

Assessment of Tree Species Composition in the Riparian Axis of River Wupa, AMAC, Abuja

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Abstract

*The floristic assessment at low altitudes and its sequential characteristics are still very scanty to guarantee the global cross-biome comparisons. The study is aimed at assessing the richness and characteristics of trees species along River Wupa, with the view of establishing a baseline for interpretation of temporal changes of vegetation with particular reference to the Guinea Savanna Ecozone in the FCC. The study is anchored on the quantitative research design. Investigation of tree stands was conducted mid-way of River Wupa along Jabi District due to its characteristic's nature of luxuriant riparian vegetation. Three riparian micro-habitats were selected; line transect method was purposively used to examine species richness, density, and tree stand. The study adopts the Simpson index of diversity, Menhinick index of species richness. Philips method of species density and Newton's formula for tree volume equation were used as three transect plot of 2m width by 50m length were delineated for vegetation studies. The analysis of variance (ANOVA) test was used to investigate the study hypothesis. The study revealed that *Azelia Africana* and *Ficus platyphylla* were the dominant riparian tree species, while *Parkia biglobosa* was recorded as the least tree species in the riparian zone of River Wupa. Dominant shrub species along River Wupa were *Anogeissu leiocarpus* and *Ceiba pentandra*. Tree species richness along sampled transect shows that transect 1 have more species richness (2.04) to the ratio of tree density than transect 2 and 3 (1.68), indicating decrease in tree species richness down the river channel. In contrast, shrub species richness shows increase downstream the river Wupa. This indicates increase in tree volume downstream. The P value (0.004) of the ANOVA test indicates significant differences in the mean value of tree stands along transects. In contrast, there was no significant difference in the occurrences of shrub along transects given the p value of 0.007. The study concludes that there is disparity in the composition and distribution of tree species along the riparian zones of River Wupa, as such recommends among others that; the current conservation principles employed in the form of plant gardening along River Wupa should be sustained.*

Keywords: *riparian forest conservation, Azelia Africana, Ficus platyphylla, Parkia biglobosa, Anogeissuleiocarpus and Ceiba pentandra.*

INTRODUCTION

Riparian vegetation is classified as a significant terrestrial biome of the earth (Breugel, Lilles, Bingham, Demissew, Dudley, and Fris, 2011; Kent, 2012). Plant communities along the riverbank laterally begins from the active channel to the uplands giving raise to active floodplains and immediate adjacent terraces, characterized by strong ecological gradients and dynamics (Ellenberg, Leuschner and Stuttgart, 2010).

Edicha and Abdullahi (2016) pointed out that; riparian vegetation is under pressure from increasing demand for land-based product and services with the environment. The impacts of anthropogenic activities on riparian systems in

urban streams are obvious (Imberger *et. al.*, 2011). In urban streams, the resultant degradation and effects are collectively termed "the urban stream syndrome" which is characterized by hydrologic flash flooding and channel erosion (Imberger *et. al.*, 2011). This most times, results to the loss of large acres of riparian areas (Magdaleno and Martinez, 2014), and species depletion (Sunil, Somashekar and Nagaraja, 2017). This, however, calls for routine assessment of riparian plant communities, with focus on the unique species composition along river system considering the increasing rate of population and antecedent human activities along River Wupa; to this end, numerous studies in the Guinea savanna ecological

zone of Nigeria highlights depletion in species richness and diversity (Agbelade and Fagbemigun, 2015; Edicha and Abdullahi, 2016; Yusuf, Abdulhakeem, and Chatta, 2017). Akomolafe, Ombugadu, and Joseph, (2017) reported low species density in three separate riparian forest habitats resulting from local human interferences or activities. It is eminent that the species richness and biodiversity of River Wupa be assessed in the light of increase housing development along the river path.

In the Federal Capital Territory, studies on riparian vegetation have been limited to River Usuma in Gwagwalada and Bwari axis (Rabiu and Edicha; 2019a; Rabiu and Edicha; 2019b) with little attention to its major tributary (River Wupa) which drains the Federal Capital City (FCC). The implication is that the dynamics of riparian community is not acknowledged particularly in the phase of increase in landscape transformation within the City Centre due to construction activities. To fill this gap, this study seeks to

evaluate the composition (*assessing the richness and characteristics of trees species*) of riparian vegetation along River Wupa, FCC. To achieve this, the following set of objectives were pursued; Provision of a site-specific checklist of trees along the riparian areas of River Wupa, examination of the species richness and diversity of trees along River Wupa and evaluation of the floristic density of trees along River Wupa.

MATERIALS AND METHODS

Study Area

River Wupa is a major tributary of River Usuma, which drains the Federal Capital City. River Wupa gets its source from the Aso-Bwari Hill and drains downward, stretches over major districts such as Wupa, through Jabi, Dakibiyu, Lugbe and Sauka where it empties into Usuma River (Figure 1.2). The FCC is located between latitudes 7°25'20"N and 7°20'40"N and longitudes 9°0'0"E and 9°6'0"E. It has a total landmass area estimated at 1,043 km².

