Potentials of cemeteries as urban tree conservation areas in Ibadan metropolis

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Abstract

A cemetery, because of its presumed sanctity, is less disturbed from other land use activities in the urban areas and thus serves in many cases as the last remnant for greenery and conservation of trees in many large cities. However, there is little information on the population, diversity and management of trees in cemeteries located in the Ibadan metropolis. Therefore, this study was carried out to determine the potentials of cemeteries as urban tree conservation areas. Eight cemeteries under different management within the metropolis were sampled and their tree species composition, density and population determined. Their land areas were also determined and the trees, classified based on their origin and uses. The size of the cemeteries ranged from 0.03 – 0.48 km^2. There were 48 tree species from 22 different families represented in the eight cemeteries, with 28 of these species indigenous to the lowland rainforest ecosystem. Fabaceae family had the highest species representation. Cemeteries under government and institutional management had a larger representation of trees than the private and religious ones, with the highest number of trees (399) found in the Ibadan South East Cemetery, Orita-Aperin which had a tree density of 0.014 m^{-2}. The University of Ibadan cemetery recorded the highest species composition (28) with a tree density of 0.03 m^{-2}. *Albizia zygia* had the highest number of identified uses (15), while shade and shelter were the most common attributes of trees in the cemeteries. They could assist in the preservation of tree genetic diversity and serve as botanic refuge for many threatened species. Therefore, management of modern city cemeteries require enlightenment on the conservation role such facilities could play in urban areas.

Keywords: graveyards, tree population, urban trees, threatened species, internment

Introduction

Urban trees are mostly planted or naturally occurring in collective masses within the boundaries of cities, towns or neighborhoods. These locations include natural woodlands, urbanized zones, suburban or peri-urban areas, playgrounds, parks and reserves, along roads and highways, yards and home gardens, public buildings, as well as, cemeteries (Miller, 1997; Wiseman, 2010; Ajewole *et al.*, 2013). Cemeteries provide environmental functions and services, serving as places of deposit and transformation of dead bodies without the process posing a danger to public health and safety. They have diverse symbolic, religious, philosophical and artistic interpretations for various disciplines such as theology, history, arts and anthropology. However, they are beginning to gain prominence as "ecological areas" or potential green areas particularly in urban planning or ecology. This ecosystem services become pertinent with the increasing reduction in available green spaces in many cities (Fogli, 2004; Uslu *et al.*, 2009; Hemmat *et al.*, 2012). This role is even more relevant because the rapid rate of urbanization, economic development and increasing human populations have made cemeteries which were formerly on the outskirts of cities and suburbs, to become integrated and entangled with inhabited areas. Consequently, cemeteries are not just places of internment; they are providing unique ecological services that extend beyond their primary role as sites for burial and remembrance (Henderson, 2012). They constitute organic links that connect urban green areas and ecological corridors. More so, ecological considerations are relevant in the planning, design and management of cemeteries (Uslu *et al.*, 2009).

As cities expand and available growing space become limited, the argument in favour of cemeteries as green areas becomes stronger with most urban areas continually experiencing a loss of tree diversity and population. Urban trees are exposed to threats such as vandalism, negative human perceptions, pressure of infrastructural development; including the conflict between managing these areas for tree diversity conservation and the 'neat and tidy' approach that severally and collectively results in reduced tree population in the urban area. There is therefore a need to evolve innovative strategies by which tree population and diversity can be enhanced in the society (Hemmat *et al.*, 2012; Ajewole *et al.*, 2013; Olajuyigbe *et al.*, 2013). Many people in the developing countries depend on trees for food, domestic energy, shelter, medicine and income. Urban trees also provide life support services such as carbon sequestration, air purification, erosion control and watershed protection. Cemeteries represent in many cases the last remnants of greenery in some large cities providing habitats, food and suitable nesting places for some bird species adapted to urban conditions (McBarron *et al.*, 1988; Kocian *et al.*, 2003; Hemmat *et al.*, 2012).

Although there is public interest in the historical relevance of cemeteries, little effort has been put into evaluating their potential ability to conserve plant biodiversity especially of trees. Hence, there is a dearth of information on the diversity and population of trees in most cemeteries. This coupled with the increase in modern cemeteries managed by private and religious organizations make it necessary that the important role cemeteries

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can play in urban tree conservation is not jettisoned to the rear in favour of profit making. Thus, this study examined the tree species diversity and population in eight selected cemeteries found in Ibadan metropolis and discussed the potential of these sites as protected habitats for urban trees, since cemeteries have little or no land use pressure which characterizes the urban centres.

