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A Study of Tree Species Composition and Diversity In Relation To Soils at Lede and Galumji in Wawa-Zange Forest Reserve, Gombe State, Nigeria

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Abstract
The study was conducted in Galumji and Lede in Wawa -Zange Forest Reserve, Gombe State, Nigeria. The aim was to investigate the Tree Species composition and diversity in relation to the Soils. Vegetation sampling was carried out using Point Centered Quarter (PCQ) method. Alpha diversity was measured using Simpson index of Diversity and Shannon-Weiner index..Composite soil samples were collected between 0-15 and 15-30cm depths and analysed in the laboratory using standard procedures.28 Tree Species belonging to 16 families and 22 genera were identified. The family Combretaceae had the highest number of five species. Leguminoseae: Caesalpiniaceae, three species. Anacadiaceae, Bombacaceae, Burseraceae, Leguminoseae:Papilionaceae and Tiliaceae two species each. The other families namely Asteraceae, Balanitaceae, Bignoniaceae, Ebanaceae,Leguminoiceae, Mimosaceae, Portulacaceae, Sapotaceae and Serophulariaceae had one specie each. Simpson index of Diversity was (0.4) and Shannon-Weiner index (0.02). Soil analysis showed loamy-Sandy soil types, Soil moisture was very low. Soil pH was acidic (5.50). Organic matter content (0.33 gkg^{-1}) was very very low, Total Nitrogen ((0.51gkg^{-1}), Available phosphorus (4.83Mgkg^{-1}), Exchangeable bases, Zinc (0.54 Mgkg^{-1}),Manganese (3.24Mgkg^{-1}) were low, Copper (1.01Mgkg^{-1}) and Iron ((6.64Mgkg^{-1}) were medium. The relationship between soil properties and vegetation showed both positive and negative correlations. This explains that plant species were selective of nutrients as well as depended entirely on the spatial heterogeneity of soil in nutrient distribution and availability. This study recommends that plants with low IVI Isoberlina doka, Parkia biglobosa, Pterocarpus erinaceous, Steculia setigeri,Grewia mollis,Anogeissus leiocarpus needs urgent conservation measures.

Keywords: Lede, Galumji, Tree Species Diversity, Soils.

INTRODUCTION
Gombe State's forest reserves have been lost to acute, human-induced deforestation (Mbaya and Hashidu, 2017). Ahmad *et al*, (2018) observed that the menace of deforestation in Gombe is the second major ecological problem after erosion that is threatening the State. Tiffen (2006) reported that the pattern of population growth of Gombe town was slow from 1900 to 1952 (300 to 18,500 people) while; from 1964 to 1991 the population growth increased tremendously from 47,000 to 138,000. However, from the year 1996, when Gombe became

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the State capital, there was a noticeable sharp increase in population from 169, 894 (1996) to 219,946 in 2000 and 312,467 in the census 2006 and is projected to have reached about 400,000 in 2010 (NPC, 2010). This population explosion resulted in high demographic pressure on land and consequent developmental processes such as building of houses. Although, deforestation occurs world-wide, it is particularly a critical issue in Wawa- Zange Forest Reserve. In Wawa- Zange forest reserve, recent interaction with forestry staff indicated that several people were employed in felling down the trees daily. Ahmad *et al.*,(2018) also reported that 35-40 loads of pick up trucks convey fuel wood to Gombe, Kano and Potiskum from various places including Wawa- Zange forest reserve. These unsustainable actions could lead to the plants becoming extinct. Trees species are crucial parts of the ecosystem and they provide tangible and intangible benefits. The need for periodic assessment of these resources for management and conservation purposes is imperative. (Lucky *et al.*,2017). Therefore, ecosystem management in particular location is important and integral part for the conservation and protection of Biological diversity of Gombe. By understanding the status of the natural forest in terms of tree species composition, richness and diversity, recommendations could be made for the restoration and future management of Wawa- Zange Forest Reserve. Much progress have been made using different vegetation, (Hashidu,2015:Mbaya and Hashidu,2017) and phytosociological studies have been conducted by various workers Abdullahi, (2010): in Yankari game Reserve, Abba (2014) in Kanawa Forest Reserve. Lucky *et al.*,(2017) in Sahelian Ecosystem in North Eastern ,Nigeria and Ikaagyaba *et al.*,(2019) in Oju Local Government Area, Benue State. However, there were no records of such studies in Wawa-Zange Forest Reserve, hence the need for the present work.The aim of the study was to investigate (tree) species composition and diversity in relation to soils of Lede and Galumji in Wawa-Zange Forest Reserve.

