastern part of Africa. It is the seat of African Union and many other regional and international organizations. The city has an area of 530 km^2 with more than 3.385 million (*https://en.wikipedia.org/wiki/Addis_Ababa*) inhabitants. For administration purpose the city is divided into 10 sub cities and 116 woreda's (local administration units).The altitude ranges from 2100 m above sea level at the south of Akaki area and 3100 m above sea level at the north of Entoto Mountain (Mekonnen, 2012) . The altitude of study areas ranges from 2155 m above sea level at the Akaki area and 2618 m above sea level at the Gullele Addisu Gebeya area.

The places with in the present Addis Ababa city boundary were forested. The mountain chains which are located in the northwest, northeast, and southwest consists of plant species that exist in dry ever green afromontane vegetation type of Ethiopia. On the other hand, the vegetation at the south part of the city has similarity with the low land vegetation of the rift valley area.

Green infrastructures are very well known to provide environmental, social and economic benefits to communities (Forest Research, 2010). And, since green infrastructures are mainly plants, they live many years in perpetuity. They provide the environmental, social and economic benefits not only to the present communities but also, with little management cost to the future generations as well. Therefore, green infrastructure should ensure the sustainability of cities and urban areas.

It is hoped that this research add to the limited knowledge available in the study area regarding the economic, social and environmental benefit from urban forestry. The outcome of this study may also be used for policy considerations, for planning and designing urban green infrastructure. This study also list out the lists of woody plants and the challenges on indigenous and endemic tree plants in the city street line plantation. The comparative between endemic, indigenous and exotic plants clearly identified and the right plant selection recommended for the urban forestry and urban beautification.

Moreover, this study will helpful for researcher to do further research on the issue at hand. Finally, the study has been important source of information for city administration, urban planners, policy makers, Researcher (Botanists and horticulturist), NGO practitioners and academics working on urban green infrastructure.

The urban forests provides several environmental services such as, water conservation, flood control, and soil conservation in Addis Ababa where many people lack access to safe drinking water and adequate shelter. Informal settlements are frequently found on steep slopes and near streams, and thus are at risk during the harsh rainy season. Water reservoirs around Addis Ababa are subject to sedimentation, and reforestation can provide a solution in combating soil erosion and gully development.

Afforestation can be used to reclaim polluted sites, abandoned quarries, construction of building, road construction and landfills, which are currently spreading out all over Addis Ababa. Besides, forests can be used for wastewater treatment. Urban forests can help to improve the microclimate and air quality. This is important as Addis Ababa's vehicle traffic is steadily increasing. Besides, urban forests sequester carbon dioxide and can be used to combat regional as well as global warming. Health, employment, education and recreation, community building and property value improvement are the major social benefits of forests (Kuchelmeister, 2000). These benefits are frequently overlooked. Especially the employment benefits are important for a developing country as Ethiopia, while other social benefits will gain in importance with raising living standard.

Urban forestry also involves costs, most importantly a budget for tree planting, care and management. The budget needed may be considered as significant, but generally the long-term benefits will outweigh the costs. For example, discounted pay back periods for urban trees planted in the Chicago Urban Forest Climate Project ranged between 9 to 18 years (McPherson 1995). Other costs may be related to threats to human safety, structural damage, vandalism, unorganized waste disposal and reduction of solar energy (Carter, 1995). However, these costs can be minimized by appropriate measures.

MATERIALS AND METHODS

Study site

The study area have been included the parts of Addis Ababa city in seven sub city which have street that have plantation richness. Those sub cities are Gullele, Arada, Yeka, Bole, Kirkos, Nifas silk lafto and Akaki Kaliti. The selected streets are classified into three phases: the first phases has been on three sub cities those were: Gullele, Arada and Bole on the way from Winget roundabout to Gullele Botanic Garden, Addisu gebeya roundabout, Semien mezegeja, st, George church, Churchill road, ambassador, meskel roundabout to bole airport. The second phases has been also three sub cities those were: Kirkos, Nefas silk lafto and Akaki kaliti which has been from Mexico roundabout to sarebet on the way to lafto mall, German round about, mebrat hayl, Nefas silk sub city office, Haile garment, Hana

mariam roundabout to kalliti roundabout. The final phase was also have three sub cities those are Gullele, Arada and Yeka starts from 6 kilo to 4 kilo through Kebena to megenegna round about.

Addis Ababa is the capital city of Ethiopia and the African Union and due to its historical, diplomatic and political significance it is often called the "African Capital". It is the third highest capital in the world. It is the geographic center of the country. Addis Ababa is the world's largest city with a population of 3,627,934 as of 2007. When the city was at risk due to a shortage of firewood in the early 1900s, an ambitious campaign to plant Eucalyptus trees imported from Australia in and around the city essentially secured its lasting location. Today, a green belt of forests and semi-subsistence cultivated land surrounds the city.

The city is located at the southern foot of Mount Entoto, in the Entoto Mountains, at an elevation of about 8000 feet (2440 meters) above sea level, Addis Ababa is located in the horn of Africa and the geographic location is Latitude: 9° 01′29″ N and Longitude: 38° 44′48″ E. on a plateau that is crossed by numerous streams and surrounded by hills and mountains, in the geographic centre of the country. Ecologically, Addis Ababa is a grassland biome, which is a climatically and geographically defined area of similar communities of plants, animals, and soil organisms. The city possesses a complex mix of highland climate zones, with temperature differences of up to 10°C (50° F), depending on elevation and prevailing wind patterns. The temperature in January ranges from a high of 68°F (20°C) to a low of 53°F (12°C).

The area of the city increased from 85.73 square miles (222.04 square kilometers) in 1984 to 204.7 square miles (530.21 square kilometers) in 1994. The Entoto Mountains start among the northern suburbs. Suburbs include Shiro Meda and Entoto in the north, Urael and Bole (home to Bole International Airport) in the east, Nifas Silk in the south-east, Mekanisa in the south, and Keraniyo and Kolfe in the west.

