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Causes and Environmental Effects of Tree Removal on the University of Ibadan Campus

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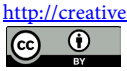

Abstract

Trees on the University of Ibadan campus provide significant economic and ecological benefits but also pose potential hazards if poorly managed. This study examines the causes and effects of tree removal across four campus zones: residential areas, administrative areas, parks and gardens, and academic areas. Utilizing structured questionnaires and focus group interviews, we identified species removed and reasons for removal, which included old age, threats to buildings, wind throw, and infrastructural development. Analysis revealed *Delonix regia* and *Albizia glaberima* as the most frequently removed species. The primary consequences of tree removal were increased temperatures, storms, and flooding. Effective tree management practices, such as pruning and periodic evaluations, are recommended to mitigate these effects.

Subject Areas

Environmental Sciences, Forestry

Keywords

Tree removal, Tree Management, Environmental Management, Urbanization, Potential Hazards

1. Introduction

Urban forests encompass all trees within an urban area, including individual street trees, clusters in parks, and peri-urban forests extending to the metropolitan periphery. These forests are categorized into various types: city parks, urban forests over 0.5 hectares, pocket parks, street trees, public square trees, and other green spaces with trees like riparian corridors, rooftops, and nurseries [1]. Consequently, urban forests significantly enhance the livability and environmental

quality of urban settings. Trees on the University of Ibadan campus play a crucial role in regulating the ecosystem. Urban trees are indispensable assets in urban planning, providing ecological, economic, and social benefits. Trees contribute to urban resilience by mitigating heat islands, managing stormwater, and offering recreational spaces that improve residents' mental health.

This study investigates the causes and effects of tree removal on the University of Ibadan campus, aiming to provide insights for better urban forestry management. The continuous removal of trees without proper replacement may lead to severe and often irreversible consequences. Despite the benefits, the tree canopy on the University of Ibadan campus has been declining. Mature trees are rarely replaced with new ones, and even when replanted, they struggle to establish due to the demands of urban infrastructure. The expansion of university facilities has significantly reduced forested areas, prompting a tree-planting initiative. Despite initial success, in recent years, there have seen a further decline in urban forest cover due to various factors. This study aims to identify the species and number of trees removed, locations of removal, reasons for removal, and public perception of the effects on the campus environment.

2. Literature Review

Ecological and Social Benefits of Urban Trees

Numerous studies have documented the ecological benefits of urban trees [2] highlighted the role of urban forests in reducing urban heat islands through shading and evapotranspiration. Trees also play a crucial role in stormwater management by intercepting rainfall, reducing runoff, and improving water quality [3]. Socially, urban trees provide recreational spaces, reduce stress, and foster community cohesion [4].

2.1. Challenges in Urban Tree Management

Despite the benefits highlighted above, taking care of urban trees is challenging. Cities often have tough conditions for tree growth, like limited soil, pollution, and damage from constant construction. Additionally, urban trees face threats from pests and diseases, which can be made worse by climate change. To manage urban trees effectively, strategic planning, regular maintenance, and community involvement are needed [5].

2.2. Tree Removal and Its Implications

Tree removal is sometimes necessary in urban settings due to various factors, including old age, disease, structural instability, and conflicts with infrastructure [6]. However, the removal of urban trees can lead to significant ecological and social consequences. Studies have shown that the loss of urban trees can exacerbate urban heat islands, increase stormwater runoff, and reduce biodiversity [7]. Moreover, tree removal can negatively affect the psychological well-being and welfare of urban residents, in this case, the students who often value the presence of trees in

their communities.

2.3. Case Studies in Urban Forestry

Several case studies have explored the impacts of urban tree removal and the effectiveness of management practices. For instance, [8] examined tree management practices in Singapore and emphasized the importance of integrating arboriculture expertise with urban planning. Similarly, [9] studied tree removal and replacement in Toronto, highlighting the need for proactive management to maintain urban forest canopy cover.

2.4. Urban Forestry in Developing Countries

In developing countries, urban forestry faces unique challenges due to rapid urbanization, limited resources, and competing land use priorities [10]. Despite these challenges, urban forests in these regions are crucial for providing ecosystem services and enhancing urban resilience.

2.5. Tree Management at the University of Ibadan

The University of Ibadan campus, with its rich biodiversity and significant tree cover, serves as an important case study for understanding urban forestry dynamics in Nigeria. Previous studies have documented the tree species present on campus and their ecological roles [11]. However, there is limited research on the causes and effects of tree removal within this specific urban environment.

