Challenges and problems of urban forest development in Addis Ababa, Ethiopia

Abstract

A study was carried out in Addis Ababa, the capital city of Ethiopia. Urban forests in Addis Ababa are affected by various problems such as encroachment, illegal cuttings, low legal enforcement and improper tree selection. Consequently, the main objective of this study was to assess the challenges and problems of the city's urban forests and to provide recommendations for different stakeholders who manage and participate in rehabilitating them. To achieve this, primary and secondary data were collected from government organisations who engage in the planting and care of urban trees. Results show the rate of illegal human intrusion doubled in two forest areas between the years 1997 and 2008. Of seedlings planted along the major road of the city, 87% were exotic species with their proportions ranging between 60 and 84%. The diversity of tree species along streets was very low (i.e. about 0.40%). Between 25 and 100% similarities of tree species were found among differing street locations. Among the exotic tree species recorded *Grevillea robusta*, *Acacia melanoxylon* and *Jacaranda mimosifolia* were found in the greatest proportions. The density of exotic tree species in three public parks was higher than indigenous trees by 74.7, 66.9 and 72.1% respectively. New tree plantings were decreasing at a household level showing a 'J' shape curve (low proportion of trees at lower age classes and high proportion of trees at higher age classes). To maintain tree coverage increased lower age class trees need to be planted. Proper guidelines to develop and manage the urban forest need to be formulated. This will help to provide green coverage according to the master plan of the city which can last for a prolonged period without creating conflict between stakeholders.

Introduction

Keywords:

indigenous trees, tree removal, urban forest management

Urban forestry refers to any revegetation effort including the planting of trees and shrubs whose design is intended to improve the environmental quality, economic opportunity, or aesthetic value associated with a city's landscape. The perception that comes to mind regarding urban forest is street trees and ornamental woody plants. However, the urban forest is a complex system of trees and smaller plants, wildlife, associated organisms, soil, water and air quality in and around a city.

Urban afforestation efforts are particularly necessary because of the quality of the environment in urban landscapes. The urban environment is characterised by air and water pollution, settlement in fragile ecosystems, and loss of water catchments and floodplain surface areas.

In Addis Ababa *Eucalyptus* species have been introduced since 1895 to satisfy the growing demand for wood and construction material and to reduce the pressure on the remaining natural vegetation. Without the successful introduction of *Eucalyptus* species under the reign of Emperor Menelik II, it is unlikely that Addis Ababa would have become the capital of Ethiopia and diplomatic centre of Africa (Hancock, 1995).

However, in recent years the urban forest of Addis Ababa including the upper catchments of the Entoto Mountain forest area has been dwindling at an alarming rate. This study aimed to assess the problems and challenges facing the urban forests of Addis Ababa and to recommend solutions based on results of the assessment.

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Problem statement

Addis Ababa, the capital and the most populated city of Ethiopia with a population of 2 112 737 million (CSA, 1999), grew at a rate of 2.1% from 1994 to 2007. A rapid and unplanned expansion and commercial development, along with population pressure, has meant the city environment is deteriorating with time. At present the forests of Addis Ababa are almost transformed to urban habitats accommodating a excessive population due to a high rate of rural–urban migration. In addition, industrialization within the urban areas and conversion of different land use within the city and the surrounding urban areas has caused the rapid depletion of existing tree cover during the past 100 years. This depletion of green resources has indicated that succeeding city governments had no proper long-term plans to keep the city green with the exception of intervening in some areas such as the establishment of a few parks and roadside plantations under a city beautification programme. These interventions also have diverse problems for sustainable management of the urban forest. Residents in general are not aware of the importance of existing tree cover in and around their living premises.

With the rapid expansion of the city, wide roads replaced narrow and unpaved roads, leaving a host of disturbed areas. However, there are no plans to plant new trees along these roads and fill the space created by different development activities. No serious effort has been made to reclaim land in a well-planned manner to allow the city to have adequate space along with its growth. On the contrary, an alarming scenario observed is the reduction in open spaces over time. To ameliorate the existing conditions, there is an urgent need to identify and assess the main problems and challenges of urban forests within Addis Ababa in order to formulate a sustainable plan and strategy of urban forest development and management.

Objectives

- To assess the major drivers of urban forest challenges and the problems urban forests face within Addis Ababa.
- To recommend solutions for the sustainable planning of urban forest development.

Materials and methods

Location

Addis Ababa is located in the central highlands of Ethopia. Geographically, it is located at 9° 38′ 0″N between 38° 42′ 0″E, with the lowest elevation of 2326 m above sea level at Bole International Airport, in the southern periphery, and the highest over 3000 m at Entoto Mountains, north of the city.

