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ESTIMATION OF TREE SPECIES DIVERSITY AND DISTRIBUTION IN THREE COMMUNITIES' FARMLAND AT DUTSINMA AND SAFANA LOCAL GOVERNMENT AREAS KATSINA STATE.

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ABSTRACT

Understanding tree species' diversity, distribution, and structure is very important in assessing the sustainability of ecosystem conservation and management. This study focused on tree species diversity and distribution in three communities' farmlands at Dutsin-Ma and Safana local government areas, to assess, identify, enumerate, estimate the richness, and their evenness, and categorise tree species distribution in the study area. A stratified sampling technique was adapted for the study. Two (2) transect lines of 210m length were laid on which sampling plots were established in each of the three study areas. Species richness and diversity were found to be low in all three communities. *Azadirachta indica* has the highest species richness and diversity in all three communities followed by Adansonia digitata and then *Piliostigma thoningii*. However, the distribution of trees is not uniform across the study area and varies significantly in their density, diversity, and richness. Tree species at Safana have the highest richness index with a value of 5.383, Turare, with an index value of 5.263 while the least was at Darawa with a value of 3.782. The tree population of the selected study area is presently dominated by the Families of Meliaceae Myrtaceae, Malvaceae, Arecaceae, Moraceae, Pinaceae, Fabaceae, Anacardiaceae, and Combretaceae. The existing flora is dominated by savanna species, particularly those associated with guinea savanna vegetation. Management of forest-savanna should be through fire protection and reforestation programmes and there should be proper awareness of the human activities affecting economic tree species and land management in the study communities.

KEYWORD: Tree species, diversity, Shannon-Weiner index, distribution, and richness.

INTRODUCTION

According to Maliyat & Datt (2010), the over-exploitation of natural resources as a result of the growth of biotic activities has also upset the delicate balance between living things and their surroundings. So, in Nigeria, both the reserve where logging is permitted under government regulation and the free areas that are not subject to strict regulation has been devastated. Sacred groves, community forests, SNRs, and biosphere reserves seem to be the only places where entire old-growth forests exist and where biodiversity is preserved for future generations. Parklands serve as the agricultural environment in the savannah zones of West Africa's sub-Saharan area. Here, food and cash crops are grown beneath the canopy of dominating but sparsely spaced trees (Bayala *et al*., 2015). The fast urbanization and population increase, persistence of shifting agriculture, and rising demand for forest products, particularly fuel wood, have all contributed to the steady decline of Nigeria's forest resources (Kehinde *et al*., 2009).

The micro-environmental changes caused by these disturbances are known to make forest species more vulnerable (Appiah, 2013). These alterations have a significant impact on the understory composition of the forest. In many tropical settings, human-caused perturbations have surpassed those caused by natural phenomena. According to Anitha *et al*. (2009), once a system experiences a human-induced disruption, it will continue to deteriorate unless and until preventive measures are implemented. Invasive species have colonized over degraded landscapes caused by repeated forest removal, destroying native species in the process (Powell *et al*., 2011). Jesse *et al*., 2018 posted that in environments where humans have had an impact, native species populations often drop while invasive species frequently gain. By substituting more complex natural vegetation with less complex agroecosystems with fewer species, changes in land use reduce ecosystem complexity and diversity. Changes in ecosystem complexity might be quantified by evaluating the densities and diversities of tree/shrub species. Therefore, one of the key factors affecting vulnerability in the human-environment system is land-use change. To track ecological processes in a changing environment, basic measurements of tree variety, forest structure, tree growth, and forest turnover are crucial characteristics. Tropical forest ecosystems have the greatest diversity of species among all terrestrial ecosystems (Parmentier *et al*., 2007). Although it is estimated that tropical forests are disappearing at a rate of 13.5 million hectares per year globally, deforestation in tropical areas is a significant contributor to

environmental issues like biodiversity loss and climate change (Malhi *et al*., 2008).
Today there is an urgent need for conservation measures and the adoption of sustainable use methods throughout the world to avoid further degradation of natural resources. According to Ihimikaiye and Tanee (2014); Patel and Patel (2013), Omoro *et al.*, 2010 and Matilo *et al.*, 2013, trees are an essential component of human life since they give us raw materials, food, housing, clothes, medicine, dental care, fuel wood, woodcraft, fodder, and forage for our animals.

This research seeks to fill in the gap between knowledge to contribute to data needed for the protection of threatened and economic species and for managing and monitoring the sustainability of the ecosystem.