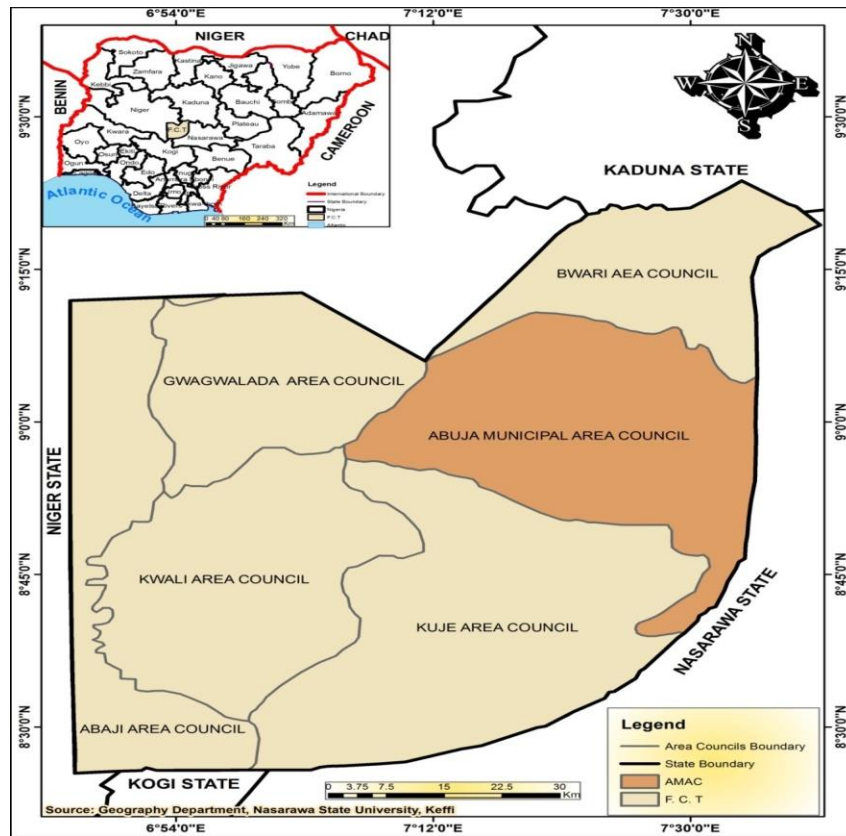


Figure 1 FCT showing Abuja Municipal Area Council
Source: Modified from Adeoye (2006)

Daytime temperature is, on a general scale, is high, but falls sharply at night, with 23°C maximum range. The mean maximum monthly temperature ranges between 28°C– 30°C and the mean minimum monthly temperature range falls between 25°C– 27°C. The area records an average maximum and minimum daily temperature range of between 30°C- 21°C during the dry season and 37°C -16°C during the rainy season respectively. This usually results in an average annual temperature of 27.2°C which varies by 4.7°C (Hassan, 2008). For relative humidity, the area records about 25% in the dry season for a year, usually in the afternoon (Abuja master plan, 2000). The highest rainfall record is in the month of August reading about 1400mm, while the least amount of rainfall record is in December with an average amount of 1mm. (Adakayi, 2000).

The study area falls within the Guinea Savanna Vegetation Zone of Nigeria. The dominant vegetation of in the area is classified into three savannah types (Savanna woodland, Park or Grassy Savanna and Shrub Savanna). Common trees are *Daniela Oliveri*, *Khaya Senegalensis*, *Terminalia ivorensis*, *Parkia biglobosa* and *pterocarpus Arenaceous*, *Afzeliaafricana*, *Gmelina arborea* (Adekayi, 2000; Ishaya & Mashi, 2008).

The soil shows high level of variability comprising mainly of sand, silt, clay and gravel. Alluvial soils are mostly found in the valleys of the various River channels within the area (Balogun, 2001). The soils within the area are often moist and poorly drained almost all year round, which to a great extent support farming due to its various natures (Edicha & Mgbanyi, 2013).

The study area is drained by River Wupa, a major tributary of River Usuma, which classified as a major system in the FCT (Balogun, 2001). Other subsequent rivulet from gully sites also drains into River Wupa, increasing the volume of water downstream. The area is characterized by gentle uprising terrain, which decreases abruptly along the river Wupa and its tributaries. The hills appear as clusters and long hill ranges, a close example is the Aso-Bwari hill (Chup, 1998).

Methodology

Nature and Types of Data

The research design is quantitative. It is aimed at testing objective theories by examining the relationship among variables. The variables employed were numerical data consisting of the spatial quantification of trees in terms of species distribution, floristic density and diversity. The variables were subjected to statistical techniques to determine tree species richness and stands along transects of River Wupa. This requires testing of the study hypothesis deductively.

