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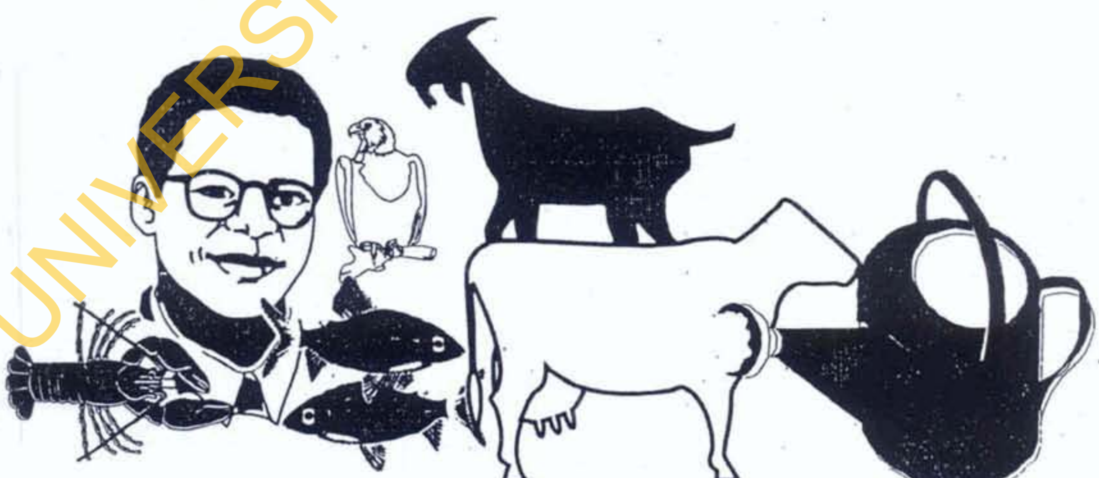

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ASSESSMENT AND CLASSIFICATION OF HAZARDOUS STREET TREES IN UNIVERSITY OF IBADAN NIGERIA.

BY

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ABSTRACT

The study was carried out to assessed and classified hazardous trees within the University of Ibadan (UI) campus, Oyo State, Nigeria. The study population was 25 municipal tree species comprising of 420 individual trees located along the major roads of the study area, which were considered hazardous to the community. With the aids of data form, health assessments which include a review of defects, surrounding site conditions, and potential targets were carried out. Data collected were subjected to statistical analysis.

The result revealed that 31.42% of the total tree species sampled within the study area are samena senna. Hazardous trees were generally lower along Agriculture, Masaba and Veterinary roads and they are 0.47%, 0.95% and 1.66% respectively. Oduduwa road had highest number of poor-quality trees with multiple defects (22.38%). A total of 132 species of samena senna had extremely high probability of failure while the probability of 69 species of Delonix regia to strike a target is extremely high, this species have very shallow roots and the species is easily affected by root/stem rots resulting in heavy damages even with little storm. Ten species of Samena senna affect the road, 33 species of Gliricidia sepium affect the walkway, 60 species of Delonix regia affect the building, 71 species of Samena senna cause street light obstruction and 6 species of Samena senna are affecting the underground cable..In conclusion the study revealed that all the sampled municipal trees of university of Ibadan were defective having some negative impacts for infrastructure damages (e.g. damage to building and sidewalks). Since there will always be a common interaction among people, property and trees in the University community, detection and removal of trees that are likely to be hazardous is essential.