3. Study Area

The study was conducted on the University of Ibadan campus, located in Ibadan, Oyo State, Nigeria (**Figure 1**). The campus spans latitudes 7˚26'58.2"N to 7˚26'0"N and longitudes 3˚53'48.56"E to 3˚53'48"E, with an average altitude of approximately 208 meters above sea level. The primary waterway on the University of Ibadan campus, River Awba, traverses several key academic departments, such as Botany, Agriculture, and Geography, before emptying into the university dam near the Zoological Garden. This river and its surroundings are integral to the campus's ecosystem, providing critical resources for irrigation, research, and supporting local biodiversity.

3.1. Methodology

3.1.1. Sampling Design

Stratified random design was adopted for this study. The University Campus was stratified into four namely, the academic areas, administrative areas, Parks and Gardens and residential areas.

3.1.2. Methodology

The study employed a mixed-method approach, combining quantitative and qualitative data collection techniques. A stratified random design was used to categorize the University of Ibadan campus into four strata: academic areas, administrative

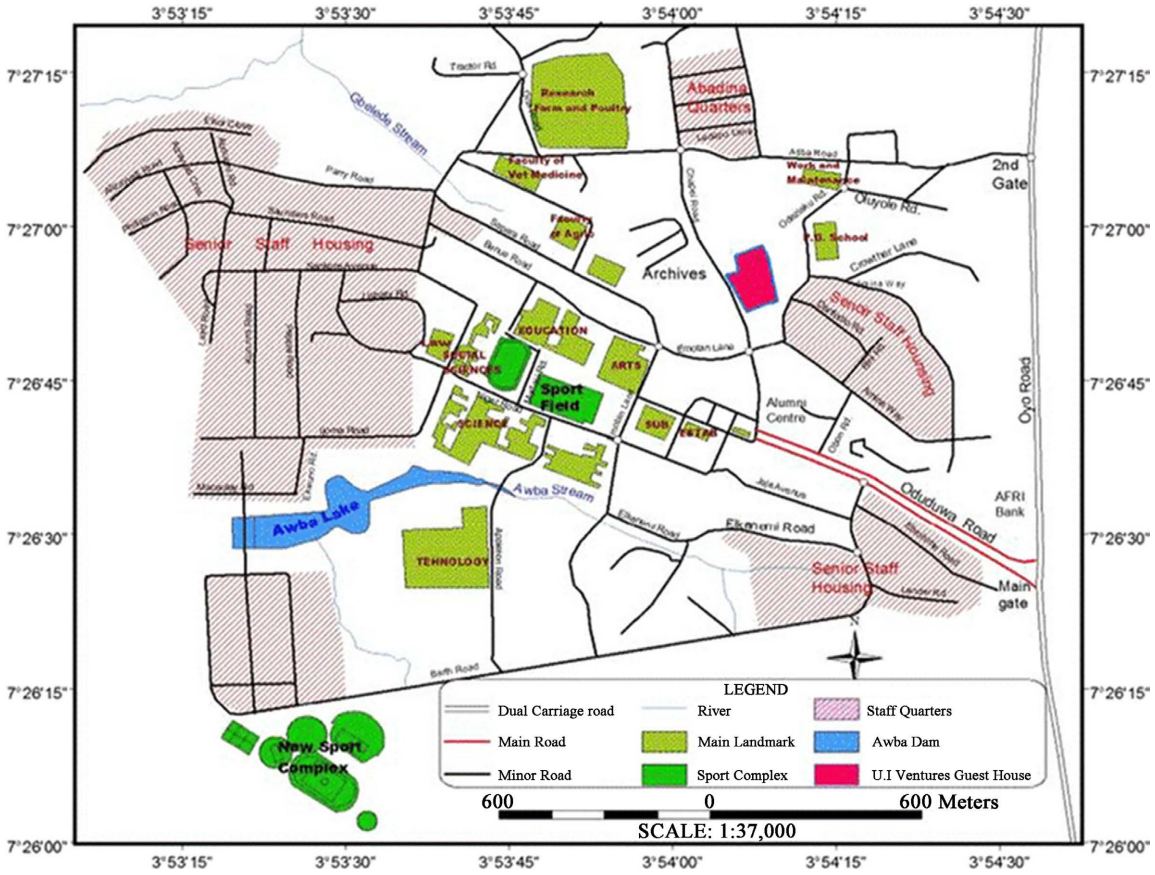

Figure 1. The University of Ibadan Campus [12].

areas, parks and gardens, and residential areas. Thirty percent of each stratum was surveyed to identify, count, and record removed trees. Fifty structured questionnaires were administered in each stratum, supplemented by focus group interviews with the members of the Biodiversity Management Committee to obtain in-depth insights into the reasons behind tree removal. The data were analyzed using descriptive statistics and chi-square tests at a significance level of 0.05 to determine the relationships between tree species, locations, and reasons for removal.

