STRUCTURAL ANALYSIS OF RIPARIAN VEGETATION IN BWARI, ABUJA, NIGERIA.

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ABSTRACT
The study examined the structural characteristics of riparian vegetation in Bwari Area Council, Federal Capital Territory, Abuja, Nigeria. The aim of this study is to investigate the growth and the development of woody plants in riparian protected area of the federal capital territory, Abuja in order to understand the climax status of the community. Ten riparian areas were identified in the study area and three riparian area were selected purposively taking into cognizance the size of the riparian area and less interference of human activities which were subjected to quadrat sampling of size 100 by 100 which was further divided into 25 equal grid lines of size of 20 by 20 meters. Four quadrats were laid in each riparian area making a total of 12 quadrats in all the riparian areas studied. However, six quadrats were randomly selected for study. Algometric properties such as Tree height, girth and volume were measured on the field using standardized method. The height of the trees was calculated using a ranging pole of a pre-determined height. While the girth of the tree at breast height was measured using a diameter tape. The data obtained from the girth and the height of the trees was used to calculate the volume of the tree. The data obtained were subjected to descriptive statistics and the results of the study shows that most of the trees in the study area has a girth <1meter and the height of most of the trees is <20meters and the maximum volume obtained was 37.8m^3. From the study it was observed that the trees with maximum volume are those economic trees that are protected by the people. It was also observed that bigger trees have larger volume compared to smaller trees this is evident in the entire quadrat studied. The implication of this finding is that trees around the riparian areas in this study area are not fully developed and matured as reflected in the values obtained with respect to girth of the tree at breast height, the height of the tree as well as the volume of the tree. Therefore, the study conclude that the growth and development of woody plants in riparian protected area are not fully developed, and matured into climax status despite the protective nature of the riparian area. The study concludes that the riparian areas should be protected against intensive human activities such as fuelwood harvesting and urban expansion programme.

Keywords: Tree height, Tree Girth, Tree volume

INTRODUCTION

The term riparian originates from the Latin word *riparius* which refers to the banks of a stream or land adjoining a body of water (IIhardt*et al*., 2000; Naiman& Decamps, 2005). Thus, some authors have excluded the aquatic component of the riparian zone (IIhardt*et al*., 2000). Others describe the riparian zone more broadly by taking into account the important functional linkages of the riparian area using energy and material flows in the associated food webs including the aquatic component (IIhardt*et al*., 2000*)*.

Studies on riparian vegetation include Alldredge and Moore (2012) who examined riparian vegetation sensitive to river hydrogen in Texas USA. Other include Zaimes et al (2011), Gadiga et al (2009), Khan (2016), Lawal (2016). However, in the present study area, studies on riparian vegetation include Edicha 2008 which examined nutrient uptake along riparian area as well as Edicha 2010 which also examined soil carbon sink in riparian area of the Federal Capital Territory. Consequently, they are no existing studies on the structural analysis of riparian vegetation in the present study area. It is assumed that because of the availability of water, vegetation along riparian area ought to be well developed and matured. Hence, this study attempt to measure and quantify the allometric properties of riparian vegetation.

STUDY AREA

This study was carried out in Bwari area council of the Federal Capital Territory in north-central geo-political zone of Nigeria. It is located between Latitudes 9^0 14" 38.28""N and 9^0 20" 01.41""N and between Longitudes 7^0 21" 44.58E and $7^0$23"28.00"" E. The Area Council is located in the geographical centre of Nigeria bordering Niger State and covers a total land mass of 914km^2. Figure 1a depicts the map of Nigeria showing the study area and Figure 1b shows the map of FCT locating the study area, Bwari Area Council.

Bwari has two main seasons, rainy (April to October) and dry (November to March). During the dry season, the typical month being February, the temperature varies between 30°C to about 37°C. Annual rainfall exceeds 1,600 mm, most of it occurring during the rainy season. The mean total annual rainfall is between 1,100 – 1,600mm, with about 80% of it occurring between May and October during the peak of the rainy season. Rainfall is heavy and an event can last more than 6 hours. Rainfall rates of about 50mm/hr are common between July and August. The annual rainfall regime consists of two peaks occurring in July and September. The wind system in the study area is strongly influenced by the seasonal migration of the dry and moist air masses through the region.

Bwari falls within the Guinea Savanna Vegetation Zone of Nigeria. Trees such as A*ntirisern africana, Anthocleistanoblis, Ceibapentandra, Cola gigantea, Celtis spp., Chtorophora excels, Piptadenianum africanum, Lophira on alata, Temlinalia ivorensis, Triplochiton scleroxylon and Dracaena arborea* dominate the area (GEHS,

2014). The dominant vegetation of the area is classified into two savanna types namely, Savanna Woodland and Shrub Savanna.

The soil in the study area shows high level of variability comprising mainly of sand, silt, clay and gravel. Alluvial soils are predominantly found in the valleys of the various Rivers within the area but highly concentrated at the valley of River Usuma.

