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Research Article

Tree Species Composition and Diversity in the Parklands of Sudan Savannah Zone of Nigeria

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Abstract

This study was carried out to assess the composition and diversity of woody tree species in the parkland of Sudan savannah region of Nigeria. Fifty (50) sampled plots each measuring 25x25m were laid systematically in the Parkland, and woody tree species were determined. A total of 877 tree species were encountered in the study area, belonging to thirty nine (39) different species, distributed within sixteen (16) families. *Fabaceae, Moraceae and combretacea* had the highest number of 13, 6 and 4 respectively; followed by *Anacardiaceae* and *Aracaceae* with three species each, other families have two or one species each. Shannon's diversity index (H') was 3.113**,** 2.967 and 3.188 for Danbatta, Gezawa and Kibiya respectively. Species Evenness (E_H) was 0.8995 (Danbatta), 0.8798 (Gezawa) and 0.8079 (Kibiya), and richness of species stood at 4.276 (Danbatta), 4.205 (Gezawa) and 5.019 (Kibiya). The parkland had high species richness and a moderate diversity on a fairly low fertile soil. Intervention is needed by the governments at all levels, NGOs, and CBOs for proper development, conservation and sustainable use of the tree species on the farms.

Keywords: Tree species, conservation, diversity, Savannah zone and sustainable development.

Introduction

The parklands form the agricultural landscape in the savannah zones of West Africa sub-Sahara region where food and cash crops are cultivated under the cover of dominant, but sparsely distributed trees (Bayala. *et al*., 2015). They provide a range of ecosystem services that enhance livelihood resilience and sustainability among sub-Saharan communities of sub-humid and semi-arid zones (Popoola, 2016). Nigeria is a country in sub-Saharan Africa endowed with rich tropical savannah biodiversity transecting from the semi-arid plains at the northern borders with the republics of Chad, Cameroon and Niger through dry and wet forests in the central and western parts to the wet mangroves spreading across the Niger-Delta in the South (Judy, 2013; Oni, 2014; Ibrahim, 2020). Nigeria's forest resources have been declining steadily due to the rapid growth of population and urban expansion, persistence of shifting cultivation and the ever-increasing demand for forest product, especially fuel wood (Kehinde. *et al.,* 2009). When trees are destroyed the natural ecosystem is undermined leading to environmental imbalance. The International Union for the Conservation of Nature (IUCN, 1994) reported that over one-tenth of known tree species of the earth are considered to be under threat, Whittaker, (1975); Walter, (1985) and UNDP, (2004) noted that deforestation may primarily lead to the extinction of between 5 to 15 percent of the world species between 1990 and 2020. It is believed that the density and diversity of tree species have been threatened by climate change, huge population pressure, deforestation, pest and diseases, drought, fires, acid rain etc (LEISA, 2008). Parklands are mixtures of trees and

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shrubs that farmers select for certain functions and cultivate together with staple food crops, such as millet and sorghum. Parklands are the principal agricultural system used by subsistence farmers in the Sahel (Boffa, 1999). The trees are deliberately selected and maintained when converting natural woodland to farmland. The trees are selected because they are valued for their diverse functions (Faye. *et al*., 2010b). Parkland trees are sources of foods, including fruits, fats, oils, leafy vegetables, nuts and condiments that complement staple food crops in the local diet. Some of these foods are particularly important during the months when grains are in short supply, and during years of intense drought (Kalinganire. *et al.,* 2008; Faye. *et al*., 2010a). Parkland degradation reduces both richness and abundance of useful trees and shrubs leaving the rural poor with fewer options to improve their health, nutrition and income. In addition, it reduces available habitat for other native plants and animals that figure importantly in local diets, medicines, etc. Since traditional knowledge is often transmitted from generation to generation by using the plants, this knowledge is also being eroded as species' richness and abundance decrease (Kalinganire. *et al*., 2008; Bayala. *et al*., 2011). In addition to climatic factors and farming systems, parkland degradation may be affected by other factors such as household wealth status and the access to market opportunities. However to date there is little data in the literature assessing the effects of these factors on parklands trees in the study area. The present study aimed at assessing tree composition and diversity patterns in three local government areas of Kano state.