Methodology

Ibadan metropolis, in Oyo state, is located between latitude 7° 16′N and 7° 75′N and also longitude 3° 31′E and 4° 3′E in the south western part of Nigeria. The city is about 3,080 km², approximately 128 km inland northwest of Lagos and 530 km southwest of Abuja. Ibadan is a large metropolitan area in Nigeria with a population of 1,338,659 (based on 2006 census) and is dominated majorly by the 'Yoruba' people (Tomori, 2010). Eight cemeteries, cutting across diverse ownership structures, were purposively selected for the study. Table 1 and Figure 1 show the size, ownership and geographical locations of the selected cemeteries in the metropolis, respectively. The ownership of these cemeteries could be categorized into public (government owned), private (religious and commercial) and institution based. All trees within each cemetery were counted, identified to species and family levels and then classified either as native or exotic species. The tree density in each cemetery was calculated using Eqn. 1.

$$Tree\ density\ (m^{-2}) = \frac{Total\ number\ of\ trees\ in\ cemetery}{Total\ area\ of\ cemetery} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ 1$$

Table 1: Location, size and ownership structure of the sampled cemeteries in the Ibadan metropolis

Name	Longitude E	Latitude N	Area (km²)	Ownership structure
All Souls Church Cemetery, Ido	3°77.92'- 3°77.94'	7°47.73'- 7°47.78'	0.03	Religious/Private
Ibadan Military Cemetery, Jericho	3°86.46'- 3°8.59'	7°39.72'- 7°39.76'	0.13	Government/Private
Ibadan North Cemetery, Sango	3°89.57'- 3°89.59'	7°41.39'- 7°41.78'	0.48	Government/Public
Ibadan South-East Cemetery, Orita-Aperin	3°91.66'- 3°91.69'	7°36.67'- 7°36.83'	0.28	Government/Public
Islamic Cemetery, Bokusoro, Shasha	3°90.47'- 3°90.53'	7°48.15'- 7°48.18'	0.016	Religious/Private
St James Cathedral Cemetery, Oke bola	3°88.12'- 3°88.07'	7°38.16'- 7°38.05'	0.03	Religious/Private
St Stevens Church Cemetery, Inalende	3°89.27'- 3°89.39'	7°39.52'- 7°39.49'	0.048	Religious/Private
University of Ibadan Cemetery	3°89.57'- 3°89.59'	7°44.89'- 7°44.92'	0.06	Government/Private

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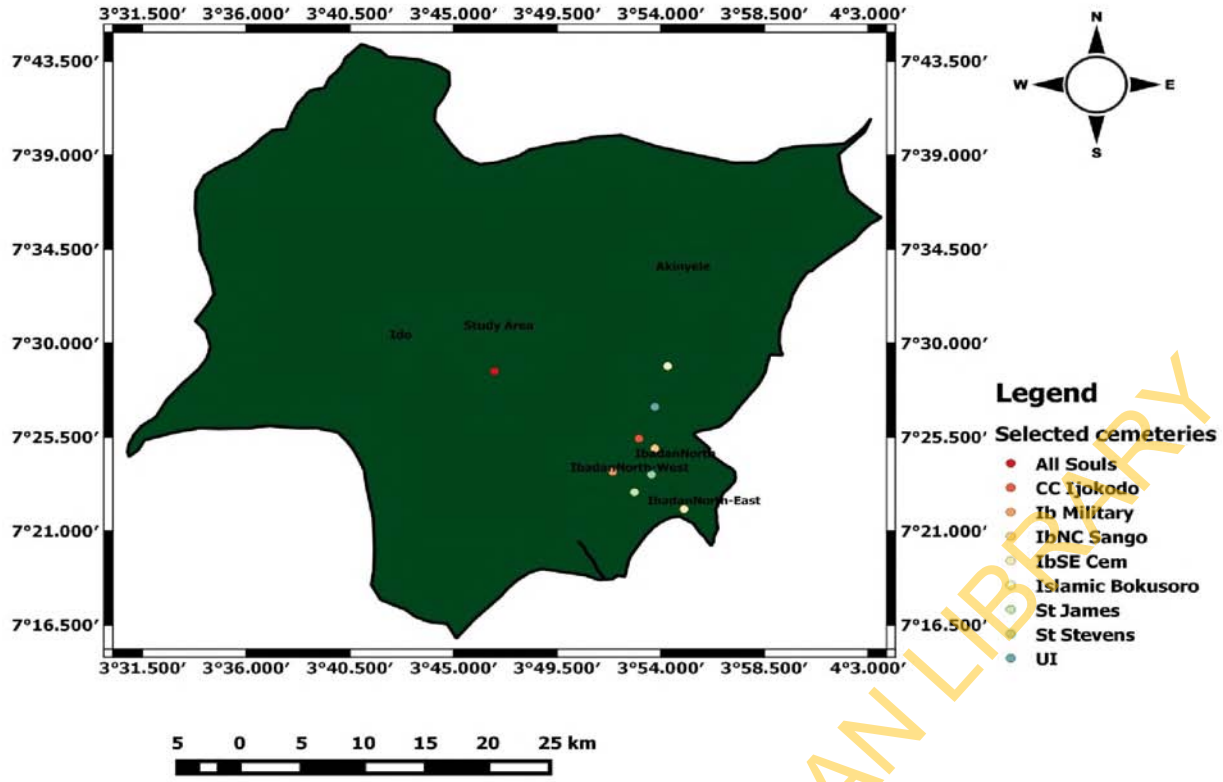