MATERIALS AND METHOD

The study was conducted at Dutsin-ma Local Government, Katsina State. It's located on Latitude $12^0 27'18"$ N and longitude $7^0 29'29"$ E.It covers an area of 527Km^{2}approximately and on the elevation on 605m above sea level.Safana is on a latitude of 12°24'50.73"N and a longitude of 7°24'49.69"E or 12.414092 and 7.413802 respectively. Safana covers an Area of 28,200 hectares 282.00 km² and on Elevation of 509 metres (1,670 feet).

The materials used during the study includes: Two (2) transect lines of 210m length, plastic rope and four wooden pegs.

SAMPLING PROCEDURE

The study area was divided into three (Darawa, Turar e, and Safana. A stratified sampling technique was ad apted for the study. Two (2) transect lines of 210m le ngth were laid on which sampling plots were establish ed in each of the three study areas to have a better rep resentation of the areas. Systematic sampling was use d to establish plots on the outlined transects. The size of the sampling plots was measured as 20m x 20m wi th 15m intervals between the plot, giving 12 sampling plots in each study area and a total of 36 sampling plo ts for the whole study.

SCOPE OF THE STUDY

The study covers three communities' farmland at Dutsinma Local Government Area and Safana Local Government Area. within the limit of the scope, tree species were identified, counted, and measured.

DATA COLLECTION

For the purpose of collecting data, a field inventory of tree flora was used.During field assessment, the plots were marked using plastic rope and four wooden pegs , within the plots. Inventory and taxonomic classificat ion of tree species with DBH ≥10cm, was identified, c ounted, and measured using plastic tape.

DATA ANALYSIS

The data obtained from the study were analyzed using biodiversity formulae and methods as follows:

$$\text{Frequency (F)} = \frac{\text{number of plots I n which species occur}}{\text{The total number of plots sampled}}$$

$$\text{Density (D)} = \frac{\text{Number of individual species}}{\text{Area sampled}}$$

Relative Frequency: The degree of dispersion of individual species in an area to the number of all the species that occurred.

- Tree species distribution was determined using the formulae below.

$$\text{Relative Frequency (RF)} = \frac{\text{species frequency of individual species}}{\text{Total frequency value of all species}} \times 100$$

Relative Density: Relative density is the study of the numerical strength of a species to the total number of individuals of all the species and can be calculated as;

$$\text{Relative Density} = \frac{\text{species density of individual species}}{\text{Total density for all species}} \times 100$$

The IVI (Importance value index) was used to identify the dominant species in the study area.

IVI = relative frequency (RF) + relative density (RD).

The diversity of tree species was computed using the Shannon diversity index as follows.

$$\text{H}' = -\sum_{i=1}^{S} \text{pi ln } pi$$

Where:

H = Shannon diversity index

Pi = proportion of individual species

In = natural logarithm

- Species evenness (E) measures the distribution of the number of individuals in each species. It was determined using Shannon's equitability (EH) as stated by Kent and Coker (1992):

$$E = \frac{H}{lnS}$$

Where:

E = evenness index

S = number of species

In = natural logarithm

$$R' = \frac{S-1}{\log N}$$

Where:

R' = richness index

N = number of individuals

S = number of species

RESULTS AND DISCUSSION

Results

A field investigation was carried out. All the tree species found within the sample regions were identified through these surveys, together with information on their frequency of occurrence, height, and diameter. All trees at each location were recognized and counted while the sites were marked utilizing wooden pegs during data collection. A total of 14 species were identified and classified according to the scientific names, common names, and families in Turare, Darawa, and Safana. Four tree species (*Adansonia digitata, Azadirachta indica, Piliostigma thoningii and Diospyros mespiliformis*) were found to be common in all three study areas. Two tree species (*Hyphaen ethebaica, Tamarindus indica)* were found to be common in Darawa and Turare. *Pinus kesiya* tree was common in Safana and Turare. Five species *Parkia bioglobosa, Ficus sycomorus, Anogeis susmicrocephale, Lannea acida, Acacia senegal* were found only in the Safana study area. The tree species identified were presented in Table 1. The families Fabaceae and Anacardiaceae, have four (4) and two (2) tree species respectively, while Malvaceae, Meliaceae, Ebenaceae, Arecaceae, Moraceae, Combretaceae, Myrtaceae, and Pinaceae represent only one (1) species representatives