Methodology

Study Area

The study area is Kano State, Nigeria, located between latitude $11^{0}23^{1}26^{11}$ and $11^{0}58^{1}11^{11}$N and longitude $7^{o}15^{o}0^{11}$ and $8^{o}11^{1}59^{11}$E, with as population estimate of about 20 million people and a total area of 20,131 km^{2} (NPC, 2011). The area has an average mean annual rainfall of about 696.4mm that last usually for three to five months, the mean temperature ranges from 26^{0}C to 33^{0}C. The State features Sudan savannah vegetation and a hot semi-arid climate consisting of farmed Parkland dotted with patches of shrubs savannah (Kabir, 2011).

Sampling Procedure

A systematic sampling technique of parallel line transect with plots method was employed and as Getachew and Biruk, (2014) suggested, fifty (50) 25×25m plots were set up and spaced at interval of 100m along linear transects separated by 200m from one another, and all the tree species encountered within the plots were identified by their local names (with the help of local people and farmers), recorded and measured. Individual trees having ≥ 30cm diameter (measured at breast height) was considered as Trees. All sample plots were located at least 50m from the road to avoid edge effect.

Data Analysis

Data collected from sampling plots was arranged in spreadsheet software (EXCEL) and analysed using PAST statistical software and appropriate biodiversity formulas as follows:

Shannon's Diversity Index:

$H' = -\sum Pi \ ln \ pi$

Where H' = Shannon diversity and Pi = proportion of individual species, ln = natural logarithm

Species richness is an index based on the number of species; it describes Variety of species or the number of different species (or genera, families, etc.).

Species richness R is given as

$$d = N/\sqrt{S}$$

Where;
S is number of species;
N is number of individuals.

Evenness is a measure of the relative abundance of the different species making up the richness of an area.

Evenness is calculated using Shannon Evenness index (*E'*)

$E'= H'/H'$max or $E'=H'/\ln S$
Where, H' is observed diversity;
H max is equal to natural logarithm of richness, ln S.

Density = total No of stems of the species/ sampled area (ha)

Species Relative Frequency
Species relative frequency (RF) was calculated for each tree species using equation (1): 1
Where: ni = number of individual species and N = Total number of species in the sampled area.

Results and Discussion
A total of 877 tree species were encountered in the state, belonging to thirty nine (39) different species, distributed within sixteen (16) families. *Fabaceae, Moraceae and combretacea* had the highest number of 13, 6 and 4 respectively; followed by *Anacardiaceae* and *Aracaceae* with three species each, other families have two or one species each

Table 1: Tree species composition of Kano State

Local Name	Scientific Name	Family
Aduwa	*Balanites aegyptiaca*	Zygophyllaceae
Agwaluma	*Chrysophyllum africanum*	Sapotaceae
Bagaruwa	*Acacia nilotica*	Fabaceae
Baure	*Ficus sycomorus*	Moraceae
Cediya	*Ficus thonningii*	Moraceae
Dabino	*Phoenix dactylifera*	Arecaceae
Danya	*Sclerocarya birrea*	Anacardiacea
Darbejiya	*Azadirachta indica*	Maliaceae
Dinya	*Vitex doniana*	Vertenaceae
Dorawa	*Parkia biglobosa*	Fabaceae
Dundu	*Dichrotachya cinerea*	Fabaceae
Durumi	*Ficus polita*	Moraceae
Dushe	*Acacia seyal*	Mimoisodeae
Faru	*Lannea microcarpa*	Anacardiacea
Gamji	*Ficus platyphylla*	Moraceae
Gawo	*Faidherbia albida*	Fabaceae
Giginya	*Borassus aethiopum*	Arecaceae
Goriba	*Hyphaene thebaica*	Arecaceae
Jiri	*Stereospermum kunthianum*	Bignoniaceae
Kadanya	*Vitellaria paradoxa*	Sapotaceae
Kalgo	*Piliostigma thonningii*	Fabaceae
Kanya	*Diospyros mespiliformis*	Ebanaceae
Karya gatari	*Combretum nigricans*	Combretaceae
Katsari	*Albizia chevalieri*	Fabaceae
Kawari	*Ficus glumosa*	Moraceae
Kuka	*Adansonia digitata*	Malvaceae
Kurna	*Ziziphus spina-christi*	Rhamnaceae
kwandari	*Terminalia macroptera*	Combretaceae
Madaci	*Khaya senegalensis*	Meliaceae
Madobiya	*Pterocarpus erinaceus*	Fabaceae
Magarya	*Ziziphus mauritiana*	Rhamnaceae
Maje	*Daniellia oliveri*	Fabaceae
Mangoro	*Mongifera indica*	Anacardiacea
Marga	*Cassia arereh; C. sieberana*	Leguminaceae