This study was subjected to the combination of primary and secondary data. The data were collated through direct field observation of tree species and data on species count along the surveyed transects. The second set of data used were from literature, maps used to define the study plot and plant diary and plant identifier software to identify the specific plant species along River Wupa.

Sampling Frame, Size and Technique

River Wupa channel along Jabi District Axis constitutes the sample frame for this research. The investigation of tree stands was conducted downstream of River Wupa. Three sampling transects were delineated and the species richness, density and tree stands were evaluated. The different sizes of transects are:

- i. **Transect 1:** 2m width by 50m length
- ii. **Transect 2:** 2m width by 50m length
- iii. **Transect 3:** 2m width by 50m length

Purposive sampling method was used. The area was chosen for the study due to its rich and luxuriant vegetation conditioned occasioned by the observed emerging anthropogenic activities along the river channel; more so that, River Wupa is one of the major tributaries of River Usuma with luxuriant riparian vegetation community. Three riparian micro-habitat were selected, and the line transect method was purposively used to examine species richness, density and tree stand because the vegetation occurs in a linear pattern along the water course (Table 1, Figure 2) and plate 3.1).

Table 1 Sampling points

Transects	Coordinates			
	Latitude	Point A Longitude	Point B Latitude	Longitude
1	7.4097801	9.0244211	7.4103723	9.0246921
2	7.4112390	9.0246398	7.4113641	9.0253246
3	7.4078204	9.0236507	7.4085715	9.0237982

Source: Author Field Work, 2021

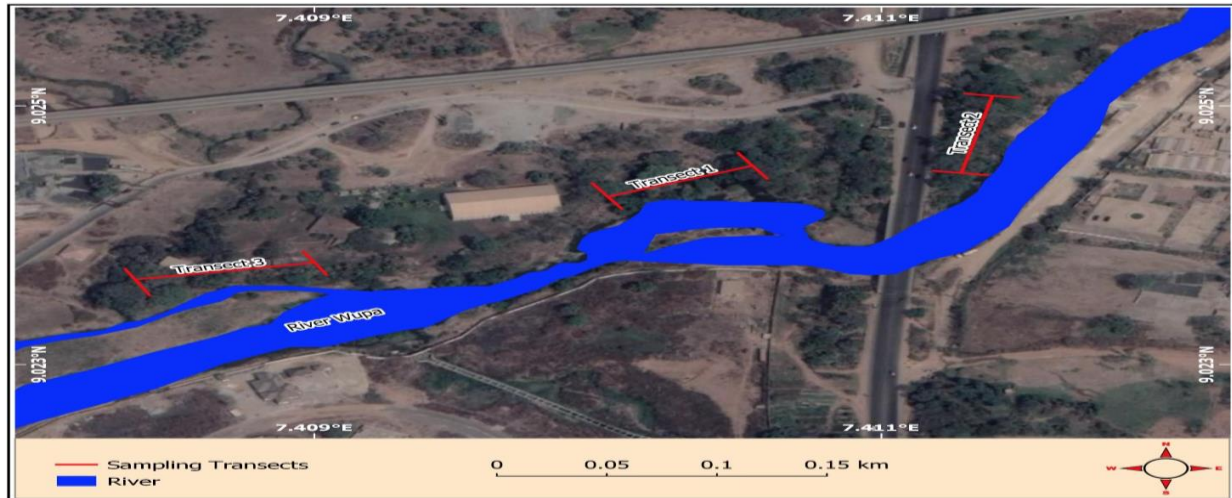


Figure 2 Map Showing Sampling Station
Source: University of Abuja (2021)

Instrumentation

The study adopted different instruments and software packages as shown in Table 2

Table 2 Instruments used

S/N	Instrument	Model	Purpose
1	Global Positioning System	GPS map 60Cx	To obtain sampling points
2	Cutlass	-	Clearing site and cutting thorns
3	Notepad/Pen	40 leaves/bic	For writing
4	Line	Plastic/ 100m	For delineating sampling points and preparing quadrat
5	Tape rule	Fibre 100ft	For measuring sampled plot
6	Wooden Peg	1ft	To delineate quadrat
7	Plant Diary	Photo book	To identify plants species
8	Plant Identifier	Mobile Software	To identify plants
9	Google Earth	Google Pro-version	To develop imagery map
10	ArcGIS	ArcGIS 10.1	To produce study map

Source: Author Field Work, 2021

Method of Data Analysis

The under-listed hypothesis guided the conduct of this study.

H0₁: There is no significant variation in the number of trees stand along River Wupa.

Therefore, to evaluate the species richness and tree stands, the ANOVA statistics for mean variance was employed.