Voucher specimen collection and identification

The altitude, longitude, and latitude had been taken by using GPS and the picture by using camera. Voucher specimens of plants that is not identified during survey has been collected from the study area, provided with collection numbers, pressed, dried, and identified at the National Herbarium (ETH), Addis Ababa University. Plants in the study area has been identified in two ways; at collection time by local people in the study area and using Flora of Ethiopia and Eritrea; and at the National Herbarium after fieldwork. During the field, some of the plants identified and checked while most has been identified at the National Herbarium by comparing with already identified herbarium specimens and using taxonomic keys in the Flora of Ethiopia and Eritrea. Nomenclature follows Flora of Ethiopia and Eritrea. Not identified plants by expert at field or during survey time its vouchers and will be finally kept at the National Herbarium.

Systematic sampling

Systematic sampling was used to collect vegetation data, following Muller-Dombois & Ellenberg (1974). The distance between the main plots was 500 m along each of the line transects along the road side. At the plantation is at three or two lines the densely populated area was selected from the three. According to this method 56 plots were taken as sample plot by classifying the team into two groups. The latitude and longitude were taken from the centre of each main plot and measured using GPS. The area of the sampling area was 100 m from starting points and the width has been depending on the road size. The densely populate and the area that have unique plan from the out of sampling area was included in the sample plot. The total population in the sample was counted.

The presence-absence and cover abundance data, defined here as the proportion of area in a plot covered by a given species, was recorded and gathered from each plot. All woody plants were counted. The species canopy cover has been done by estimation to identify the effects of the planted plants on the area on screening traffic along road side. The status of the vegetation were determine as excellent (if the plants free from disease, insects, scarcity of water problem, wilting, yellowing and feel green), very good for medium, good for the plants in normal status and bad for not normal plants.

Data analysis

The collected lists of the woody vegetation ethnobotanical uses have been analyzed using Microsoft Excel spread sheet, compared by bar graph chart. The results have been expressed in terms of maps, figures, tables and graphs.

RESULTS

Comparative of between families

According to the study, most of the vegetation planted in the city was classified into 40 families. The dominant plants were under the family of Fabaceae (13.5%), followed by Myrtaceae (6.8%) and the least were 25 different species which was represents with one species each. Table 1 below shows that the number of species in each families.

Table 1. Comparative plant diversity by family level.

S.N.	Family	Number of species under the family	Percentage
1	Fabaceae	10	13.6
2	Myrtaceae	5	6.8
3	Cupressaceae	4	5.4
4	Dracenaceae	4	5.4
5	Euphorbiaceae	4	5.4
6	Rosaceae	4	5.4
7	Moraceae	3	4.00
8	Agavaceae	2	2.7
9	Arecaceae	2	2.7
10	Asteraceae	2	2.7
11	Bignoniaceae	2	2.7
12	Flacourtiaceae	2	2.7
13	Oleaceae	2	2.7
14	Verbenaceae	2	2.7
15	Aloaceae	1	1.35
16	Amaranthaceae	1	1.35
17	Anacardiaceae	1	1.35
18	Apocynaceae	1	1.35
19	Araucariaceae	1	1.35
20	Boraginaceae	1	1.35
21	Casuarinaceae	1	1.35
22	Combretaceae	1	1.35
23	Crassulaceae	1	1.35
24	Lamiaceae	1	1.35
25	Lauraceae	1	1.35
26	Lythraceae	1	1.35
27	Malvaceae	1	1.35
28	Meliaceae	1	1.35
29	Myrsinaceae	1	1.35
30	Nyctaginaceae	1	1.35
31	Onagraceae	1	1.35
32	Phytolaccaceae	1	1.35
33	Pinaceae	1	1.35
34	Pittosporaceae	1	1.35
35	Polygonaceae	1	1.35
36	Podocarpaceae	1	1.35
37	Punicaceae	1	1.35
38	Rutaceae	1	1.35
39	Solanaceae	1	1.35
40	Tiliaceae	1	1.35
	Total	**74**	**100**

Lists of plants found in the city road and road side

The total vegetation encountered in areas where the study was undertaken are listed in table 2. This table shows the scientific name, local name and family. According to this study about 74 woody species were identified.

Table 2. Total lists of the plant species in the city with its families.

S.N.	Botanical name	Local name	Family
1	*Acacia abyssinica* Hochst. ex Benth.	Bazira girar	Fabaceae
2	*Acacia decurrens* Willd.	Decurens	Fabaceae
3	*Acacia melanoxylon* R.Br.	Omedla	Fabaceae
4	*Acacia saligna* (Labill.) Wendl.	Aba Hawi	Fabaceae
5	*Agave americana* L.	Kecha	Agavaceae
6	*Agave attenuate* Salm	--	Agavaceae
7	*Albizia gummifera* (J.F.Gmel.) C.A.Sm.	Sissa	Fabaceae
8	*Aloe vera* (L.) Burm.f.	Eret	Aloaceae
9	*Amaranthus caudatus* L.	Amaranthus	Amaranthaceae