Marke	*Anogeissus leiocarpus*	Combretaceae
Matsatstsagi	*Bauhinia rufescens*	Fabaceae
Rimi	*Ceiba pentandra*	Malvaceae
Sarkin Itatuwa	*Parkinsonia aculeata*	Fabaceae
Shirinya	*Ficus iteophylla*	Moraceae
Talauniya	*Terminalia superba*	Combretaceae
Tawatsa	*Entada abyssinica; E. africana*	Fbaceae
Tsamiya	*Tamarindus indica*	Fabaceae
Turare	*Eucalyptus camaldulensis*	Myrtaceae
Zawayin gyatuma	*Zanthocercis zambesiaca*	Fabaceae
Zogale	*Moringa oleifera*	Moringaceae

Source: Field Survey, 2021

Table 2: Frequency and Percentages of tree Species

	Species	Danbatta		Gezawa		Kibiya	
S/N		Freq.	Percentage	Freq.	Percentage	Freq.	percentage
1	*Balanites aegyptiaca*	11	4.06	5	1.77	0	0.00
2	*Acacia nilotica*	11	4.06	2	0.71	16	4.95
3	*Acacia seyal*	3	1.11	0	0.00	12	3.72
4	*Adansonia digitata*	17	6.27	13	4.59	18	5.57
5	*Albizia chevalieri*	0	0.00	3	1.06	3	0.93
6	*Anogeissus leiocarpus*	10	3.69	10	4.24	13	4.03
7	*Azadirachta indica*	19	7.01	30	10.61	19	5.88
8	*Bauhinia rufescens*	0	0.00	6	2.12	0	0.00
9	*Borassus aethiopum*	8	2.95	16	5.65	0	0.00
10	*C. sieberana*	0	0.00	2	0.71	0	0.00
11	*Daniellia oliveri*	0	0.00	0	0.00	6	1.86
12	*Dichrotachya cinerea*	0	0.00	0	0.00	8	2.48
13	*Diospyros mespiliformis*	9	3.32	9	3.18	23	7.12
14	*Entada africana*	0	0.00	4	1.41	0	0.00
15	*E. camaldulensis*	13	4.80	15	5.30	29	8.98
16	*Faidherbia albida*	11	4.06	25	8.83	9	2.79
17	*Ficus glumosa*	0	0.00	0	0.00	9	2.79
18	*Ficus iteophylla*	0	0.00	0	0.00	2	0.62
19	*Ficus platyphylla*	5	1.85	0	0.00	3	0.93
20	*Ficus polita*	6	2.21	0	0.00	7	2.17
21	*Ficus thonningii*	0	0.00	0	0.00	2	0.62
22	*Hyphaene thebaica*	0	0.00	0	0.00	13	4.03
23	*Khaya senegalensis*	8	2.95	0	0.00	11	3.41
24	*Lannea microcarpa*	0	0.00	0	0.00	5	1.55
25	*Mongifera indica*	10	3.69	14	4.95	0	0.00
26	*Moringa oleifera*	17	6.27	17	6.01	20	6.20
27	*Parkia biglobosa*	22	8.12	20	7.07	20	6.20
28	*Phoenix dactylifera*	12	4.43	10	3.53	0	0.00
29	*Piliostigma thonningii*	18	6.64	20	7.07	0	0.00
30	*Pterocarpus erinaceus*	0	0.00	0	0.00	1	0.31
31	*Sclerocarya birrea*	0	0.00	20	7.07	19	5.88
32	*Tamarindus indica*	7	2.58	31	10.95	16	4.96
33	*Terminalia macroptera*	4	1.48	0	0.00	6	1.86