Key words: Street trees, hazardous trees, Health assessment, infrastructural damage, Potential target

INTRODUCTION

Trees are important to humankind economically and socially because of their environmental, industrial, spiritual historical and aesthetic values. Trees sustain human life through direct and indirect by providing a wide range of products for survival and prosperity. Municipal trees however, are trees that are planted mainly for aesthetic purpose (Venkatesh, 1976; Panshin & Zeeuw, 1980; Hawkins, 1986). According to Nilsson *et al*. 2000, three different types of municipal trees can be identified, based on the conditions under which they grow: park trees, street trees and trees growing in urban woodlands. Urban trees play a central role in built-up urban environments, creating pleasant outdoor experiences whether in forests, parks, or urban landscapes. (Kuo 2003, Wolf 2003). Although, municipal trees provide significant benefits to homes and cities, but quite often, we may not be aware of the risks associated with defective trees around us which can cause personal injury and property damage. These trees may become liabilities when they fail and injure unsuspecting people, resulting in damages to property or produce messy fruit which require additional cost to pack. Early detection and management of such trees makes property safer and prolongs the life of the tree. Once the hazard is recognized, it is important that steps be taken to reduce the likelihood of the tree falling and causing injury to someone (Albers and Hayes 1993, I.S.A 2000). Although dying and falling trees are important in the development of forests, they are undesirable in high use recreation areas where they pose risk to human life and property. The goal of hazard tree assessment is therefore to sustain the municipal trees in an aesthetically pleasing condition and as well as eliminating unacceptable risk to the University community. (Harvey and Hessburg,. 1992) he University community consists of both the gray infrastructure (buildings, streets, utilities) and the green infrastructure – the municipal trees. Although the gray infrastructure has long been assessed and monitor for acceptable levels of risks, green infrastructure cannot be said to have enjoyed same subjective evaluations. Identifying hazardous trees on University of Ibadan has always been a subjective process. The difficulty arises in predicting which trees are actually hazardous and should be removed Several efforts have been made to properly manage these trees in the recent past but these have not yielded the desired results because the management of these trees was at those times carried out by non professionals in the area of forestry and arboriculture (Omole 2008). This has led to gross under management of the trees with some of them growing into bad forms and many also growing on a wrong site.

Municipal trees within the University of Ibadan are important assets that have long been admired for their roles in the beautification of the university landscape. They also have historical, cultural and social significance in the life of the University (Osundare 1994 and 2008). Members of the university community (Students and staff) enjoy recreating under large old trees with heavy canopy, as well as making use of this tree area as a parking space for vehicles. However, these are the very trees that often provide the greatest risk in terms of hazard. Large municipal trees are more likely to suffer significant level of internal wood decay and other defects. Also, they cause more damage when they fall due to their sizes.

The purpose of this study is to identify and classify the various factors responsible for the risks associated with municipal trees within the University of Ibadan community. Broken down to specifics the study was carried out to take the inventory of tree species that has become hazardous in the University and to qualify and quantify the various potential hazard posed by municipal trees.

MATERIALS AND METHODS

Study Area

The survey was confined to municipal trees within the University of Ibadan Community. The university is situated 5km to the north of the city of Ibadan on latitude $7^0 27$'N and longitude $3^0 54$'E with a mean altitude of 200m above sea level. For data collection, The University community was divided in four zones which are entrance, administration, academics and residential areas. This was represented by (1) Oduduwa road (2) Benue road (3) Niger road and (4).Junior and Senior Staff Residential areas.

Data collection

Prior to data collection, reconnaissance survey was carried out to have a general view of the municipal trees on campus and get familiar with the site. During survey the condition of individual tree and the ambient conditions under which the municipal trees have been growing, the land area along the road and other infrastructure were assessed. Using a checklist the information collected includes tree health, defects, surrounding site conditions, and potential targets.

METHODOLOGY

The internationally recognized approach of Visual Tree Assessment (VTA) as formulated by Mattheck and Breloer (1994) was used for tree inventory in the study area. The method has been adopted by other internationally recognized arborists and has been incorporated into the essential arboricultural texts including those by Lonsdale (1999) and Harris *et al* (2004).
VTA involves:

(i) Visual inspection for defect symptoms and vitality. If there is no sign of a problem then the investigation is concluded.
(ii) If a defect is suspected on the basis of symptoms, its presence or absence was confirmed by a thorough examination.
(iii) If a defect is confirmed and appears to be a cause for concern, it must be assessed and classified.
Present health condition of tree species sampled was determined by a review of the tree in terms of failure. The probability of tree failure rating was therefore determined by four variables which ranged from extremely high to low. A tree was rated as either (extremely high), (high), (moderate), or (low), depending on the level of disturbance or type of activity around the tree.