10	*Araucaria heterophylla* (Salisb.) Franco	Awurikaria	Araucariaceae
11	*Bauhinia purpurea* L.	Bahunia	Fabaceae
12	*Borassus aethiopum* Mart	Zenbaba	Arecaceae
13	*Bougainvillea glabra* Choisy.	Boganvil	Nyctaginaceae
14	*Callistemon citrinus* (Curtis) Skeels	Bottle Brush	Myrtaceae
15	*Casimiroa edulis* La Llave	Kazmir	Rutaceae
16	*Casuriana equistifolia* L.	Shewashewa	Casuarinaceae
17	*Cordial africana* Lam	Wanza	Boraginaceae
18	*Cordyline australis* (G.Forst.) Hook.f.	Kordyline	Dracenaceae
19	*Crassula ovata* (Miller) Druce	--	Crassulaceae
20	*Croton macrostachyus* Del.	Bisanna	Euphorbiaceae
21	*Cuphea macropetala* Kunth	American cigarette	Lythraceae
22	*Cupressus lusitanica* Mill	Yeferanji tid	Cupressaceae
23	*Cupressus sempervirens* 'Pyramidalis'	--	Cupressaceae
24	*Discopodium penninervium* Hochst	Menji	Solanaceae
25	*Dovyalis abyssinica* (A.Rich.) Warb.	Koshim	Flacourtiaceae
26	*Dovyalis caffra* (Hook.f. & Harv.) Hook.f.	Koshim	Flacourtiaceae
27	*Dracaena fragrancy* (L.) Ker Gawl.	Dracena	Dracaenaceae
28	*Dracaena steudneri* Engl.	Etsapatos	Dracaenaceae
29	*Dracaena erecta 'variegated'*	--	Dracenaceae
30	*Duranta erecta* L.	Durenta	Verbenaceae
31	*Echinops macrochaetus* Fresen	Kosheshilla	Asteraceae
32	*Erthrina brucei* Schweinf	Korch	Fabaceae
33	*Eucalyptus citriodora* Hook.	Keybewrzaf	Mytaceae
34	*Eucalyptus globulus* Labill	Nechberzaf	Myrtaceae
35	*Euphorbia abyssinica* Gmel	Kulkoal	Euphorbiaceae
36	*Euphorbia milii* Des Moulins	Yeesho aklil	Euphorbiaceae
37	*Ficus benjamina* L.	Ficus	Moraceae
38	*Ficus elastica* Roxb. ex Hornem.	Yegomma zef	Moraceae
39	*Ficus thonningii* Blume	Chibah	Moraceae
40	*Fuschia magellanica* (Ruiz & Pav.) Munz.	--	Onagraceae
41	*Grevillea robusta* R.Br.	Gravellia	Mytaceae
42	*Grewia ferruginea* Hochst. ex A. Rich.	Lenkato	Tiliaceae
43	*Hagenia abyssinica* (Bruce) J.F. Gmel	Kosso	Rosaceae
44	*Hibiscus rosa-sinensis* L.	Hibiscus	Malvaceae
45	*Jacaranda mimosifolia* D. Don	Yetemenja zaf	Bignoniaceae
46	*Juniperus procera* Hochst. ex Endl.	Ye habesha tid	Cupressaceae
47	*Lantana camara* L.	Yewafkolo	Verbenaceae
48	*Ligistrium vulgaris* L.	Yekibrit enchat	Oleaceae
49	*Maesa lanceolata* Forssk.	Kelewa	Myrsinaceae
50	*Melia azedarach* L.	Nim	Meliaceae
51	*Millettia ferruginea* (Hochst.) Bak.	Birbirra	Fabaceae
52	*Nerium oleander* L.	Oleander	Apocynaceae
53	*Olea europaea* L. subsp. *cuspidata* (Wall. ex G.Don) Cif.	Waeyra	Oleaceae
54	*Persea americana* Mill.	Avocado	Lauraceae
55	*Phoenix reclinata* Jacq.	Zenbaba	Arecaceae
56	*Phytolacca dodecandra* L'Herit	Endode	Phytolaccaceae
57	*Pinus patula* D.Don	Patula	Pinaceae
58	*Pittosporum abyssinicium* Del	--	Pittosporaceae
59	*Podocarpus falcatus* (Thunb.) R.Br. ex Mirb.	Zigba	Podocarpaceae
60	*Prunus africana* (Hook.f.) Kalkm.	Tikur enchet	Rosaceae
61	*Psidium guajava* L.	Zaytune	Mytaceae
62	*Punica granatum* L.	Roman	Punicaceae
63	*Ricinus communis* L.	Gulo	Euphorbiaceae

64	*Rosa abyssinica* Lindley	Kega	Rosaceae
65	*Rosa x richardis* Rehd.	Tsigereda	Rosaceae
66	*Rumex nurvosus* Vahl	Embuacho	Po1ygonaceae
67	*Salvia nilotica* Jacq.	Hulagab	Lamiaceae
68	*Schinus molle* L.	Tikur berbere	Anacardiaceae
69	*Senna petersiana* (Bolle) Lock	Lelabamar	Fabaceae
70	*Sesbania sesban* (L.) Merr.	Susbania	Fabaceae
71	*Spathodea campanulata* P. Beauv.	Yecheka nebelbal	Bignoniaceae
72	*Terminalia brownii* Fresen	Key enchet	Combretaceae
73	*Thuja orentales* L.	Tuya	Cupressaceae
74	*Vernonia amygdalina* Del.	Gerawa	Asteraceae

Endemism, native and exotic

The vegetation in the study areas were identified as endemic to Ethiopia, native and exotic (Fig. 1). These were represented by 4, 21 and 66 species respectively as listed in table 3 below.

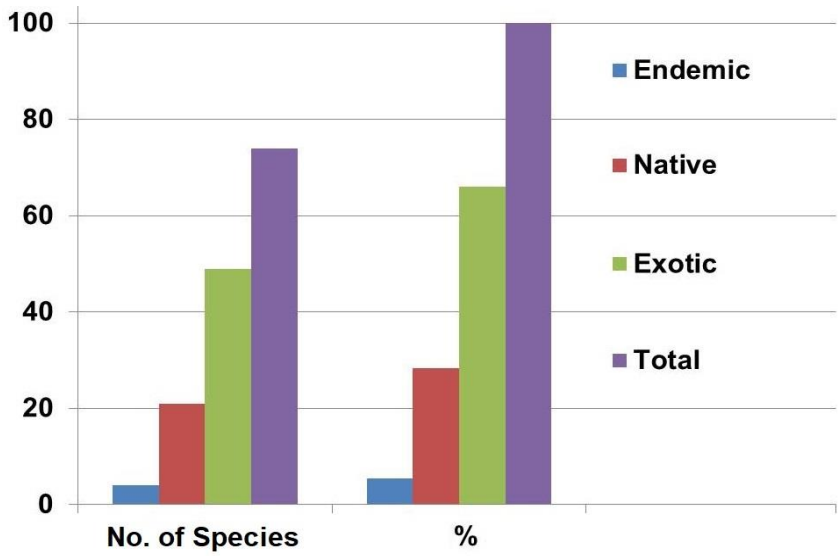

Figure 1. Number and percentage of endemic, native and exotic species.