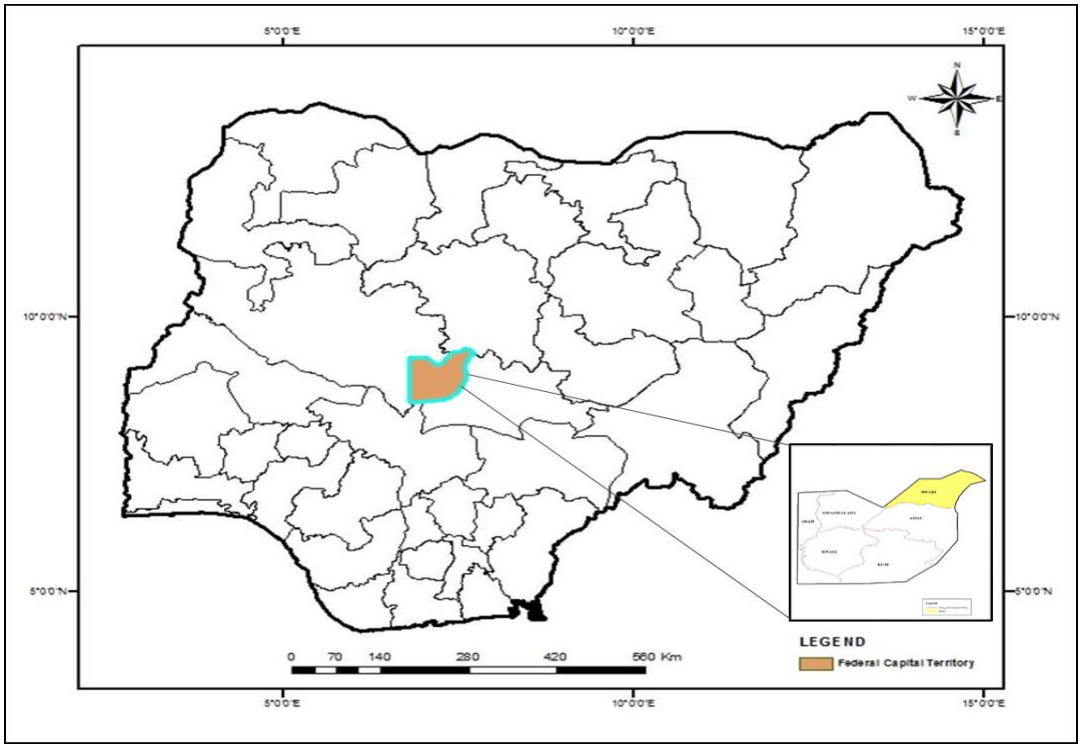


Figure 1a: Map of Nigeria showing the FCT

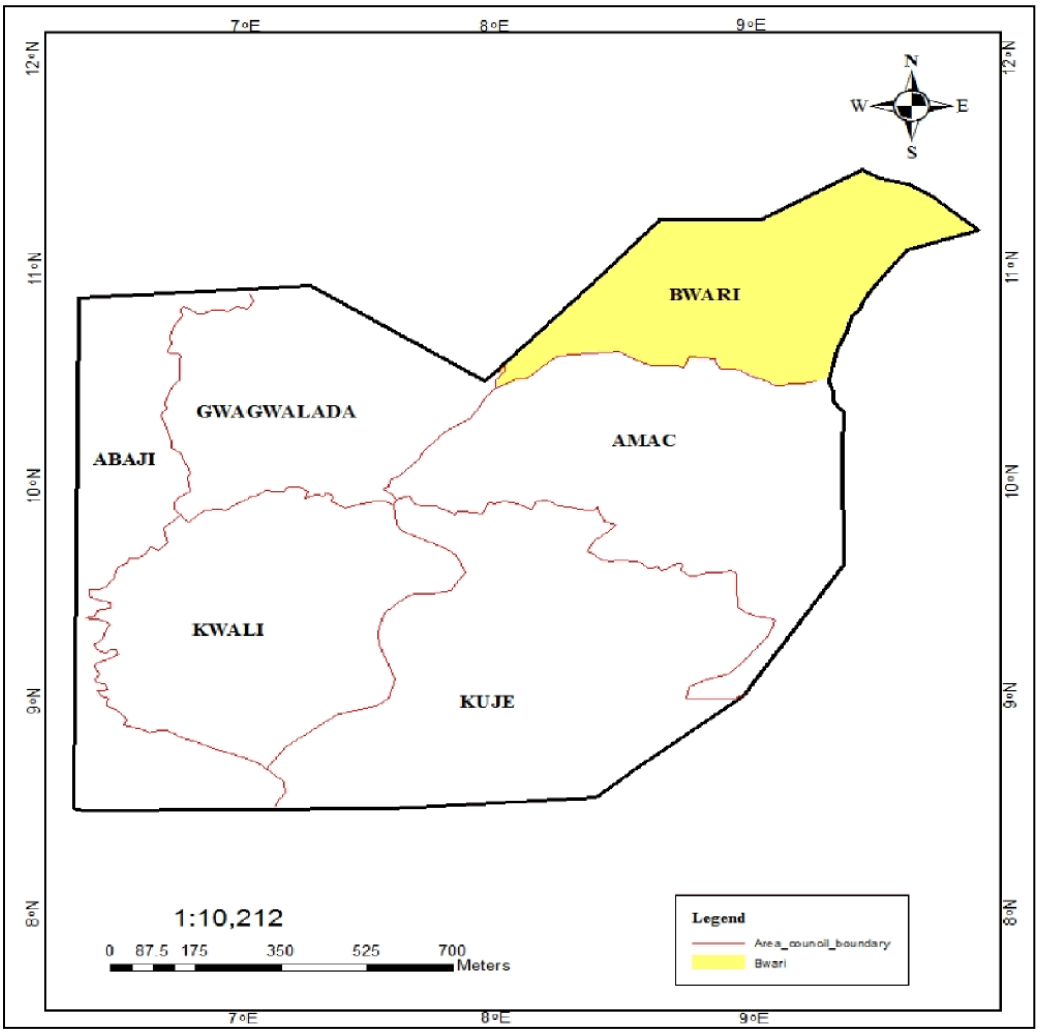


Figure 1b: Map of the FCT showing Bwari Area Council

METHODOLOGY

Sampling Procedure

The quadrat sampling technique was employed for the study and the quadrat of sample size 100m by 100m was used. The quadrat was divided into 25 equal grid squares with a dimension of 20 by 20 meters. Samples were taken from the grid squares. Four quadrats were laid out in each sampling plot and two quadrats were randomly selected from each of the riparian areas for the study using the table of random numbers. This is because the quadrant size was sufficient to analyze the vegetation. In the study area, there exist ten riparian areas as shown in Table 1 and three riparian areas in the study area were selected using the