Variance Estimate

$$S_B^2 = \frac{BSS}{K-1}$$

$$S_W^2 = \frac{WSS}{N-K}$$

The Simpson diversity index was used to assess the species density across the three different plots. The tree volume, height, and radius were also measured.

Simpson Diversity Index

$$D = \frac{\sum n(n-1)}{N(N-1)} \text{----- equation 1}$$

Where: n = total number of organism (Plant) of a particular species.

N = total number of organism (Plant) of all species

The value of this index ranges between 0 and 1.0, with this index, 0 represents infinite diversity and 1, no diversity. That is, the bigger the value of D, the lower the diversity.

Simpson's Index of Diversity = 1-D..... equation 2

The value of this index also ranges between 0 and 1, but now, the greater the value, the greater the sample diversity.

Simpson's Reciprocal Index = 1/D

Also the greater the value of this index the greater the diversity.

Species Richness

Menhinick index modified by Sagar and Singh, (2004) was used to estimate the species richness.

$$R = \frac{s}{\sqrt{N}} \text{..... equation 3}$$

Where D= Species richness
S = number of species

N =Total number of individuals

Species Density

Density was determined following Philips (1959)

$$\text{Density} = \frac{\text{Total no of individual species}}{\text{No. of quadrat per units studied}} \dots \text{eq. 4}$$

Volume of Tree

The volume of tree was determined using the formula adopted by Husch, Beers and Kershaw (2003) and Aminu, Sameer D. and Yakubu, (2019)

$$V = \pi r^2 h$$

Where: V= volume

π = is a constant and stands for 22/7=3.14

h= height of the tree

r^2 = stands for radius of the tree and it is derived by dividing the girth by two.

RESULTS AND DISCUSSION

Inventory of Tree Species in the Study Area

The identified plants species in the sampling transect are grouped into trees and shrub respectively. The assessment shows that tree species are most dominant in the riparian area than shrub species (Table 3 and 4). This could be attributed to the availability of constant moisture content in the soil, well-aerated soil rich in alluvial soils have been attributed to the growth of trees within riparian zones (Dybkjær, Baattrup-Pedersen, Kronvang and Thodsen, 2012; Khan, Saeed, Ahmad, Qamar, *et. al.*, 2016).

Table 3 shows that a total of 13 species were identified across the three transects in the riparian zones of River Wupa within Jabi District. In transect 1, the frequency count of tree species was 24, while the mean distribution is 1.85.

Average occurrence of tree species in transect 2 and 3 are 3.31 and 4.62, while the frequency count of species abundance is 43 and 60 in both transect 2 and transect 3 respectively.

Azelia Africana and *Vitex doniana* were the dominant tree species in transect 1 with a frequency count of 4, while in transect 2, *Azelia Africana*, *Ficus platyphylla* and *Bombax costatum* were recorded as the dominant tree species with a frequency count of 8 and 6, respectively.

Table 3 Checklist of tree species

S/N	Species	Transect 1		Transect 2		Transect 3	
		Freq	%	Freq	%	Freq	%
1	<i>Daniella oliveri</i>	1	4.2	3	7	4	6.7
2	<i>Azalia africana</i>	4	16.7	8	18.6	9	15
3	<i>Gmelina arborea</i>	2	8.3	0	0.0	4	6.7
4	<i>Ficus platyphylla</i>	2	8.3	6	14	7	11.7
5	<i>Vitex doniana</i>	4	16.7	5	11.6	5	8.3
6	<i>Bombax costatum</i>	3	12.5	6	14	6	10
7	<i>Terminalia ivorensis</i>	0	0.0	2	4.7	4	6.7
8	<i>Khaya senegalensis</i>	3	12.5	1	2.3	3	5
9	<i>Mangifera indica</i>	0	0.0	2	4.7	6	10
10	<i>Azadirachta indica</i>	0	0.0	3	7	4	6.7
11	<i>Nauclea latifolia</i>	2	8.3	4	9.3	3	5
12	<i>Prosopis Africana</i>	1	4.2	0	0.0	2	3.3
13	<i>Parkia biglobosa</i>	2	8.3	3	7	3	5
Species Number		24	100	43	100	60	100
Mean Distribution		1.85		3.31		4.62	

Note: Freq = Frequency count; % = Percentage distribution

Source: Author's Field Work (2021)

Similarly, *Azalia Africana*, *Ficus platyphylla*, *Bombax costatum* and *Mangifera indica*, were recorded as the dominant tree species in transect 3, with a count of 9, 7 and 6 respectively. Irrespective of the sampling transect, *Azalia Africana* and *Ficus platyphylla* were recorded as the dominant riparian tree species in the study, while *Parkia biglobosa* was recorded as the least tree species. The number of tree species increases with increase

in the width of the river as indicated by the increase in tree species and number of species occurrences downstream (transect 3). The result concurs with the works of Dybkjær et al. (2012).