MATERIALS AND METHODS

The Study Area.

This research was carried out at Galumji and Lede areas of Wawa-Zange Forest Reserve in Gombe State, Nigeria. (Dukku and Funakaye LGAs) (Fig 1). This Forest Reserve was gazetted in 1962 and lies between latitude 10^0 49′ 22."N to longitudes 10^0 46′ 23"E with an altitude of 411 m above sea level .The forest reserve has seven main settlements within it. Prominent among them were; Zange, Lede, Feshare, Bozonshulawa, Shuwe, Galumji and Wawa villages (Field work,2019).

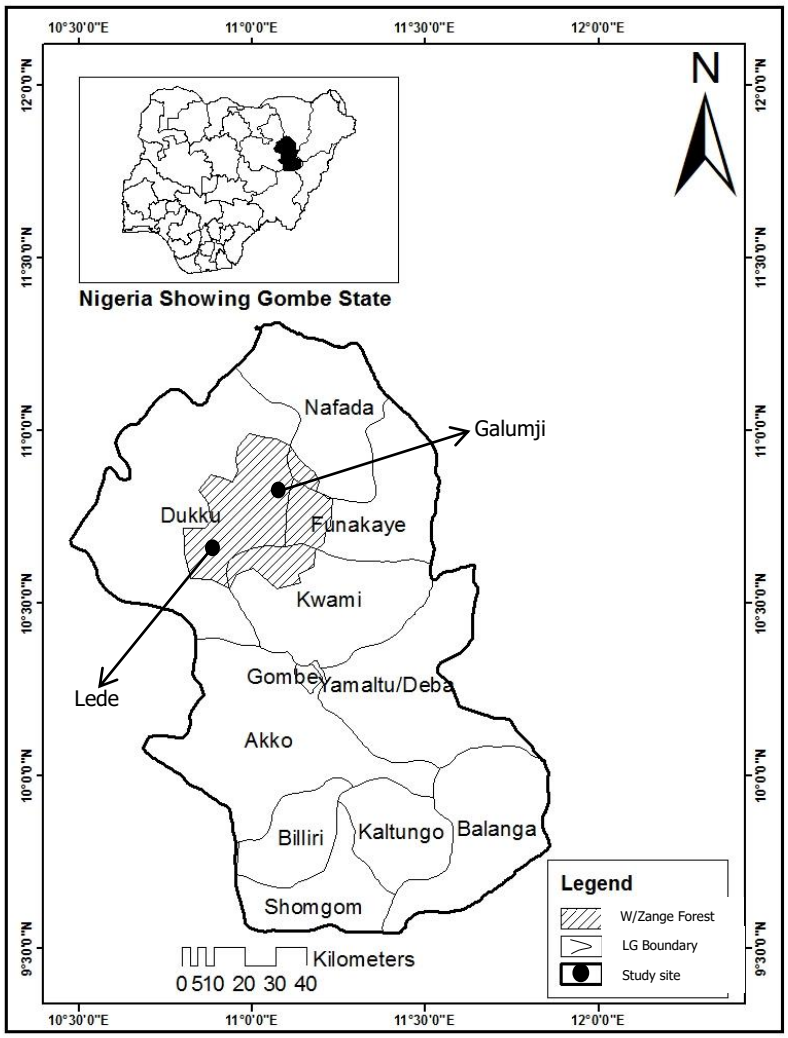

Fig1 .Showing Wawa-Zange Forest Reserve and the Study Sites.
Source: (Field Work, 2019).

