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Assessment of Ecological Status and Tree Diversity in Watershed Area of Dandi Local Government Area in Kebbi State, Nigeria

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ABSTRACT: This study assessed the ecological and tree diversity status of watershed area of Dandi local government area in Kebbi state using systematic sampling technique. Three transects of 300 m long were laid at 100 m intervals. On each transect, six sample plots of size 50 m x 50 m (0.25ha) were alternately laid at 50 m intervals. A total of 18 sample plots will be used for the study. Diameters at breast height (Dbh) of all the trees found in the plot with Dbh ≥ 5cm will be measured. Fourteen tree species belonging to 10 genera and 8 families were identified. *Borassus aethiopum* of the family Arecaceae was the most abundant species in the area with a relative density (RD) and diversity index (DI) of 0.296 and 0.08728 respectively. This was followed by *Cocos nucifera* in the Arecaceae family also, with RD and DI of 0.192 and 0.03662 respectively. *Daniella oliveri* of the family Fabaceae was the least represented species with RD and DI of 0.0018 and 0.00002 respectively. The overall tree species richness in the area was 0.0052.

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The rate of biodiversity loss has been accelerating rapidly throughout the current industrial era. Over the past few hundred years, humans have increased the species extinction rate by as much as 1,000 times over background rates typical over the planet's history (Millennium Ecosystem Assessment, 2005). However, extinction is just the final step in a long process of ecosystem degradation, in which deterioration in the abundance and distribution of many species of trees are becoming more common and rare species rarer. In Nigeria, just as it is the case in most countries of the developing world, habitat devastation, utilization, pollution and species introduction have been identified as major causes of biodiversity loss (UNEP, 2001). Many tropical forests are under great human pressure and require urgent supervision to maintain the overall biodiversity, productivity and sustainability. The appearance and function of forest ecosystem is represented by the plant constituent more than any other living component of the system (Richards 1996). Plant diversity at any site is as a result of species distribution and abundance patterns (Palit and Chanda 2012) and the richness of plant species is determined by different biotic and abiotic factors (Rannie 1986, Huston 1994). Species diversity is one of the most important indices used for appraising the stability and sustainability of forest communities. Knowledge on the species richness of a forest is essential for its wise supervision in terms of economic value, rejuvenation potential

(Wyatt-Smith 1987) and in due course may be leading to conservation of biological diversity (Verma *et al*. 1999). In recent times, there has been significant deforestation in many wetland areas of Nigeria and different watershed to give way to other competing land needs, as population soars. Although environmental changes influence or determine processes that augment or wear away distribution of species, its abundance and richness, all these remain assumed guesses without field confirmation. There has specifically been neglect of watershed conservation, protection and ecological preservation of fauna and flora of such forested areas. This has led to land degradation, destruction and loss of biological diversity (Mon *et al*., 2012). For example in Nigeria, illegal logging in forests, and even in reserves, is prevalent and has led to loss of species. Tree diversity refers to the abundance of different tree species living within a specific area or region (Shuaibu *et al.* (2014). The diversity of trees is fundamental to the total tropical rainforest diversity as trees provide means and habitat structure for almost other forest species (Cannon *et al.*, 1998). The diversity of trees is fundamental to total tropical forest biodiversity, because trees provide resources and habitats for almost all other forest species (Huston, 1994; Cannon *et al.*, 1998; Whitmore, 1998). Whitmore (1998) reported that tree species diversity in tropical forest varies greatly from place to place mainly due to variation in biogeography, habitat and disturbance. Tree species diversity, richness and distribution are the most important characteristics of tropical rain forest ecosystem. Regardless of plot size, studies have shown that the number of tree species is far greater in tropical rain forest than in any other forest community (Adekunle, 2006), except in a situation where deforestation and encroachment have eaten deep into the forest reserves. Exploitation of tropical forest for timber causes much internal damage such as; canopy opening, leading to changes in microclimate (Minckler *et al.*, 1973; Vitousek and Sanford, 1986) which influences the remaining trees. Watershed can be seen as an area of land that drains water, sediment and dissolved materials to a common receiving body or outlet (Thomas, C. *et al.*, 2017). The term is not restricted to surface water runoff and includes interactions with subsurface water. Watersheds vary from the largest river basins to just acres or less in size. The study of watersheds as ecosystems, primarily the analysis of interacting biotic and abiotic components within a watershed's boundaries. Watershed ecology is essential knowledge for watershed managers because it teaches us that watersheds have structural and functional characteristics that can influence how human and natural communities coexist within them. The gross structure of a watershed -- its headwaters area, side slopes, valley floor, and water body, as well as its soils, minerals, native plants and animals -- are, in one sense, raw material for all the human activities that may potentially occur there. The watershed's natural processes -- rainfall runoff, groundwater recharge, sediment transport, plant succession, and many others -- provide beneficial services when functioning properly, but may cause disasters when misunderstood and disrupted. Each watershed is separated from adjacent watersheds by ridges of high ground. The flow of water over land from small to progressively larger water bodies provide water sources for urban, agricultural, industrial and environmental needs. Thus, the watershed community (humans, animals and plants) depend on the watershed for survival and influence it in many ways. In addition, the flowing water carries organic debris and dissolved organic matters which Provide food and shelter for aquatic life. (Mathew, 2008; Enwelu *et al*., 2010). The process of development continues to undermine the sustainable utilization of watershed resources in many tropical countries including Nigeria. Watersheds have suffered from exceptional rates of change as they are degraded or destroyed by anthropogenic activities such as farming, industrial development and urbanization. Human activities had been found as a major driving force with vast implications on changes in watershed ecosystems. (Bamgbose and Arowolo, 2007; Huber *et al*., 2005; EA, 2005). Forest degradation and deforestation negatively affect livelihoods, ecosystems functions, climate and diversity of forest (Ismail *et al*., 2011). Therefore, the study assessed the ecological status and tree diversity in watershed with a view to providing a baseline data on which subsequent management successes can be gauged.