Climate

The average maximum temperature ranges between 17 and 22°C and the average minimum temperature varies between 11 and 14°C. The average rainfall is *c.* 1200 mm per year, with the major rain season occurring between June and September.

Land use

The city administration covers an area of 54 000 ha. The city has a recently revised master plan which allocates a total 22 000 ha (about 41% of the city) for greenery. The forest land, agricultural land, woodland, parks and riverbanks are considered as the major green components of the city. The peri-urban forest area occupies 8528 ha.

Site selection for data collection

The selected sites for urban forest data collection were:

- For roadside tree plantations: CMC to Legehar, Legehar to Piazza, Piazza to the Semen Hotel, Sidis Kilo to Meskel Flower, Meskel Flower to Bole, Kasanchis to the Ethiopia Hotel, National Bank to Goma Kuteba, Megenagan to Signal, Salitemehret to Gerji, Goma Kuteba to Tekelehaimanot and Tekelehaimanot to Piazza.
- For the assessment of trees planted in residential areas, real estate and newly established residential areas around CMC, Gerji, Lebu, Lafto and Asko were visited.
- Assessments on four selected functional parks (Beherstige, Gola, Sheger and Yeka parks) were made.
- For data on river banks Kebena, bambis and tributaries for the major river of the city were assessed.
- To assess trees planted in church compounds six churches were selected by their tree coverage (Silase, Saint George (Pissa), Saint Merry, Peteros paulos, Bole Medhanialem and Kechene Medehanialem).
- For the assessment of roadside tree plantations 11 roads were selected based on their age, length and location.
- A survey was also made on peri-urban mixed and pure plantation forest areas of the city.

Data collection methods

Data was collected on peri-urban forest area, selected parks, roadside plantation through transect walk. Questionnaires were developed to collect data from all sub-cities to assess problems in relation to trees planted in different institutional private and other compounds within the city.

Analysis

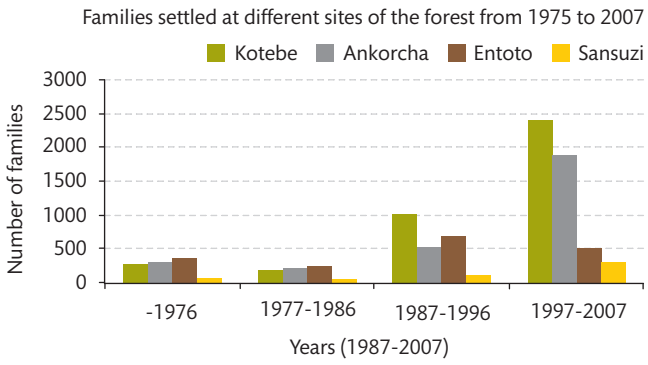
Descriptive statistics (such as percentage, pie-chart, histogram) were used to analyse and present the data. SYN–TAX 2000 soft ware was used to determine the diversity and similarity of tree species in three parks and eight streets of the city. In addition photographs have been used to support discussions.

Results and discussion

Encroachments

From Figure 1 we can infer that the population pressure within the forest area is increasing at an alarming rate. The highest encroachment is observed in the Kotebe and Ankorcha forest areas. Figure 1 indicates that the rate of intrusion doubled in these two areas between the years 1997 and 2007.

Figure 1 Population pressure on upper catchment's forest area of Addis Ababa.



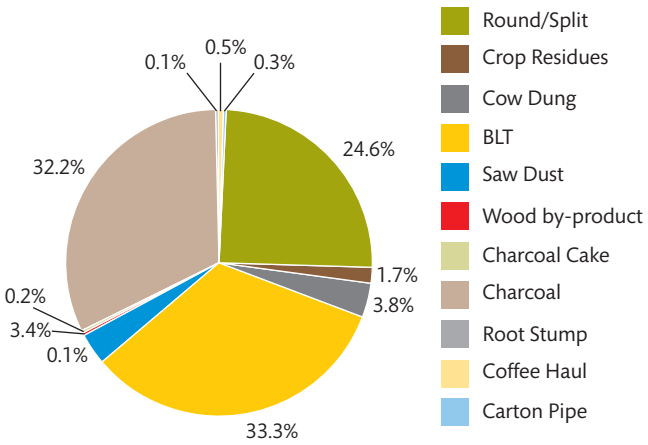
Thus, the forest in Yeka sub-city is in a progressive depletion and degradation state due to land use change of the forest area into housing settlement.

Deforestation

In Addis Ababa tree branches, leaves, twigs (BLT) and charcoal provide the largest proportion of energy derived from biofuels, followed by round/split wood (24.6%; Figure 2).