Methodology

Soil Sampling

The soil samples were collected from Lede and Galumji.Soil samples at two depths namely 0-15cm (top soil) and 15-30cm (sub soil) respectively from 12 sampling points across the study sites using soil auger. Standard analytical procedures were used to analyze the collected soil samples: Data representing soil properties from two sites of the reserve were further subjected to principal components analysis (PCA) approach at 0.05% probability level in order to determine the relative contributions of soil physical and chemical properties to the variation in the distribution pattern of species within the sites (Deshi *et al,* 2013).

Vegetation Sampling

Vegetation sampling was conducted by PCQ method (Machange, 1985; Abdullahi, 2010; Abba, 2014). PCQ was carried out by measurement of distances from randomly chosen points to the nearest woody plant species. Twenty random sampling points were located along a series of line transects passing through the stand. At each sampling point, 4 quarters were established using a cross. The individual nearest to the point in each quadrant was located.

Data collection and analysis.

The distances from the sampling point to the mid-point of the nearest tree in each quadrant were measured and recorded. Single-stem woody perennials of up to 5m height and 7cm diameter at breast height (dbh) within the quadrats were identified to species level and counted. Also morphological characteristics involving the fruits, flowers, leaves and stem, bark and sap were used for identification. However, few individuals that could not be identified were identified by a specialist, brought and compared with the herbarium specimens of the Botany Department Gombe State University .Nomenclature of the species follows Hutchinson and Dalzeil (2014). Parameters obtained by this method include tree species composition, density, diameter and frequency. The following computations were made: (a) Plant species point to point distance; (m).(b) tree species mean point distance; (m). (c) Mean area (M.A,)/ tree species (m^2); and (d) Total (Absolute) density (Trees/hectare) Data obtained was quantitatively analyzed for Total densities, relative and absolute densities, frequency, relative frequencies, dominance, relative dominance and importance value as per (Sabogal,1992; Abdullahi,2010).The formula used to calculate RD,RF and IVI were as follows:

$$\text{Relative density of a species} = \frac{\text{Number of Individuals of a species}}{\text{Total number of Individuals of all species}} \times 100$$

$$\text{Relative frequency} = \frac{\text{Frequency of a species } x\ 100}{\text{Total frequencies of all species}}$$

$$\text{Relative dominance of a species} = \frac{\text{Absolute dominance of a species } x\ 100}{\text{Total number of absolute dominance of all species}}$$

$$\text{Importance value of a specie} = \text{relative density} + \text{relative dominance} + \text{relative frequency}$$

$$\text{Relative importance value} = \frac{\text{Relative Density} + \text{Relative Frequency} + \text{Relative Dominance}}{3}$$

Species diversity was calculated using Simpson's index (Simpson, 1949) and Shannon Weinner index of diversity (Kent and Coker,1992).

RESULTS

Table 1: Soil Physico-Chemical Characteristics of Galumji and Lede areas of Wawa-Zange Forest Reserve, Gombe State, Nigeria.

	Locations			
Soil properties	Lede (Site 1)	Galumji (Site 2)	SE± Mean (Lede)	SE± Mean (Galumji)
Sand	78.097	74.013	48123	1.15888
Silt	12.280	13.113	.43406	.92405
Clay	9.6233	13.290	35055	.56866
Texture	loamy-sandy soil type	loamy-sandy soil type	loamy-sandy soil type	loamy-sandy soil type
pHw1.1	5.236	5.1525	.13816	.12749
Moisture	7.1387	8.7121	.16440	37044
Organic carbongkg-1	0.3142	0.2804	.02953	.01533
Av.P.mgkg-1	4.7562	4..6329	14673	00269
TNgkg-1	0.4792	0.0446	.13103	.00147
Ca	1.8125	2.3629	.06336	07050
MgCmol(+)kg-1	0.5546	0.6083	.01997	.01885
K kg-1	0.1504	0.2000	.00591	.00832
Na	0.0846	0.0925	.00442	.00391
Zn	0.4229	0.5396	.03094	.02964
Cu	0.1633	0.6721	.02278	17764

Fe	5.9633	6.4571	40911	.51745
Mn	2.2950	3.4050	20518	.37877

Means followed by the same letter in a column are not significantly different at 5% probability level using Duncan Multiple Range test.