table of random numbers and these included; Zuma riparian area in Shere, Ushafa riparian are along Tasha-Bwari Express Road, and also Jigo riparian area in ushafa. Therefore, the total sample size is six quadrat as two quadrats were selected from each of the riparian areas. These riparian areas were considered because they were the largest and relatively undisturbed by human activities compared to other riparian areas identified in the study area. Furthermore, these three riparian areas have permanent water regime however, the other ones identified varied seasonally which could account for species composition, diversity and development. In this study, the floral composition refers to the trees and the shrub species found in the sampled riparian areas as herbaceous plants, lianas and epiphytes were not considered in the study. In this study woody plants with heights greater than five meters were considered as trees while the shrub species have height ranging from 0.5meters to 5meters this classification was done following Edwards 1983.

Table 1: identification and locations of riparian Areas Bwari Area Council, Abuja

S/No.	Riparian Areas	Coordinates		Elevation (m)
		Lat. (N)	Long. (E)	
1	Igu	9°16'14"	7°28'36"	659
2	Gyeyidna	9°16'51"	7°26'18"	672
3	Kuchiko	9°15'33"	7°19'21"	530
4	Piawe	9°14'52"	7°22'00"	554
5	Dutse Sagwari	9°10'07"	7°22'26"	501
6	Jikoko	9° 08'18"	7°28'12"	656
7	Shere	9°13'52"	7°30'01"	700
8	Zuma	9°14'30"	7°29'04"	682
9	Ushafa (Tasha-Bwari Express Road)	9°11'53"	7°23'33"	567
10	Jigo	9°13'19"	7°23'10"	524

Data Analysis

The height of the trees was calculated using a ranging pole of a pre-determined height but when the height of the tree was higher than the pre-determined height the difference in height was estimated, however the girth of the tree was measured from 1.3 meters from the ground by taking the circumference of the tree. From the girth and the height of the tree the volume was calculated using the formula;

$$\mathbf{V} = \pi r^2\ \mathbf{h} \quad \text{.....Equation 1}$$

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 from dividing the girth by two.

The radius will be calculated using the formula for calculating area of a circle since the girth of a tree is similar to a circumference.

$$\mathbf{C = 2\pi r} \quad \text{.....Equation 2}$$

$$\mathbf{r = C/2\pi} \quad \text{.....Equation 3}$$

Data Availability

The datasets generated or analyzed during this current study are available from the corresponding author on reasonable request.

RESULTS AND DISCUSSIOB

Table 2 shows that *Miliciaexcelsa, Danielliaoliveri, Khayasenegalensis*, Magniferaindica, and*Gmelinaarborea*, has the highest height with average, maximum and minimum of (16.27m,17.1m, and 15.3m), (13.75m, 22.21m and 9.85m), (13.27m, 15.21m and 11.32m), (13m, 14.3m, and 11.5m) and (14.44m, 16.22m and 11.56m) respectively. Also the table revealed that *Rothmannialongiflora, Guierasenegalensis, Philiostigmareticulatum, Cassia Arereh*, Prosopis Africana, Danielliaoliveri, Parkiabiglobosa and *Datariumsenegalense* has the lowest height with a mean height, maximum and minimum height of (3.56m, 4.52m, and 1.87m), (3.14m, 3.56m, and 2.67m), (2.92m, 3.86m, and 2.31m), (3.63m, 4.67m, and2.58m), (3.26m,4.73m and1.75m), (3.02m, 4.86m, and 1.78m), (3.49m, 4.57m and 2.33m) and (3.4m, 3.96m and 2.84m) respectively. With respect to girth; *Miliciaexcelsa, Gmelinaarborea, Magniferaindica, Prosopis Africana* and*Parkiabiglobosa* has the largest girth with average, maximum and minimum of (1.47m, 1.57m and 1.31m), (0.97m, 1.2m, and 0.6m), (1.034m, 1.2m, and 0.87m), (1.005m, 1.3m and 0.85m) and (1.1m, 1.51m and 0.54m) respectively.

Also in the same vein *Danielliaoliveri, Guierasenegalensis,* and *Philiostigmareticulatum* has the lowest girth with average, maximum and minimum of (0.33m, 0.39m and 0.28m), (0.31m, 0.32m and 0.3m) and (0.37m, 0.41m and 0.33m) respectively.With regards to the volume of trees *Miliciaexcelsa,*

Magniferaindica, Parkiabiglobosa, Danielliaoliveri, and *Gmelinaarborea* has the highest volume with average, maximum and minimum of (37.76m^3, 42.1 m^3, 31.5 m^3), (21.24 m^3, 26.9 m^3, and 15.7 m^3), (18.26m^3, 31.3m^3 and 8.2m^3), (19.34m^3, 33.13m^3 and 9.13m^3) and (22.14m^3, 29m^3, and 10.88m^3) respectively also in the same vein *Guierasenegalensis,Prosopis Africana,* and *Danielliaoliveri* has the lowest volume with average, maximum and minimum of (1.53m^3, 1.73m^3, and 1.34m^3), (1.86m^3, 3.8m^3, and0.63m^3), and (1.58 m^3, 2.98m^3, and 0.84 m^3)respectively, this is also as a result of the over exploitation of the trees for fuel wood given the trees little time to attain maturity as observed by Edicha and Abdullahi (2016).