Remaining biofuels represent 10% of the total biofuel consumption.

Figure 2 Contributions to household energy consumption by biofuel in Addis Ababa.



About 10 500 women in Addis Ababa are currently engaged in fuel wood collection and selling from the forest area. Fuel wood selling was another major threat for forest depletion over the forest area of Addis Ababa.

On the other hand, socio-economic background assessment of the households involved in fuel wood sales indicate that they are living under the poverty line, and are incapable of sustaining their families with their low level of income. Consequently, poverty is another important cause of urban forest degradation. Moreover, besides fuel wood, construction materials such as posts, pole and pillars were also exploited and sold.

Between 2006 and 2007, 71 tree poachers were caught in the Kotebe (59%) and Ankorcha (41%) forest areas. All of the poachers were living within and around a forest area, were male and were between 18 and 35 years in age. Tree poachers use different soundless cutting equipments and the equipment is prepared in a form not to be identified by security personnel. Such conditions make it difficult for forest security personnel to protect the forest from poachers (Figure 3).

In addition to the settlers and fuel wood collectors, illegal tree cutters are also one of the major problems in the forest area environment contributing to the depletion of forest resources within Addis Ababa.

Figure 3 Partial view of equipment used by tree poachers in the upper catchment forest area.

Street trees and associated problems

From six new roads surveyed almost all did not have space for pedestrian tree planting. In some of the newly constructed roads the agency responsible planted the trees badly, which impacted detrimentally on survival. This was due to poor soil structure, aeration and drainage problems caused by compaction. Roots of trees, shrubs and other plants cannot grow optimally in compacted soils. Furthermore, water does not drain well into and through compacted soil. Insufficient oxygen was available to plant roots in the compacted soil. Soil temperature also influenced root growth by reducing the rate of chemical and biological processes.

Infrastructure development

In Addis Ababa most of the underground utility trenching work for telecommunication, sewers and water was not undertaken in a co-ordinated manner. Damage to tree roots occurred during the installation and maintenance of service utilities. Root damage from trenching is not unique to newly developed areas in Addis Ababa, and also occurred in more established communities as a result of maintenance, or installation of utilities, such as fibre-optic lines (Figures 4a–c).

The development of infrastructures such as water lines and tankers, new roads and repair and/or expansion of old roads affected trees found in each area to include household compounds (Table 1). Moreover, no one consulted the owner of the trees while trees were cut, in turn having a negative impact on the future development of the green area and initiating the community to participate in future tree planting.

Figures 4a–c Trenching as a result of telecommunication installation of fibre-optics.

Table 1 Number of trees cleared for infrastructure in the mountain forest area of the city.

No.	Infrastructure reason for cutting of trees	Location	No of trees cleared	
			Indigenous	Exotic
1	Water line	Yeka	0	27
2	Water tanker area	Yeka (Ankorcha)	0	131
3	High tension electric power line	Yeka (Ankorcha)	0	344

Problems with selection of appropriate urban forest species

From the assessment made, it can be observed that most of the trees planted in Addis Ababa do not fulfil any specific selection criteria. For example, no evidence exists to show consideration for factors such as the purpose of the tree (shade, fruit, seasonal colour, windbreak), location of the planting site (overhead and/or below-ground wires, existing utilities), size of tree (i.e. space to accommodate large, medium or small size trees), and existing soil conditions (depth, fertility and structure). Due to the lack of these factors most of the trees planted within the city are facing several problems detrimental to their survival. As a result they do not provide the required environmental, social and economic functions they should. On the other hand, since selection criteria to date focus on flower colour and attractive morphology, they neglect other important characteristics such as a poisonous nature (e.g. *Nerium oleander*) and invasiveness of some species that impact detrimentally on socio-environmental problems and health.

In the survey undertaken it was identified that poisonous plant species such as *Nerium oleander* and *Lantana camara* were planted along roadsides, recreational parks and compounds within the city. Since popular culture is to use plant twigs for tooth brushes, the negative impact of such plants potentially can be high. In recreational parks children may cut and eat plant parts because of their attractive flowers. Consequently, the toxic chemical contained within the petals may affect their long-term health. In addition *Acacia melanoxylon* is one of the dominant species planted along streets and in the forest areas of the city. In 2008 from the total planted exotic tree species in the upper catchments of Addis Ababa 55 939 seedlings were *Acacia melanoxylon* and the survival rate of this species was 75.7%. Since this tree grows quickly and up to 45 m in height, this species can replace native non-tree vegetation, such as grass and shrub land (Geldenhuys, 1986).