KEY
Site 1=Galumji
Site2=Lede

Table 2 : Species Composition of Tree Species identified at Galumji and Lede in Wawa-Zange Forest Reserve.

S/N	FAMILY	SPECIES
1	Anacadiaceae	Tricalysia chevalieri
		Sclerocarya birrea
2	Asteraceae	Azadirachta indica
3	Balanitaceae	Balanites aegyptiaca
4	Bignoniaceae	Strerospernum kunthianum
5	Bombacaceae	Ceiba pentandra
		Adansonia digitata
6	Burseraceae	Boswellia dalzielli
		Commiphora africana
7	Caesalpiniaceae	Tamarindus indica
		Detarium microcarpum
		Isoberlina doka
8	Combretaceae	Combretum glutinosum
		Combretum collinum
		Combretum molle
		Combretum nigricans
9	Ebanaceae	Anageissus leiocarpus
10	Leguminoceae	Diospyros mespiliformis
		Strychnos spinosa
11	Mimosaceae	Parkia biglobosa
		Dichrostachys cinerea
12	Papilionaceae	Pterocarpus erinaceus
		Pericopsis laxiflora
13	Portulacaceae	Prosopis africana
14	Sapotaceae	Vitellaria paradoxa
15	Serophulariaceae	Steculia setigera
16	Tiliaceae	Grewia mollis
		Grewia bicolor

Table . 3 Importance Value Index (IVI) of Tree Species at Galumji and Lede in Wawa-Zange Forest Reserve, Gombe State.

S/N	Species	Relative Density(%)	Relative Frequency(%)	Relative Dominance(%)	Importance Value Index (IVI)
1	*Isoberlina doka*	2.5	2.6	2.0	2.4
2	*Combretum collinum*	14	15	15	15
3	*Azadirachta indica*	4.8	1.9	6.0	4.2
4	*Combretum nigricans*	5.8	9.3	8.0	7.7
5	*Detarium macrocarpum*	3.1	7.1	6.5	5.6
6	*Combretum molle*	13	9.7	1.8	8.2
7	*Diospyros mespiliformis*	0.8	2.0	2.0	2.4
8	*Balanites aegyptiaca*	*1.7*	*1.7*	*3.0*	*2.1*
9	*Boswellia daizielli*	0.6	5.2	2.0	3.9

10	*Commiphora africana*	7.1	10	7.0.	8.0
11	*Parkia biglobosa*	0.6	2.6	1.0	1.4
12	*Prosopis africana*	7.3	1.7	2.0	3.7
13	*Dichostachys cinerea*	0.6	2.6	6.0	3.1
14	*Grewia mollis*	*0.8*	*3.5*	*2.0*	*2.1*
15	*Anageissus leoicarpus*	0.8	2.6	1.0	1.5
16	*Steculia setigeri*	0.6	1.7	2.0	1.4
17	*Sclerocarya birrea*	1.2	12	0.7	4.6
18	*Ceiba pentandra*	2.7	6.5	1.0	3.4
19	*Vitellaria paradoxa*	1.8	5.8	3.0	3.5
20	*Grewia bicolor*	1.8	7.3	7.0	5.4
21	*Combretum glutinosum*	9.2	12	14	12
22	*Pericopsis laxiflora*	1.4	4.9	2.0	2.8
23	*Strychnos spinosa*	*1.4*	*4.7*	*7.0*	*13*
24	*Tricalysia chevalieri*	2.9	4.9	3.0	3.6
25	*Tamarindus indica*	2.3	11	6.0	6.4
26	*Adansonia digitata*	1.0	2.2	4.5	2.6
27	*Strerospernum kunthianum*	1.8	11	2.0	5.0
28	*Pterocarpus erinaceous*	1.0	1.0	1.0	1.0

Importance Value Index (IVI) of Trees Species Identified in Galumji and Lede areas of Wawa-Zange Forest Reserve, Gombe State.