Inventory of Shrubs Species

The inventory of shrub species in the sampled transects is presented in Table 4.

Table 4 Checklist of shrub species

S/N	Species	Transect 1		Transect 2		Transect 3	
		Freq	%	Freq	%	Freq	%
1	<i>Anogeissu leiocarpus</i>	7	29.2	5	38.5	3	37.5
2	<i>Ceiba pentandra</i>	4	16.7	3	23.1	2	25
3	<i>Guiera senegalensis</i>	5	20.8	2	15.4	2	25
4	<i>Cassia Arereh</i>	4	16.7	2	15.4	1	12.5
5	<i>Rothmania longiflora</i>	4	16.7	1	7.7	0	0
Species Number		24	100	13	100	8	100
Mean Distribution		4.8		2.6		1.6	

Note: Frq = Frequency count; % = Percentage distribution

Source: Author's Field Work (2021)

The result showed that, total frequency counts varied from 24 in transect 1 to 13 and 8 in transect 2 and 3 respectively. Average species distribution showed that transect 1 has more shrub species (4.8) than transect 2 (2.6) and transect 3 respectively

(1.6). Dominant shrub species in the entire transects include: *Anogeissu leiocarpus* and *Ceiba pentandra* with a count of 7 and 5 (transect 1), 5 and 3 (transect 2), 3 and 2 (transect 3). *Rothmania longiflora* was recorded as the least occurred shrub

species in the riparian vegetation with frequency count recorded only 1 in the transect 1. The absence of tree species in transect 1 is associated with high number of shrubs.

Tree Species Richness and Diversity

Results of the richness and diversity of tree species along each sampled transect in the riparian vegetation area are presented in Table 5.

Table 5 Tree species richness and diversity along sampled transect

Species Richness				
Altitude	S	N	\sqrt{N}	R
Transect 1	10	24	4.9	2.04
Transect 2	11	43	6.6	1.68
Transect 3	13	60	7.7	1.68
Species Diversity Index				
	Transect 1	Transect 2	Transect 3	
D	0.16	0.05	0.03	
SD	0.84	0.95	0.97	
SRI	6.1	18.2	30.3	

Note: D = Diversity; SD = Simpson's Diversity; SRI = Simpson's Reciprocal Index

Source: Author's Field Work (2021)

The species richness along sampled transects shows that transect 1 have more species richness (2.04) to the ratio of tree density than transect 2 and 3 (1.68). The result shows that the species richness of the riparian vegetation decreases down the river channel, whereas the frequency or abundance of trees increases down the river channel. The species diversity as presented in Table 5 varies from 0.16 in transect 1 to 0.05 and 0.03 in transect 2 and 3 respectively. The result

implied that transect 1 has the highest rate of tree species diversity followed by transect 2. The Simpson's diversity index also commensurate same fact with a diversity of tree species at the rate of 0.97 and 0.95 for both transect 1 and transect 2, while transect 3 recorded the least tree species diversity (0.84). The result is in conformity with the Simpson's reciprocal index, which estimates tree species index of 6.1, 18.2, and 30.3 across the tree transects.

The shrub Species Richness

Table 6 Shrub species richness and diversity along sampled transect

Species Richness				
Altitude	S	N	\sqrt{N}	R
Transect 1	5	24	4.9	1.0
Transect 2	5	13	3.6	1.4
Transect 3	4	8	2.8	1.4
Species Diversity Index				
	Transect 1	Transect 2	Transect 3	
D	0.04	0.13	0.21	
SD	0.96	0.87	0.79	
SRI	27.6	7.8	4.7	

Note: D = Diversity; SD = Simpson's Diversity; SRI = Simpson's Reciprocal Index

Source: Author's Field Work (2021)

The shrub species richness along sampled transects shows that transect 2 and 3 have more shrub species richness (1.4) than transect 1 (1). The result shows that the species richness of shrubs in the riparian vegetation increases down the river

channel. The species diversity as presented in Table 4.4 varies from 0.04 in transect 1 to 0.13 and 0.21 in transect 2 and 3 respectively. The result implied that transect 1 has the highest rate of tree species diversity followed by transect 2. The

Simpson's diversity index also commensurate same fact with the diversity of shrub species at the rate of 0.96 and 0.87 for both transect 1 and transect 2, while transect 3 recorded the least shrub species diversity (0.79). The result is in conformity with the Simpson's reciprocal index, which estimates shrub species index of 27.6, 7.8, and 4.7 across the tree transects. Similar study has reported variations in tree and shrub species of riparian vegetation, which is an indication of anthropogenic

activities (Meragiaw, Woldu, Martinsen and Singh, 2018).

Species Density

Tree density is simply the number of trees per unit area and is generally reported as the number of trees per hectare. However, considering the miniature size of the sampling transects, meter(s) was adopted (Table 7).