Table 2: Structural characteristics of species in quadrant one (Zuma Rapirian Area)

S/N	Species	Height(m)	Girth (m)	Volume(m^3)
1	*Parkiabiglobosa*			
	Average	10.7	1.1	18.26
	Maximum	14.2	1.51	31.3
	Minimum	7.1	0.54	8.2
2	*AzadiractaIndica*			
	Average	10.87	0.83	14.48
	Maximum	14.1	1.1	21.9
	Minimum	8.72	0.45	6.3
3	*Vitellariaparadoxa*			
	Average	9.52	0.63	9.35
	Maximum	13	0.83	12.9
	Minimum	7.6	0.35	4.9
4	*Prosopis Africana*			
	Average	11.1	1.005	17.68
	Maximum	14.2	1.3	27.1
	Minimum	8.5	0.85	11.3
5	*Magniferaindica*			
	Average	13	1.034	21.24
	Maximum	14.3	1.2	26.9
	Minimum	11.5	0.87	15.7
6	*Miliciaexcelsa*			
	Average	16.27	1.47	37.77
	Maximum	17.1	1.57	42.1
	Minimum	15.3	1.31	31.5

Table 2: (continued)

S/N	Species	Height(m)	Girth (m)	Volume(m^3)
7	*Danielliaoliveri*			
	Average	13.75	0.48	19.34
	Maximum	22.21	0.67	33.13
	Minimum	9.85	0.34	9.13
8	*Khayasenegalensis*			
	Average	13.27	0.72	15.09
	Maximum	15.21	0.78	18.63
	Minimum	11.32	0.65	11.55
9	*Ficusplatyphylla*			
	Average	11.43	0.49	8.78
	Maximum	12.2	0.6	10.6
	Minimum	10.31	0.34	5.5
10	*Gmelinaarborea*			
	Average	14.44	0.97	22.14
	Maximum	16.22	1.2	29
	Minimum	11.56	0.6	10.88
11	*Rothmannialongiflora*			
	Average	3.56	0.48	2.45
	Maximum	4.52	0.71	3.1
	Minimum	1.87	0.32	2.1
12	*Guierasenegalensis*			
	Average	3.14	0.31	1.53
	Maximum	3.56	0.32	1.73
	Minimum	2.67	0.3	1.34
13	*Philiostigmareticulatum*			
	Average	2.92	0.37	2.54
	Maximum	3.86	0.41	5.08
	Minimum	2.31	0.33	1.1
14	*Cassia Arereh*			
	Average	3.63	0.47	2.63
	Maximum	4.67	0.51	3.15
	Minimum	2.58	0.43	2.1

Table 2: (continued)

S/N	Species	Height(m)	Girth (m)	Volume(m^3)
15	*Datariumsenegalense*			
	Average	3.4	0.36	1.93
	Maximum	3.96	0.38	2.36
	Minimum	2.84	0.33	1.5
16	*Prosopis Africana*			
	Average	3.26	0.38	1.86
	Maximum	4.73	0.52	3.8
	Minimum	1.75	0.23	0.63
17	*Danielliaoliveri*			
	Average	3.02	0.33	1.58
	Maximum	4.86	0.39	2.98
	Minimum	1.78	0.28	0.84
18	*Parkiabiglobosa*			
	Average	3.49	0.46	2.55
	Maximum	4.57	0.58	4.16
	Minimum	2.33	0.27	1.22

From the Table 3, *Ficusplatyphylla, Ceibapentandra, Parkiabiglobosa and Gmelinaarborea* has the highest height with an average, maximum and minimum height of (15.03m, 16.45m,and 13.33m), (14.25m, 18m, and 9.81m), (13.06m, 15.26m, and 10.91m), and (13.29m, 17.52m, and 10.32m) also in the same vein *TremaOrientalis, Datariumsenegalense, Rothmannialongiflora*and *Prosopis Africana* has the lowest height with an average, maximum and minimum of (3.28m, 4.77m and 1.65m), (3.28m, 4.33m and 1.87m), (4.59m, 4.83m and 4.36m) and (3.96m, 4.92m, and 2.64m). and also with regards to the girth of the trees *Ceibapentandra, Ficusplatyphylla, Danielliaoliveri, Anogeissuleiocarpus, Vitellariaparadoxa*and *Gmelinaarborea* has the largest girth with average, maximum and minimum of (0.77m, 1m, and 0.44m), (0.80m, 0.94m, and 0.6m), (0.72m, 0.94m, 0.55m), (0.68m, 0.88m and 0.43m), (0.602m, 0.98m, and 0.33m) and (0.64m, 1m, and 0.33m) respectively also *TremaOrientalis, Datariumsenegalense, Rothmannialongiflora,* and *Prosopis Africana* has the lowest girth with average, maximum and minimum of (0.35m, 0.37m, and 0.33m), (0.37m, 0.44m, and 0.31m), (0.37m, 0.38m, and 0.36m), and (0.37m, 0.41m, and 0.34m) respectively.

Also with regards to the volume of the trees *Ficusplatyphylla,* and *Ceibapentandra,* has the highest volume with an average, maximum and minimum of (19.04m^3, 24.28m^3, and 14.43m^3), and (18.22m^3,27.69m^3, and 6.78m^3), while *Datariumsenegalense, TremaOrientalis, Rothmannialongiflora* and *Prosopis*

Africana had the lowest volume with an average, maximum and minimum of (1.92m^3, 2.72m^3, and 1.12m^3), (1.76m^3, 2.55m^3, and 0.96m^3), (2.67m^3, 2.73m^3, and 2.6m^3) and (2.31m^3, 2.94m^3, and 1.69m^3) respectively.