The tree species whose Importance value index was highest in both Galumji and Lede sites was *Combretum collinum* (15%) while the lowest Importance value index was recorded on *Pterocarpus erinaceous* (1.0%) (Table 3)

Tree Species Diversity

Ecological distance measures were used to explain alpha (with-in site) diversities for the two sites. Both Simpson's index of diversity (1-D) was 0.40, while .Shannon Weinner index of diversity was 0.02 for trees in the study area.

Table 4: Correlation matrix between vegetation types and soil properties in Wawa -Zange Forest Reserve in Gombe State, Nigeria during 2018-19.

	LOCATIONS	
Soil properties	1 (Galumji)	2 (Lede)
Na	-0.16801	0.03284
Moisture	-0.04879	-0.05925
ORG_C	0.30460	-0.26594
PHw	0.09226	0.17335
Sand	0.21341	0.44425
Silt	-0.04824	-0.45257
TN	0.26176	-0.18926
Zn	-0.11907	-0.14680
AV_P	0.09784	-0.01305
Clay	-0.30673	-0.16831
Ca	-0.30691	-0.27115
Cu	-0.16615	-0.34019
Fe	-0.33040	0.29842
K	-0.33361	-0.06040

Mg	-0.23482	-0.05388
Mn	-0.34941	0.11858

Key to Locations
Site 1 = Galumji
Site 2 =Lede

DISCUSSION

Soil Physico-chemical characteristics and Plant distribution at Galumji and Lede Areas of Wawa-Zange Forest Reserve.

The physicochemical properties of the soils of Galumji and Lede areas of Wawa-Zange Forest Reserve are shown in Table 1. The soil texture were mainly made up of loamy sandy soils.. Uzoho and Obi (2005) observed that the texture of soils is greatly determined by the parent materials. Enweazor *et al.*, (1977) also observed that texture plays dominant role in soil behaviour as it affects water and nutrient retention as well as suitability of soils as a rooting medium. The two sites had low moisture contents ((7.20-8.62%).The vegetation types were dominated by*Azadirachta indica, Combretum ghasalense, Tricalysia chevaleiri, Prosopis africana, Anogeissus leiocarpus, Balanites aegyptiaca Adansonia digitata,Commiphora africana, Combretum collinum, Combretum nigricans, Pterocarpus erinaceus, Grewia mollis and Grewia bicolor* trees indicating that these species could be well adapted to loamy sandy soils and adapted to low soil moisture hydromorphic conditions This was consistent with several studies that have shown the effects of soil quality on vegetation (Dezzeo *et al.*, 2004; Abba,2014).In this study, the acidic. pH ranges between 4.8-5.49 which is less than the value for maximum uptake. It does therefore indicate that the absorption of water in the study area will be low. Most plants are known to thrive under a pH range of 6.0-7.5. This is consistent with the works of Oluwadare *et al*, (2013). The soils had very very low organic matter content ranging(0.25-0.33 gkg^{-1}) with a mean of 0.3gkg^{-1} which may be due to the fact that forest soils contain high leaf and stem litter fall but lacks moisture due to the decomposition of leaf litter, hence, the inability of the leaves to decompose. This study was not consistent with high organic matter contents (18.85 gkg^{-1}) at Kanawa forest reserve as reported by Abba (2014). The soils of the study area could be generally classified as having very high total nitrogen (0.51 gkg^{-1}).All the functional processes of plants are associated with the presence of nitrogen. The amounts of Phosphorus Calcium,Magnesium,Sodium (Na^+)were generally classified as having low amounts .Potassium was categorized as very low This result was in line with the findings of (Akubuilo, 1977; Lombin,1983; Ayuba, 1992;Abdullahi,2010;Abba,2014;Daniel,.2018).The extractable micronutrients concentrations were low in Zinc (0.48 $Mgkg^{-1}$) and Manganese (2,85 Mgkg-1) moderate in copper(0.42 $Mgkg^{-1}$) and iron (6.21$Mgkg^{-1}$) which was all consistent with the works of Abba,(2014) Similarly, the abundance of the micronutrients seems to adequately support the growth of different vegetation types. The assertion proved the findings of Lombin, (1983); Cox *et al*, (1994).The relationship between soil properties and vegetation showed both positive and negative correlations. This explains that plant species were selective of nutrients as well as depended entirely on the spatial heterogeneity of soil in nutrient distribution and availability. This study would act as a guide to foresters, farmers, horticulturists and land use planners alike to recognize the likely soil conditions that are suitable for a particular purpose.