34	*Terminalia superba*	0	0.00	0	0.00	6	1.86
35	*Vitellaria paradoxa*	12	4.43	3	1.06	8	2.48
36	*Vitex doniana*	10	3.69	8	2.83	5	1.55
37	*Zanthocercis zambesiaca*	0	0.00	0	0.00	7	2.17
38	*Ziziphus mauritiana*	13	4.80	0	0.00	7	2.17
39	*Ziziphus spina-christi*	15	5.54	0	0.00	0	0.00

Tree Species Frequency and Percentages

The species frequency obtained from the study indicates that the occurrences of species in the sampled plots show that the degree of distribution of all individual species encountered in the sampled plots within the study area. Thus, in Danbatta, *Moringa oleifera* had the highest percentage of 8.11% followed by *Azadirachta indica* with 7.01%, *Acacia Seyal* had the least appearance with only 3 with (1.11%) recorded. But in Gezawa forest, *Sclerocarya birrea* had the highest level of occurrence with 10.95% followed by *Azadirachta indica.*

Table 3: Diversity indices of Tree species in the Study Area

Indices	Danbatta	Gezawa	Kibiya
Individuals	271	283	323
Dominance_D	0.04909	0.06579	0.04747
Simpson_1-D	0.9509	0.9342	0.9525
Shannon_H	3.086	2.86	3.188
Evenness_e^H/S	0.9124	0.7936	0.8079
Brillouin	2.915	2.713	3.015
Menhinick	1.458	1.308	1.669
Margalef	4.106	3.72	6.073
Equitability_J	0.9712	0.9252	0.9373
Fisher_alpha	6.356	5.574	8.08
Berger-Parker	0.08118	0.1095	0.08978

Sources: Field Survey, 2021DISCUSSION

Tree Species Composition

The species and families of woody species encountered in this study area shows that 39 species and 16 families gave vegetation composition in the study area which is far more than what Abdulrashid. *et al.,* (2017) found in the parkland of neighboring Gwarzo local government with 16 species and 11 families respectively within the same State and that of Bello. *et al.,* (2012) found at Kogo forest reserve of Katsina State in north-western Nigeria. The number of species was also more than what Mu'azu, (2010) found in kuyanbana forest reserve of Maru, in Zamfara State. The result of this study also had higher species composition compared to 15 species documented by Nuraddeen, (2014) at the parklands of Katsina State, but the result is similar to that of Nikiema. *et al.,* (2005) where they recorded 43 species in the Agroforestry parklands of some communities in Sudan savannah zone of Burkina Faso. The result is also higher than the findings of Isah and Shinkafi, (2000), where they recorded only 11 tree species at Dabagi. Other findings compared to this research include: Sarkar and Devi, (2014) who reported a total of 75 tree species belonging to 60 genera and 40 families in Assam, northeastern India, which is higher than the findings of this research. Getachew and Biruk, (2014) at the plantation stand of Yeraba priority State forest, Amhara region, Ethiopia, reported 31 different species. Ihenyen. *et al.,* (2009), identified 99 different species belonging to 87 genera and 36 families at Ehor forest reserve, Edo State of southern Nigeria. Weather and climate of the ecological zones are important factors influencing the distribution and abundance of different species as described by Causton, (1988). The

occurrence of typical Sudanian species in the parklands suggests that farmers have, either consciously or unconsciously, domesticated those species through selection and/or regeneration practices. This has already been supported by Ouedraogo, (1995) and Lovett and Haq, (2000) who studied *Parkia biglobosa* and *Vitellaria paradoxa* population diversity respectively.