3.1.3. Data Analysis

The data generated was subjected to descriptive statistics including frequency distributions, tables, pie charts, and histograms. Chi-square at a significance level of 0.05 was employed to determine the relationship between the species felled and the reason(s) behind the felling of the trees.

Also, a chi-square at a significance level of 0.05 was employed to determine the relationship between the location and the reason(s) behind the felling of the trees.

$$DF = (r-1)*(c-1)$$

where, r = number of rows; c = number of columns

$$X = \frac{\sum(\text{Observed} - \text{Expected})}{\text{Expected}}$$

4. Results and Discussion

A total of 38 tree species from 20 families were identified as removed from various locations on campus (Table 1). The most frequently removed species, in descending order, were *Delonix regia, Albizia glaberima, Terminalia catapa, Gliricidia sepium,* and *Antiaris africana*. Residential areas had the highest number of tree removals, while parks, gardens, and administrative areas had the least.

Table 1. Reasons for tree removal as documented by biodiversity committee.

Reasons for Tree Removal	Species of Tree	Frequency	Percentage (%)
Old Age	*Acacia auriculiformis* *Albizia glaberima* *Anarcadium occidentale* *Azadirat aindica* *Bridelia micrantha* *Casuarina equisetifolia* *Cocos nucifera* *Cola nitida* *Delonix regia* *Elaesis guinensis* *Ficus thoningii* *Gliricidia sepium* *Magnifera indica* *Milicia excelsa* *Roystonia regea* *Terminalia catapa* *Terminalia superba* *Triplochyton scleroxylon*	18	47.37
Threat to building	*Albizia glaberima* *Alstonia boonei* *Antiaris africana* *Blighia sapida* *Casuarina equisetifolia* *Delonix regia* *Ficus thoningii* *Gliricidia sepium* *Gmelina arborea*	15	39.47

Continued

	Magnifera indica		
	Millettia thonningii		
	Persia americana		
	Roystonia regea		
	Tarebuea rosea		
	Terminalia catapa		
Wind Throwing	*Albizia glaberima*	14	36.84
	Antiaris africana		
	Azadirata indica		
	Blighia sapida		
	Casuarina equisetifolia		
	Ceiba petandra		
	Delonix regia		
	Ficus thoningii		
	Gliricidia sepium		
	Gmelina arborea		
	Nesogordonia papaverifera		
	Pinus carribea		
	Spathodea campanulata		
	Terminalia catapa		
Infrastructural Development	*Acacia auriculiformis*	*9*	23.68
	Albizia glaberima		
	Anogeissus leiocarpus		
	Casuarina equisetifolia		
	Delonix regia		
	Ficus mucuso		
	Khaya senegalensis		
	Newbouldea leavis		
	Terminalia catapa		
Damage Roof	*Albizia glaberima*	8	21.05
	Alstonia boonei		
	Antiaris africana		
	Azadirata indica		
	Delonix regia		
	Gmelina arborea		

Continued

	Magnifera indica		
	Terminalia catapa		
Potential Hazards	*Casuarina equisetifolia* *Funtumia africana* *Lamea welwitschii* *Milicia excelsa* *Millettia thonningii* *Pycnanthus angolensis*	7	18.42
Tree Hole	*Triplochyton scleroxylon* *Albizia glaberima* *Antiaris africana* *Magnifera Indica* *Millettia thonningii* *Morinda Lucinda* *Newbouldea leavis*	6	15.79
Root Rots	*Albizia glaberima* *Azadirata indica* *Delonix regia* *Persia americana* *Terminalia catapa*	5	13.16
Threat to Lives	*Albizia glaberima* *Gliricidia sepium* *Millettia thonningii*	3	7.89
Insect Infestation	*Auraucaria columnaris* *Ceiba pentandra* *Lamea welwitschii*	3	7.89
Rest on Building	*Delonix regia* *Magnifera indica*	2	5.26
Tree Snapping	*Terminalia catapa*	1	2.63
Damage Building	*Albizia glaberima*	1	2.63

Total number of species reported = 38 species of tree.