MATERIALS AND METHODS

Study area: Kebbi State is located on the north western part of Nigeria between latitudes 10^0 and 13^0N and longitudes 303^{0}' and 60E. It has a total landmass of about 37,699 square kilometers out of which 36.46% is made up of farmland. However, about one third of the state is situated in desert prone environment thus making it one of the front-line states for the menace of drought and desertification. The state shares an extensive border with Niger Republic to the North and Benin Republic to the west with many inter-cultural and ethnic linkages. It is internally bordered to the North-East by Sokoto State to the East by Zafara State and to the south by Niger State.

The landscape of Kebbi State is dominated by extensive flood plains (Fadama) of the inland river valley systems. The Niger River flows southwest

across part of the state and the Rima River flows southerly through the center of the state to join the Niger. Both rivers have broad flood plains. The flow of River Rima is, however, perennial which reaches its peak during the short wet season that last between June and September. The largest sources of surface water, however, is in Yauri and Ngaski Local Government Areas where the River Niger forms large body of water several square kilometers in size known as Kainji Lake; which is 80% located in Kebbi State. Dandi is a Local Government Area (LGA) in Kebbi State, Nigeria, sharing a boundary with the Republic of Niger. Its headquarters are in the town of Kamba. Dandi shares a southern border with Bunza LGA. It has an area of 2,003 km² and a population of 144,273 at the 2006 census.