Table 1: Tree species composition, common name, and families

Scientific Name	Common Name	Family
Acacia senegal	Gum Arabic	Fabacaece
Adansonia digitata	Baobab	Malvaceae
Anogeissus leiocarpus L	African birch	Combretaceae
Azadirachta indica	Neem	Meliaceae
Piliostigma thoningii	Bauhinia	Fabaceae
Diospyros mespiliformis	West Africa Ebony	Ebenaceae
Eucalyptus camaldulensis	River red gum	Myrtaceae
Ficus sycomorus	Sycamore fig	Moraceae
Hypaene thebaica	Doun palm	Arecaceae
Lannea acida	White lead tree	Anacardiaceae
Mangifera indica	Mango	Anacardiaceae
Parkia biglobosa	Locust beans	Fabaceae
Pinus helpensis	Pine	Pinaceae
Tamarindus indica	Tamarind	Fabacaece

Source: Field Survey, 2021

Population, Average Diameter at Breast Height, and Total number of Tree Species in the Study Area

The population of tree individuals, tree species, and average DBH of tree species in all three communities were evaluated: Safana community has the highest population of tree species (47), followed by Turare (33) and Darawa (31). Fourteen (14) tree species were collectively identified, six (6) species at Darawa, ten (10) species at Safana, and nine (9) species at Turare. *Azadirachta indica* has the highest population representation in all three communities while *Anagiessus microcephala, Lannea acida, Mangifera indica, and Parkia biglobosa* have the least representation of the individual population. *Adansonia digitata* represent species with the highest DBH (8.03, 3.56, and 3.83) in all the communities. while *Anageissus microcephala and Pinus kesiya* have the least DBH representation. The result of DBH shows that the average tree species at Darawa has higher DBH, thus the species are more mature than those in Safana and Turare.

Table 2: population, average diameter at breast height, and total of tree species in the study area

Tree Specie	Darawa		Safana		Turare		Specie Total
	Population	Average DBH	Population	Average DBH	Population	Average DBH	
Acacia nilotica			1	0.85			1
Adasonia digitata	3	0.03	3	3.56	3	3.83	9
Anogeissus microcephala			1	0.50			1
Azadirachta indica	10	1.35	32	0.99	11	1.16	53
Bauhinia thoningii	1	1.15	1	0.70	1	0.90	3
Diospyros mespiliformis	1	1.54	3	1.76	1	0.95	5
Eucalyptus camaldulensis					11	0.96	11
Ficus sycomorus			1	1.65			1
Hypaen ethebaica	5	0.89			3	0.76	8
Lannea acida			1	2.45			1
Magnifera indica					1	1.60	1
Parkia biglobosa			1	3.75			1
Pinus kesiya			1	0.70	1	1.10	2
Tamarindus indica	1	3.20			1	1.60	2
Total	**21**	**2.69**	**47**	**1.60**	**33**	**1.40**	**101**

Source: Field Survey 2021

Distribution of Trees in the Study Area

The frequency, density, relative density, relative frequency, and important value index of tree species are collectively found in the study areas. The result shows that *Azadirachta indica* has the highest frequency (0.556), density (0.00368), relative frequency (28.51), and relative density (0.526) among the fourteen species, while *Acacia senegal* , *Anageissus microcephala, Ficus sycomorus, Lannea acida, Mangifera indica, and Parkia biglobosa* have the least relative frequency and relative density. This shows the degree of dispersion of tree species and the numerical strength of species to the number of individual species in the study area. Meanwhile, *Azadirachta indica* has the highest important value index (IVI) in all three communities indicating that it is the most dominant species of tree in the study area. The least IVI is recorded for the following species *Anageissus microcephala, Lannea acida, Mangifera indica, and Parkia biglobosa.*

Discussion

As a result, the study tends to characterize the tree composition in the study region as subpar, haphazard, and unscientific. Field investigation indicated that they weren't being managed appropriately (Iyanuoluwa, *et al*.,2020). Inferences from the field survey and data analyzed have shown little differences for the determined factors of interest in selected study areas namely Darawa, Safana, and Turare respectively. Fourteen (14) species *(Acacia nilotica, Azadirachta indica, Adansonia digitata, Anogeissus microcephala, Mangifera indica, Lannea acida, Pinus kesiya, Parkia biglobosa, Bauhinia thoningii, Hyphaene thabaica, Ficus sycomorus, Diospyrus mespilliformis, Tamarindus indica, Eucalyptus camaldulensis*,) was identified, this observation is in close agreement with the finding of Abdulrashid and Bilyaminu 2020, Abdulrashid *et al*.,2022, Dangbo *et al*.,2020, Maryam and kungo, 2023, and Iyanuoluwa *et al*., 2020 that listed most of the species identified.