Table 7 Tree species density along transects

S/N	Species	No of individual species			Total No of individuals	Total Transects	Density (m ²)		
		T1	T2	T3					
1	<i>Daniella oliveri</i>	1	3	4	8	3	2.7		
2	<i>Afzelia africana</i>	4	8	9	21	3	7		
3	<i>Gmelina arborea</i>	2	0	4	6	3	2		
4	<i>Ficus platyphylla</i>	2	6	7	15	3	5		
5	<i>Vitex doniana</i>	4	5	5	14	3	4.7		
6	<i>Bombax costatum</i>	3	6	6	15	3	5		
7	<i>Terminalia ivorensis</i>	0	2	4	6	3	2		
8	<i>Khaya senegalensis</i>	3	1	3	7	3	2.3		
9	<i>Mangifera indica</i>	0	2	6	8	3	2.7		
10	<i>Azadirachta indica</i>	0	3	4	7	3	2.3		
11	<i>Nauclea latifolia</i>	2	4	3	9	3	3		
12	<i>Prosopis Africana</i>	1	0	2	3	3	1		
13	<i>Parkia biglobosa</i>	2	3	3	8	3	2.7		
Total Density					127	39	42.3		
Mean Density					9.8	3	3.3		
Standard Deviation					4.8	0.00	1.6		
Tree Species	1	<i>Anogeissuleiocarpus</i>	7	5	3	15	3	5.0	
	2	<i>Ceiba pentandra</i>	4	3	2	9	3	3.0	
	3	<i>Guiera senegalensis</i>	5	2	2	9	3	3.0	
	4	<i>Cassia Arereh</i>	4	2	1	7	3	2.3	
	5	<i>Rothmanialongiflora</i>	4	1	0	5	3	1.7	
	Total Density					45	15	15	
	Mean Density					9	3	3	
	Standard Deviation					3.3	0.0	1.1	
	Shrubs Species	1	<i>Anogeissuleiocarpus</i>	7	5	3	15	3	5.0
		2	<i>Ceiba pentandra</i>	4	3	2	9	3	3.0
3		<i>Guiera senegalensis</i>	5	2	2	9	3	3.0	
4		<i>Cassia Arereh</i>	4	2	1	7	3	2.3	
5		<i>Rothmanialongiflora</i>	4	1	0	5	3	1.7	
Total Density					45	15	15		
Mean Density					9	3	3		
Standard Deviation					3.3	0.0	1.1		

Note: T = transects

Source: Author's Field Work (2021)

As shown in Table 7, thirteen (13) tree species were identified with a sum density of 42.3 and average of 3.3±1.6 individual per m². *Afzelia africana* and *Bombax costatum* tree species recorded the highest density at the rate of 7m² and 5m² individual along the transects. In contrast,

Prosopis Africana recorded the least individual species density at the rate 1 m² in the sampled transects. The total shrub species identified were five (5), which have a sum total density of 15 and an average of 3±1.1 individuals per m². The highest shrub species density of 5 per m² was

recorded for *Anogeissu leiocarpus*, while the least recorded density (1.7) per m² was recorded for *Rothmania longiflora*.

Volume of Tree Species

The total volume of trees and shrub species in the sampled transects are presented in Table 8. The

result shows that the height, girth, and volume of the respective tree species differs along the sampled transects. Table 8 shows that at transect 1, the tree species with the least volume (8.2m³) belong to the species of *Mangifera indica*, while the tree with the highest volume (13.3m³) belong to the specie of *Daniella oliveri*.