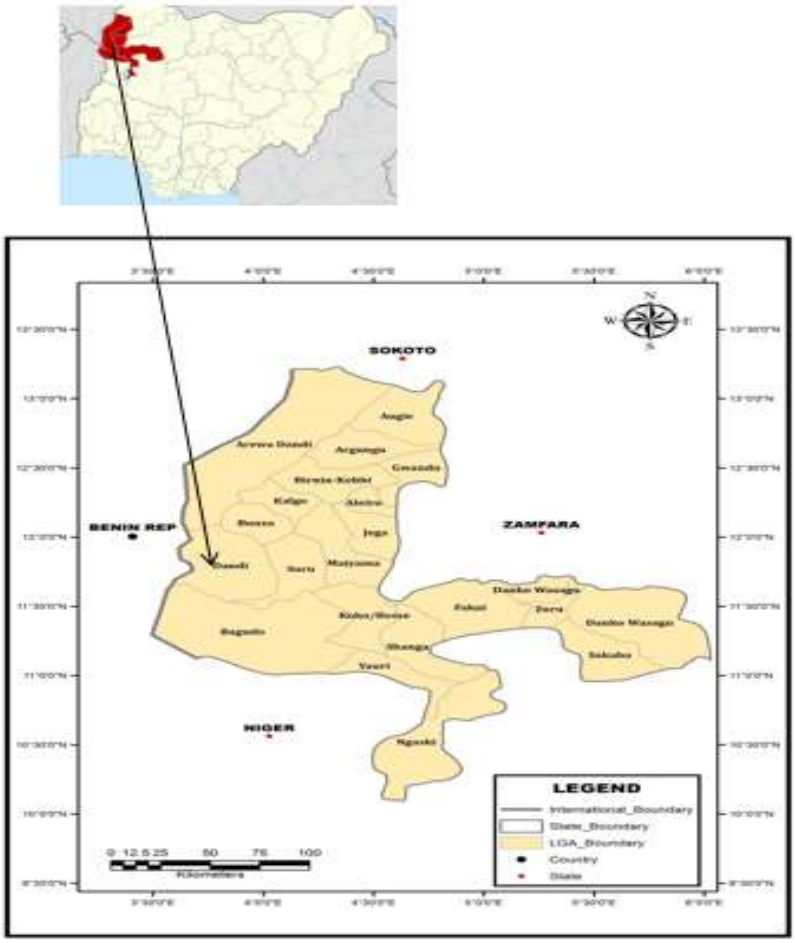

Fig1. Showing map of Nigeria indicating the study area

Tree sampling procedure: Systematic line transects {described by Osemeobo (1992)} will be used in the laying of the sample plots in the selected location along the river**.** Three transects of 300 m long were laid at 100 m intervals. On each transect, six sample plots of size 50 m x 50 m (0.25ha) were alternately laid at 50 m intervals. A total of 18 sample plots will be used for the study. Diameters at breast height (Dbh) of all the trees found in the plot with Dbh ≥ 5cm will be measured.

*Data Collection***:** Basal Area (BA) Calculation: The basal area of all trees in the sample plots will be calculated using the formulae:

$$BA = \left[\frac{\prod D_2}{4} \right]. \qquad (1)$$

Where BA = Basal area (m^2), D = Diameter at breast height (cm) and π = Pie (3.142).

The total basal area for each of the sample plots was obtained by adding the BA of all trees in the plot while mean BA for the plot (*BAp*) was obtained by dividing the total BA by the number of sample plots.

Tree Species Classification and Diversity Indices: All the trees encountered were allocated to families and number of species in each family will be obtained for tree species diversity classification. Frequency of occurrence will be obtained for species abundance/ richness. This was repeated for all tree plants encountered in the sample plots for the two sites. Species relative density (RD) number of individual per hectare was obtained using the formula given by Oduwaiye *et al.* (2002): Statistical analysis: Species diversity: Species diversity index was computed using Simpson's index (D) of species diversity as:

$$D = \frac{\sum n(n-1)}{N(N-1)} \text{ ---------- (2)}$$

Where, N = the total number of tree species; n = the number of individuals of each tree species (Simpson, 1949).

Relative species abundance: Species relative density was computed for each of the tree species using:

$$RD = \frac{n}{N} \text{ ---------- (3)}$$

Where, n = number of individual tree species; N = total number of species in the entire forest.

Basal area computation: Basal area was computed using:

$$BA_P = \sum_{i-1}^{n} BAi \text{---------- (4)}$$

Where, BA = Basal area (m²); π is a constant, which equals 3.143. The basal area for each plot was obtained by adding individual tree basal areas in each plot. The basal area per hectare was computed by multiplying the plot value by 4, 4 being the number of 0.25ha-plot in a hectare. The species relative dominance was computed using:

$$RD = \frac{\sum BAi}{BAn} X100 \text{ ---------- (5)}$$

Where, BA_i = basal area of trees belonging to the ith species; BA_n = stand basal area of all species, as adopted by Onyekwelu *et al.* (2007), and used by Bello *et al*. (2013).

Species richness was computed using Margalef's index (Margalef, 1958):

$$d = \frac{S}{\sqrt{N}} \text{ ---------- (6)}$$

Where, S = number of species; N = number of individual of all tree species in the area.

RESULT AND DISCUSSION

Tree species, relative densities and the diversity indices from the watershed study area was presented in Table 1. Fourteen (14) tree species were identified in the area belonging to ten (10) genera and eight (8) families. *Borassus aethiopum* of the family Arecaceae was the most abundant species in the area with a relative density (RD) and diversity index (DI) of 0.296 and 0.08728 respectively. This was followed by *Cocos nucifera* in the Arecaceae family also, with RD and DI of 0.192 and 0.03662 respectively. *Daniella oliveri* of the family Fabaceae was the least represented species with RD and DI of 0.0018 and 0.00002 respectively. The overall tree species richness in the area was 0.0052.