Figure 1: Map indicating the location of the selected cemeteries in the Ibadan metropolis

Results

A total of 48 tree species from 22 different families were observed in the eight cemeteries. Twenty eight of these species were native to the lowland rainforest ecosystem (Table 2). The Fabaceae family had the highest species representation, while *Delonix regia* (130 trees), found in Ibadan North Cemetery had the highest number of individuals (Table 3). The government and institution owned cemeteries had a larger representation of trees than the religious/private ones. The highest number of trees (399) was found in the Ibadan South East Cemetery, Orita-Aperin (Fig. 2), which had a tree density of 0.014 m^{-2}. However, the University of Ibadan Cemetery had the highest number of tree species (28), and contributed the highest tree density (0.033 m^{-2}) among all the sampled cemeteries (Fig. 3). The University of Ibadan also had the highest number of native species (19) while St Stevens Cemetery had only planted exotic species (5). Whereas, All Souls Cemetery, Ido had the lowest number of species (3), even though its tree density was not different from that of the Ibadan Military Cemetery (0.007 m^{-2}) which had 16 tree species growing on it (Table 3). Ibadan North Cemetery, Sango was the largest in size (0.48 km^2) and had the second largest number of trees (388) among all the sampled sites (Fig. 2). Most of the tree species provide multiple products (food, fibre, fodder, latex, timber etc.) as well as service functions (shade, nitrogen fixing, ornamental, soil improvement) to the environment (Table 4). *Albizia zygia,* was documented to have 15 known uses while *Morus mesozygia* had 14. Generally the privately owned cemeteries had a low population and diversity of trees with exotic species dominating these landscapes (Table 3). On the other hand, a wide range of tree species occurred in government owned cemeteries which were less disturbed.

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Table 2: Tree species diversity in cemeteries located within the Ibadan metropolis.

S/N	Species	Origin	Local names	Family
1	*Acacia equisetifolia* Maslin & Cowie	Exotic	Acacia	Fabaceae
2	*Albizia adianthifolia* (Schum) W. F. Wight	Native	West African Albizia	Fabaceae
3	*Albizia saman* F. Muell.	Exotic	Rain tree	Fabaceae
4	*Albizia zygia* (DC.) Macbr.	Native	Ayin rela	Fabaceae
5	*Alstonia boonei* De Wild.	Native	Alstonia	Apocynaceae
6	*Anacardium occidentale* L.	Exotic	Cashew	Anacardiaceae
7	*Annona senegalensis* Pers.	Native	Wild sour sop	Annonaceae
8	*Annona squamosa* L.	Exotic	Sugar apple fruit	Annonaceae
9	*Antiaris toxicaria* Leschenault	Native	Antiaris	Moraceae
10	*Azadirachta indica* A. Juss.	Exotic	Neem tree	Meliaceae
11	*Blighia sapida* Konig.	Native	Akee apple	Sapindaceae
12	*Calytrix* spp.	Exotic	Fringe myrtle	Myrtaceae
13	*Cassuarina equisetifolia* L.	Exotic	Ironwood	Casuarinaceae
14	*Chrysophyllum albidium* G. Don	Native	White star apple	Sapotaceae
15	*Citrus reticulata* Blanco.	Exotic	Dancy tangerine	Rutaceae
16	*Citrus sinensis* (L.) Osbeck	Exotic	Sweet orange	Rutaceae
17	*Cola millenii* K. Schum	Native	Monkey cola	Sterculiaceae
18	*Croton macrostachyus* Hochst.	Native	Broad-leaved croton	Euphorbiaceae
19	*Delonix regia* Hook. (Raf.)	Exotic	Flamboyant flame tree	Fabaceae
20	*Elaeis guineensis* Jacq.	Native	African oil palm	Arecaceae
21	*Ficus exasaperata* Vahl.	Native	Forest sandpaper fig	Moraceae
22	*Ficus lutea* Vahl-Fl.	Native	Lagos rubber tree	Moraceae
23	*Gliricidia sepium* (Jacq.) Walp.	Exotic	Gliricidia	Fabaceae
24	*Gmelina arborea* Roxb.	Exotic	Gmelina	Verbenaceae
25	*Holarrhena floribunda* (G.Don.) Dur. & Schinz	Native	False rubber tree	Apocynaceae
26	*Jatropha curcas* L.	Exotic	Fig nut	Euphorbiaceae
27	*Khaya senegalensis* (Desr.) A. Juss.	Native	African mahogany	Meliaceae
28	*Lophira alata* Banks ex Gaertn.	Native	Ekki	Dipterocarpaceae
29	*Mangifera indica* L.	Native	Mango	Anacardiaceae
30	*Margaritaria dicoidea* (Baill.) Webster	Native	Common pheasant berry	Euphorbiaceae
31	*Millettia thoningii* (Schum. & Thonn.) Baker	Native	Turburku fruit	Fabaceae
32	*Morinda lucida* Benth.	Native	Brimstone tree	Rubiaceae
33	*Morus mesozygia* Stapf.	Native	African mullberry	Moraceae
34	*Newbouldia laevis* P. Beauv.	Native	African Border tree	Bignoniaceae
35	*Peltophorum pterocarpum* (DC.) Backer ex Heyne	Exotic	Yellow flame	Fabaceae
36	*Pinus caribea* Morelet	Exotic	Honduras yellow pine	Pinaceae
37	*Plumeria rubra* Linn.	Native	Frangipani	Apocynaceae
38	*Polyathia longifolia* (Sonnerat) Thwaites	Exotic	Indian mast tree	Annonaceae
39	*Psidium guajava* L.	Exotic	Guava	Myrtaceae
40	*Psydrax parviflora* (Afzel.) Bridson	Native	Canthium	Compositae
41	*Pycnanthus angolensis* (Welw.) Warb.	Native	African nutmeg	Myristicaceae
42	*Rauvolfia vomitoria* Afzel.	Native	Swizzle stick	Apocynaceae
43	*Senna siamea* (Lamarck) Irwin et Barneby	Exotic	Black-wood cassia	Fabaceae
44	*Spondias mombin* L.	Native	Mombin plum	Anacardiaceae
45	*Tectona grandis* Linn F.	Exotic	Teak	Verbenaceae
46	*Terminalia catappa* L.	Exotic	Tropical almond	Combretaceae
47	*Trichilia monadelpha* (Thonn.)	Native	Mafura nut	Meliaceae
48	*Triplochiton scleroxylon* Schumann	Native	Obeche	Sterculiaceae