4.1. Reasons for Tree Removal on Campus as Documented by Campus Biodiversity Committee

According to our findings, and as documented by the Biodiversity Committee, the

leading causes were old age (47.37%), threat to buildings (39.47%), windthrow (36.84%), and infrastructural development (23.68%). These statistics shed light on the various issues associated with urban tree management and underscore the necessity of proactive and strategic approaches to urban forestry on the University of Ibadan Campus.

- Old Age (47.37%):

Old age emerged as the most prevalent reason for tree removal, accounting for nearly half of all cases. As trees age, they can become structurally unsound, increasing the risk of falling branches or complete tree failure. Aging trees often exhibit signs of decay, disease, and weakened structural integrity, making them hazardous in urban environments [13]. The necessity to remove such trees is crucial to prevent potential accidents and ensure public safety. This aligns with the findings of [11] who reported similar issues with aging trees along Oduduwa Road on the university campus.

- Threat to Buildings (39.47%):

Trees that pose a threat to buildings constitute a significant proportion of removals. Large trees planted close to buildings can cause damage to foundations, roofs, and other structural components through root growth, falling branches, and direct impact. The risk is exacerbated during storms and high winds, which can lead to branches breaking off or entire trees being uprooted. Managing this risk involves careful assessment and sometimes necessitates the removal of trees to safeguard infrastructure.

- Windthrow (36.84%):

Windthrow, or the uprooting of trees by wind, was identified as another major reason for removal. Urban trees, especially those not properly maintained or those with compromised root systems, are susceptible to windthrow during severe weather events. This not only poses a danger to people and property but also highlights the importance of regular maintenance and health assessments of urban trees to identify those at risk of windthrow [14]

- Infrastructural Development (23.68%):

The need for infrastructural development was another significant factor leading to tree removal. As urban areas expand and new buildings, roads, and other infrastructure are constructed, trees are often removed to make way for these developments [15]. While this is sometimes unavoidable, it underscores the need for urban planning that integrates tree conservation and considers the ecological benefits of preserving mature trees.

All these findings are also consistent with previous research, particularly the study by [11] which highlighted similar issues with urban trees on the University of Ibadan campus (**Figure 2**). He noted the hazards posed by aging trees and the infrastructural damage caused by species like *Samanea saman* and *Delonix regia*. These species, known for their large canopies and extensive root systems, can cause significant damage to nearby structures and pavements if not properly managed (**Figure 3**).

Figure 2. Oduduwa Road, University of Ibadan.

Figure 3. Sapara Road, University of Ibadan.

4.2. Perceived Effects of Tree Removal on Campus

This study highlighted several critical effects of tree removal on the University of Ibadan campus, as identified by respondents. The major impacts included high temperatures (86.9%), storms (62.9%), and flooding (27.9%) (**Table 2**). These

findings underscore the roles that urban trees play in moderating environmental conditions and the significant consequences of their removal [16].

Table 2. Perceived effects of tree removal on campus.

Variables	Responses	Frequency	Percentage (%)
Environmental hazards witnessed before on campus	Very high temperature	171	86.9
	Storm	124	62.9
	Flooding	55	27.9
Do you know that tree removal is a major the factor responsible for these environmental	Yes	160	80.0
	No	40	20.0
Hazards on campus? Do you think reforestation and replacement? of trees removed on campus can help miti-gate the effect of these hazards?	Yes	186	93.0
	No	14	7.0

- High Temperatures (86.9%):

The overwhelming majority of respondents (86.9%) indicated that tree removal contributes to increased temperatures on campus. Trees play a crucial role in regulating urban temperatures through shading and evapotranspiration [17]. Their canopies provide shade, reducing the heat absorbed by buildings and pavement, while the process of evapotranspiration releases moisture into the air, contributing to cooling. The loss of tree cover not only affects the comfort and well-being of campus occupants, especially students but also increases energy consumption for cooling purposes.

- Storms (62.9%):

Approximately 62.9% of respondents identified storms as a major consequence of tree removal. Trees act as windbreaks, reducing wind speeds and mitigating the impact of storms. The removal of trees can exacerbate the effects of storms, leading to higher wind speeds and increased damage to buildings and infrastructure. Additionally, tree roots help stabilize the soil, reducing the risk of erosion and landslides during heavy storms.

- Flooding (27.9%):

Flooding was identified by 27.9% of respondents as a significant impact of tree removal. Trees facilitate water infiltration into the soil, reducing surface runoff and the risk of flooding [18]. Their root systems create channels in the soil that enhance water absorption, while the canopy intercepts rainfall, slowing its descent to the ground [19]. The removal of trees disrupts these processes, increasing surface runoff and the likelihood of flooding. This is particularly concerning on the campus, where impervious and hard surfaces like roads and buildings further worsen runoff.

