Vol. 10(10), pp. 419-431, October 2018
DOI: 10.5897/IJBC2018.1185
Article Number: 994B2D358833
ISSN: 2141-243X

http://www.academicjournals.org/IJBC

ACADEMIC JOURNALS
expand your knowledge

International Journal of Biodiversity and Conservation

Full Length Research Paper

Spatial variation in diversity of woody vegetation species within Kwara State University Malete campus, Kwara, Nigeria

Romoke Monsurat Suleiman[1*], Henry Olawale Sawyerr[1], Abdulrasheed Adio[1] and Gabriel Salako[2]

[1]Department of Plant and Environmental Biology, Kwara State University, Nigeria.
[2]Department of Environmental Management and Toxicology, Kwara State University, Nigeria.

Received 14 March, 2018; Accepted 18 April, 2018

The roles of woody vegetations and Africa savanna in human development and survival as attracted interest in their conservation to prevent the depletion or loss of those resources. However, there is need for accurate data on species composition, distribution and conservation of woody species in many parts of Africa for adequate planning, monitoring, management and conservation efforts. This study assessed woody species composition, distribution and diversity in Kwara State University, Malete Campus. Simple random sampling technique was applied using plot method which was achieved using geographic information system (GIS) application to overlay the area boundary with grids of cell of 100 x 100 m plots. Data were collected from each plot, all woody species were identified, counted, and trees basal covers were measured. Species frequency, density, abundant, dominance, importance value index (IVI) and diversity were determined. A total of 46 trees and 10 shrubs species belonging to 20 families of tree and 8 families of shrubs were identified. Abundant tree species were *Daniella oliveri* and *Azadirachata indica* while the abundant shrubs species were *Piliostigma thonningii* and *Acacia nilotica*. Shannon diversity index and Shannon measure of evenness revealed that the diversity for trees species was higher (H'=2.4309 and J= 0.6349) than shrubs species (H'=1.1166 and J= 0.4849). There was spatial variation in diversity of trees and shrubs within the university which has more tree species than shrubs species. Hence, university management and community should pay attention to conservation planning and management activities with special consideration on their ecological implication.

Key words: Diversity, tropical forest, savanna ecosystem, humid savanna, *D. oliveri*, *A. indica*, *P. thonningii.*

INTRODUCTION

In recent times, the richness of tropical forest has led to upsurge of interest in conservation of Africa Savanna due to the fact that it harbours three or four times more species than the temperate forest as a result of warm

climate and high primary productivity (Michaela, 2005). Since the first earth summit in Rio de Jeneiro, there has been a sustained global awareness of the importance of the superfluity of biodiversity and natural resources from tropical forests for several purposes. However, tropical forests have been rapidly depleted of natural resources due to increasing urbanization, industrialization, fragmentation, degradation and conversion to other forms of land use (Ayodele, 2005).

Savanna ecosystems of the tropical forest are not left out and are generally described as tropical seasonal ecosystems with a continuous grass layer, mixed with forbs and sedges with a variable cover of trees and shrubs (Khavhagali and Bond, 2008). Savanna ecosystem plays important roles in the welfare and economy of man through the ecosystem services (Ikyaagba et al., 2015). The mean annual rainfall divides savannas into arid and humid/ derived and they reportedly occupy sixty percent vegetation cover of sub-Saharan Africa (Sankaran et al., 2005). This ecosystem is however classified as Derived/ Humid, Guinea, Sudan and Sahel Savanna in Nigeria.

Humid savanna is a region of savanna- forest boundary that is ecotone representing the natural limit of distribution of tropical forest and offers an opportunity to understand how the tropical forest responds to climate change and disturbance regimes (Hoffmann et al., 2009). The intermediate disturbance hypothesis shows that communities are likely to contain greatest numbers of species when the quantity of disturbance is neither too high nor too low (Bowman, 2000; Michaela 2005) reported that rain fall patterns, fire and grazing are of great importance and can override other factors at all tropic levels out of all the disturbances in the savanna – 'climate change, increase in atmospheric CO_2 concentration, fire regimes, grazing by livestock and wild herbivores, rain fall, canopy cover, and soil resources'. Ruggiero et al. (2002) however included climate and soil characteristics. Hoffmann et al. (2009) opined that fire is the most universal determinant of savannah forest boundaries worldwide. Bowman (2000) also reported that savanna-forest boundary containing tree species being common to both savanna and forest ecosystem. Resilience however plays a crucial role in the maintenance of savanna ecosystems.

Wood vegetations are made up of plants that produce wood as its structural tissue which include trees, shrubs and lianas and are usually perennial plants whose stems and larger roots are reinforced with wood produced from secondary xylem. Nodza et al. (2014) indicated that Nigeria vegetation is one of the most endowed in Africa, as almost all the vegetation types that exist in other African countries are widely distributed in different geopolitical zones of the country. This is as a result of favourable climate and geographic features, which harbors about 7895 species of plants (Adeyemi and Ogundipe, 2012). However, the continual existence of this forest is uncertain due to the deforestation rate in the country.

Today, there is an urgent need for conservation measures and adoption of sustainable methods throughout tropical forests to avoid further degradation of the natural resources (Ikyaagba et al., 2015). In Nigeria, for instance, there is limited accurate data on flora composition. Thus species currently perceived as abundant might actually be endangered while those previously perceived as endangered might be nearing extinction (Ikyaagba et al., 2015).

For every proposed development such as establishing a university campus like the case study of this research, the effect of such development may cause habitat degradation, fragmentation and loss, which will affect biodiversity occurrence, distribution, and abundance of species present in such an ecosystem. There is no comprehensive inventory of biodiversity present in the area prior to the establishment of the university campus. Therefore, there is need to account for woody vegetation inventory, which will serve as a baseline information that will identify and evaluate the woody vegetations distribution in the Malete campus.

MATERIALS AND METHODS

Study setting

The study area covers a location known administratively as the Malete Campus of Kwara State University. It lies between Latitudes 8.7284 and 8.6979 N and Longitudes 4.4595 and 4. 5030 E with 1,612.60 hectares of land (Figure 1). The area shares boundaries with Malete - Elemere road in the South, Malete - Adio Road in the West, undefined foot path and forest vegetation in the North and East by undeveloped tracts of land. The area lies within the Southern Guinea Savanna ecological zone with rainy season period between April and October and average annual rainfall of 1100 mm/yr while the dry season period is between November and March. Annual mean temperature is 27°C and relative humidity is 89% in the morning and 55% in the evening. The daily minimum temperature is 20°C mostly around December and January, while daily maximum temperature is 33°C and it is the highest in March. The topography information shows that elevation is averagely 300 m and the maximum topographical height is located at the eastern axis with 346 m above sea level. The elevation rises upwards with a gentle slope from South-Western axis to North-Eastern axis where a stream is located. It is therefore characterised by clusters of trees, shrubs and seasonal herb and grass communities with a number of associated animal species.