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Table 3: Frequency distribution of tree species in selected cemeteries in the Ibadan metropolis

S/N	Species	Number of trees	Frequency (%)
All Souls Cemetery, Ido			
1	*Citrus sinensis*	4	19.05
2	*Elaeis guineensis*	2	9.52
3	*Polyathia longifolia*	15	71.43
Ibadan Military Cemetery, Jericho			
1	*Acacia equisetifolia*	1	1.15
2	*Annona squamosa*	9	10.34
3	*Azadiractha indica*	12	13.79
4	*Cassuarina equisetifolia*	1	1.15
5	*Citrus reticulata*	1	1.15
6	*Croton spp*	1	1.15
7	*Delonix regia*	3	3.45
8	*Elaeis guineensis*	13	14.94
9	*Ficus exasperata*	1	1.15
10	*Magnifera indica*	3	3.45
11	*Newbouldia laevis*	4	4.60
12	*Peltophorum pterocarpum*	1	1.15
13	*Pinus caribaea*	10	11.49
14	*Psidium guajava*	12	13.79
15	*Tectona grandis*	12	13.79
16	*Terminalia catappa*	3	3.45
Ibadan North Cemetery, Sango			
1	*Albizia zygia*	10	2.58
2	*Albizia saman*	2	0.52
3	*Anacardium occidentale*	1	0.26
4	*Azadirachta indica*	8	2.06
5	*Psydrax parviflora*	4	1.03
6	*Delonix regia*	130	33.51
7	*Ficus exasperata*	18	4.64
8	*Gliricidia sepium*	109	28.09
9	*Khaya senegalensis*	2	0.52
10	*Mangifera indica*	32	8.25
11	*Millettia thoningii*	4	1.03
12	*Morinda lucida*	40	10.31
13	*Newbouldia laevis*	14	3.61
14	*Pycnanthus angolensis*	1	0.26
15	*Spondias mombin*	9	2.32
16	*Tectona grandis*	4	1.03
Ibadan South-East, Orita-Aperin			
1	*Azadiractha indica*	9	2.26
2	*Psydrax parviflora*	13	3.26
3	*Citrus sinensis*	1	0.25
4	*Delonix regia*	64	16.04
5	*Ficus exasperata*	28	7.02
6	*Gliricidia sepium*	105	26.32
7	*Margaritaria dicoidea*	2	0.50
8	*Morinda lucida*	42	10.53
9	*Newbouldia laevis*	15	3.76
10	*Peltophorum pterocarpum*	1	0.25
11	*Rauvolfia vomitoria*	13	3.26
12	*Senna siamea*	106	26.57