In this study tree density varied across the study communities, ranging from 0.00007 to 0.000368, though lower than estimations from other ecosystems. This is in line with Attua (2003) who reported mean tree density per hectare of 231.81 and 55.92 in an undisturbed rainforest and matured fallows respectively.

The average DBH of the tree ranges enumerated are relative of the same magnitude at Safana and turare communities (1.6 and 1.4 respectively) while the DBH of Darawa is higher and species are much more mature. These findings are in line with the work of Dangbo *et al*., 2020 and Abdulrashid and Bilyaminu, (2020).

Results of the computed importance value index from the three communities show that *Azadirachta indica*, *Adansonia digitata*, and *Eucalyptus camaldulensis* trees respectively in order of decreasing value of IVI as the most dominant tree species in the area. These results corroborated the work of Abdulrashid and Bilyaminu, (2020) and Adekunle *et al*., 2013; 2010 that the IVI value for the whole community irrespective of the stratification identifies *Azadirachta indica* tree with the highest IVI value, then followed by *Eucalyptus camaldulensis*.

A value of 1.522 was obtained, interpreted as moderate diversity (considering a scale of 0-3). Therefore, the number of tree species (14) is moderate and hence the species distributions are intermediate. Species diversity at individual communities was analyzed/computed and 1.693, 1.409, and 1.276 values were obtained for Safana, Turare, and Darawa respectively. Therefore, species diversity was highest at Safana with 10 species, followed by Turare with 9 species and the least at Darawa with 6 species. It can be comparatively understood that individual tree species representation per plot is highest at Safana, Darawa, and least at Turare. This observation is in line with that of Abdulrashid and Bilyaminu, (2020) results of research show that the composition of species in the two study locations slightly differs with a difference of two tree species. From the Shannon index scale the higher the index value the greater the diversity which ranges from 0 to 5. Species at Turare are more even at an evenness index value of 0.484 than Darawa with index values of 0.463 and the least evenness at Safana at 0.331. Evenness in the whole study area was computed as 0.330.).

Tree species at Safana have the highest richness index with a value of 5.383, then Turare with an index value of 5.263, and least at Darawa with a value of 3.782. This can be justified by the number/population of tree species. Safana has the population of 47 while Turare and Darawa have the population of 33 and 21 respectively.Though Turare and Darawa were in the same Local Government. This is in close agreement with the finding of Abdulrashid and Bilyaminu, (2020). Attua and Pabi (2013) in research on Tree composition, richness & diversity in the forest–savanna ecotone of Ghana concludes that tree population of the northern forest-savanna ecotone is presently dominated by the *Leguminosae, Fabaceae, Moraceae, Meliaceae and Euphorbiaceae* families.

CONCLUSIONS

This study's analysis of tree species density, distribution, and population structure could be helpful for managing tree diversity in semi-arid habitats in the Sudan Savanna zone. A good database, essential for management measures in the study area, is produced by documenting the patterns of tree variety and their distribution. The study comes to the conclusion that the Meliaceae, Myrtaceae, Malvaceae, Arecaceae, Moraceae, Pinaceae, Fabaceae, Anacardiaceae, and Combretaceae families now dominate the tree population in the chosen study locations. Savanna species, especially those connected to guinea savanna vegetation, predominate the present flora to a significant extent. However, the density, diversity, and richness of trees vary greatly between sites and are not distributed uniformly throughout the study areas. Safana and Turare have the greatest richness indices for tree species, both with values of 5.383, while Darawa has the lowest, with a value of 3.782. These habitats must be protected to support the fundamental requirements of the local inhabitants and preserve their unique biodiversity. In order to preserve biodiversity, this study urges the creation of an urgent conservation strategy. The studied region's community composition and species distribution pattern appears to have been significantly impacted by localized processes or disturbances such as wildfires, shifting agriculture, and logging. The population of bigger plants is declining, which has a considerable influence on human activities' effects on plant resources. A quantitative examination of the variety of tree species found in this study might offer a starting point for developing management and conservation plans for the study area. To help the ecology and tree species in the research region recover, a number of steps must be taken: (a) Limiting the population's reliance on wood energy, and developing reforestation based on assisted natural regeneration. (b) planting plantations in severely degraded areas, and educating farmers about biodiversity, its value, and the need to preserve it through sustainable management are just a few of the goals.

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