Furthermore the model developed by Matheny and Clark (1994) was also used to assess the selected trees. These include visual examination of the tree trunk/stem, structural defects, scars, external indications of decay such as fungal fruiting bodies, evidence of insect attack, discolored foliage, the condition of any visible root structures, the degree and direction of lean (if any), the general condition of the trees and the surrounding site and the proximity of property and people. The data collected was subjected to non-parametric analysis.

RESULTS AND DISCUSSION

Tree Species Diversity and Distribution

A total number of 420 hazardous trees were observed along the major roads selected in this study. The number of defective trees found along the selected roads within the University of Ibadan community expressed as a percentage of total number of hazardous trees ranged from 0.48 % to 22.38% per location (Tables 1). Hazardous trees were generally lower along Agriculture, Veterinary and Masaba roads and they are 0.48%, 1.67%, and 0.95% respectively. Oduduwa road had highest number of poor-quality trees with multiple hazardous conditions (22.38%). Total number of tree species identified was 24, and their percentage of occurrence ranges from 0.24 to 31.42% where *Samena sena* had the highest percentage of occurrence (31.42%) followed by *Delonix regia* 16.43% while *Adansonia digitata, Azadiractha indica* and *Holarhena spp* had the least percentage of occurrences (0.24%) (Table 2). This implies that highest number of tree sampled was *Samena sena* (132 tree species) and it is the dominant species occurring along the major roads within the study area. The two dominant species were the exotic species deliberately introduced to the campus landscape between late 1960s and early 1970s because they are fast growing and easy to establish.

Table 1: Location and cumulative count of sampled municipal trees

Location	Count	Cumulative	%	Cumulative %
Chapel Road	24	24	5.71	5.71
Agric Road	2	26	0.48	6.19
Benue Road	64	90	15.24	21.43
Abadina Road	30	120	7.14	28.57
Niger Road	23	203	19.76	48.33
Kurunmi Road	26	229	6.19	54.52
Ijeoma Road	42	271	10	64.52
Kashim Road	16	287	3.81	68.33
Veterinary Road	7	294	1.67	70.00
Sankore Road	17	311	4.05	74.05
Sapara Road	11	322	2.62	76.67
Masaba Road	4	362	0.95	77.62
Oduduwa Road	94	420	22.38	100.00

Source: Field Survey 2009

Table 2: Identified tree species and their percentage of occurrence

Species	count	cumlative	%	%cum
Penthophorum sp	35	35	8.33	8.33
Delonix regia	69	104	16.43	24.76
Samena sena	132	236	31.42	56.19
Casuarina sp	40	276	9.52	65.71
Tabebua sp	9	285	2.14	67.85
Mangifera indica	16	301	3.81	71.66
Bombax sp	2	303	0.47	72.14
Triplochyton scleroxylon	6	309	1.43	73.57
Albizia zygia	10	319	2.38	75.95
Ficus exasepirata	7	326	1.67	77.61
Terminalial catapa	6	332	1.43	79.05
Spondias mobium	5	337	1.19	80.23
Blighia sapida	4	341	0.95	81.19
Cola nitida	4	345	0.95	82.14
Melicia excelsa	3	348	0.71	82.86
Neubouldia sp	2	350	0.48	83.33
Khaya ivorensis	3	353	0.71	84.05
Adansonia digitata	1	354	0.24	84.29
Azadiractha indica	1	355	0.24	84.52
Holarhena sp	1	256	0.24	84.76
Eucalyptus sp	17	373	4.04	88.81
Lonchocarpus sp	3	376	0.71	89.52
Gliricidia sepium	33	409	7.86	97.38
Antiaris toxicaria	9	418	2.14	99.52
Lenonodisus sp	2	420	0.48	100.00

Source: Field Survey 2009

Table 3: Inventory and classification of hazardous tree species within the university community.