*Corresponding author. E-mail: ladyrommy4real@gmail.com.

Sampling design and procedure

The study is a descriptive ecological study that utilized an adaptive simple random sampling technique to establish plots sample of 100 m by 100 m for trees and shrubs species enumeration. The sampling strategy utilized the university land area that was already grouped into: built up, disturbed and undisturbed area. In order to trace out the study area boundary, an image band was combined, geo-referenced and digitized to enable equal distribution and sampling. Identification and species count of trees and shrubs in each selected plot were then carried out after locating the centre point of each plot using Garmin geographic position system (GPS) to capture the geographic coordinates (Latitude, Longitude and Elevation).

In each plot, woody vegetation survey covered 50 m away from the centre point in a square plot of North, South, East, and West. Trees with diameter at breast height 'DBH ≥ 10 cm' were selected for assessment. Tree count, diameter and location coordinate were recorded. Also, shrubs with 'DBH ≥ 5 cm' were identified, counted and location coordinate was recorded. *In-situ* and *ex-situ* identification was performed by a plant taxonomist aided by manuals and Floras and were presented in tables and chart that reported relative frequency, relative density and Importance Value Index.

Data analysis

Normalized Difference Vegetation Index (NDVI)

Normalized Difference Vegetation Index (NDVI) is a remote sensing/GIS technique used to qualitatively and quantitatively evaluate the vegetation covers of an area (Neelima et al., 2013). NDVI can be calculated as:

$$NDVI = \frac{NIR - R}{NIR + R}$$

Where NIR is the reflectance in the near infrared region and R is the reflectance in the red region.

Species Occurrence, Density and Important Value Index (IVI)

This study adopted techniques described by Nautiyal *et al*. (2015) to compute frequency, relative frequency, density, relative density, abundance and important value index. IVI of the species was calculated as the sum of species relative density; relative frequency and relative dominance as shown below:

$$\text{Frequency} = \frac{number\ \ of\ sampling\ \ units\ \ (plot\,)\ in\ which\ a\ species\ \ occurs}{Total\ \ number\ \ of\ sampled\ \ units'\ studied}\ \text{X}\ 100 \quad (1)$$

$$Relative\ frequency\ (RF) = \frac{Number\ \ of\ occurrences\ \ of\ a\ species}{Total\ \ number\ \ of\ occurrence\ \ of\ all\ species}\ \text{X}\ 100 \quad (2)$$

$$Density = \frac{Total\ \ number\ \ of\ individual\ \ in\ all\ sampling\ \ unit\ s}{Total\ \ number\ \ of\ sampled\ \ units\ \ studied}\ \times\ 100 \quad (3)$$

$$Relative\ density\ (RD) = \frac{Number\ \ of\ individual\ \ of\ a\ species}{Total\ \ number\ \ of\ indivi\ dual\ \ of\ all\ species}\ \times\ 100 \quad (4)$$

$$Relative\ dominance\ (RD_{\text{o}}) = \frac{Total\ \ basal\ \ cover\ \ of\ individual\ \ species}{Total\ \ basal\ \ cover\ \ of\ all\ species}\ \text{X}\ 100 \quad (5)$$

$$Abundance = \frac{Total\ \ number\ \ of\ individuals\ \ in\ all\ sampling\ \ units}{Total\ \ number\ \ of\ sampling\ \ units\ \ of\ occurrence} \quad (6)$$

$$IVI = RD + RF + RD_{\text{o}} \quad (7)$$

Species diversity and evenness

Trees and shrub composition in the University campus were estimated using Shannon-Wiener indices of diversity and evenness (Ikyaagba et al., 2015). This index considered species richness and proportion of each species in the sample plots. It was noted

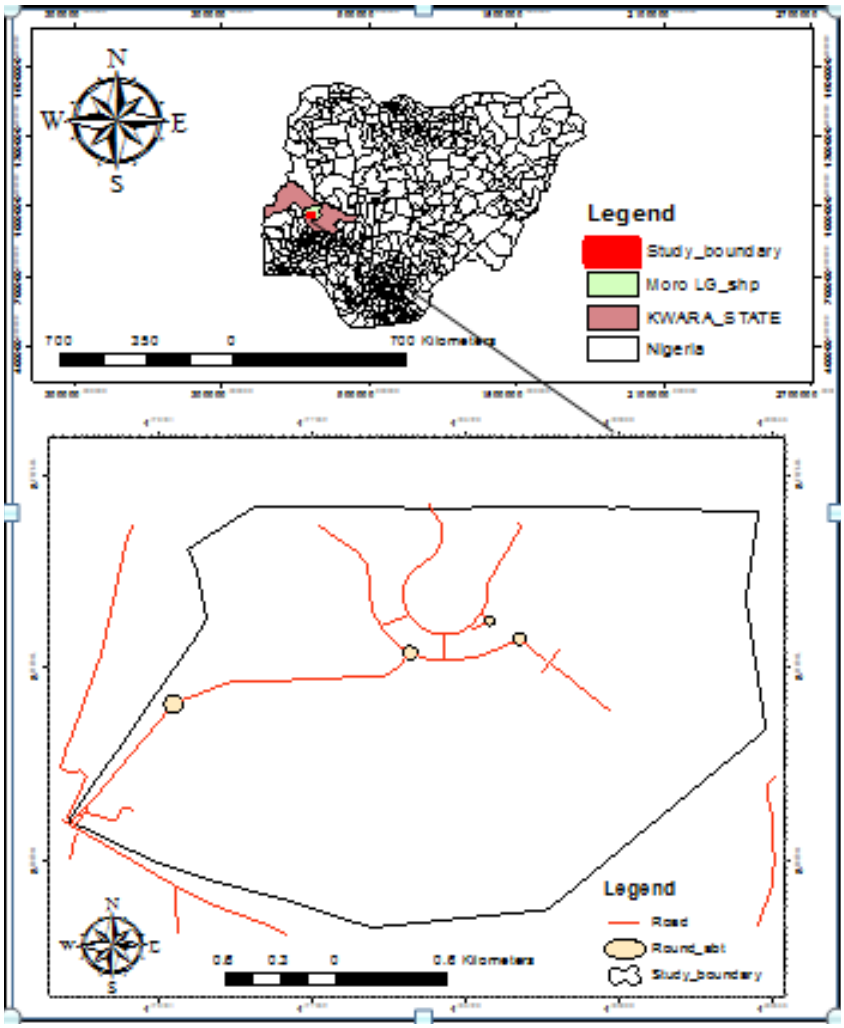

Figure 1. Map of the study area (Nigeria Inset).