Therefore, it is critical to note that maximum benefits are gained from planting the right trees in the right place. Many conflicts can be reduced or avoided by careful planning and by matching tree characteristics to site conditions. As indicated in Table 2 the major motive (72%) to seek permission to cut trees in all sub-cities by the community was to avoid the risk associated with mature trees. Consequently, considering size at maturity and form of the tree crown and root system are important characteristics when planting trees in and around compounds because of potential interference with utility lines, pavements, structures and signsposts.

Table 2 Ranked tree cutting reasons in the sub-cities of Addis Ababa.

No.	Reasons for cutting of trees	1st	2nd	3rd
1	Conflict between neighbourhood	0%	100%	0%
2	To avoid risk caused by the trees	72%	0%	28%
3	For economic reason/utilize	28%	0%	78%

According to the survey made in all the sub-cities of Addis Ababa the major problems created by urban trees are branch shed or whole tree failure damaging houses, buildings, cracking of concrete and interference with above-ground utilities respectively. As indicated in Table 3, all sub-cities rank leaves and branches (57%) as the first and roots (57%) as the second reasons given by individuals for requests to cut down trees planted within their compound.

Table 3 Plant organ ranked as reasons for tree felling request in the sub-cities of Addis Ababa.

No.	Plant organ	Rank by sub-city			
		1st	2nd	3rd	4th
1	Leaves and branches	57%	14.3%	28.5%	0%
2	Root	14.3%	57%	28.5%	0%
3	Stem	28.5%	14.3%	28.5%	28.5%
4	Fruit	0%	14.3%	14.3%	71.4%

Tree roots growing under asphalt or cement pavement can cause the pavement to heave. To alleviate such problems appropriate species selection together with site factors should be given prime consideration. According to Gilman (1997), the planting site should be located at least 3.6 m from a major underground utility line for large trees. *Grevillea robusta*, *Jacaranda mimosifolia*, *Cuperssus lusitanica*, *Casuarina equisetifolia* and *Acacia abyssinica* planted along roads within Addis Ababa can come into contact with electric wires. Tall-growing trees near overhead lines can

cause service interruptions when trees reach a certain height. Appropriate selection and placement of trees in and around overhead utilities can eliminate potential public safety hazards, reduce expenses for utilities and improve the appearance of landscapes.

According to Gilman (1997), for sites which have above-ground utility lines then selection of small species that will 'top out' at least 1.5 m below the wire are important, or selection of a species with a narrow crown planted so that it will not grow into a utility line.

Diversity of tree species within different green areas

Diversity of tree species along major roads

The present study indicated that the proportion of indigenous tree species planted along streets is between 10 and 40% whereas the proportion of exotic tree species ranged between 60 and 84%. The contribution of urban forest in conserving indigenous trees of Ethiopia or adopting indigenous species for ornamentation is low (Table 4). Moreover, though the exotic tree species are contributing towards the green cover of the city, these species have not had sufficient time adaptation to the ecology of the city so face their own problems (e.g. *Cupressus lusitanica* affected by severe aphid infection).

Table 4 Tree species along five major streets in Addis Ababa.

No.	Street	Tree species		Proportion of indigenous tree as %
		Exotic	Indigenous	
1	Megenanga to 22	18	3	14.3
2	Legehar to Piazza	13	3	18.8
3	Piazza to Semen Hotel	16	4	20.0
4	Sidis Kilo to Meskel Square	18	11	37.9
5	Meskel Square to Bole	13	4	23.5

As shown in Table 5 the diversity of tree species along the streets of Addis Ababa is 0.4064, indicating that the contribution of street trees towards diversity is very low and that most of the streets have similar tree species composition. This may impact on urban flora diversity and also if disease outbreak occurs in one street it will detrimentally affect all trees found in the other streets.

Table 5 Diversity of street trees in Addis Ababa.

No.	Name	Mean	Stand.Dev.	Sum	D`
1	STREET1	3.333	8.165	20.0000	0.0000
2	STREET2	7.000	8.944	42.0000	0.6066
3	STREET3	43.000	67.510	258.0000	0.4910
4	STREET4	2.667	6.532	16.0000	0.0000
5	STREET5	7.000	14.297	42.0000	0.2540
6	STREET6	5.000	6.000	30.0000	0.6333
7	STREET7	14.333	21.454	86.0000	0.5222
8	STREET8	3.500	2.811	21.0000	0.7438
Averages		**10.73**	**16.96**	**64.37**	**0.4064**

D = Simpson`s diversity index for infinite population = 1 - sum (Pi*Pi), where Pi is the fraction of individuals belonging to the i-th species.

Six tree species were identified that densely covered the eight surveyed streets (Table 6). Diversity is important in any urban forest ensuring that entire urban canopies are not destroyed by problems such as aphid infestation which wiped-out *Cuppurssus lusitanica* in Addis Ababa when this species was overplanted as a hedge.