Table 3: Structural characteristics of species in quadrant two(Zuma Rapirian Area)

S/N	Species	Height(m)	Girth (m)	Volume(m^3)
1	Ceibapentandra			
	Average	14.25	0.77	18.22
	Maximum	18	1	27.69
	Minimum	9.81	0.44	6.78
2	Parkiabiglobosa			
	Average	13.06	0.56	11.62
	Maximum	15.26	0.71	17
	Minimum	10.91	0.38	7.1
3	Gmelinaarborea			
	Average	13.29	0.64	13.27
	Maximum	17.52	1	20.9
	Minimum	10.32	0.33	5.81
4	Vitellariaparadoxa			
	Average	12.46	0.6	12.45
	Maximum	17.23	0.98	24
	Minimum	9.54	0.33	4.99
5	Ficusplatyphylla			
	Average	15.03	0.81	19.04
	Maximum	16.45	0.94	24.28
	Minimum	13.33	0.6	14.43
6	Danielliaoliveri			
	Average	12.8	0.72	14.99
	Maximum	15.21	0.94	22.45
	Minimum	10.85	0.55	9.37
7	Anogeissuleiocarpus			
	Average	12.56	0.69	13.89
	Maximum	14.23	0.88	18.99
	Minimum	10.55	0.43	7.1

Table 3: (continued)

S/N	Species	Height(m)	Girth (m)	Volume(m^3)
8	TremaOrientalis			
	Average	3.28	0.35	1.76
	Maximum	4.77	0.37	2.55
	Minimum	1.65	0.33	0.96
9	Datariumsenegalense			
	Average	3.28	0.37	1.92
	Maximum	4.33	0.44	2.72
	Minimum	1.87	0.31	1.12
10	Rothmannialongiflora			
	Average	4.59	0.37	2.67
	Maximum	4.83	0.38	2.73
	Minimum	4.36	0.36	2.6
11	Prosopis Africana			
	Average	3.96	0.38	2.31
	Maximum	4.92	0.41	2.94
	Minimum	2.64	0.34	1.69

Table 4 shows that *New bouldialaevis, Ampelocissus Africana, AzadiractaIndica, Prosopis Africana, Khayasenegalensis, Danielliaoliveri* and *CeibaPentandra* have the highest height with a mean, maximum and minimum height of (11.45m, 15m, and 9.32m), (11.85m, 14.21m and 9.85m), (12.06m, 15.23m and 9.23m), (11.46m, 15.21, and 9.22m) (11.94m, 14.31m and 9.87m), (12.07m, 14.33m, and 9.88m) and (11.58m, 14.44m, and 9.73m) respectively. Also, *CassiaArereh, Datariumsenegalense, TremaOrientalis,* and *Guierasenegalensis* have the lowest height with a mean, maximum and minimum of (3.54m, 4.87m, and 1.89m), (3.47m, 4.89m, and 1.79m), (3.95m, 4.85m and 2.21m) and (3.97m, 4.88m and 2.32m) respectively.

Furthermore, with regards to the girth of the trees*Khayasenegalensis, New bouldialaevis, Ampelocissus Africana, AzadiractaIndica, CeibaPentandra* and *Guierasenegalensis* have the largest girth with a mean, maximum and minimum of (0.51m, 0.92m, and 0.32m), (0.46m, 0.86m, and 0.31m), (0.45m, 0.78m, and 0.31m), (0.46m, 0.98m, and 0.3m) and (0.52m, 0.85m, and 0.33m) respectively. Again, *Annona Senegalensis, Cassia Arereh,*and *Datariumsenegalense*have the lowest girth with a mean, maximum and minimum of (0.33m, 0.38m and 0.3m), (0.31m, 0.33m, and 0.29m) and (0.32m, 0.34m, and 0.3m) respectively.The result obtained corroborated with the findings of Edicha and Abdullahi (2016) in their

study observed that tree height, tree girth, and canopy cover in estimating volume of wood in Kuje Area of Abuja, Nigeria also observed that most of the girth of the trees in Kuje Area are relatively low which is connected to the fact of frequent fuel wood exploitation given the girth little time to develop into maturity.

Also with regards to the volume of the trees *Khayasenegalensis,*and *AzadiractaIndica,* has the highest volume with a mean value, maximum and minimum of (10.17m^3, 20.53m^3, and 4.95m^3), and (9.27m^3, 23.43m^3, and 4.6m^3), while *Cassia Arereh, Datariumsenegalense,* and *TremaOrientalis* have the lowest volume with a mean value, maximum and minimum of (1.73m^3, 2.26m^3, and 0.93m^3), (1.75m^3, 2.37m^3, and 0.84m^3) and (2.19m^3, 2.88m^3, and 1.11m^3) respectively.