S/N	Species	Defects
1	*Penthophorus*	Poor Tree Architecture,Visible obstruction,Weak Branch Union,Leaning Tree, Physical obstruction.
2	*Delonix regia*	Poor Tree Architecture,Root problem,Decay,Weak Branch Union, Leaning Tree, Dead, Heartrot.
3	*Casuarina sp*	Dead, Poor Tree Architecture, Cancer.
4	*Samena sena*	Poor Tree Architecture,Visible obstruction,Weak Branch Union, Leaning Tree, Physical obstruction.
5	*Triplochiton scleroxylon.*	Visible obstruction, Physical obstruction, Side Walk Buckling.
6	*Abizia zygia*	Leaning Tree, Cancer ,Weak Branch Union
7	*Ficus exasepirata*	Decay
8	*Mangifera indica*	Poor Tree Architecture,Weak Branch Union,Leaning Trees, Visible obstruction.
9	*Bombax sp*	Side Walk Buckling.
10	*Terminanial catapa*	Poor Tree Architecture, Physical obstruction Visible obstruction, Side Walk Buckling, Root problem.
11	*Lenonodisus sp*	Poor Tree Architecture, Leaning Tree.
12	*Spondias sp*	Poor Tree Architecture,Weak Branch Union.
13	*Azardiracta indica*	Poor Tree Architecture, Physical obstruction.
14	*Blighia sapida*	Leaning Tree, Physical obstruction.
15	*Gliricidia sepium*	Poor Tree Architecture, Leaning Tree, Root problem.
16	*Cola nitida*	None
17	*Adansonia digitata*	None
18	*Khaya ivorensis*	Side Walk Buckling, Leaning Tree.
19	*Lenchocarpus sp*	Poor Tree Architecture, Leaning Tree.
20	*Melicia excelsa*	Side Walk Buckling, Dead branches.
21	*Neubouldia sp*	Poor Tree Architecture.
22	*Antiaris toxicaria*	Side Walk Buckling, Leaning Tree.
23	*Tabebua sp*	Poor Tree Architecture.
24	*Eucalyptus sp*	Leaning Tree, Poor Tree Architecture.

Probability of failure of the hazardous trees.

The results of the visual exanimation of hazardous trees conducted as revealed in Table 3 shows that a large number of old municipal trees are in poor conditions and are affected by different forms of defects . The total number of identified trees species within the studied location were 24, and of this number 14 species have poor architecture (60%) while 5 species have visible obstruction and these represent about 20%. Twelve species have leaning trees (50%). 6 species have physical obstruction (25%). 3 species have root problem (12.5%), 2 species have decay (8.33%) 6 have side walk bulking (25%), 2 are dead (8.33%), one species with dead branches and heart rot(4.1%) and 2 have canker (8.33%).

Table 4: Probability of natural tree failure in the study site

Species	EH	H	M	L
Penthophorum sp	24	11	0	0
Delonix regia	69	0	0	0
Samania sama	132	0	0	0
Casuarna sp	0	0	40	0
Tabebua sp	0	0	9	0
Mangifera indica	0	16	0	0
Bombax sp	0	0	0	2
Triplochyton sc.	0	0	0	6
Albizia zygia	0	0	10	0
Ficus exasepirata	0	0	0	7
Terminanial catapa	0	6	0	0
Spondias mobium	0	0	5	0
Blighia sapida	0	0	0	4
Cola nitida	0	0	0	0
Melicia excelsa	0	0	3	0
Neubouldia sp	0	0	2	0
Khaya ivorensis	0	0	0	3
Adansonia digitata	0	0	0	0
Azadiractha indica	0	0	0	1
Holloarhena sp	0	0	0	1
Eucalyptus sp	0	0	17	0
Lonchocarpus sp	0	0	3	0
Gliricidia sepium	0	0	33	0
Antiaris toxicaria	0	0	9	0
Lenonodisus sp	0	0	2	0