Table 3. Comparative plant diversity according to origin.

S.N.	Plant species	Endemic	Native/indigenous	Exotic
1	*Acacia abyssinica* Hochst. ex Benth.		✓	
2	*Acacia decurrens* Willd.			✓
3	*Acacia melanoxylon* R.Br.			✓
4	*Acacia saligna* (Labill.) Wendl.			✓
5	*Agave americana* L.			✓
6	*Agave attenuate* Salm			✓
7	*Albizia gummifera* (J.F.Gmel.) C.A.Sm.		✓	
8	*Aloe vera* (L.) Burm.f.	✓		
9	*Amaranthus caudatus* L.			✓
10	*Araucaria heterophylla* (Salisb.) Franco			✓
11	*Bauhinia purpurea* L.			✓
12	*Borassus aethiopum* Mart		✓	
13	*Bougainvillea glabra* Choisy.			✓
14	*Callistemon citrinus* (Curtis) Skeels			✓
15	*Casimiroa edulis* La Llave			✓
16	*Casuriana equistifolia* L.			✓
17	*Cordial africana* Lam		✓	
18	*Cordyline australis* (G.Forst.) Hook.f.			✓
19	*Crassula ovata* (Miller) Druce			✓
20	*Croton macrostachyus* Del.		✓	
21	*Cuphea macropetala* Kunth			✓
22	*Cupressus lusitanica* Mill			✓

23	*Cupressus sempervirens* 'Pyramidalis'			✓
24	*Discopodium pennianervium* Hochst		✓	
25	*Dovyalis abyssinica* (A.Rich.) Warb.		✓	
26	*Dovyalis caffra* (Hook.f. & Harv.) Hook.f.			✓
27	*Dracaena fragrancy* (L.) Ker Gawl.			✓
28	*Dracaena steudneri* Engl.			✓
29	*Dracaena erecta 'variegated'*			✓
30	*Duranta erecta* L.			✓
31	*Echinops macrochaetus* Fresen		✓	
32	*Erthrina brucei* Schweinf	✓		
33	*Eucalyptus citriodora* Hook.			✓
34	*Eucalyptus globulus* Labill			✓
35	*Euphorbia abyssinica* Gmel		✓	
36	*Euphorbia milii* Des Moulins			✓
37	*Ficus benjamina* L.			✓
38	*Ficus elastica* Roxb. ex Hornem.			✓
39	*Ficus thonningii* Blume			✓
40	*Fuschia magellanica* (Ruiz & Pav.) Munz.			✓
41	*Grevillea robusta* R.Br.			✓
42	*Grewia ferruginea* Hochst. ex A. Rich.		✓	
43	*Hagenia abyssinica* (Bruce) J.F. Gmel		✓	
44	*Hibiscus rosa-sinensis* L.			✓
45	*Jacaranda mimosifolia* D. Don			✓
46	*Juniperus procera* Hochst. ex Endl.		✓	
47	*Lantana camara* L.			✓
48	*Ligistrium vulgaris* L.			✓
49	*Maesa lanceolata* Forssk.		✓	
50	*Melia azedarach* L.			✓
51	*Millettia ferruginea* (Hochst.) Bak.	✓		
52	*Nerium oleander* L.			✓
53	*Olea europaea* L. subsp. *cuspidata* (Wall. ex G.Don) Cif.		✓	
54	*Persea americana* Mill.			✓
55	*Phoenix reclinata* Jacq.		✓	
56	*Phytolacca dodecandra* L'Herit		✓	
57	*Pinus patula* D.Don			✓
58	*Pittosporum abyssinicium* Del	✓		
59	*Podocarpus falcatus* (Thunb.) R.Br. ex Mirb.		✓	
60	*Prunus africana* (Hook.f.) Kalkm.		✓	
61	*Psidium guajava* L.			✓
62	*Punica granatum* L.			✓
63	*Ricinus communis* L.		✓	
64	*Rosa abyssinica* Lindley		✓	
65	*Rosa x richardis* Rehd.			✓
66	*Rumex nurvosus* Vahl		✓	
67	*Salvia nilotica* Jacq.			✓
68	*Schinus molle* L.			✓
69	*Senna petersiana* (Bolle) Lock			✓
70	*Sesbania sesban* (L.) Merr.			✓
71	*Spathodea campanulata* P. Beauv.			✓
72	*Terminalia brownii* Fresen			✓
73	*Thuja orentales* L.			✓
74	*Vernonia amygdalina* Del.		✓	
	Total	**4**	**30**	**48**
	Percentage	**5.4**	**28.4**	**65.2**

Habits of the plants

According to this study the dominant habit of the woody vegetation was 44 tree species or 55.5% and 30 or 45.5% plants species were shrubs. Table 4 shows the habits of the plants in the study area.

Table 4. Habits of plant species in the study areas.