Table 4: Structural characteristics of species in quadrant one (Jigo)

S/N	Species	Height(m)	Girth (m)	Volume(m^3)
1	*New bouldialaevis*			
	Average	11.45	0.46	8.74
	Maximum	15	0.86	20.25
	Minimum	9.32	0.31	4.68
2	*Ampelocissus Africana*			
	Average	11.85	0.45	8.81
	Maximum	14.21	0.78	17.4
	Minimum	9.85	0.31	4.79
3	*AzadiractaIndica*			
	Average	12.06	0.46	9.27
	Maximum	15.23	0.98	23.43
	Minimum	9.23	0.3	4.6
4	*Annona Senegalensis*			
	Average	10.75	0.33	5.66
	Maximum	12.39	0.38	7.2
	Minimum	9.55	0.3	4.6
5	*Prosopis Africana*			
	Average	11.46	0.43	8.21
	Maximum	15.21	0.86	20.53
	Minimum	9.22	0.3	4.48
6	*Khayasenegalensis*			
	Average	11.94	0.51	10.17
	Maximum	14.31	0.92	20.53
	Minimum	9.87	0.32	4.95

Table 4: (continued)

S/N	Species	Height(m)	Girth (m)	Volume(m^3)
7	*Danielliaoliveri*			
	Average	12.07	0.39	7.75
	Maximum	14.33	0.67	15.1
	Minimum	9.88	0.3	4.65
8	*Ceiba Pentandra*			
	Average	11.58	0.46	8.64
	Maximum	14.44	0.79	17.91
	Minimum	9.73	0.33	5
9	*Cassia Arereh*			
	Average	3.54	0.31	1.73
	Maximum	4.87	0.33	2.26
	Minimum	1.89	0.29	0.93
10	*Datariumsenegalense*			
	Average	3.47	0.32	1.75
	Maximum	4.89	0.34	2.37
	Minimum	1.79	0.3	0.84
11	*TremaOrientalis*			
	Average	3.95	0.35	2.19
	Maximum	4.85	0.42	2.88
	Minimum	2.21	0.3	1.11
12	*Guierasenegalensis*			
	Average	3.97	0.45	2.77
	Maximum	4.88	0.55	4.13
	Minimum	2.32	0.33	1.64

Table 5 reveals that *Vitellariaparadoxa, Parkiabiglobosa, Prosopis Africana, Terminoliamacroptera, Pterocarpuserinaceus*, and *AzadiractaIndica* have the highest height with a mean value, maximum and minimum height of (12.89m, 15.26m and 9.67m), (12.077m, 14.33m and 9.82m), (11.35m, 13.45m and 9.22m), (11.43m, 14.53m and 8.95m), (11.49m, 14.31m and 9.83m) and (10.92m, 14.21m and 8.71m) respectively, also *Terminoliamacroptera, Rothmanialongiflora,* and *Vitellariaparadoxa* has the lowest height with an average, maximum and minimum of (4.42m, 4.95m and 3.87m), (3.73m, 4.86m and 1.99m) and (4.54m, 4.99m and 3.64m) respectively. And also with regards to the girth of the trees *Vitellariaparadoxa, Parkiabiglobosa, AzadiractaIndica, Prosopis Africana, Terminoliamacroptera, Pterocarpuserinaceus* and *Vitellariaparadoxa* have the

largest girth with average, maximum and minimum of (0.749m, 1.2m, and 0.45m), (0.69m, 1.3m, and 0.35), (0.614m, 0.87m, and 0.35m), (0.61m, 0.88m, and 0.33m), (0.69m, 0.99m, and 0.35m), (0.63m, 0.92m and 0.38m), and (0.66m, 0.88m, and 0.45m) respectively also *Terminoliamacroptera,* and *Rothmanialongiflora*has the lowest girth with average, maximum and minimum of (0.37m, 0.42m, and 0.33m) and (0.412m, 0.46m and 0.38m) respectively.

Also with regards to the volume of the trees *AzadiractaIndica, Vitellariaparadoxa, Parkiabiglobosa, Prosopis Africana, Terminoliamacroptera,* and *Pterocarpuserinaceus*have the highest volume with an average, maximum and minimum of (11.036m^3, 18.29m^3, and 5.4m^3), (15.8m^3, 28.74m^3, and 7.45m^3), (13.88m^3, 29.24m^3, and 6m^3), (11.29m^3, 18.58m^3, and 5.11m^3), (12.81m^3, 20.91m^3, and 4.92m^3), and (11.85m^3, 20.67m^3, and 5.86m^3) respectively while *Terminoliamacroptera, Rothmanialongiflora* and *Vitellariaparadoxa* had the lowest volume with an average, maximum and minimum of (2.56m^3, 2.58m^3, and 2.55m^3), (2.42m^3, 3.1m^3, and 1.22m^3), and (4.69m^3, 6.89m^3, and 3.35m^3) respectively.

Table 5: Structural characteristics of species in quadrant two (Jigo)

S/N	Species	Height(m)	Girth (m)	Volume(m^3)
1	*AzadiractaIndica*			
	Average	10.92	0.614	11.036
	Maximum	14.21	0.87	18.29
	Minimum	8.71	0.35	5.4
2	*Vitellariaparadoxa*			
	Average	12.89	0.749	15.8
	Maximum	15.26	1.2	28.74
	Minimum	9.67	0.45	7.45
3	*Parkiabiglobosa*			
	Average	12.077	0.69	13.88
	Maximum	14.33	1.3	29.24
	Minimum	9.82	0.35	6
4	*Prosopis Africana*			
	Average	11.35	0.61	11.29
	Maximum	13.45	0.88	18.58
	Minimum	9.22	0.33	5.11
5	*Terminoliamacroptera*			
	Average	11.43	0.69	12.81
	Maximum	14.53	0.99	20.91
	Minimum	8.95	0.35	4.92
6	*Pterocarpuserinaceus*			
	Average	11.49	0.63	11.85
	Maximum	14.31	0.92	20.67
	Minimum	9.83	0.38	5.86

Table 5: (continued)

S/N	Species	Height(m)	Girth (m)	Volume(m^3)
7	*Terminoliamacroptera*			
	Average	4.42	0.37	2.56
	Maximum	4.95	0.42	2.58
	Minimum	3.87	0.33	2.55
8	*Rothmanialongiflora*			
	Average	3.73	0.41	2.42
	Maximum	4.86	0.46	3.1
	Minimum	1.99	0.38	1.22
9	*Vitellariaparadoxa*			
	Average	4.54	0.66	4.69
	Maximum	4.99	0.88	6.89
	Minimum	3.64	0.45	3.35