EH- Extremely high, H- High, M- Moderate, L- low

Table 5: Cumulative count of probability of tree failure

Category	Count	Cumulative	%tage	%Cumulative
EH	225	225	53.57	19.76
H	33	258	7.86	89.5
M	133	391	31.67	92.38
L	24	415	5.71	98.81

EH- Extremely high, H- High, M- Moderate, L- low

Based on the condition of the living tree as shown in table 4, probability of tree failures observed in the selected tree species showed 132 species of *Samena sena,* 69 sampled trees of *Delonix regia* and 24 *Penthophorum sp* had extremely high probability of failure while 11 tree species of *Penthophorum sp* and 16 trees of *Mangifera indica* 'had high probability of failure. The probability of failure was however moderate in all the species of *Casuarina sp Eucalyptus sp Lonchocarpus sp Gliricidia sepium Antiaris toxicaria Lenonodisus sp* Table 5, further reveal that probability of tree failure of 225 tree species out of 420 total tree species sampled are extremely high, 33 trees are high, 133 moderate and 24 trees are low. The actual number of tree failures as reported in this study may be probably much higher than the probability that an accident will occur. This is because it is not likely that all tree failure will eventually lead to accident.

Potential target and Associated risks during failure

As presented on table 6, the potential target of tree was determined by four variables which ranged from extremely high to low. Probability of 69 species of *Delonix regia* to strike a target is extremely high while probability of 132 species of *Samena sena* and 40 tree species of *Casuarina sp.*to strike a target is high. Table 7 further reveals that potential target of 83 tree species out of 420 total tree species sampled were extremely high, 291 species are high, 14 species are moderate, 27 species are low.

Hazardous municipal tree causing Infrastructural damage

Table 8 shows the different tree species and the infrastructure damage within the Campus. Ten trees of *Samena sena* species affect the road, 33 of *Gliricidia sepium* affect the walkway, 60 trees of *Delonix regia* affect the building, 71 of *Samena sena* affect the building and 6 species of *Samena sena* are affecting the underground cable. Table 9, thus further reveal that 148 tree species out of 420 total tree species sampled are affecting the walkway, while 140 are affecting the buildings, 87 trees are obstructing street lights and 7 affecting underground cable and water pipes.

Table 6: Potential target and associated risks if tree Failure occur

Species	EH	H	M	I
Penthophorus sp	14	21	0	0
Delonix regia	69	0	0	0
Samania sama	0	132	0	0
Casuarina sp	0	40	0	0
Tabebua sp	0	0	9	0
Mangifera indica	0	16	0	0
Bombax sp	0	0	0	2
Triploxyton sclexylon	0	6	0	0
Albizia zygia	0	10	0	0
Ficus exasperata	0	0	7	0
Terminalia catapa	0	6	0	0
Spondias mobium	0	5	0	0
Blighia sapida	0	0	0	4
Cola nitida	0	0	0	0
Melicia excelsa	0	3	0	0
Neubouldia sp	0	2	0	0
Khaya ivorensis	0	0	0	3
Adansonia digitata	0	0	0	0
Azadiractha indica	0	0	0	1
Holarhena sp	0	0	0	1
Eucalyptus sp	0	17	0	0
Lonchocarpus sp	0	0	3	0
Gliricidia sepium	0	33	0	0
Antiaris toxicaria	0	0	0	9
Lenonodisus sp	0	0	2	0