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Islamic Cemetery, Bokusoro, Shasha			
1	*Azadiractha indica*	12	75
2	*Chrysophyllum albidium*	2	12.5
3	*Elaeis guineensis*	1	6.25
4	*Psidium guajava*	1	6.25
St. James Cathedral Cemetery, Oke bola			
1	*Albizia adianthifolia*	4	3.31
2	*Albizia saman*	25	20.66
3	*Alstonia boonei*	14	11.57
4	*Annona senegalensis*	5	4.13
5	*Antiaris toxicaria*	8	6.61
6	*Ficus spp*	5	4.13
7	*Gliricidia sepium*	12	9.92
8	*Lophira alata Banks ex Gaertn.*	3	2.48
9	*Morinda lucida*	18	14.88
10	*Peltophorum pterocarpus*	6	4.96
11	*Pycnanthus angolensis*	8	6.61
12	*Spondias mombin*	13	10.74
St. Steven's Cemetery, Inalende			
1	*Albizia saman*	5	20
2	*Azadiractha indica*	8	32
3	*Citrus sinensis*	3	12
4	*Delonix regia*	5	20
5	*Gliricidia sepium*	4	16
University of Ibadan Cemetery			
1	*Albizia saman*	4	2.04
2	*Albizia zygia*	2	1.02
3	*Alstonia boonei*	5	2.55
4	*Antiaris toxicaria*	4	2.04
5	*Azadiractha indica*	19	9.69
6	*Blighia sapida*	5	2.55
7	*Calytrix spp*	2	1.02
8	*Psydrax parviflora*	6	3.06
9	*Cola millenii*	1	0.51
10	*Delonix regia*	27	13.78
11	*Ficus exasaperata*	3	1.53
12	*Ficus lutea*	4	2.04
13	*Gliricidia sepium*	17	8.67
14	*Gmelina arborea*	1	0.51
15	*Holarrhena floribunda*	4	2.04
16	*Jatropha curcas*	2	1.02
17	*Magnifera indica*	3	1.53
18	*Morinda lucida*	1	0.51
19	*Morus mesozygia*	4	2.04
20	*Newbouldia laevis*	14	7.14
21	*Peltophorum pterocarpum*	11	5.61
22	*Plumeria rubra*	1	0.51
23	*Pycnanthus angolensis*	5	2.55
24	*Rauvolfia vomitoria*	4	2.04
25	*Senna siamea*	42	21.43
26	*Spondias mombin*	2	1.02
27	*Trichilia monadelpha*	1	0.51
28	*Triplochiton scleroxylon*	2	1.02

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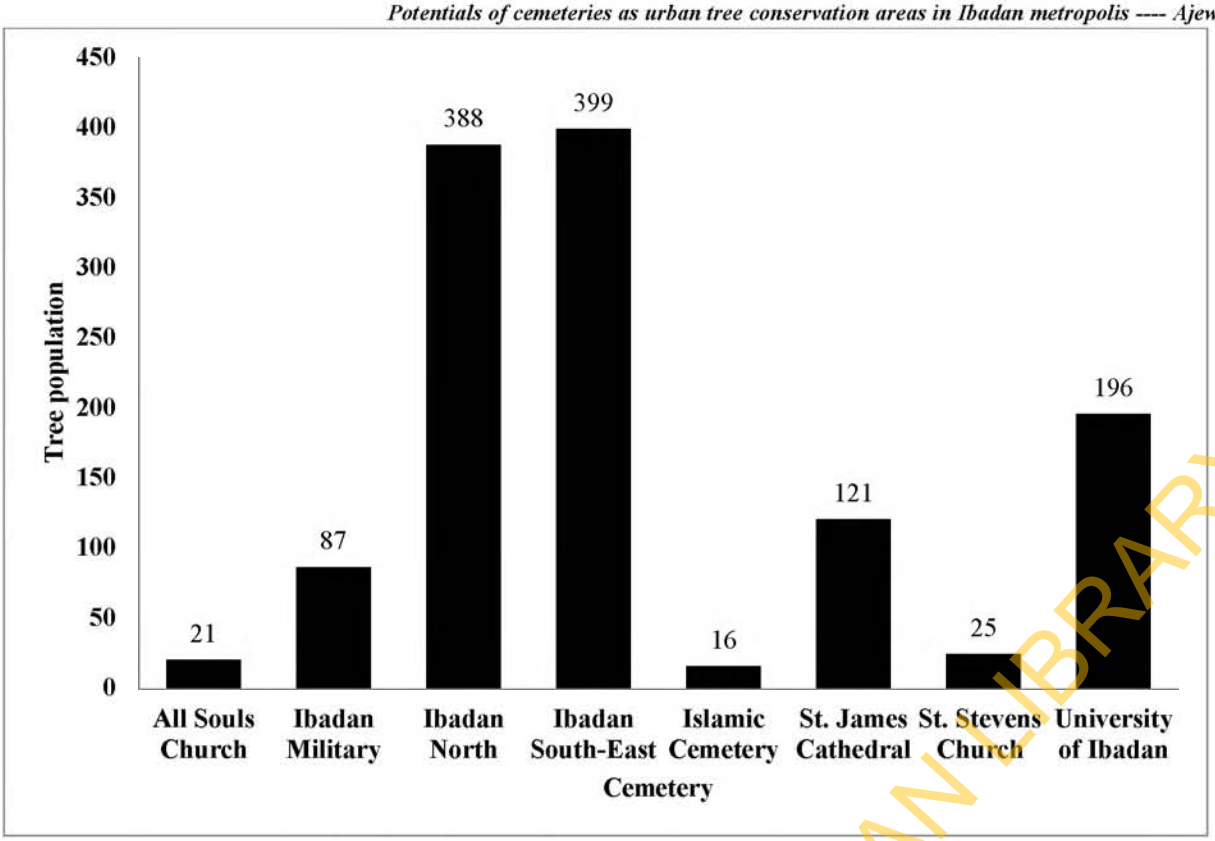