Table 6 Commonly planted tree species in eight streets located within Addis Ababa.

No.	Species	Number of tree stems
1	*Acacia melanoxylon*	97
2	*Casuarina cunninghamiana*	46
3	*Grevillea robusta*	263
4	*Jacaranda mimosifloia*	66
5	*Phoenix reclinata*	35
6	*Spathodeia nilotica*	8

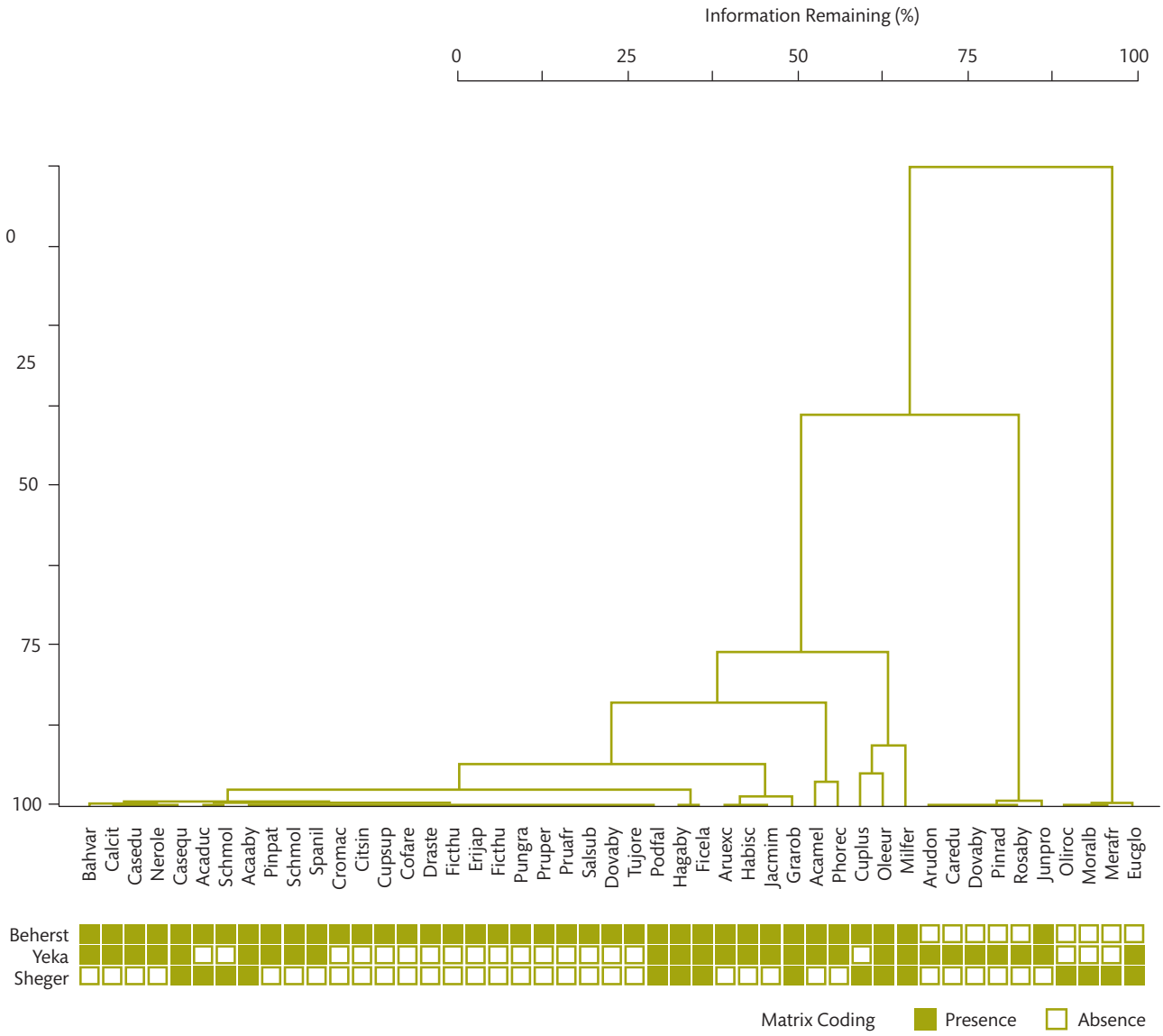
Out of the six tree species in Table 6, *Grevillea robusta*, *Jacaranda mimosifolia* and *Acacia melanoxylon* are distributed widely in the city. This limited diversity of species may have negative impacts on the survival of dominant species where outbreaks of disease and pest attack are recorded to which these trees are vulnerable.