that, the value of H' obtained from empirical data usually falls between 1.5 and 3.5, and rarely surpasses 4 (Magurran, 2004) which can be obtained as:

$$H' = -\sum_{i=1}^{S} Pi\ InPi$$

Where *H'* is Shannon-Wiener diversity index, P_i is Proportion of individuals in the ith species and lnPi is the Natural logarithm of Pi. An index of evenness (j') can be derived from the Shannon Wiener index. This index of evenness range between 0 and 1 which can be defined as:

J'=H'/H' max

Where H' is the Shannon Wiener diversity index, H'max is ln S and S is the number of species in the community.

Spatial variation mapping of species diversity using ordinary kriging interpolation

Kriging is a type of spatial interpolation that uses complex mathematical formulas to estimate values at unknown points, based on the values at known points. The values of known points are the grids/plot visited. Shannon index of species diversity was used to calculate the spatial diversity of the whole area. There are different types of Kriging, which include Ordinary, Universal, Co-Kriging, and Indicator Kriging. In this research, Ordinary kriging was used for interpolation; it assumes that the constant mean is unknown. This is a reasonable assumption except there is a scientific reason to reject it (Childs, 2004).

$$\hat{Z}(S_o) = \sum_{i=1}^{N} \lambda_i Z(S_i)$$

Where:

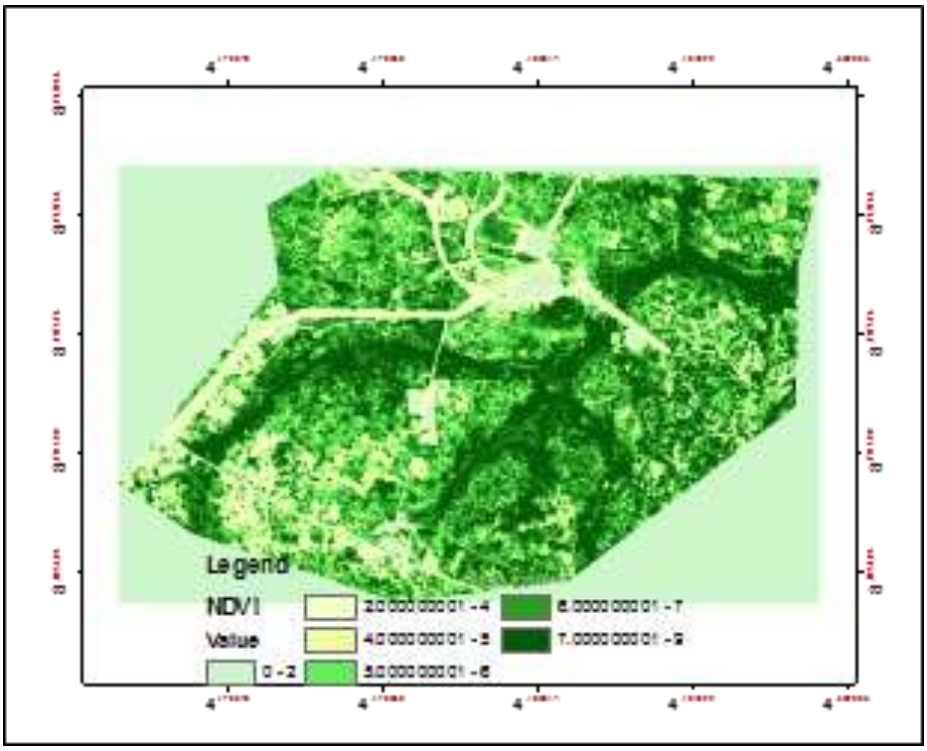

Figure 2. Map showing NDVI.

$Z(S_i)$ = the measured value at the ith location
λi = an unknown weight for the measured value at the ith location
So = the prediction location
N = the number of measured values

RESULTS

NDVI and land cover map

NDVI results show the area distribution of the university vegetation. NDVI value range from 0 to 9; and the higher the value the more vegetative the area. Figures 2 and 3 below show the map revealing NDVI values and the respective corresponding land cover of University Campus:

Woody species composition

A total of 46 trees and 10 shrub species were identified within the university campus, amounting to a total of 56 woody species (trees and shrubs) encountered during the study. The trees belonged to 20 families and 33 genera, while the shrubs belonged to 8 families and 10 genera. Trees were the most dominant woody species identified in the studied area.

The results shown in Figure 4 reveals that 13 of the families were represented by one species each while the dominant family was Fabaceae with 12 species followed by Moraceae, Combretaceae, Meliaceae and Myrtaceae with 5, 4, 4 and 4 species, respectively for tree species, while Figure 5 reveals that 7 families were represented by one species each for shrubs species, with family Fabaceae the only family with multiple species representation.

Woody species occurrence, abundance and IVI

In the sample units of tree species studied, *Azadirachta indica* is the most frequent (11.47), most dominant (24.57) and the most important species with IVI of 58.41/300 but *Daniellia oliveri* (11.01) is the most abundant (22.04) with the highest density (26.89) tree species in the vegetation; while 10 species of trees were the least abundant species (1) with relative frequency of 0.46 among which *Ficus spp* is among the least dominant (0.02) and least dense (0.05) as well the least important tree species (0.52/300).