Table 8 Volume of tree species

S/N	Species	Transect 1			Transect 2			Transect 3			
		H	G	V	H	G	V	H	G	V	
1	<i>Daniella oliveri</i>	8.2	1.03	13.3	9.1	2.1	30.0	9	3.1	43.8	
2	<i>Azalia africana</i>	5.1	0.61	4.9	7.6	0.86	10.3	10.2	1.1	17.6	
3	<i>Gmelina arborea</i>	7.3	0.37	4.2	9.3	0.41	6.0	8.3	0.9	11.7	
4	<i>Ficus platyphylla</i>	5.2	0.87	7.1	8.2	1.2	15.4	7.1	1.1	12.3	
5	<i>Vitex doniana</i>	9.1	0.33	4.7	11.0	0.31	5.4	11.4	0.5	8.9	
6	<i>Bombax costatum</i>	5.3	0.54	4.5	9.5	0.66	9.8	7.3	0.6	6.9	
7	<i>Terminalia ivorensis</i>	9.8	0.41	6.3	11.3	0.45	8.0	10.5	0.6	9.9	
8	<i>Khaya senegalensis</i>	7.7	0.9	10.9	8.4	1.1	14.5	8.3	1.3	16.9	
9	<i>Mangifera indica</i>	5.9	0.37	3.4	10.5	0.91	15.0	11.3	1.2	21.3	
10	<i>Azadirachta indica</i>	9.3	0.56	8.2	9.2	0.72	10.4	10.1	0.83	13.2	
11	<i>Nauclea latifolia</i>	10.3	0.71	11.5	11.4	1.1	19.7	12.2	1.04	19.9	
12	<i>Prosopis Africana</i>	8.4	0.41	5.4	10.3	0.34	5.5	9.1	1.0	14.3	
13	<i>Parkia biglobosa</i>	9.3	0.9	13.1	9.2	0.7	10.1	11.2	1.03	18.1	
	Sum total	97.5	125	10.86	160.1	126	14.3	214.8	97.5	125	
	Mean	7.5	9.62	0.84	12.32	9.69	1.1	16.52	7.5	9.62	
	Standard Deviation	3.40	1.16	0.46	6.57	1.58	0.62	8.92	3.40	1.16	
Tree Species											
	1	<i>Anogeissuleiocarpus</i>	1.3	0.13	0.3	1.1	0.11	0.2	3.2	0.3	1.5
	2	<i>Ceiba pentandra</i>	2.4	0.21	0.8	3.2	0.31	1.6	4.1	0.45	2.9
	3	<i>Guiera senegalensis</i>	2.2	0.15	0.5	2.9	0.11	0.5	5.01	0.21	1.7
	4	<i>Cassia Arereh</i>	1.9	0.6	1.8	2.7	0.8	3.4	3.1	0.07	0.3
	5	<i>Rothmanialongiflora</i>	2.1	0.4	1.3	3.0	0.3	1.4	4.1	0.31	2.0
	Sum total	9.9	1.5	4.7	12.9	1.6	7.1	19.5	1.3	8.4	
	Mean	2.0	0.3	0.9	2.6	0.3	1.4	3.9	0.3	1.7	
Shrubs Species											
	1	<i>Anogeissuleiocarpus</i>	1.3	0.13	0.3	1.1	0.11	0.2	3.2	0.3	1.5
	2	<i>Ceiba pentandra</i>	2.4	0.21	0.8	3.2	0.31	1.6	4.1	0.45	2.9
	3	<i>Guiera senegalensis</i>	2.2	0.15	0.5	2.9	0.11	0.5	5.01	0.21	1.7
	4	<i>Cassia Arereh</i>	1.9	0.6	1.8	2.7	0.8	3.4	3.1	0.07	0.3
	5	<i>Rothmanialongiflora</i>	2.1	0.4	1.3	3.0	0.3	1.4	4.1	0.31	2.0
	Sum total	9.9	1.5	4.7	12.9	1.6	7.1	19.5	1.3	8.4	
	Mean	2.0	0.3	0.9	2.6	0.3	1.4	3.9	0.3	1.7	

Note: H= height; G = girth; V = volume

Source: Author's Field Work (2021)

Table 8 shows that at transect 1, the tree species with the least volume (8.2m³) belong to the species of *Mangifera indica*, while the tree with the highest volume (13.3m³) belong to the specie of *Daniella oliveri*. In transect 2, *Daniella oliveri* specie has the highest volume (30m³), while *Vitex doniana* has the least volume (87.6m³). In transect 3, the volume of 23.3m³ was estimated as the highest and found among the *Daniella oliveri*

species, while the least volume (5.4m³) belong to the species of *Bombax costatum*. On the average, the volume of trees species was 0.84m³, 1.1m³, and 9.62m³ in transect 1, 2 and 3 respectively. This indicates that the highest volume of trees was recorded in transect 3. The highest volume of shrub species was recorded among *Cassia Arereh* (1.8m³) in transect 1, *Guiera senegalensis* (3.4m³) in transect 2 and *Ceiba pentandra* (2.9m³) in transect 3.

Test of Hypothesis

To determine the degree of variation in the distribution of tree species along linear transect of River Wupa, ANOVA was employed. The hypothesis is thus.

H₀₁; There is no significant variance in the number of trees stands along River Wupa.

Decision rule: null hypothesis is rejected where the p value is greater than 0.05% (confidence value).

The mean variation of tree stands along the riparian zone of River Wupa is presented in Table 9.

Table 9 Test of variance

	Source of Variation	SS	df	MS	F	P-value	F crit
Tree Stand	Between Groups	49.897	2	24.949	6.437	0.004	3.259
	Within Groups	139.539	36	3.876			
	Total	189.436	38				
Shrub	Between Groups	26.8	2	13.4	7.585	0.007	3.885
	Within Groups	21.2	12	1.766667			
	Total	48	14				

Source: Author’s Field Work (2021)

The result shows that the sum of squares for the tree stands are 49.897 and 139.539 for between groups and within groups, while for shrubs, the sum of squares are 26.8 and 21.2 for between groups and within groups respectively. In reflection to the F value of 6.437 and degree of freedom (2), the P value (0.004) indicates significant differences in the mean value of tree stands along transects. In contrast, there was no significant difference in the occurrences of shrub along transects given the p value of 0.007 (Table 4.7). The result is like the findings of Rabi and Edicha where woody trees were significantly different across quadrat in a riparian zone along River Usama in Bwari Area Council.