Table 6 shows that *Ficuspolita, Gmelinaarborea, MangiferaIndica, Prosopis Africana, AzadiractaIndica, Vitellariaparadoxa, Danielliaoliveri, Ceibapentandra* and *Parkiabiglobosa* have the highest height with an average, maximum and minimum height of (10.184m, 13.22m, and 7.88m), (11.56m, 14.95m, and 8.79m), (13.085m, 14.26m, and 11.91m), (10.69m, 14.34m, and 7.64m), (10.84m, 14.91m, 7.42m), (10.56m, 13.24m, and 7.32m), (9.63m, 11.89m, and 8.42m), (10.35m, 11.95m, and 8.75m) and (10.3m, 13.46m, and 7.92m) respectively. Also, *Rothmannialongiflora,Cassia Arereh, Danielliaoliveri* and *Parkiabiglobosa* have the lowest height with a mean value, maximum and minimum of (4.31m, 4.95m, and 3.55m), (4m, 4.92m, and 2.23m), (4.11m, 4.94m, and 2.77m) and (4m, 4.99m, and 2.31m) respectively. Also with regards to the girth of the trees *MangiferaIndica, Prosopis Africana, Gmelinaarborea* and *AzadiractaIndica* have the largest girth with average, maximum and minimum of (1.075m, 1.3m and 0.9m), (0.745m, 1.3m, and 0.43m), (0.66m, 1.2m, and 0.38m) and (0.64m, 1.1m, and 0.36) respectively while *Rothmannialongiflora, Cassia Arereh, Danielliaoliveri* and *Parkiabiglobosa* have the lowest girth with average, maximum and minimum of (0.39m, 0.45m and 0.33m), (0.4m, 0.51m, and 0.34m), (0.42m, 0.6m and 0.32m) and (0.48m, 0.62m, and 0.38m).

Also with regards to the volume of the trees *MangiferaIndica, Gmelinaarborea, Prosopis Africana,* and *AzadiractaIndica* have the highest volume with an average, maximum and minimum of (22.28m^3, 29.1m^3, and 16.82m^3), (12.8m^3, 26.9m^3, and 5.2m^3), (13.15m^3, 29.3m^3, and 5.2m^3), and (11.65m^3, 25.74m^3, and 4.3m^3) respectively while *Rothmannialongiflora, Cassia Arereh, Danielliaoliveri* and *Parkiabiglobosa* have the lowest volume with an average, maximum and minimum of (2.63m^3, 3.49m^3, and 2.12m^3), (2.54m^3, 3.46m^3, and 1.33m^3), (2.76m^3, 4.65m^3, and 1.94m^3), and (3.03m^3, 4.43m^3, and 1.7m^3) respectively.

Table 6: Structural characteristics of species in quadrant two (Ushafa Riparian Area)

S/N	Species	Height(m)	Girth (m)	Volume(m^3)
1	*Ficuspolita*			
	Average	10.184	0.55	9.38
	Maximum	13.22	0.89	18.5
	Minimum	7.88	0.36	4.5
2	*Gmelinaarborea*			
	Average	11.56	0.66	12.8
	Maximum	14.95	1.2	26.9
	Minimum	8.79	0.38	5.2
3	*MangiferaIndica*			
	Average	13.085	1.075	22.28
	Maximum	14.26	1.3	29.1
	Minimum	11.91	0.9	16.82
4	*Prosopis Africana*			
	Average	10.69	0.745	13.15
	Maximum	14.34	1.3	29.3
	Minimum	7.64	0.43	5.2
5	*AzadiractaIndica*			
	Average	10.84	0.64	11.65
	Maximum	14.91	1.1	25.74
	Minimum	7.42	0.36	4.3
6	*Vitellariaparadoxa*			
	Average	10.56	0.54	9.39
	Maximum	13.24	0.86	17.88
	Minimum	7.32	0.37	4.3
7	*Danielliaoliveri*			
	Average	9.63	0.56	8.93
	Maximum	11.89	0.86	16.1
	Minimum	8.42	0.38	5.1
8	*Ceibapentandra*			
	Average	10.35	0.58	9.94
	Maximum	11.95	0.75	14.1
	Minimum	8.75	0.42	5.77

Table 6: (continued)

S/N	Species	Height(m)	Girth (m)	Volume(m^3)
9	*Parkiabiglobosa*			
	Average	10.3	0.55	9.36
	Maximum	13.46	0.96	20.3
	Minimum	7.92	0.35	4.35
10	*Rothmannialongiflora*			
	Average	4.31	0.39	2.63
	Maximum	4.95	0.45	3.49
	Minimum	3.55	0.33	2.12
11	*Cassia Arereh*			
	Average	4	0.4	2.54
	Maximum	4.92	0.51	3.46
	Minimum	2.23	0.34	1.33
12	*Danielliaoliveri*			
	Average	4.11	0.42	2.76
	Maximum	4.94	0.6	4.65
	Minimum	2.77	0.32	1.94
13	*Parkiabiglobosa*			
	Average	4	0.48	3.03
	Maximum	4.99	0.62	4.43
	Minimum	2.31	0.38	1.7