S.N.	Plant species	Tree	Shrubs
1	*Acacia abyssinica* Hochst. ex Benth.	✓	
2	*Acacia decurrens* Willd.	✓	
3	*Acacia melanoxylon* R.Br.	✓	
4	*Acacia saligna* (Labill.) Wendl.	✓	
5	*Agave americana* L.		✓
6	*Agave attenuate* Salm		✓
7	*Albizia gummifera* (J.F.Gmel.) C.A.Sm.	✓	
8	*Aloe vera* (L.) Burm.f.		✓
9	*Amaranthus caudatus* L.		✓
10	*Araucaria heterophylla* (Salisb.) Franco	✓	
11	*Bauhinia purpurea* L.	✓	
12	*Borassus aethiopum* Mart	✓	
13	*Bougainvillea glabra* Choisy.		✓
14	*Callistemon citrinus* (Curtis) Skeels	✓	
15	*Casimiroa edulis* La Llave	✓	
16	*Casuriana equistifolia* L.	✓	
17	*Cordial africana* Lam	✓	
18	*Cordyline australis* (G.Forst.) Hook.f.		✓
19	*Crassula ovata* (Miller) Druce		✓
20	*Croton macrostachyus* Del.		
21	*Cuphea macropetala* Kunth	✓	
22	*Cupressus lusitanica* Mill	✓	
23	*Cupressus sempervirens* 'Pyramidalis'	✓	
24	*Discopodium pennianervium* Hochst		✓
25	*Dovyalis abyssinica* (A.Rich.) Warb.		✓
26	*Dovyalis caffra* (Hook.f. & Harv.) Hook.f.		✓
27	*Dracaena fragrancy* (L.) Ker Gawl.		✓
28	*Dracaena steudneri* Engl.	✓	
29	*Dracaena erecta 'variegated'*		✓
30	*Duranta erecta* L.		✓
31	*Echinops macrochaetus* Fresen		✓
32	*Erthrina brucei* Schweinf	✓	
33	*Eucalyptus citriodora* Hook.	✓	
34	*Eucalyptus globulus* Labill	✓	
35	*Euphorbia abyssinica* Gmel		✓
36	*Euphorbia milii* Des Moulins		✓
37	*Ficus benjamina* L.	✓	
38	*Ficus elastica* Roxb. ex Hornem.	✓	
39	*Ficus thonningii* Blume	✓	
40	*Fuschia magellanica* (Ruiz & Pav.) Munz.		✓
41	*Grevillea robusta* R.Br.	✓	
42	*Grewia ferruginea* Hochst. ex A. Rich.	✓	
43	*Hagenia abyssinica* (Bruce) J.F. Gmel	✓	
44	*Hibiscus rosa-sinensis* L.		✓
45	*Jacaranda mimosifolia* D. Don	✓	
46	*Juniperus procera* Hochst. ex Endl.	✓	
47	*Lantana camara* L.		✓
48	*Ligistrium vulgaris* L.		✓
49	*Maesa lanceolata* Forssk.	✓	
50	*Melia azedarach* L.	✓	
51	*Millettia ferruginea* (Hochst.) Bak.	✓	
52	*Nerium oleander* L.		✓
53	*Olea europaea* L. subsp. *cuspidata* (Wall. ex G.Don) Cif.	✓	
54	*Persea americana* Mill.	✓	
55	*Phoenix reclinata* Jacq.	✓	
56	*Phytolacca dodecandra* L'Herit		✓
57	*Pinus patula* D.Don	✓	
58	*Pittosporum abyssinicium* Del	✓	

59	*Podocarpus falcatus* (Thunb.) R.Br. ex Mirb.	✓	
60	*Prunus africana* (Hook.f.) Kalkm.	✓	
61	*Psidium guajava* L.	✓	
62	*Punica granatum* L.		✓
63	*Ricinus communis* L.		✓
64	*Rosa abyssinica* Lindley		✓
65	*Rosa x richardis* Rehd.		✓
66	*Rumex nurvosus* Vahl		✓
67	*Salvia nilotica* Jacq.		✓
68	*Schinus molle* L.	✓	
69	*Senna petersiana* (Bolle) Lock	✓	
70	*Sesbania sesban* (L.) Merr.		✓
71	*Spathodea campanulata* P. Beauv.	✓	
72	*Terminalia brownii* Fresen	✓	
73	*Thuja orentales* L.		✓
74	*Vernonia amygdalina* Del.	✓	
	Total	**44**	**30**
	Percentage	**59.5**	**40.5**

Canopy of vegetation

The plantations in the city have different shapes (Fig. 2). The planted one do not selected as the arboriculture plant selection. It has different canopy coverage as indicated on the table 5 below.