Diversity of species in three functional parks

Beherstige Park had a higher number of tree species than Yeka Park while Sheger Park has the lowest number of tree species (Figure 5).

Yeka Park had similar proportions of indigenous and exotic species. On the other hand the density of exotic tree species

Figure 5 Diversity of species in three functional parks (Beherstige,Yeka, Sheger).



in Yeka, Sheger and Beherstige was (74.7%), (66.7%) and (72.1%) respectively. This indicates that the density of exotic tree species is higher than the indigenous tree species in these parks (Table 7).

Eucalyptus globulus was found dominantly in the upper catchment's forest area of the city. *Juniperus procera* is a naturally grown indigenous tree species found growing next to *Eucalyptus globulus* in forest areas. As indicated in Table 8, 62.8% of forest cover was by exotic tree species. Cities such as Kuala Lumpur, Rio de Janeiro and Singapore (Chin and Corlett, 1986; El Lakany, 1999; Webb, 1999) still have tracts of tropical rainforest within their boundaries. These examples indicate that there should be a strong intervention by planting indigenous tree and reducing the number of exotic tree species to attain indigenous tree conservation zones.

Table 7 Type and density of exotic and indigenous tree species in four parks.

No.	Park	Type of species		No of individual trees (density)		
		Exotic	Indigenous	Exotic	Indigenous	% density of exotic
1	Gola	8	9	-	-	
2	Yeka	12	12	635	215	74.7
3	Sheger	14	19	200	99	66.7
4	Beherstige	26	16	2800	1080	72.1

Table 8 Upper catchment forest covers by area.

No.	Forest type	Area covered (ha)
1	Exotic species	2828.3
2	Mixed exotic and indigenous	1224
3	Indigenous species	535
Total		**4500**

Diversity of tree species at household premises

Table 9 presents the most common tree species found on households' land in Addis Ababa. Other species were identified but not listed in Table 9 as they represented less than 1% of the total tree population. As indicated in Table 9 the commonest exotic tree species recorded was *Cupressus lusitanica*. However, this species is highly susceptible to attack by aphids that in turn have impacted on the attitude of tree planting among the communities around their gardens.

As shown in Figure 6 and Table 10 the largest age group of trees found at household level was between 31 and 40 years. This indicates that planting of trees is decreasing at a household level (i.e. a low proportion of trees at lower age classes and a high proportion of trees at a higher age class). To maintain city tree coverage a high proportion of trees at a lower age class and a low proportion of trees at a higher age class need to be planted.

Table 9 Most common tree species found on house holders land in Addis Ababa.

Species	Total number of trees	Proportion of trees
Cupressus lusitanica	2112	27.1%
Dovyalis abyssinica	1474	18.9%
Juniperus procera	1443	18.5%
Vernonia amygdalina	751	9.6%
Eucalyptus camaldulensis	494	6.3%
Eucalyptus globulus	216	2.8%
Juniperus sp.	133	1.7%
Eucalyptus sp.	124	1.6%
Eucalyptus citriodora	100	1.3%
Ensete ventricosum	92	1.2%
Other species	853	10.9%
Total	**7792**	**100.0%**

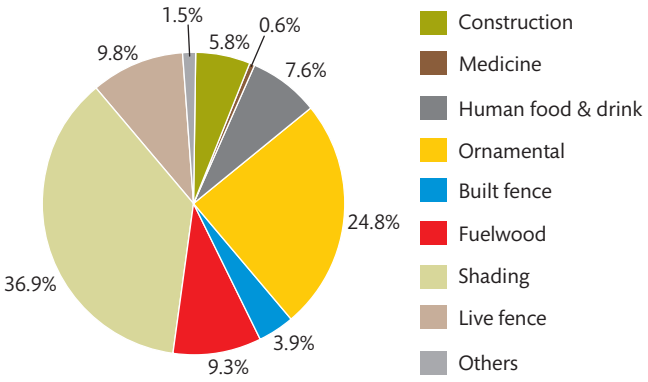
Figure 6 Proportion of households with trees by age group.

Table 10 Total, average number and age distribution of trees of households owning trees.

Total and average number of trees for tree owners					Total and average number of trees for tree owners
	(0 to 10 yrs)	(11 to 20 yrs)	(21 to 30 yrs)	(31 to 40 yrs)	
Total	1437	2221	1872	2262	7792
Average	4.1	6.4	5.4	6.5	22.4

As indicated in Figure 7, the highest proportion of trees planted at household level is used primarily for shade (36.9%) and ornamental purposes (24.8%). Consequently, to encourage tree planting at a household level tree species used for shading and ornamental purposes should be grown and distributed. Moreover, awareness creation should be made among the community to plant other multipurpose tree species such as *Prunus africana*, *Ekbergia capensis*, *Podocarpus falcatus* and *Hypericum revolutum* to enhance tree coverage, diversity and subsequent benefits.