Among the Shrubs, *Piliostigma thonningii* is the most frequent (92.86) and abundant (19.77), while *Olax subcordata* with the least density (10.71) is the least

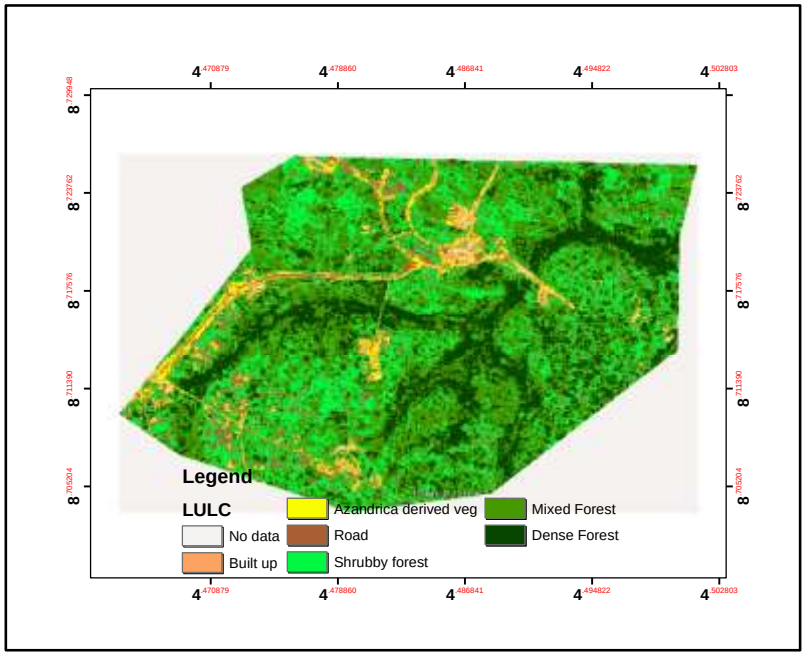

Figure 3. Land cover map.

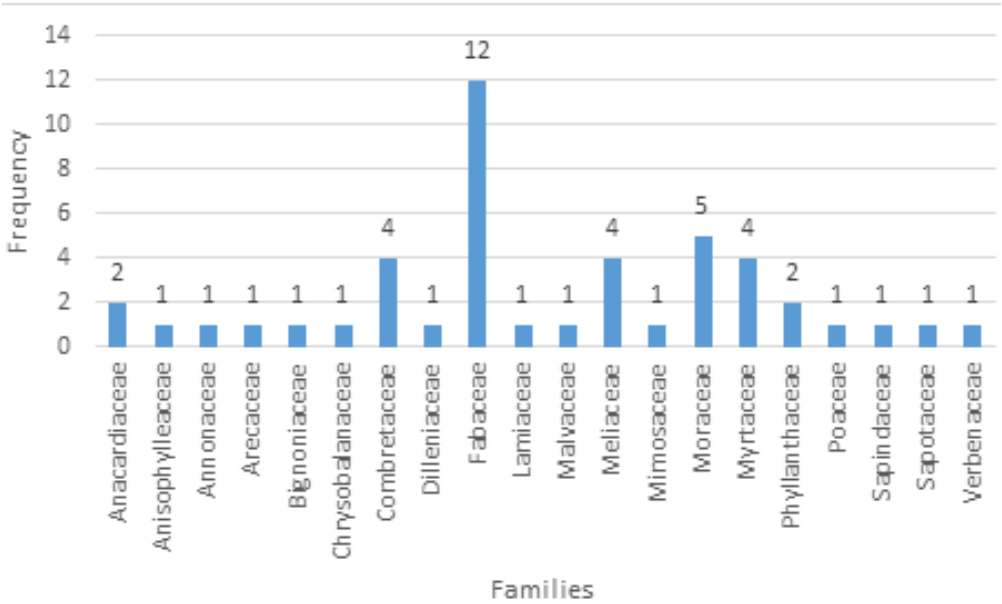

Figure 4. Trees species distribution by family.

abundant (1) shrub. Table 1 shows the individual trees species composition with their scientific, family/common names and IVI. Table 2 shows individual shrubs species composition with their Scientific, Family/Common names, frequency, abundance and density.

Woody species diversity

Trees and shrubs species present in the vegetation sample are 46 and 10, respectively, per 30 hectare. Proportion Pi was obtained for individual trees and

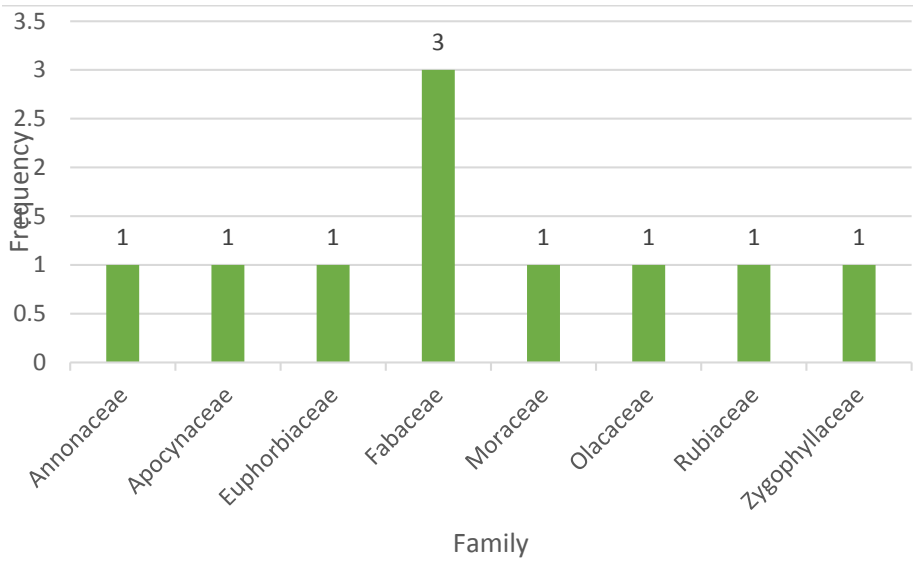

Figure 5. Shrubs species distribution by family.