Diversity Index

Depending on the available tree species in an ecological zone, the diversity indices varies with location, the parklands of Kano State is blessed with moderate diversity of woody tree species, in which Kibiya had higher diversity of 3.188, followed by Danbatta (3.086) and Gezawa had the least diversity with 2.86, this falls within the general limits of 1.5 -3.5 (Kent and Coker, 1992). In comparison, the result agreed with the findings of Bello. *et al.,* (2013) in which they recorded a diversity value of 2.626 for trees at Kogo forest reserve, but higher than what Dikko, (2012) reported for Dabagi, who recorded H' value of 1.45 for trees which is very low, and also higher than that of Owiny, (2011) at Mt. Otzi forest reserve, Moyo district, in Uganda, where H' values ranged between 0.91 to 0.95 respectively. Nikiema, (2005) reported a diversity value of 1.09 to 2.49 in Burkina Faso. Also, other findings such as Onyekwelu. *et al.,* (2007) recorded H' values of 3.12 and 3.31 at Oluwa and Queen's Forests, south-western Nigeria, which aligned with the findings of this work. The moderate diversity obtained at the parkland of the State showed that climate favors diversity and may be partly responsible for the diversity obtained in the area; this also depict that ecological factors dictate the distribution and abundance of species. Margurran, (1988) described Evenness (E_H) as a measure of equitability of spread of available tree species in an area. The tree species had a calculated evenness of 0.9124, 0.7936 and 0.8079 for Danbatta, Gezawa and Kibiya, respectively, which is higher than Kuwanka Banza forest reserve (0.74) as recorded by Danjibo, (2014), Dabagi (0.74) as recorded by Dikko, (2012) and (0.70) as the highest evenness value reported in different vegetation types of Ondo State by Adeduntan and Olusola, (2013). This indicate that all the regeneration indicators are moderately distributed in the parklands, which may be due to less competition for space among the tree species considering the nature of the site. Rad. *et al.,* (2009) reported E_H of 0.64, 0.76, 0.71 and 0.65 in four different experimental forests at University of Tehran, which are quite contrary to the findings of this work. Aparajita, (2007) described richness of species as the basic component of diversity of any community, the parklands of Kano State, had a species richness of 4.106, 3.72 and 6.073 for Danbatta, Gezawa and Kibiya respectively which is high compared to 1.84 recorded by Bishir, (2012) at Kogo forest reserve, 1.92, 1.85 and 2.16 found at Oluwa, Queen's and Elephant forests of the low land humid tropical rainforest region of Nigeria by Onyekwelu, (2009). In a similar research conducted by Nuraddeen, (2014) at the parklands of Katsina State, the species richness stood at 0.73 to 1.56. The differences can be as a result of the low level of exploitation, adaptability of species, and preference of species by the farmers.

Conclusion and Recommendations

It was concluded that the parkland of the State was moderate in terms of tree species composition, and diversity and some species were endangered which may be due to over exploitation, climatic and or edaphic factors like low nutrient status of the soil in the area. This highlighted the need to draw an all inclusive integrated management approach that will bring back the diminishing tree resources in the area.

References

1. Abdullahi, I. N. "Parkland Trees under Severe Drought: An Assessment of Species Diversity and Abundance across Three Agroecological Zones of Northern Nigeria." *Open Journal of Forestry* 11 (2021): 117-134.
2. Adeduntan, S. A. and Olusola J. A. "Diversity and abundance of arthropods and tree species as influenced by different forest vegetation types in Ondo state, Nige-