4.3. Relationship between Location and Reasons for Tree Removal, and Tree Species Removed and Reasons for Removal

The P-value of the chi-square test, as presented in **Table 3**, is 0.011, indicating a statistically significant association between tree species locations and the reasons for tree removal. Consequently, we reject the null hypothesis. This finding implies that the location of trees significantly influences the reasons for their removal. For instance, residential areas are more prone to tree removal, with many trees on campus, particularly in residential zones, being old. This observation aligns with the findings of [11] who reported that 94 trees along Oduduwa Road on the campus were hazardous (**Figure 2**). Furthermore, [11] also noted that many trees on the campus are as old as the University itself and have experienced considerable stress due to numerous changes over the past fifty years. This stress has resulted in a decline in the tree canopy and poor management, necessitating the removal of t.hese trees to mitigate threats to lives, buildings, and properties in residential areas on the campus [20].

Conversely, the P-value of 0.54 from **Table 3** indicates no significant association between the species of trees removed and the reasons for their removal. Therefore, we fail to reject the null hypothesis in this case. This suggests that the species of trees removed do not significantly impact the reasons for their removal [21]. This finding is also consistent with the observations of [11] who reported that the defects observed in municipal trees within the campus are common across various tree species.

Table 3. Chi-square showing the relationship between reasons for removal and location of tree species, and the relationship between tree species removed and reasons for removal.

Variables	Pearson Value	Chi-Square	df	P value
Relationship between reasons for removal and location of tree species	58.199[a]		36	0.011
Relationship between tree species removed and reasons for removal	440.584[a]		444	0.537

5. Conclusions

While urban trees on the University of Ibadan campus offer numerous benefits, unmanaged trees can pose significant hazards. This study identified the primary reasons for tree removal as old age, threats to buildings, windthrow, and infrastructural development. Our findings indicate that the location of trees significantly influences the reasons for their removal, whereas the species of trees do not have a significant impact. High temperatures, storms, and flooding were identified as the main effects of tree removal, highlighting the importance of effective urban forest management practices.

Effective management practices, such as regular pruning and tree evaluation, are essential to mitigate these hazards and preserve the urban forest [22].

Implementing these practices can enhance the safety and longevity of the campus's urban forest, ensuring it continues to provide ecological, aesthetic, and health benefits to the university community [23]. The findings of this work suggest that urban forestry policies should prioritize the protection of existing trees, promote the planting of diverse species, and integrate tree management into broader urban planning frameworks. Policymakers on campus should also ensure adequate funding for reforestation programs and support community engagement initiatives. Policies that promote the planting of climate-resilient tree species to adapt to changing environmental conditions should also be implemented.

6. Future Research Projections for Urban Forests in Nigeria

To enhance urban forest management in Nigeria, future research should focus on the following areas: developing predictive models to anticipate tree failure and identify high-risk trees based on factors like age, species, location, and environmental conditions; exploring resilient tree species suitable for planting near infrastructure; quantifying the ecosystem services provided by urban trees, including air quality improvement, temperature regulation, and biodiversity support.

Also, modeling the environmental impacts of tree removal and reforestation under various scenarios to inform urban planning and policy decisions, and assessing the social and economic benefits of urban trees, such as their impact on property values, community health, and overall quality of life.

7. Recommendations

Species that are well-suited to the local climate and soil conditions and that offer maximum benefits in terms of temperature regulation, storm mitigation, and water absorption must be selected. Also, strategic planting plans that prioritize areas most affected by tree removal, such as those with high impervious surface cover or those prone to flooding and storm damage must be implemented. Species like *Samanea saman, Khaya ivorensis, Terminalia catapa,* and *Terminalia ivorensis* should be avoided near residential and administrative areas due to their heavy crowns and potential to damage buildings.

Also, engaging the campus community in reforestation efforts to foster a sense of ownership and stewardship must be encouraged. Educational programs on campus can highlight the benefits of trees and promote participation in planting and maintenance activities must be encouraged. Consequently, prioritize that newly planted trees receive adequate care, including watering, pruning, and protection from pests and diseases. Maintenance plans should also address the long-term health and sustainability of the urban forest. Routine inspections to assess the health and structural integrity of trees, especially those near buildings and other infrastructures, must be prioritized.

Conflicts of Interest

The authors declare no conflicts of interest.

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