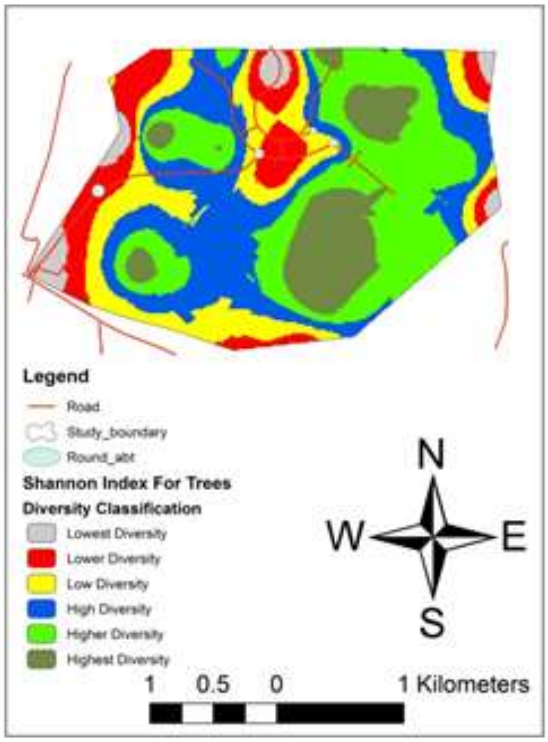

Figure 6. Showing spatial variation in trees species diversity**.**

shrubs species while H measure (PilnPi). Thus, Shanon H' is given as -$\sum_{i=1}^{s}(PilnPi)$ – (-2.4309) = (2.4309) for Shannon index of trees species and also for shrubs species – (-1.1166) = 1.1166. Hence, Shannon index of evenness of species in the community ranging between 0 and 1 is J' = (H'/lnS) = 0.6349 and 0.4849 for trees and shrubs species in the community, respectively. Tables 3 and 4 show Shannon index with respect to individual species for trees and shrubs, respectively.

Spatial variation mapping of trees and shrubs species diversity using ordinary kriging interpolation

Figures 6 and 7 show the spatial variation mapping of trees and shrubs species diversity using ordinary kriging interpolation. Shannon indices were used to map out variation of trees and shrubs within the vegetation. The map of Shannon index for woody species shows that the dark green colour areas have the highest species diversity while grey colour areas have the least species diversity within the community.

The map reveals that the highest diversity of trees species are mostly in North East (NE) part of the studied area while North West area have the lowest diversity. For shrub species, areas with highest diversity of species are mostly in the North West (NW) while North East (NE) areas have the lowest diversity. Figures 6 and 7 below show the spatial variation maps of trees and shrubs species diversity in the community.

DISCUSSION

Forty- Six (46) trees species and Ten (10) shrubs species

Table 1. List of Trees Species and their Corresponding IVI.

S/N	Species	Family Name	Common Name	Abundance	Relative Frequency	Relative Density	RelativeDominance	IVI
1	*Acacia spp*	Fabaceae	Gum acacia	3.22	4.13	1.47	0.96	6.56
2	*Accacia spp*	Fabaceae	Wattles, Acacias	2.67	1.38	0.41	0.22	2.01
3	*Adansonia digitata*	Malvaceae	Macaw-fat	1	1.38	0.15	1.16	2.69
4	*Afzelia Africana*	Fabaceae	Afzelia, African mahogany	53	0.46	2.69	1.97	5.12
5	*Albizia lebbeck*	Mimosaceae	Indian siris	1	0.46	0.05	0.08	0.59
6	*Anacardium occidentale*	Anacardiaceae	Cashew	7.17	2.75	2.19	3.2	8.14
7	*Annona squamosa*	Annonaceae	Sugar-apple	1	0.46	0.05	0.02	0.53
8	*Anogeissus leiocarpus*	Combretaceae	Axle-wood tree	18.09	5.05	10.12	8.8	23.96
9	*Azadirachta indica*	Meliaceae	Neem	17.6	11.47	22.37	24.57	58.41
10	*Bambusa vulgaris*	Poaceae	Bamboo	3.5	0.92	0.36	0.07	1.34
11	*Bauhinia tomentosa*	Fabaceae	Yellow bauhinia, Yellow bell orchid tree	3.5	0.92	0.36	0.65	1.93
12	*Blighia sapida*	Sapindaceae	Akee	3	0.92	0.31	0.11	1.33
13	*Bridelia ferruginea*	Phyllanthaceae		3.67	2.75	1.12	0.96	4.83
14	*Bridelia micrantha*	Phyllanthaceae	Bridelia, Coast goldleaf	11	0.46	0.56	0.29	1.31
15	*Daniellia oliveri*	Fabaceae	West african copal tree	22.04	11.01	26.89	15.52	53.42
16	*Dialium guineense*	Fabaceae	Velvet tamarind	6	1.83	1.22	0.55	3.6
17	*Dillenia spp*	Dilleniaceae		9	0.46	0.46	0.22	1.14
18	*Eleais guineensis*	Arecaceae	African oil palm	5	0.46	0.25	0.26	0.97
19	*Erythrina gigantica*	Fabaceae	Coral tree, Flame tree	1	0.46	0.05	0.07	0.58
20	*Eucalyptus camadulasis*	Myrtaceae	Red gum	10.67	1.38	1.63	1.3	4.31
21	*Eucalyptus globulus*	Myrtaceae	Blue gum	7	0.46	0.36	0.2	1.02
22	*Eucalyptus spp*	Myrtaceae		3	0.46	0.15	0.06	0.67
23	*Eucalyptus torelliana*	Myrtaceae	Cadagi tree	1	0.46	0.05	0.02	0.53
24	*Ficus capensis*	Moraceae	Wild fig	1	0.46	0.05	0.02	0.53
25	*Ficus macrophylla*	Moraceae	Moreton bay fig	4	0.46	0.2	0.25	0.91
26	*Ficus mucuso*	Moraceae	Doumbourou	5.5	5.5	3.36	1.89	10.76
27	*Ficus spp*	Moraceae		1	0.46	0.05	0.02	0.52
28	*Ficus sur*	Moraceae	Wild fig	3.2	2.29	0.81	0.76	3.86
29	*Khaya ivorensis*	Meliaceae	Red mahogany	1.5	0.92	0.15	0.13	1.19
30	*Khaya senegalensis*	Meliaceae	Mahogany	1.5	0.92	0.15	0.08	1.15
31	*Mangifera indica*	Anacardiaceae	Mango	2.6	2.29	0.66	1.02	3.97
32	*Parinari spp*	Chrysobalanaceae	Cork tree, Hissing tree	3	1.38	0.46	0.25	2.09
33	*Parkia biglobosa*	Fabaceae	African locust bean tree	6.96	11.01	8.49	22.1	41.6
34	*Poga oleosa*	Anisophylleaceae	Ovoga	1	0.46	0.05	0.02	0.53