ria." *International Journal of Ecosystem* 3.3 (2013): 19-23.
3. Aparajita, D. "Patterns of Plant Species Diversity in the Forest Corridor of Rajaji–Corbett National Parks, Uttaranchal, India." *Current Science* 92.1 (2017): 90-93.
4. Bayala, J., J. Sanou., Z. Teklehaimanot., Ouedraogo, S.J., A. Kalinganire, R. Coe., M. van Noordwijk. "Advances in knowledge of processes in soil–tree–crop interactions in parkland systems in the West African Sahel: A review." *Agriculture, Ecosystems and Environment* 205 (2015): 25–35.
5. Bello, A. G., Isah, A.D. and B. Ahmad. "Tree species diversity analysis of Kogo forest reserve in north-western Nigeria." *International Journal of Plant, Animal and Environmental Sciences* 3.3 (2013): 189-196.
6. Bishir, A. "Tree Species Diversity and Soil status of Kogo forest reserve in North-western Nigeria." *Unpublished MSc Dissertation, Department of forestry and fisheries, Usmanu Danfodio University Sokoto* (2012): 85.
7. Danjibo, M. "Assessment of floristic composition of Kuwanka Banza forest reserve kebbi state, Nigeria." *Unpublished Msc dissertation, Department of Forestry and Environment, Usmanu Danfodio University, Sokoto* (2014): 75.
8. Dikko, A. A. "Tree Species Density and Diversity Distribution in Dabagi Forest Reserve." *Unpublished B. Forestry project, Department of Forestry and Fisheries, Usmanu Danfodio University, Sokoto* (2012): 27.
9. Getachew, M. and Biruk, A. "Status of native woody species regeneration in the plantation stands of Yeraba priority state forest, Amhara Region, Ethiopia." *Journal of Natural Sciences Research* 4.16 (2014): 91.
10. Ihenyen, J.E.E., Okoegwode, J.K. and Mensah, J.K. "Composition of tree species in Ehov forest reserve, Edo state, Nigeria." *Nature and science* 7.8 (2009): 818.
11. International Union for the Conservation of Nature and Natural Resources (IUCN). "Guidelines for Protected Area Categories." *IUCN, World* (1994).
12. Kabir, A. "The Kano physical Environment." www.kanoonline.com (2011).
13. Kano State Government (KSNG). "Climate." www.kano.gov.ng (2014).
14. Kehinde, A.L., Akande J.A. and E. Ntabe "Forest stakeholders awareness of reduced impact logging (Lehmann, Zheng, & Rillig) in Nigeria and Cameroon." *Journal of Horticulture and forestry* 1.9 (2009): 173-181.
15. Kent, M. and P. Coker "Vegetation Description and Analysis: A Practical Approach." *Belhaven Press, London* (1992): 363.
16. Kumar, J.I.N., Rita, N. K., Rohit, K. B. and Sajish, P.R. "Tree species diversity and soil nutrient status in three sites of tropical dry deciduous forest of western India." *Tropical ecology* 51.2 (2010): 273-279.
17. LEISA. "Dealing with climate change." *Low external input and sustainable agriculture* 24(2008):4 (http://www.leisa.info).
18. Margurran, A. E. "Ecological Diversity and its Measurements, Croom, Helm." (1988): 350.
19. Nikiema, A. "Agroforestry Parkland Species Diversity: Uses and Management in Semi-Arid West Africa (Burkina Faso)." *PhD thesis Department of Plant Sciences, Wageningen University, the Netherlands., Wageningen* (2005).
20. Nuraddeen, A.M. "Girth class distribution analysis of some tree species in the parklands of North-western Katsina state." *International Journal of Current microbiology and applied Sciences* 3.12 (2014): 183-188.
21. Okonkwo, M.C. "Analysis of Agroforestry practices in Katsina state, Nigeria." *A PhD thesis (unpublished) in the Department of Geography and planning faculty of Environmental science, University of Jos* (2010).
22. Onyekwelu, J. C., Reinhard, M. and Bernd, S. "Tree Species Diversity and Soil Status of Two Natural Forest Ecosystems in Lowland Humid Tropical Rainforest Region of Nigeria." *International Agricultural Research for Development,* Tropentag (2007): 4.
23. Rad, J.E., M. Manthey. and A. Mataji. "Comparison of plant species diversity with different plant communities in deciduous forests." *International Journal of Environmental Science & Technology* 6.3 (2009): 389-394.
24. Sarkar, M. and Ashalata, D. "Assessment of diversity, population structure and re-

generation status of tree species in Hollongapar Gibbon Wildlife Sanctuary, Assam, Northeast India." *Tropical plant research* 1.2 (2014): 26-36.
25. United Nations Development Programme "Human Development Report 2000." http:/w.hdr.undp.org/reports/global 2004 (2004).
26. Whittaker. R. H. "Communities and Ecosystems." *New York: Macmillan* (1975).

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