EH- Extremely high, H- High, M- Moderate, L- low

Table 7: Summary and Cumulative Count of Potential targets

Category	Count	Cumulative	%	Cum. %
EH	83	83	19.76	19.76
H	291	274	69.29	89.5
M	14	388	3.33	92.38
L	27	415	6.43	98.81

EH- Extremely high, H- High, M- Moderate, L- low

Table 8: Infrastructural damage caused by hazardous municipal tree

Species	RD	WY	BLD	SLO	EUC&WP
Penthphorum sp	5	12	17	0	1
Delonix regia	0	9	60	0	0
Samania sama	10	9	36	71	6
Casuarina sp	8	32	0	0	0
Tabebua sp	0	9	0	0	0
Mangifera indica	0	16	0	0	0
Bombax sp	0	2	0	0	0
Triploxyton scleroxylon	0	6	0	0	0
Albizia zygia	0	0	10	0	0
Ficus exasepirata	0	0	7	0	0
Terminalia catapa	0	0	5	1	0
Spondias mobium	5	0	0	0	0
Blghia sapida	0	0	4	0	0
Cola nitida	0	0	0	0	0
Melicia excelsa	0	0	0	3	3
Neubouldia sp	1	0	0	0	0
Khaya ivorensis	0	0	0	3	0
Adansonia digitata	0	0	0	0	0
Azadiractha indica	0	1	0	0	0
Holarhena sp	0	0	0	0	0
Eucalyptus sp	0	17	0	0	0
Lonchocarpus sp	0	2	1	0	0
Glicidia sepium	0	33	0	0	0
Antiaris toxicaria	0	0	0	9	0
Lenonodisus sp	2	0	0	0	0

RD- Road, WY- Walkway, BLD- Building, SLO- Street Light Obstruction, EUC&WP-Electric Underground Cable and Water Pipe.

Table 9: Summary of Infrastructural damage caused by hazardous municipal tree

Category	Count	Cumulative	%	% Cumulative
EUC & WP	31	31	7.38	7.38
RD	148	179	35.24	42.61
WY	140	319	33.33	79.67
SLO	87	406	20.71	96.66
BLD	7	413	1.67	98.33

Tree risk inspections provide a systematic method of examining trees, assessing defects present, and estimating the degree of risk trees pose to public safety. Visual inspections of individual trees, using the 360-degree walk –by method, are sufficient for detecting most defects and assessing the probability of tree failure. Some defects, however, do not have external signs or symptoms and their detection requires in- depth inspections and the use of specialized diagnostic tool which is not available for this study. In-depth tree assessments are warranted when a tree poses a high degree risk to public safety and exhibits suspected defects that cannot be fully evaluated during the visual inspection process. In general there are twelve potential defects (Poor Tree Architecture, Visible obstruction, Weak Branch Union, Leaning Tree, Physical obstruction, Root problem, Decay, Dead, Heart rot, Side Walk Buckling, Cancer and Dead branches.) causing hazards for trees observed in the University of Ibadan community. all the 24 trees species observed shows multiple defects. Such defect observed in this study ranged from poor tree Architecture to Dead branches. The results of this study thus suggest that visual assessment can be a means of predicting the internal extent of decay and hollow in potentially hazardous Municipal trees, this was supported by the findings of Costello and Peterson (1989), Shigo and Berry (1975). However, Matheny and Clark (1994) explain tree hazard as a combination of a failure of tree (or tree part) with the presence of an adjacent target which will be aligned to the identified defect. Lonsdale (1999) noted that tree having multiple defect are source of potential harm. According to Kane (2008) severe defects can accelerate the likelihood of failure. However, observed trees in this study having multiple defects are hazardous within the University of Ibadan Community. Although the university of Ibadan campus tree management committees are responsible for removing or otherwise treating hazardous trees growing on campus property, they are also responsible for maintaining urban tree canopies, thereby minimizing unjustified tree removal. Risk assessments of urban trees are mainly based on symptoms of the current state of tree health.