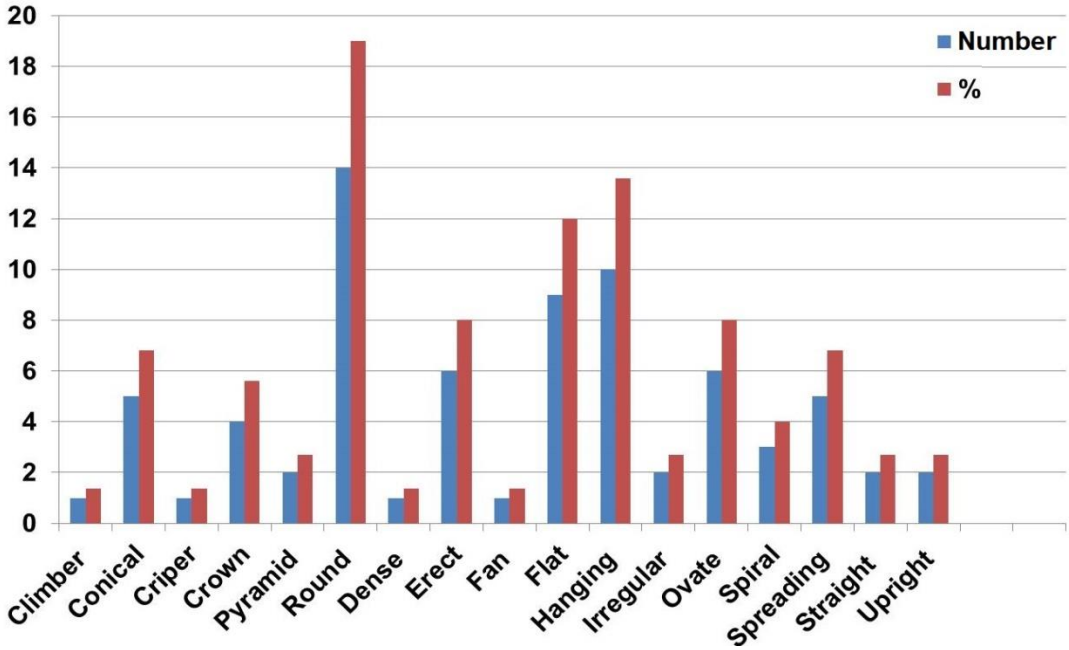

Figure 2. The comparision of the vegetation canopy type.

Table 5. The canopy type of the species in the study area.

S.N.	Plant species	Canopy shape
1	*Acacia abyssinica* Hochst. ex Benth.	Flat topped
2	*Acacia decurrens* Willd.	Upright
3	*Acacia melanoxylon* R.Br.	Conical
4	*Acacia saligna* (Labill.) Wendl.	Flattened
5	*Agave americana* L.	Spiral
6	*Agave attenuate* Salm	Spiral
7	*Albizia gummifera* (J.F.Gmel.) C.A.Sm.	Flat
8	*Aloe vera* (L.) Burm.f.	Spiral
9	*Amaranthus caudatus* L.	Hanging
10	*Araucaria heterophylla* (Salisb.) Franco	Flat
11	*Bauhinia purpurea* L.	Round
12	*Borassus aethiopum* Mart	Fan
13	*Bougainvillea glabra* Choisy.	Hanging
14	*Callistemon citrinus* (Curtis) Skeels	Hanging

15	*Casimiroa edulis* La Llave	Hanging
16	*Casuriana equistifolia* L.	Conical
17	*Cordial africana* Lam	Rounded
18	*Cordyline australis* (G.Forst.) Hook.f.	Conical
19	*Crassula ovata* (Miller) Druce	Ovate
20	*Croton macrostachyus* Del.	Rounded
21	*Cuphea macropetala* Kunth	Ovate
22	*Cupressus lusitanica* Mill	Conical
23	*Cupressus sempervirens* 'Pyramidalis'	Pyramidal
24	*Discopodium pennianervium* Hochst	Ovate
25	*Dovyalis abyssinica* (A.Rich.) Warb.	Rounded
26	*Dovyalis caffra* (Hook.f. & Harv.) Hook.f.	Upright
27	*Dracaena fragrancy* (L.) Ker Gawl.	Conical
28	*Dracaena steudneri* Engl.	Crown
29	*Dracaena erecta 'variegated'*	Erect
30	*Duranta erecta* L.	Erect
31	*Echinops macrochaetus* Fresen	Erect
32	*Erthrina brucei* Schweinf	Ovate
33	*Eucalyptus citriodora* Hook.	Rounded
34	*Eucalyptus globulus* Labill	Hanging
35	*Euphorbia abyssinica* Gmel	Rounded
36	*Euphorbia milii* Des Moulins	Erect
37	*Ficus benjamina* L.	Round
38	*Ficus elastica* Roxb. ex Hornem.	Round / spreading
39	*Ficus thonningii* Blume	Hanging
40	*Fuschia magellanica* (Ruiz & Pav.) Munz.	Hanging
41	*Grevillea robusta* R.Br.	Oval
42	*Grewia ferruginea* Hochst. ex A. Rich.	Hanging
43	*Hagenia abyssinica* (Bruce) J.F. Gmel	Rounded
44	*Hibiscus rosa-sinensis* L.	Round
45	*Jacaranda mimosifolia* D. Don	Light crown
46	*Juniperus procera* Hochst. ex Endl.	pyramidal
47	*Lantana camara* L.	Erect or scandent
48	*Ligistrium vulgaris* L.	Erect
49	*Maesa lanceolata* Forssk.	Flat
50	*Melia azedarach* L.	Flat
51	*Millettia ferruginea* (Hochst.) Bak.	Spreading
52	*Nerium oleander* L.	Dense
53	*Olea europaea* L. subsp. *cuspidata* (Wall. ex G.Don) Cif.	Rounded
54	*Persea americana* Mill.	Straight
55	*Phoenix reclinata* Jacq.	Crown
56	*Phytolacca dodecandra* L'Herit	Climber
57	*Pinus patula* D.Don	Conical
58	*Pittosporum abyssinicium* Del	Spreading
59	*Podocarpus falcatus* (Thunb.) R.Br. ex Mirb.	Straight bole
60	*Prunus africana* (Hook.f.) Kalkm.	Rounded and compact
61	*Psidium guajava* L.	Irregular
62	*Punica granatum* L.	Spreading
63	*Ricinus communis* L.	Spreading
64	*Rosa abyssinica* Lindley	Creeper or climber
65	*Rosa x richardis* Rehd.	Round
66	*Rumex nurvosus* Vahl	Flat
67	*Salvia nilotica* Jacq.	Flat
68	*Schinus molle* L.	Spreading
69	*Senna petersiana* (Bolle) Lock	Hanging
70	*Sesbania sesban* (L.) Merr.	Hanging
71	*Spathodea campanulata* P. Beauv.	Rounded
72	*Terminalia brownii* Fresen	Flat
73	*Thuja orentales* L.	Pyramidal
74	*Vernonia amygdalina* Del.	Ovate

Growth status of the city street vegetation

According to the study the growth status of many plant species is very good condition which is represented by 27 species and followed by in excellent 24 species (Table 6). This implies that the city is comfortable for plantation of different species.