Table 7 reveals that *AzadiractaIndica, Prosopis Africana, Danielliaoliveri, Vitellariaparadoxa, TremaOrientalis, Annona Senegalensis*, and*Ampelocissus Africana*have the highest height with an average, maximum and minimum height of (10.49m, 13.42m and 7.52m), (10.57m, 12.85m, and 8.52m), (10.59m, 14.45m, and 7.32m), (11.27m, 14.52m, and 7.99m), (11.05m, 13.44m, and 8.65m), (11.25m, 13.47m, and 8.93m) and (10.69m, 12.74m, and 8.72m) respectively, while *Cassia Arereh, Guierasenegalensis, TremaOrientalis*, and *Rothmanialongiflora* have the lowest height with a mean value, maximum and minimum of (4.21m, 4.99m, and 3.63m), (4.31m, 4.92m, and 3.34m), (4.49m, 4.98m, and 3.33m) and (4.5m, 4.95m and 3.55m) respectively. Also, with respect to the girth of the trees *AzadiractaIndica, Prosopis Africana, Danielliaoliveri, Vitellariaparadoxa, TremaOrientalis, Annona Senegalensis* and *Ampelocissus Africana* have the largest girth with average, maximum and minimum of (0.7m, 1.2m, and 0.39m), (0.71m, 0.87m, and 0.54m), (0.7m, 1.3m, and 0.35m), (0.83m, 1.2m, and 0.4m), (0.81m, 0.99m, 0.63m), (0.89m, 1.1m, and 0.75m) and (0.82m, 0.95m and 0.68m) respectively while *CassiaArereh, Guierasenegalensis, TremaOrientalis* and

Rothmanialongiflora have the lowest girth with average, maximum and minimum of (0.49m, 0.6m, and 0.39m), (0.54m, 0.61m, and 0.45m), (0.52m, 0.63m, and 0.37m) and (0.52m, 0.6m, and 0.43m) respectively. Moreover, with respect to the volume of the trees *AzadiractaIndica, Prosopis Africana, Danielliaoliveri, Vitellariaparadoxa, TremaOrientalis, Annona Senegalensis*, and*Ampelocissus*have the highest volume with an average, maximum and minimum of (12.16m^3, 25.28m^3, and 4.72m^3), (11.98m^3, 16.74m^3, and 8m^3), (12.44m^3, 29.49m^3, and 4m^3), (15.46m^3, 27.35m^3, and 5m^3), (14.34m^3, 20.89m^3, and 8.56m^3), (16.13m^3, 23.26m^3, and 10.52m^3), and (14m^3, 19m^3, and 9.31m^3) respectively. Again, *CassiaArereh, Guierasenegalensis, TremaOrientalis* and *Rothmanialongiflora*have the lowest volume with an average, maximum and minimum of (3.24m^3, 3.72m^3, and 3m^3), (3.66m^3, 4.71m^3, and 2.99m^3), (3.64m^3, 4.7m^3, and 2.59m^3) and (3.69m^3,4.66m^3, and 2.73m^3) respectively.

As observed in the results presented with respect to height, girth and volume of woods in the study area, they seem to be a small sizes of the girth of the species, the height as well as the volume in all the riparian areas studied. This is not unconnected to the fact that most of the species found along the riparian areas are not allowed to mature into climax which could have accounted for the development of the species and these are reflected in the allometric properties obtained. The driving factor for the development observed in the allometric properties of the species in the study area could include; urbanization with attendant consequences on urban expansion and hence plant species are at the receiving end.

Table 7: Structural characteristics of species in quadrant two (Ushafa Riparian Area)

S/N	Species	Height(m)	Girth (m)	Volume(m^3)
1	*AzadiractaIndica*			
	Average	10.49	0.7	12.16
	Maximum	13.42	1.2	25.28
	Minimum	7.52	0.39	4.72
2	*Prosopis Africana*			
	Average	10.57	0.71	11.98
	Maximum	12.85	0.87	16.74
	Minimum	8.52	0.54	8
3	*Danielliaoliveri*			
	Average	10.59	0.7	12.44
	Maximum	14.45	1.3	29.49
	Minimum	7.32	0.35	4

Table7: (continued)

S/N	Species	Height(m)	Girth (m)	Volume(m^3)
4	*Vitellariaparadoxa*			
	Average	11.27	0.83	15.46
	Maximum	14.52	1.2	27.35
	Minimum	7.99	0.4	5
5	*Trema Orientalis*			
	Average	11.05	0.81	14.34
	Maximum	13.44	0.99	20.89
	Minimum	8.65	0.63	8.56
6	*Annona Senegalensis*			
	Average	11.25	0.89	16.13
	Maximum	13.47	1.1	23.26
	Minimum	8.93	0.75	10.52
7	*Ampelocissus Africana*			
	Average	10.69	0.82	14
	Maximum	12.74	0.95	19
	Minimum	8.72	0.68	9.31
8	*Cassia Arereh*			
	Average	4.21	0.49	3.24
	Maximum	4.99	0.6	3.72
	Minimum	3.63	0.39	3
9	*Guierasenegalensis*			
	Average	4.31	0.54	3.66
	Maximum	4.92	0.61	4.71
	Minimum	3.34	0.45	2.99
10	*TremaOrientalis*			
	Average	4.49	0.52	3.64
	Maximum	4.98	0.63	4.7
	Minimum	3.33	0.37	2.59
11	*Rothmanialongiflora*			
	Average	4.5	0.52	3.69
	Maximum	4.95	0.6	4.66
	Minimum	3.55	0.43	2.73

CONCLUSION

The result of the study shows that most the trees in the study area have girths that is less than one meter and also the height of most the trees is < 20meters this findings is not unconnected to the fact that due to over exploitation of the trees as a result of fuel wood harvesting, overgrazing, urban expansion and medicinal harvest. These human activities have given the trees little time to attain maturity. The import of the finding is that vegetation in the riparian area are not matured and fully developed and therefore the ecological services performed by this ecosystem is limited and the ecosystem is rather unstable.

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