Table 1. Cont'd

35	*Prosopris Africana*	Fabaceae	Guele	1.33	1.38	0.2	0.11	1.69
36	*Pterocarpus erinaceus*	Fabaceae	African rosewood	14	0.46	0.71	0.37	1.54
37	*Pterocarpus soyauxii*	Fabaceae	African padouk, Barwood, African coral	1.5	0.92	0.15	0.08	1.15
38	*Tabebuia spp*	Bignoniaceae	Trumpet trees, Roble	8	0.46	0.41	0.23	1.1
39	*Tamarindus spp*	Fabaceae	Tamarind	4.5	0.92	0.46	0.26	1.64
40	*Terminalia spp*	Verbenaceae	Teak	1	0.92	0.1	0.05	1.07
41	*Tectona grandis*	Combretaceae		4	0.46	0.2	0.08	0.74
42	*Terminalia laxiflora*	Combretaceae	Stage tree	1	0.46	0.05	0.02	0.53
43	*Terminalia radii*	Combretaceae		2	0.46	0.1	0.11	0.67
44	*Trichilia emetic*	Meliaceae		3.33	2.75	1.02	0.75	4.52
45	*Vitellaria paradoxa*	Sapotaceae	Shea butter tree	6.5	11.01	7.93	9.43	28.37
46	*Vitex doniana*	Lamiaceae	West african plum, African oak	2.71	3.21	0.97	0.69	4.87
	Total			275.26	100	100	100	300

Table 2. List of shrubs species and their corresponding frequency, abundance and density.

S/N	Species	Family name	Common name	Abundance	Relative frequency	Relative density
1	*Acacia nilotica*	Fabaceae	Scented-pod acacia	11.88	35.82	31.53
2	*Acalypha wilkesiana*	Euphorbiaceae	Red acalypha	9	1.49	1
3	*Annona senegalensis*	Annonaceae	African custard-apple, Wild soursop	1.67	4.48	0.55
4	*Balanites aegyptiaca*	Zygophyllaceae	Desert date	2	2.99	0.44
5	*Entada gigas*	Fabaceae	Monkey-ladder , Sea bean	4.5	5.97	1.99
6	*Ficus benjamina*	Moraceae	Ficus benjamina, Ficus tree	53	1.49	5.86
7	*Nauclea latifolia*	Rubiaceae	African peach	4	1.49	0.44
8	*Olax subcordata*	Olacaceae		1	4.48	0.33
9	*Piliostigma thonningii*	Fabaceae	Camel's foot tree, Monkey bread	19.77	38.81	56.86
10	*Rauvolfia vormitoria*	Apocynaceae	Swizzle-stick	4.5	2.99	1
	Total			111.32	100	100

were identified in Malete Campus, Kwara State University. The number of tree species recorded is quite close to the one recorded (52) by Ikyaagba et al. (2015) in Federal university of Agriculture Makurdi, Ngeria in Guinea Savanna. This is in contrast with 67 woody species recorded by Nodza et al. (2014) in Akoka Campus Lagos state and 26 recorded by Iwara et al. (2012) in Ugep Cross-river state, as a result of difference in

Table 3. Shannon weiner diversity index for trees species.

S/N	Species	Pi	LnPi	H
1	*Acacia spp*	0.0147	-4.217	-0.0622
2	*Acacia spp*	0.0041	-5.5048	-0.0224
3	*Adansonia digitata*	0.0015	-6.4857	-0.0099
4	*Afzelia africana*	0.0269	-3.614	-0.0974
5	*Albizia lebbeck*	0.0005	-7.5843	-0.0039
6	*Anacardium occidentale*	0.0219	-3.8231	-0.0836
7	*Annona squamosa*	0.0005	-7.5843	-0.0039
8	*Anogeissus leiocarpus*	0.1012	-2.291	-0.2318
9	*Azadirachta indica*	0.2237	-1.4975	-0.335
10	*Bambusa vulgaris*	0.0036	-5.6384	-0.0201
11	*Bauhinia tomentosa*	0.0036	-5.6384	-0.0201
12	*Blighia sapida*	0.0031	-5.7925	-0.0177
13	*Bridelia ferruginea*	0.0112	-4.4932	-0.0503
14	*Bridelia micrantha*	0.0056	-5.1864	-0.029
15	*Daniellia oliveri*	0.2689	-1.3133	-0.3532
16	*Dialium guineense*	0.0122	-4.4062	-0.0538
17	*Dillenia spp*	0.0046	-5.387	-0.0246
18	*Eleais guineensis*	0.0025	-5.9748	-0.0152
19	*Erythrina gigantica*	0.0005	-7.5843	-0.0039
20	*Eucalyptus camadulasis*	0.0163	-4.1185	-0.067
21	*Eucalyptus globulus*	0.0036	-5.6384	-0.0201
22	*Eucalyptus spp*	0.0015	-6.4857	-0.0099
23	*Eucalyptus torelliana*	0.0005	-7.5843	-0.0039
24	*Ficus capensis*	0.0005	-7.5843	-0.0039
25	*Ficus macrophylla*	0.002	-6.198	-0.0126
26	*Ficus mucuso*	0.0336	-3.3946	-0.1139
27	*Ficus spp*	0.0005	-7.5843	-0.0039
28	*Ficus sur*	0.0081	-4.8117	-0.0391
29	*Khaya ivorensis*	0.0015	-6.4857	-0.0099
30	*Khaya senegalensis*	0.0015	-6.4857	-0.0099
31	*Mangifera indica*	0.0066	-5.0193	-0.0332
32	*Parinari spp*	0.0046	-5.387	-0.0246
33	*Parkia biglobosa*	0.0849	-2.4663	-0.2094
34	*Poga oleosa*	0.0005	-7.5843	-0.0039
35	*Prosopris africana*	0.002	-6.198	-0.0126
36	*Pterocarpus erinaceus*	0.0071	-4.9452	-0.0352
37	*Pterocarpus soyauxii*	0.0015	-6.4857	-0.0099
38	*Tabebuia spp*	0.0041	-5.5048	-0.0224
39	*Tamarindus spp*	0.0046	-5.387	-0.0246
40	*Terminalia spp*	0.001	-6.8911	-0.007
41	*Tectona grandis*	0.002	-6.198	-0.0126
42	*Terminalia laxiflora*	0.0005	-7.5843	-0.0039
43	*Terminalia radii*	0.001	-6.8911	-0.007
44	*Trichilia emetic*	0.0102	-4.5885	-0.0467
45	*Vitellaria paradoxa*	0.0793	-2.5344	-0.201
46	*Vitex doniana*	0.0097	-4.6398	-0.0448
	Total	1.0000	-248.6922	-2.4309

Thus, Shannon Index (H') for trees = - (-H), Therefore : - (-2.4309) which is 2.4309.