CONCLUSION

The study reveals that in transect 1, the frequency count of tree species was 24, while the mean distribution is 1.85. Average occurrence of tree species in transect 2 and 3 are 3.31 and 4.62, while the frequency count of species abundance is 43 and 60 in both transects. *Azelia Africana* and *Vitex doniana* were the dominant tree species in transect 1 with a frequency count of 4, while in transect 2, *Azelia Africana*, *Ficus platyphylla* and *Bombax costatum* were recorded as the dominant tree species with a frequency count of 8 and 6 respectively. Similarly, *Azelia Africana*, *Ficus platyphylla*, *Bombax costatum* and *Mangifera indica*, were recorded as the dominant tree species in transect 3, with a count of 9, 7 and 6

respectively. Irrespective of the sampling transect, *Azelia Africana* and *Ficus platyphylla* were recorded as the dominant riparian tree species in the study, while *Parkia biglobosa* was recorded as the least tree species. Shrub inventory analysis shows that total frequency counts varied from 24 in transect 1 to 13 and 8 in transect 2 and 3 respectively. Average species distribution showed that transect 1 has more shrub species (4.8) than transect 2 (2.6) and transect 3 respectively (1.6). Dominant shrub species in the entire transects is *Anogeissu leiocarpus* and *Ceiba pentandra* with a count of 7 and 5 (transect 1), 5 and 3 (transect 2), 3 and 2 (transect 3).

Mean species richness was 2.04, for transect 1 and 1.68 for transect 2 and 3 respectively. The total of 39, 23 and 60 stands of tree species was identified across the three transects. The species diversity varies from 0.16 in transect 1 to 0.05 and 0.03 in transect 2 and 3 respectively. The Simpson’s diversity index also commensurate same fact with a diversity of tree species at the rate of 0.97 and 0.95 for both transect 1 and transect 2, while transect 3 recorded the least tree species diversity (0.84). The shrub species richness along sampled transects shows that transect 2 and 3 have more shrub species richness (1.4) than transect 1 (1), while the species diversity varies from 0.04 in transect 1 to 0.13 and 0.21 in transect 2 and 3 respectively. The Simpson’s diversity index also commensurate same fact with the diversity of shrub species at the rate of 0.96 and 0.87 for both

transect 1 and transect 2, while transect 3 recorded the least shrub species diversity (0.79).

Thirteen (13) tree species were identified with a sum density of 42.3 and average of 3.3 ± 1.6 individual per m^2 . *Azelia Africana* and *Bombax costatum* tree species recorded the highest density at the rate of $7m^2$ and $5m^2$ individual along the transects. In contrast, *Prosopis Africana* recorded the least individual species density at the rate 1 m^2 in the sampled transects. The total shrub species identified were five (5), which have a sum density of 15 and an average of 3 ± 1.1 individuals per m^2 . The highest shrub species density of 5 per m^2 was recorded for *Anogeissuleiocrarpus*, while the least recorded density (1.7) per m^2 was recorded for *Rothmania longiflora*.

On the average, the volume of trees species was $0.84m^3$, $1.1m^3$, and $9.62m^3$ in transect 1, 2 and 3 respectively. This indicates that the highest volume of trees was recorded in transect 3. The highest volume of shrub species was recorded among *Cassia Arereh* ($1.8m^3$) in transect 1, *Guiera senegalensis* ($3.4m^3$) in transect 2 and *Ceiba pentandra* ($2.9m^3$) in transect 3.

In relation to the F value of 6.437 and degree of freedom (2), the P value (0.004) indicates significant differences in the mean value of tree stands along transects. In contrast, there was no significant difference in the occurrences of shrub along transects given the p value of 0.007.

Based on the findings, the study concludes that there is disparity in the composition and distribution of tree species along the riparian zones of River Wupa, while shrub species shows no significant disparities. The abundance of tree stands is conditioned by the rate of conservation of trees along the River. In different parts along River Wupa, gardening practices are ongoing and this favours the presence of tree stand, forming a preserved riparian tree species.

The study recommends the following:

- i. The current conservation principles employed in the form of plant gardening along River Wupa should be sustained.
- ii. Law against encroachment by sedentary farmers and herds should be strictly enacted to protect the River Wupa riparian zones and its counterparts in the terrestrial region. This will ensure regulation of environment against hazards such as erosion, wildfire, and soil impoverishment.

- iii. To ensure sustainability of vegetation zones in the FCT, forestry extension services should educate locals on the benefits, importance and contributions of forest to the environment.

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