Figure 2. Population of trees in selected cemeteries in the Ibadan metropolis

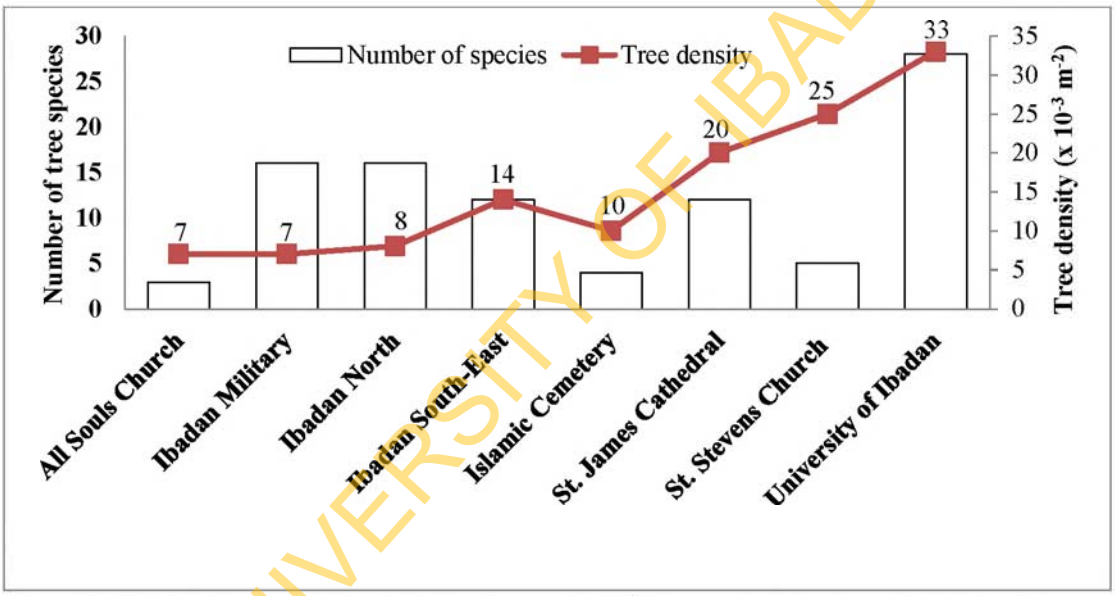

Figure 3. Number of tree species and tree density (x 10^{-3}) in selected cemeteries in the Ibadan metropolis

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Table 4: Some common uses of tree species found in selected cemeteries in the Ibadan metropolis