Table 4. Shannon weiner diversity index for shrubs species.

S/N	Species	Pi	lnPi	H
1	*Piliostigma thonningii*	0.5686	-0.5646	-0.321
2	*Olax subcordata*	0.0033	-5.7082	-0.0189
3	*Acacia nilotica*	0.3153	-1.1543	-0.3639
4	*Annona senegalensis*	0.0055	-5.1974	-0.0287
5	*Nauclea latifolia*	0.0044	-5.4205	-0.024
6	*Acalypha wilkesiana*	0.01	-4.6096	-0.0459
7	*Ficus benjamina*	0.0586	-2.8365	-0.1663
8	*Rauvolfia vormitoria*	0.01	-4.6096	-0.0459
9	*Entada gigas*	0.0199	-3.9165	-0.078
10	*Balanites aegyptiaca*	0.0044	-5.4205	-0.024
Total		1.0000	-39.4377	-1.1146

Thus, Shannon Index (H') for shrubs = - (-H), therefore: – (-1.1146) which is 1.1146.

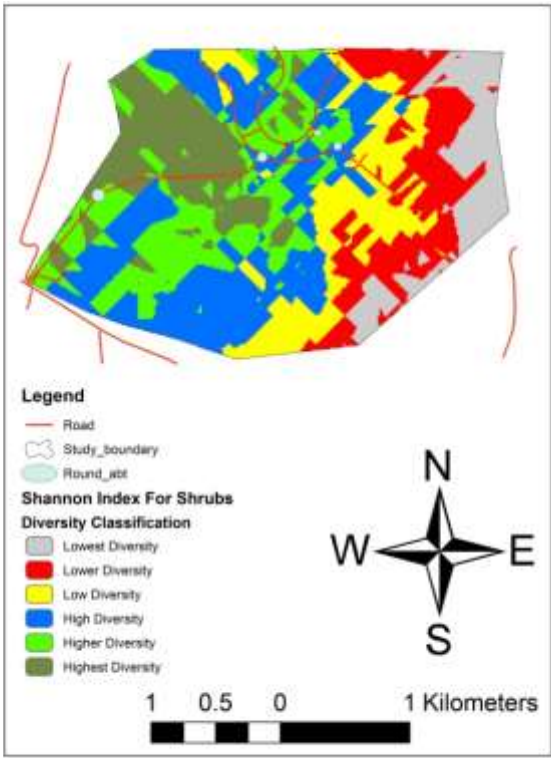

Figure 7. Showing spatial variation in shrubs species diversity.

species richness in a tropical rain forest compared to a savanna ecosystem of our present study.

Fabaceae family was majorly represented accounting for twelve (12) and three (3) trees and shrubs species, respectively (Ikyaagba, 2008). This corroborates the affirmation of other Nigeria studies like Erhenhi and Obadoni (2016) in Urhonigbe forest reserve in Edo State, and Bello and Musa (2016) in Shika, Zaria. John et al. (2013) in Northern Botswana and Elizabeth (2011) studied in Kumasi, Ghana also reported family Fabaceae as the most represented family. This is due to similarity in species recorded and close geographical characteristic with similar ecological distribution. Though, this is not in agreements with Athua and Pabi (2013) in Ghana and Ikyaagba (2008) in Nigeria whose studies postulated that Mimosoideae, Combretaceae, Euphorbiaceae are the most represented families.

D. oliveri and *A. indica* were the two (2) most frequency while *Afzelia africana* had the highest abundance value (53) for trees species. *P. thonningii* and *Acacia nilotica* were the two (2) with most frequency; while *Acalypha wilkesiana* and *Rauvolfia vormitoria* were the least frequent for shrub species. The result also indicated that *O. subcordata* have the lowest abundance value out of the shrubs species. This result is in agreement with Oyedepo et al. (2016) whose study reported that *D. oliveri* have the highest frequency. In contrast with this, Bello and Musa (2016) in Shika, Zaria Nigeria revealed that *Isoberlinia doka* was the most abundant species.

IVI result revealed that *A. indica* and *D. oliveri* have the highest IVI value of 58.41 and 53.42, respectively per 300 which indicated their ecological importance while Seven (7) species: *Annona squamosa, Eucalyptus spp, Eucalyptus toreliana, Poga oleosa, Tectona grandis, Terminalia laxiflora and Ficus spp* have IVI values less than 0.54 per 300. Bello and Musa (2016) in their study in Shika, Zaria Nigeria and John et al. (2013) in their study in Northern Botswana also utilized IVI value to determine the most importance species.

The overall diversity and evenness of woody species was much higher in trees species (H'=2.4309and J= 0.6349) than shrubs species (H'=1.1166 and J= 0.4849),

which may be a consequence of high species richness in tree species. It has been noted that the value of H' obtained from empirical data usually falls between 1.5 and 3.5, and rarely surpasses 4 (Magurran, 2004). This implies that the diversity of woody shrubs falls at the lowest values of diversity range while the diversity of woody trees falls at the highest value of diversity range indicating the extent of tree species diversity in the woody population. Bello and Musa (2016) in their study in Shika, Zaria Nigeria obtained Shannon diversity values of 2.441, 2.331, and equitability of 0.733, 0.685 for trees and shrubs species, respectively which therefore highlighted close diversity evaluation of tree species in the savanna ecosystem of Nigeria.

Result of spatial variation map of woody species diversity using ordinary kriging interpolation indicates that, spatial diversity is higher in some region and lowers in some region within the community for both trees and shrubs species. The North East (NE) region had the highest diversity while the North West (NE) region had the lowest diversity of trees species. For shrubs species the reverse was the case, highest diversity was in the North West (NW) while the lowest diversity was in the North East region. This result can be attributed to high disturbances in terms of concentration of built up area in the North Western region of the University Campus due to clear cutting of vegetation before building structures compared to North Eastern region with low concentration of built up areas.

Conclusion

The university has more trees species richness and diversity than shrubs species with forty-six (46) tree species (33 genera and 20 families) and ten (10) shrubs species (10 genera and 8 families) identified. *D. oliveri* and *A. indica* occurred mostly with high density and therefore highlighted as the two most ecologically important woody trees while *P. thonningii* and *A. nilotica* are the most abundant shrubs in the vegetation. There is spatial variation in distribution of woody species across the community: the North- East part of the vegetation has the highest trees diversity while the North- West part has the highest shrubs diversity.