Table 1: Tree species relative densities and diversity indices in the study area

Species	Family	English	Trees/ha	RD	DI
Borassus aethiopum	Arecaceae	African fan palm	185	0.296	0.08728
Cocos nucifera	Arecaceae	Coconut	120	0.192	0.03662
Piliostigma Reticulatum	Fabaceae	purple orchid tree	33	0.053	0.00271
Daniella oliveri	Fabaceae	African copaiba balsam tree	11	0.018	0.00002
Parinari macrophylla	*Chrysobalanaceae*	gingerbread plum	59	0.09	0.008784
Ficus platyphylla	Moraceae	Broadleaf Fig	32	0.051	0.00254
Vitex doniana	Verbenaceae	Black plum	49	0.078	0.00603
Cissus populnea	Amplidaceae	food gum	19	0.030	0.00008
Gardenia aqualla	Rubiaceae	Cape Jasmine	23	0.037	0.00129
Patrinia rufescens	Caprifoliaceae	golden lace	38	0.061	0.00361
Tamarindus indica	Fabaceae	tamarind	12	0.019	0.00003
Adansonia digitata	Malvaceae	Baobab	32	0.051	0.00254
Ziziphus mauritiana	Rhamnaceae	Chinese date		0.019	0.00003
Balanite aegyptica	**Zygophyllaceae**	**Desert date**	**29**	**0.046**	**0.00208**

Note: RD – relative density; DI – diversity index

The individual tree species mean basal area/ha and their corresponding relative dominance are presented in table 2. *Borassus aethiopum* appears to be the dominant species in the area with a mean basal area/ha of 0.248 m^2 and relative dominance (RDo) of 24.27. The least dominant species in the area was *Daniella oliveri* of the Fabaceae family with a mean BA/ha of 0.0057 and RDo of 2.45. Details are shown in table 2.

Table 2: Individual tree species basal area/ha and relative dominance

Species	Family	English	BA/ha(m^2)	RD_0
Borassus aethiopum	Arecaceae	African fan palm	0.248	24.27
Cocos nucifera	Arecaceae	Coconut	0.118	3.07
Piliostigma Reticulatum	Zygophyllaceae	purple orchid tree	0.134	4.25
Daniella oliveri	Fabaceae	African copaiba balsam tree	0.0057	2.45
Parinari macrophylla	Fabaceae	gingerbread plum	0.224	20.20
Ficus platyphylla	*Chrysobalanaceae*	Broadleaf Fig	0.111	10.22
Vitex doniana	Moraceae	Black plum	0.064	7.39
Cissus populnea	Verbenaceae	food gum	0.0061	0.28
Gardenia aqualla	Amplidaceae	Cape Jasmine	0.155	5.12
Patrinia rufescens	Rubiaceae	golden lace	0.082	4.28
Tamarindus indica	Caprifoliaceae	tamarind	0.034	4.34
Adansonia digitata	Fabaceae	Baobab	0.028	7.48
Ziziphus mauritiana	Malvaceae	Chinese date	0.065	5.25
Balanite aegyptica	**Rhamnaceae**	**Desert date**	**0.083**	**5.41**

Note: BA – tree basal area; RDo – relative dominance

Tree species diversity may be at its lowest due to consistent logging in the area, and this may affect species rejuvenation and development. The low tree species diversity at Dandi local government area watershed may be due to heavy and constant indiscriminate logging in the area, which may have impacted greatly on species revival and growth. This was supported by Adekunle and Olagoke (2008), who emphasized that increased pressure on forests for several uses affected species diversity in Bitumen producing area of Ondo State. The species richness was very poor with a value of 0.0056, when compared with what obtain in the other protected area as reported by Bello *et al*. (2013). Factors like anthropogenic activities may have, in one way or the other affect the advent and structure of the forest. Adekunle (2006) stated that Nigerian forest ecosystem has been under unrestrained logging and other illegal happenings over the years, and this has led to the loss of biodiversity and reduction in forest size and extent and this is in agreement with what is obtainable in this research. The diversity indices gotten in this study for the fourteen tree species under study are less than the values described by Adeyemi *et al*. (2013) for a protected area in southern Nigeria. From the study, it was observed that there is relatively low mean (in total) at the basal area per hectare, this result may be attributed to occurrence of illegal loggings and illegal removal of forest resources. In contrast to the findings of Alder and Abayomi (1994) for a well-kept forest. Despite the individual species dominance gotten from the study area, there is higher contrast to the values obtained by previous studies, there are still evidences of massive human illegal logging activities in the study area and this has brought lots of strain and tension to the biodiversity in and around the forest.

Conclusion: The investigation has shown fewer tree species diversity in the area in comparison to other established forest reserves in Nigeria. The dominant tree species was *Borassus aethiopum* form the family Arecaceae. The overall species diversity was low in the area compared to the other ecosystems previously studied. The mean trees/ha were equally low compared to those reported for other protected area in the country, especially forest reserves. The basal area per hectare recorded in the area was also lesser than the value suggested for a well-managed forest in Nigeria. As a way of recommendation to the stake holders in forestry, measures should be put in place that will bring back the original status of watershed in our forest. There is also a need for aggressive enlightenment of the farmers on forest practices that will not endanger the biodiversity in their surrounding forest.

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