S/N	Species	Alcohol	Apiculture	Barrier/boundary	Erosion control	Essential oils	Food	Fodder	Fuel wood	Fibre	Gum and resins	Intercropping	Latex	Lipids	Medicine	Nitrogen fixing	Ornamental	Poison	Land reclamation	Shade/shelter	Soil improver	Tannins and dyestuffs	Timber	Number of uses
1	*Acacia equisetifolia*			X	X				X	X		X			X	X	X		X	X	X	X	X	13
2	*Albizia adianthifolia*				X		X				X	X			X		X			X			X	8
3	*Albizia saman*				X		X	X	X		X				X	X	X			X	X		X	11
4	*Albizia zygia*		X		X		X	X	X		X	X			X	X	X		X	X	X	X	X	15
5	*Alstonia boonei*								X				X		X					X			X	5
6	*Anacardium occidentale*	X					X	X			X	X		X	X				X				X	9
7	*Annona senegalensis*					X	X	X		X								X				X		6
8	*Annona squamosa*					X	X		X			X			X		X	X		X		X	X	10
9	*Antiaris toxicaria*						X		X			X			X			X		X	X	X	X	9
10	*Azadirachta indica*				X		X	X	X		X	X		X	X			X		X	X	X	X	13
11	*Blighia sapida*		X		X	X	X		X					X	X		X	X		X	X		X	12
12	*Calytrix spp.*		X		X				X						X		X		X					6
13	*Cassuarina equisetifolia*			X	X				X	X		X			X	X	X		X	X	X		X	12
14	*Chrysophyllum albidium*	X					X								X								X	4
15	*Citrus reticulata*					X	X								X									3
16	*Citrus sinensis*		X			X	X	X	X						X		X			X			X	9
17	*Cola millenii*						X								X								X	3
18	*Croton macrostachyus*		X	X				X	X						X		X			X	X		X	9
19	*Delonix regia*		X	X					X		X				X		X			X			X	8
20	*Elaeis guineensis*	X	X				X					X		X	X				X	X	X		X	10
21	*Ficus exasaperata*	X	X				X							X	X					X			X	7
22	*Ficus lutea*	X	X				X							X	X					X			X	7
23	*Gliricidia sepium*			X	X		X		X			X			X	X		X	X	X	X		X	12
24	*Gmelina arborea*						X	X	X	X		X			X		X	X	X	X			X	11
25	*Holarrhena floribunda*												X		X		X	X					X	5
26	*Jatropha curcas*			X			X		X		X	X			X	X		X		X	X	X		11

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27	*Khaya senegalensis*							X	X	X	X			X	X		X	X	X	X		X	X	12
28	*Lophira alata*								X						X					X			X	4
29	*Mangifera indica*		X				X	X	X			X			X			X		X	X	X		10
30	*Margaritaria dicoidea*		X					X							X			X					X	5
31	*Millettia thoningii*		X		X			X	X						X	X	X	X		X	X			10
32	*Morinda lucida*						X					X			X							X	X	5
33	*Morus mesozygia*	X			X	X	X	X	X	X					X		X		X	X	X	X	X	14
34	*Newbouldia laevis*			X											X									2
35	*Peltophorum pterocarpum*			X				X	X			X			X	X	X		X	X	X	X	X	12
36	*Pinus caribea*				X					X	X				X				X				X	6
37	*Plumeria rubra*														X		X							2
38	*Polyathia longifolia*			X	X										X		X						X	5
39	*Psidium guajava*	X		X		X	X		X			X			X		X	X	X	X		X	X	13
40	*Psydrax parviflora*		X			X	X	X	X						X		X			X			X	9
41	*Pycnanthus angolensis*								X					X	X					X			X	5
42	*Rauvolfia vomitoria*							X	X	X		X	X		X	X	X	X		X		X	X	12
43	*Senna siamea*		X		X		X	X	X	X		X			X		X		X	X	X		X	13
44	*Spondias mombin*		X		X		X	X	X	X					X		X		X	X	X		X	12
45	*Tectona grandis*								X			X			X		X					X	X	6
46	*Terminalia catappa*				X		X	X	X	X	X			X	X		X			X	X	X	X	13
47	*Trichilia monadelpha*		X				X	X	X					X	X	X	X	X		X	X		X	12
48	*Triplochiton scleroxylon*								X														X	2

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Plate 1: Natural regeneration of tree species in the University of Ibadan Cemetery

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Discussion

A few studies have reported a high level of plant diversity in old cemeteries including both naturally occurring and deliberately planted native and exotic species particularly for their funerary symbolism, aesthetic value or personal associations (Kocian *et al.,* 2003; McBarron *et al.,* 1988; Uslu *et at.*, 2009). For instance, McBarron *et al.* (1988) recorded an average of 100 plant species in 17 cemeteries in Australia. They found common tree species such as *Eucalyptus spps., Araucaria bidwillii, Grevillea robusta, Cupressus funebris* and *Pinus pinea* in many of the cemeteries. In this study, the government/institution owned cemeteries, which were older, had more trees not only because they were planted but some other species were introduced through natural seed dispersal. For example, the spatial distribution and varying level of maturity of the tree population at the University of Ibadan Cemetery coupled with the presence of many wildlings suggest the influence of the natural regeneration processes (Plate 1). It was observed that most of the cemeteries had a mixture of native and exotic tree species.