Table 6. The growth status of the city street vegetation.

S.N.	Plant species	Growth status			
		Bad	Good	V. good	Excellent
1	*Acacia abyssinica* Hochst. ex Benth.				✓
2	*Acacia decurrens* Willd.				✓
3	*Acacia melanoxylon* R.Br.				✓
4	*Acacia saligna* (Labill.) Wendl.				✓
5	*Agave americana* L.				✓
6	*Agave attenuate* Salm				✓
7	*Albizia gummifera* (J.F.Gmel.) C.A.Sm.				✓
8	*Aloe vera* (L.) Burm.f.			✓	
9	*Amaranthus caudatus* L.			✓	
10	*Araucaria heterophylla* (Salisb.) Franco				✓
11	*Bauhinia purpurea* L.			✓	
12	*Borassus aethiopum* Mart			✓	
13	*Bougainvillea glabra* Choisy.				✓
14	*Callistemon citrinus* (Curtis) Skeels				✓
15	*Casimiroa edulis* La Llave			✓	
16	*Casuriana equistifolia* L.			✓	
17	*Cordial africana* Lam			✓	
18	*Cordyline australis* (G.Forst.) Hook.f.		✓		
19	*Crassula ovata* (Miller) Druce		✓		
20	*Croton macrostachyus* Del.			✓	
21	*Cuphea macropetala* Kunth				✓
22	*Cupressus lusitanica* Mill				✓
23	*Cupressus sempervirens* 'Pyramidalis'			✓	
24	*Discopodium pennianervium* Hochst				✓
25	*Dovyalis abyssinica* (A.Rich.) Warb.			✓	
26	*Dovyalis caffra* (Hook.f. & Harv.) Hook.f.				✓
27	*Dracaena fragrancy* (L.) Ker Gawl.			✓	
28	*Dracaena steudneri* Engl.			✓	
29	*Dracaena erecta 'variegated'*			✓	
30	*Duranta erecta* L.			✓	
31	*Echinops macrochaetus* Fresen		✓		
32	*Erthrina brucei* Schweinf				✓
33	*Eucalyptus citriodora* Hook.			✓	
34	*Eucalyptus globulus* Labill				✓
35	*Euphorbia abyssinica* Gmel			✓	
36	*Euphorbia milii* Des Moulins		✓		
37	*Ficus benjamina* L.		✓		
38	*Ficus elastica* Roxb. ex Hornem.		✓		
39	*Ficus thonningii* Blume		✓		
40	*Fuschia magellanica* (Ruiz & Pav.) Munz.		✓		
41	*Grevillea robusta* R.Br.				✓
42	*Grewia ferruginea* Hochst. ex A. Rich.			✓	
43	*Hagenia abyssinica* (Bruce) J.F. Gmel				✓
44	*Hibiscus rosa-sinensis* L.		✓		
45	*Jacaranda mimosifolia* D. Don		✓		
46	*Juniperus procera* Hochst. ex Endl.				✓
47	*Lantana camara* L.		✓		
48	*Ligistrium vulgaris* L.			✓	
49	*Maesa lanceolata* Forssk.			✓	
50	*Melia azedarach* L.		✓		
51	*Millettia ferruginea* (Hochst.) Bak.			✓	
52	*Nerium oleander* L.		✓		

53	*Olea europaea* L. subsp. *cuspidata* (Wall. ex G.Don) Cif.			✓	
54	*Persea americana* Mill.		✓		
55	*Phoenix reclinata* Jacq.			✓	
56	*Phytolacca dodecandra* L'Herit		✓		
57	*Pinus patula* D.Don				✓
58	*Pittosporum abyssinicium* Del			✓	
59	*Podocarpus falcatus* (Thunb.) R.Br. ex Mirb.				✓
60	*Prunus africana* (Hook.f.) Kalkm.			✓	
61	*Psidium guajava* L.		✓		
62	*Punica granatum* L.		✓		
63	*Ricinus communis* L.				✓
64	*Rosa abyssinica* Lindley			✓	
65	*Rosa x richardis* Rehd.		✓		
66	*Rumex nurvosus* Vahl		✓		
67	*Salvia nilotica* Jacq.		✓		
68	*Schinus molle* L.		✓		
69	*Senna petersiana* (Bolle) Lock			✓	
70	*Sesbania sesban* (L.) Merr.			✓	
71	*Spathodea campanulata* P. Beauv.				✓
72	*Terminalia brownii* Fresen	✓			
73	*Thuja orentales* L.		✓		
74	*Vernonia amygdalina* Del.				✓
	Total	**1**	**22**	**27**	**24**

DISCUSSION

Values of street trees

Trees in the street have different function and values for the city population while the survey were done. These functions are: For recreation and leisure, for economic benefits through job opportunities, environmental benefits: reducing run off, for ecological value: conservation of biodiversity, for socio-cultural cohesion: green areas have a power of attraction as a centre of meeting for different age, culture and sex groups and helps to integrate and discuss about their localities, politics, religion, economy etc. and for practical education of students about nature, environment, flora and fauna and about their interaction and relationship.

In spite of the above uses and other related values, the community, civil servants, the officials and even professionals are not well aware of these values or simply ignored them. Because of these low levels of awareness, the community has the habit of using green spaces for unwanted or illegal purpose like for dumping solid wastes, letting domestic animals in the area, cutting for some other purposes, stealing metal fences and storing and selling construction materials. Lack of awareness is not only a problem of the people but also that of officials as well. The woreda officers' plants seedlings at the beginning of each summer, but none of the seedlings had developed well because they are not taken care of and maintained regularly.

Distance between each tree

The distances between each tree and shrubs have been not according to the standard. The plantation is also never monotony nor mixed. When one plants are not survive they plant what the city beautification and recreation gets in the markets. This implies that the dead plants were not replaced by the same plants.