Figure 7 Tree uses by households in Addis Ababa.



Endemic and threatened woody species in the urban forest

The survey revealed that the urban forest of Addis Ababa is known to encompass 12 individual woody species of threatened and endemic plants of the country. These species are registered under a different category in the red list species. Species found in a red list are categorized as vulnerable, threatened or endangered. *Prunus africana*, a important medicinal tree species used to manufacture pharmaceuticals for the treatment of prostate cancer, has been found in churches and parks as well as naturally grown individual trees in the upper catchment forest area. This species has been registered in appendix II of the red data list by the Convention on Trade in Endangered Species (CITES).

Endemic species such as *Millettia ferruginea* are also an important component of the urban forest within Addis Ababa (Table 11). At present *Solanecio gigas* has been observed in a few remote and less developed areas of the city as a hedge mix with other species such as *Justicia schimperiana*. The conversion of hedge to concrete fences is aggravating the extinction of species such as *Solanecio gigas* which was once commonly found as a living fence in the forest area of the city.

Medicinal woody plant species within Addis Ababa

Many species of medicinal plants are used in Addis Ababa, more than any other part of the country. Although many types of medicinal plant species are brought in from different agro-climatic zones of the country, a number of herbaceous, shrubby and tree species growing in the city are extensively used.

In addition to the use of existing medicinal plants to treat a wide range of health problems, traditional healers are also extensively using these plants for commercial purposes. This is due to the presence of large number of inhabitants in the city as well as migration of people with different cultures from different regions of the country. Such conditions enable the occurrence of diverse traditional knowledge in the use of medicinal plants. Furthermore, the accessibility of greater numbers of commercial traditional healers and modern medical facilities in the city has also contributed to the wider use of medicinal plants. Consequently, patients all over the country visit the city to receive these medicinal treatments. As a result, most of the identified woody medicinal plants are under severe threat as traditional healers are obligated to exhaustively use these once readily available but now scarce plants.

Though the medicinal value of these plants is well known, they are utilized in unsustainable ways. For instance, roots of *Carissa spinarum*, *Vernonia amygadalina*, *Bersama abyssinica*, *Olea europea*, *Meas lanceolata* and *Clausena aniseta* are used for the treatment of gastric ulcers, intestinal upsets, haemorrhoids, jaundice and infulenza. However, removing the root of a plant is a cause of whole plant death. Similarly, removing the leaves of plants affects photosynthetic ability and respiration, which in turn reduces survival of the plant. Some representative examples of parts of the plant used to treat health problems are presented in Table 12.

As shown in Table 13, in most church-yards more than 50% of tree species are exotic. Indigenous trees are often few in diversity and number. The dominant tree in all churches is the exotic *Cuprresus lusitanica* and the dominant indigenous tree is *Juniperus procera* followed by *Olea europea* subsp. *cuspidata*. Remaining indigenous trees are only one or two in number.

Table 11 Endemic and/or threatened woody species of Addis Ababa.

No.	Species	Family	Common name
1	*Inula confertiflora* A.Rich	Asteraceae	Wonagift
2	*Maytenus addat* (Loes.) Sebsebe	Celastraceae	Atat
3	*Rhus glutinosa* A. Rich. subsp. *glutinosa*	Anacardiaceae	Embus
4	*Rubus erlangeri* Engl.	Rosaceae	Yechaka enjori
5	*Echinops ellenbekii* O. Hoffm.	Asteraceae	Kosheshila
6	*Echinops longisetus* A.Rich	Asteraceae	Qeilo
7	*Erythrina brucei* Schweinf.	Fabaceae	Korch
8	*Solanecio gigas* (Vatke) C. Jefferey	Asteraceae	Yeshikoko Gomen
9	*Lippia adoensis* Hochst ex. Walp.	Verbenaceae	Kessie
10	*Millettia ferruginea* (Hochst.) Bak. subsp. *ferruginea*	Leguminaceae	Birbira
11	*Prunus africana* (Hook.F.) Kalkm	Rosaceae	Tikur Enchet

Table 12 Some medicinal woody species found in the city and the parts used to treat different health problems.