The private/religious based cemeteries were carefully maintained as reflected in the low presence of trees, as also reported by McBarron *et al.* (1988). They noted that well-trimmed cemeteries usually had fewer numbers of trees and more of other plant life forms like herbs and grasses. These private/religious cemeteries had mostly exotic species which were low in population (Table 3 and Fig. 2). However, it must be stated that the protection and management of large vegetation in cemeteries is difficult and expensive (McBarron *et al.*, 1988; Uslu *et al*., 2009). During the survey, most of the managers in the privately owned cemeteries opined that the cost of maintaining (branch and root prunings, felling etc.) trees in their cemeteries was too high, thus they preferred to use smaller ornamental plants for beautification and aesthetics. Ajewole *et al.* (2013) mentioned that amenity tree management was a challenging endeavour, particularly, with wrong species selection and improper placements resulting in damages to existing infrastructure. In many societies, the public are accustomed to well-groomed grasses and flowers in their backyard lawns, neighbourhood parks and cemeteries. Thus, there is a general misconception that cemeteries with scattered trees and tall grasses are abandoned or unkempt even though such cemeteries retain high vegetation diversity (see Plate 1). Nevertheless, it must be emphasized that caring for plants especially trees, protecting cemetery stones, and providing public access are attainable goals that need not be in conflict (Hemmat *et al.*, 2012; Moorehouse and Hassen, 2004).

Trees provide inherent benefits such as protective and productive functions, beautification as well as comfort to people, thus contributing to their physiological, sociological, psychological and economic well-being (Ajewole *et al.* 2013; Olajuyigbe *et al.,* 2013). In this study, it was observed that the tree species encountered have numerous uses and are multipurpose plants (Table 4). For instance, *Albizia zygia* is known to provide at least 15 uses at both domestic and industrial levels. Consequently, trees do not only improve the ecological state (e.g. soil improvement, nitrogen fixation) of the cemeteries but also provide social amenities such as shade for visitors and facilities for recreation, meditation and spiritual activities (Moorehouse and Hassen 2004; Tyrväinen *et al.*, 2005). Nevertheless, human activities continue to mount pressure on the world's biodiversity, and the need to learn to coexist with the rest of nature presents a daunting challenge. Therefore, solutions to this challenge require not only technical answers but also a shift in attitudes and philosophies. Thus, the roles of sacred places (such as cemeteries) become more

profound, particularly as unofficial protected areas for tree conservation and maintenance of ecological processes and services (Kocian *et al.*, 2003; McBarron *et al.*, 1988). Furthermore, there is continued pressure on the protective function of most protected areas with many becoming isolated in fragmented habitats, owing to poor management, thus an establishment of a network of informal protected areas (such as cemeteries, sacred groves and shrines) would further facilitate biodiversity conservation and sustenance (Fogli, 2004; Hemmat *et al.*, 2012). To this end, there is a conservation value in preserving variants of plant species in cemeteries, particularly when natural populations are becoming scarce in the wild (McBarron *et al.*, 1988). For example the high number of tree species observed during this study is relatively protected as long as they do not interfere with the original purpose of the cemetery. However, the trees are usually removed when they obstruct spaces required for grave yards or damage existing tombstones.

Trees are also recognized to play a sacred role because of their longevity, support for associated ecological processes and socio cultural values. They are planted in cemeteries to provide shade (Table 4) and harvesting them for uses such as firewood is prohibited. Equally cemeteries are revered and believed to be inhabited by spirits of the departed souls. Thus, most people will not go into them to hunt, collect firewood, or farm. This sacredness indirectly confers a potential to conserve natural heritage and enhance biodiversity management (Hemmat *et al.*, 2012; Henderson, 2012). Although the land area of the selected cemeteries are relatively small (0.01 to 0.48 km^2), they have unique specimens of vegetation (Table 2). Therefore, cemeteries could serve the function of preserving genetic diversity of common tree species. In particular, old cemeteries are regarded as botanic refuges, harbouring old trees that could be sequenced for information in biological and environmental research as well as in the reforestation and reclamation of degraded areas (Jimme *et al.*, 2010; Hemmat *et al.*, 2012; Henderson, 2012; Uslu *et al.*, 2009). In addition, different insects (such as bees) and animals especially birds benefit from the different types of trees using them as habitats and corridors of movement from the forest to the urban areas; therefore it becomes pertinent that tree heterogeneity be increased in urban areas through protected areas such as cemeteries (Kocian *et al.*, 2003).

Conclusion

Urban cemeteries are special ecological green areas that require appropriate planning and sustainable management. The high tree diversity observed in some of the cemeteries provides a unique opportunity for *ex situ* germplasm conservation in the Ibadan metropolis. However, it was observed that most of the modern and privately owned cemeteries did not place emphasis on the presence of trees on their properties. There is therefore a need for environmental protection agencies, conservation advocates, non-governmental organizations as well as training institutions with bias in biodiversity conservation to encourage players in the funeral industry in Nigeria, to incorporate and promote greenery in the design and management of cemeteries. These protected landscapes could become important botanic refuge for threatened species, if properly managed.

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