Total lists of the woody vegetation in the city street

According to the study, 74 woody plant species were identified as botanical nomenclature within 40 families. Most of the vegetation planted in the city was classified into 40 families. The dominant plants were under the family of Fabaceae 10 (13.5 %), followed by Myrtaceae 5 (6.8%) Cupressaceae, Dracenaceae, Euphorbiaceae and Rosaceae are equal which represented by 4 (5.4%) each family, Moraceae 3 (3%) other 7 families are represented by 2 species and 26 families are represented by one species.

From the total identified lists According to this study the dominant habit of the 44 plant species was tree or 55.5% and 30 or 45.5% plants species were shrubs. The vegetation in the study areas were identified as endemic to Ethiopia, native and exotic. These were represented by 4, 21 and 66 species respectively. The status of the species was classified as bad, good, very good and excellent.

CONCLUSION

Street trees development and management as well as maintenance require multidisciplinary professionals and high

budget allocation. Street trees had a nature of inclusiveness in their development and utilization activities and values. To examine these and other related issues of street trees in the study areas data were collected through different tools and finally analysis was made.

The results obtained from the analysis are summarized as follows: street trees developed by governmental institutions, non-governmental stakeholders, and community based organizations and individuals have many purposes. These were at first developed for beautification and recreation, for shade and for celebrating different festivals.

Due to lack of community participatory and problem of integrating different stake holders the present state of street trees in the sampling area are very poor because of population density, illegal buildings, land use change, unwise use of resources and storing and selling construction materials. Also Public awareness towards developing, managing and using street trees for the intended values are very poor. They prefer to use these places for illegal activities like dumping solid wastes etc.

The study also identified lack of collaboration and participation among stakeholders as another challenge which affects their co-ordinate efforts and roles to develop and manage street trees. Lack of regular follow-up, inspection, irrigation, fencing and other facilities *i.e.* fertilizer, soil etc. have great contribution for the low level development of street trees in the study sub cities road. Air pollution problem from different sources of factories, vehicle and others is also the factor. The road side trees are seriously exposed for smokes coming out from automobiles. The time plants leaf has been seen it turns from green colour to brown or dark; this limits its growth and finally gets dry. Lack off effective and integrated data base system, poor selection of tree species, traffic accidents, street vending and installation of utilities are also identified as hindrances which affect the development and management of street trees. Lack of integration between road construction and city beautifications office during plantation and road construction is also the main problem. The road construction office has been not prepare pitting place for the plantation and it remove the vegetation while road construct. The selected trees and shrubs in the city are more exotic and the plantation has been lack of consistency. The planted vegetation was not identified and has not gated its botanical nomenclature.

Recommendations

Starting from this study the following has been recommended for the future in the city.

- Planting indigenous or endemic vegetation due to this plant ha the resistance of soil born disease and pests.
- Replacing of the existing different shapes of plants by the straight, flat, pyramidal, spreading, erect and others
- It is better when the plantation type is fully monotony or fully mixed according to the area and function.
- Integration between road construction office and beautification office for the sustainable plant growth.
- Awareness creation for the city population about the city street plantation as they familiarized with the plant.
- Fund rising from different government organization, embassy, Non-Government Organization and others.
- Government give priority for the city plantation and green area in the city as it is the lungs of the population in the city from different carbon emission.
- Using different type of irrigation for management.
- Replacing by the same plants early when the planted plants are destroyed by different problem.
- The recommend plants for the city in the future are given in table 7.

Table 7. Recommended plants for the city.

S.N.	Botanical Name	Local name	Family	Habit	Altitude	Length	Purpose
1	*Acacia abyssinica* Hochst. ex Benth.	Bazira girar	Fabaceae	Tree	1500-2800 m	20 m	Shade
2	*Albizia gummifera* (J.F.Gmel.) C.A.Sm.	Sissa	Fabaceae	Tree	1700-2400 m	15 m	Shade
3	*Albizia schimperiana* Oliv.	Sissa	Fabaceae	Tree	1600-2600 m	15 m	Shade
4	*Cordia africana* Lam.	Wanza	Boraginaceae	Tree	700-2550 m	18 m	Shade
5	*Croton macrostachyus* Del.	Besana	Euphorbiaceae	Tree/shrub	1050-2350 m	15 m	Shade
6	*Dombeya torrida* (J.F.Gmel.) P.Bamps.	Wilkifa	Sterculaceae	Tree/shrub	1300-1800 m	20 m	Shade
7	*Dodonea angustifolia* L.f.	Ketkita	Sapindaceae	Shrub	500-2900 m	3 m	Hedge
8	*Ekebergia capensis* Sparrm.	Lole	Meliaceae	Tree	1680-3000 m	30 m	Shade
9	*Erythrina brucei* Schweinf.	Korch	Fabaceae	Tree	1400-2600 m	20 m	Shade
10	*Hagenia abyssinica* (Brace) J.F.Gmel.	Kosso	Rosaceae	Tree	2450-3250 m	20 m	Shade
11	*Juniperus procera* Hochst. ex Endl.	Yehabesha tid	Cupressaceae	Tree	--	25 m	Shade
12	*Millettia ferruginea* (Hochst.) Bak.	Berbera	Fabaceae	Tree	1000-2500 m	25 m	Shade
13	*Olea europaea* subsp. *cuspidata* (Wall. ex G.Don) Cif.	Waeyra	Oleaceae	Tree	1250-3000 m	15 m	Shade
14	*Phoenix reclinata* Jacq.	Zenbaba	Arecaceae	Tree	500-2400 m	15 m	Shade
15	*Podocarpus falcatus* (Thunb.) R.Br. ex Mirb.	Zigba	Podocarpaceae	Tree	--	30 m	Shade
16	*Syzygium guineense* (Willd.) DC.	Dokma	Myrtaceae	Tree	1200-2500 m	35 m	Shade

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