Species	Parts used	Disease treated
Ficus thonningii	Bark and root bark	Wounds, cold and influenza
Carissa spinarum	Root Leaf and the seed	With goat milk used to treat gastric ulcer and chest complaints Tooth ache
Vernonia amygadalina	Roots and stem Bark of young twigs	Intestinal upset Appetizer
Cordia africana	Roots and fruits	Ascaris
Croton macrostachus	Fruits and root Roots	Venereal diseases Purgative and malaria
Bersama abyssinica	Roots	Ascaris and rabies
Olea europea subsp. cuspidate	Roots	Haemorrhoids and intestinal complaints
Hagenia abyssinica	Female flowers	Remove tape worm
Maesa lanceolata	Root	Jaundice
Clausena aniseta	Root	Ascaris and influenza
Dodonaea angustifolia	Root and leaves	Hemorrhoids and wound dressing

Table 13 Diversity of woody species in six inner city churches.

No.	Church	Exotic	Indigenous	Total
1	Silase Arat kilo	13	9	22
2	Saint George (Pissa)	8	8	16
3	Saint Merry (Amist kilo)	7	10	17
4	Peteros paulos	6	14	20
5	Bole Medhanialem	17	13	30
6	Kechene Medehanialem	8	8	16

During the assessment it was observed that the existing indigenous trees are aged and some only have a limited lifespan. Some species of aged trees become susceptible to natural hazards such as strong winds, storms and flooding. Old trees therefore need to be replaced by new indigenous tree seedlings to improve the metropolitan environment.

Awareness level of the community

As illustrated in Table 14, rows 2 and 3, 67.7% of the respondents agreed that a urban forest located within their vicinity is considered as a place for sexual violence or hiding place for criminals. These facts discourage the community in and outside the forest to contribute to planting and protecting the tree from illegal cutting. Olembo and De Rham

Table 14 Social problem assessment on urban forest area.

No.	Social problems	Respondents' category				Total	
		In the forest		Outside the forest			
		Frequency	%	Frequency	%	Frequency	%
1	As a physical threat to human safety	8	5.9	6	4	14	4.9
2	A hiding place for criminals	46	34.1	45	30	91	31.9
3	A place for sexual violence	52	38.5	50	33.3	102	35.8
4	A place for dumping industrial waste	2	1.5	4	2.7	6	2.1
5	A place for dumping domestic waste	1	0.7	0	0	1	0.4
6	Attracting dangerous wild animals	0	-	2	1.3	2	0.7
7	(2,3)	9	6.7	13	8.7	22	7.7
8	(1,2,3)	3	2.2	15	10	18	6.3
9	Has no problem	14	10.4	15	10	29	10.2
Total		**135**	**100**	**150**	**100**	**285**	**100**

(1987) stated that in most development endeavours the active participation of the concerned was the key to success. Thus, strong awareness creation and controlling criminals and sexual violence in the forest area should be given a higher priority.

Conclusions

1. Encroachment by new settlement and removal of trees for various purposes is affecting the green coverage of Addis Ababa at an alarming rate. This problem is accelerated by low legal enforcement. Residents in Addis Ababa are poor. The use of forest products for fuel wood and to supplement income is high. There is also a serious lack of public awareness about the necessity and the environmental, social and economic benefits of trees. Consequently, the poor do not hesitate to cut down trees.
2. The selection of tree species for different purpose in the city has been poorly undertaken in the past. This has resulted in poor growth and a detrimental impact on infrastructure development. These problems are also due to lack of urban forest development guidelines for the city.
3. The contribution of the urban forest for floristic diversity was low since most of the plant species planted in the city area were uniform and focused on exotic species.
4. Although awareness creation is ongoing by different stakeholders to rehabilitate and develop urban forest in the city, there is a need for further awareness creation focused towards decision makers and the general public at all levels in order to develop and manage the forest resource.

Recommendations

In order to have a sustainable urban forest in Addis Ababa the following recommendations are proposed:

- Guidelines to develop and manage the urban forest should be formulated.
- Intensive capacity-building programmes for concerned stakeholders should be carried out.
- Upper catchment management plans which benefit both regions should be developed to ameliorate the problem of boundary impact.
- Up-to-date comprehensive inventories of urban forests and tree resources across various ownerships in the city should be performed with a common inventory methodology.
- Development and construction authorities need to consult with the City Administration Environmental Protection Authority on activities impacting on forest resources.
- Environmental impact assessment procedures should be followed and improved cross-sectoral linkages and joint enforcement of environmental laws and standards should occur.
- Landscape proposals should be prepared for all development applications including housing, commercial, institutional and industrial development and given to the green area regulatory body.
- Further buffer zone encroachments should be controlled through strong legal enforcement. Frequent awareness creation programmes should be conducted for the sub-city and Kebele officials to reduce encroachment through using local level decision makers.
- A greater selection of appropriate species for roadside plantations and public gardens should be made.
- Involvement of stakeholders should be encouraged by concerned government offices.

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