Trees Species Composition

28 species of trees under 24 genera and 16 families were identified within 6 Hectares of Galumji and Lede areas in Wawa-Zange forest reserve in Gombe State, Nigeria in the Northern Savanna Woodlands (Table 2). From the results of the study, the families that had

the most common tree species were Combretaceae and Caesalpiniaceae. These families were known to be native species in most Savannah-Woodland mosaics in Africa and more typical of the Sudano-Sahelian zones. A similar report was presented by (Abdullahi, 2010; Moksia *et al*., 2012; Sawadogo *et al*., 2007; Abba, 2014).The findings was not consistent with the works of (Lawal and Adekunle ,2011; Ikyaagha *et al*, 2015; Lucky *et al*.,2017;Asinwa *et al,* 2018) probably because of the differences in climatic factors,sizes, edaphic factors, locations, geology and hydromophic conditions of the areas.

Importance value index for trees

The tree with the highest importance value in the reserve was *Combretum collinum* (15%). This could probably be as a result of its ability to grow best on loamy sandy soils. This is consistent with the works of (Soumana et al., 2017). .The tree with the lowest Importance value index in the study area was *Pterocarpus erinaceous*(1.1%). This could likely be due to a mullti purpose usefulness (commercial and medicinal uses) of the tree that is very important to the local economy. The present study is consistent with the works of David,(2014).It weighs relative basal area, dominance, relative density and relative frequency equally. This may lead to the result, that species occurring singular but with a big basal area are given the same dominance as mostly small but wide spread species. According to Curtis and McIntosh (1951), high importance value index (IVI) of a species indicated its dominance and ecological success, its good power of regeneration and greater ecological amplitude and also those plants need-monitoring management, while, species which were grouped as having low importance value therefore need high conservation effort (Abdullahi, 2010; Abba,2014).

Trees species diversity.

Simpson's index of diversity (1-D) was (0.40), The value of Shannon –Wiener index of tree species was (0.02). The values were very low probably due to level of deforestation going on in the study area indicating a less stable, and less complex and unhealthy community. The low diversity could also be due to the low fertility related parameters and low moisture contents in the study area. It could also be due to the position of study area which is not well protected. This is consistent with the works of Lucky *et al*.,(2017).

Conclusion

The study revealed that the soils were generally loamy- sandy and the moisture contents was very low. Soil pH was generally acidic. Organic matter content was very high, total nitrogen was very very low and available phosphorus was low. Exchangeable bases were generally low except for copper and iron which were medium. Concentration of zinc and manganese in the study area were low. Based on the IVI values, *Combretum colinum* (15%) could be said to be the most important elements of the forest. Those with lower values such as *Parkia biglobosa, Prosopis africana, Anageisus leoicarpus, Steculia setigeri, Pterocarpus erinaceous Pericopsis laxiflora, Cissus populnea, Isoberlina doka and Acacia ataxacantha ,Haematostophis barteri* must be conserved. Simpson index of diversity was (0.40) and (0.02) for Shannon Weinner index.. This was quite low indicating that the vegetation is poor and less stable.

Recommendations

Government should readdress issues on forest conservation urgently. Issues of environmental degradation are often extremely complex and require long periods of time and multiple initiatives to stop. Though much work is needed, the Sudan -Savanna is a diverse and ecologically important area that many people depend on, and is worth sustaining.

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Conflict of interest.
The authors declare that there is no conflict of interest.

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