The probability of tree failure occurs in all the tree species sampled as a result of multiple defects as observed in *Delonix regia*. This observation was supported by the early work of Wilcox 1978 and Adrew 2002 and thus furnishing material for investigation (Table 1). Trees that are stressed have reduced energy reserves, and therefore, have less ability to deal with wounds and the ensuing decay (Andrew, 2002). The defects observed in the municipal trees within the campus are common to all the tree species and can be associated to age of the trees. Most of these trees are old and massive which make them more prone to failure. Large trees present a greater hazard because they can strike targets at considerable distance and leading to more damages when they fail. Thus, mature and over mature trees species in the University community constitute a higher failure potential than younger trees. Similar relationships of higher failure potential have also been noted for older trees as reported by Albers and Hayes, (1993),. This is however at variance with the conclusion of Wagar and Barker (1983) that rather than tree age, infrastructure age, faults and deterioration are the major sources for root colonization that eventually lead to failure and damages. In the study area, infrastructural ages are not responsible for the hazards posed by the trees but the tree sizes and ages.

The potential for damage is extremely high and high for *Delonix regia and Samena sena* respectively but *Samena sena* has a potential to cause more infrastructure damage. This suggests that though the probability of *Delonix regia* to hit a target is extremely high but most of the trees are free from infrastructure and the possibility of striking a target depends mostly on the size of failed portion of tree (e.g., ranches, or size of entire tree in complete tree failure). Consider that some structures far from a hazard tree may not seriously be damaged if the top of a tree strikes, but a structure close to a hazard tree may be demolished if the bole strikes. Accurately assessing the probability that a tree or branch will fail is highly dependent upon the skill and experience of the assessor. In this study, this component of the system provides a probability of failure range 1-four and each range represent a range of probability of failure expressed as a percentage (Table

4). This rating was consistent with the rating of Albers and Hayes (1993) but deviate from the rating of Matheny and Clark (1994), thus having assessed the tree, 132 species of *Samena sema* have the probability to fail and this is extremely high, this suggest that *Samena sema* pose a highest level of hazard as they are most likely to fall , this may be attributed to the fact that most municipal trees within the university community survive on construction-altered soils that may be compacted, poorly drained, littered with construction debris. landscape maintenance. All these cumulative stresses are expected to take a toll on tree vitality and structural integrity, increasing the risk of failure. This was in line with the findings of Andrew (2002). The target value is the most significant and most easily quantified element of the assessment. Mature and over mature trees species dominate municipal tree species in the university community as described by Omole 2008 and they constitute a higher failure potential than younger trees. Similar relationships of higher failure potential have also been noted for older trees as reported by Albers and Hayes, 1993, therefore it can be concluded that the reason for higher potential failure for *Delonix* regia is age which is in support of the findings of Omole (2008) who reported that most of the tress are as old as the University and that many changes in the University campus over the last fifty (50) years have greatly stressed many of these trees resulting in decline tree canopy that is grossly undermanaged this is contrary to the conclusion of Wagar and Barker 1983 who reported infrastructure age, faults and deterioration as the sources for root colonization that eventually lead to damage. He further explained that the materials used in construction can lead directly to failure. Tree defect is usually fairly simple to recognize. Dead tops can result from various forms of damage, including root disease and soil problems.

CONCLUSION AND RECOMMENDATIONS

Trees in the study area have some negative impacts such as infrastructure damages (e.g. damage to building and sidewalks) and that some of the dangerous trees identified can cause damages or personal injury, particularly during natural loading events such as winds and storms. Failed trees have some defects which predispose the risk of tree failure and removal of hazardous trees which have already interconnected with electrical cables place a high demand on maintenance.

Recommendations

Within the scope of this study, the following recommendations are Creation of awareness on the impact of hazardous municipal trees. Old and defective trees should be treated early or removed and formulation tree policy that will minimize the disturbance of municipal trees and promote a tree friendly attitude in relation to development and expansion.

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