Hence, there is need for University management and the entire community to pay attention to conservation planning and management activities that will put ecological implication into consideration. Maps on forest ecology of Malete Campus, Kwara State University should be widely circulated and made easy to interpret which will be readily available to the institution and local communities. This research, being a base line study, has opened up space for further researches; hence it is recommended that more researches should be carried out on the identified species in order to ascertain their morphological, anatomical, phyto-chemical characteristics, ethnobotanical and economic importance.

ACKNOWLEDGEMENT

The authors appreciate Oyedele Oyewole Kazeem for statistical analysis and Ibrahim Lawal of Forest Research Institute of Nigeria (FRIN) for assisting in identification of plants using the institution herbarium.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Adeyemi TO, Ogundipe OT (2012). Biodiversity of Sapindaceae in West Africa: A checklist'. International Journal of Biodiversity and Conservation 4(10):358-363.

Athua EM, Pabi O (2013). Tree Species Composition, Richness and Diversity in the Northern Forest Savanna Ecotone of Ghana. Journal of Applied Biosciences 69:5437-5448.

Ayodele AE (2005). The Medicinally Important Leafy Vegetables of South West Nigeria. Ethno botanical Leaflets 1:16.

Bello H, Musa AO (2016). Species Composition and Structure of Isoberlinia Woodland of Shika, Zaria Nigeria. Journal of Agriculture and Ecology Research International 5(1):1-9.

Bowman G (2000). Ecological climatology: concepts and applications. Cambridge University Press.

Childs C (2004). Interpolating surfaces in ArcGIS spatial analyst. ArcUser, July-September, 3235, 569. Available at: http://webapps.fundp.ac.be/geotp/SIG/interpolating.pdf

Elizabeth AK (2011). Patterns of Woody Plant Species Richness, Diversity and Structure along a Disturbance Gradient in the Atiwa Range Forest Reserve, Eastern Region, Ghana. Thesis Presented to the Department of Theoretical and Applied Biology, College of Science, Kwame Nkrumah University of Science and Technology. pp. 22-23.

Erhenhi AH, Obadoni BO (2016). Flora Diversity of Urhonigbe Forest Reserve, Edo State, Nigeria. International Journal of Modern Botany 6(2):19-25.

Hoffmann WA, Adasme R, Haridasan M, T de Carvalho M, Geiger EL, Pereira MA, Gotsch SG, Franco AC (2009). Tree Top kill, Not Mortality, Governs the Dynamics of Savanna–Forest Boundaries under Frequent Fire in Central Brazil. Ecology 90(5):1326-1337.

Ikyaagba ET (2008). Plant Biodiversity and Ethnobotanical Potential or University or Agriculture Makurdi Wildlife Park and Ikwe Game Reserves, Igbo Benue State Nigeria. Unpublished Thesis in the Department of Forest Resources Management University of Ibadan, Ibadan Nigeria pp. 1-123.

Ikyaagba TE, Tee TN, Dagba BI, Anncha UP, Ngibo KD, Tume C (2015). Tree composition and distribution in Federal University of Agriculturema Kurdi, Nigeria. Journal of research in Forestry wildlife and Environment 7(2):147-157.

Iwara AI, Offiong RA, Njar GN, Atu JE, Ogundele FO (2012). The Effect of Land Use Change on the Structure and Floristic Pattern of Vegetation in Ugep, Nigeria. Sacha Journal of Environmental Studies 2:101-113.

John N, Demel T, Wellington M, Keotshephile K (2013). Diversity, Population Structure and Regeneration Status of Woody Species in Dry Woodlands Adjacent to Molapo Farms in Northern Botswana. Open Journal of Forestry 3(4):138-151.

Khavhagali VP, Bond WJ (2008). Increase of woody plants in savannah ecosystems. Newsletter Grassland Society of Southern Africa 8:21-24.

Magurran AM (2004). Measuring Biological Diversity. Oxford: Blackwell Science Ltd. Available at: https://www2.ib.unicamp.br/profs/thomas/NE002_2011/maio10/Magurran%202004%20c2-4.pdf

Michaela C (2005). Vegetation Succession in Savanna Determined by Interaction of Grazing, Browsing and Fire: A Comparison between Hypotheses. Sambandet miljö och utveckling i Syd Södertörns Högskola. P 20.

Nautiyal S, Bhaskar K, Imran Khan YD (2015). Biodiversity of Semiarid Landscape, Environmental. Switzerland: Springer International Publishing. Available at: https://link.springer.com/book/10.1007%2F978-3-319-15464-0

Neelima TL, Ramana MV, Devender RM (2013). Spatial and Temporal Rice Yield Variation in Jurala Irrigation Project using Remote Sensing and GIS. Scholarly Journal of Agricultural Science 3(7):274-283.

Nodza IG, Onuminya TO, Ogundipe OT (2014). A Checklist of Tree Species Growing on Akoka Campus of University of Lagos, Nigeria. International Journal of Science Environment and Technology 3(3):1021-1034.

Oyedepo JA, Oyatogun MO, Jaiyeola O, Oladoye O (2016). GIS-Supported Survey of Ecological Biotopes within the Federal University of Agriculture Abeokuta Campus, Ogun State, Nigeria'. Proceedings of NTBA/NSCB Joint Biodiversity Conference, Unilorin pp. 190-198.

Ruggiero PGC, Batalha MA, Pivello VR, Meirelles ST (2002). Soil-Vegetation Relationships in Cerrado(Brazilian savanna) and Semi Deciduous Forest, Southeastern Brazil. Plant Ecology 160:1-16.

Sankaran M, Hanan NP, Scholes RJ, Ratnam J, Augustine DJ, Cade BS, Gignoux J, Higgins SI, Le Roux X, Ludwig F, Ardo J, Banykwa F, Bronn A, Bucini G, Caylor KK, Coughenour MB, Diouf A, Ekaya W, Freal CJ, February EC, Frost P GH, Hiernaux P, Hrabar H, Metzeger KL, Prins HHT, Ringrose S, Sea W, Tews J, Worden J, Zambatis N (2005). Determinants of Woody Cover in African Savannas. Nature 438:846-849.