Journal of Research in Forestry, Wildlife & Environment Vol. 10(4) December, 2018
http://www.ajol.info/index.php/jrfwe
jfewr ©2018 - jfewr Publications
E-mail: jfewr@yahoo.com
ISBN: 2141 – 1778
Omijeh and Tella (2018)

TREE SPECIES ASSOCIATION IN BAGALE FOREST RESERVE, ADAMAWA STATE, NIGERIA

***Omijeh J.E. and Tella I.O.**

Department of Forestry and Wildlife Management, ModibboAdama University of Technology, Yola, Nigeria.
***Correspondence author**: *jeomijeh@yahoo.com;* +2348059457403

ABSTRACT

The relationship among indigenous trees ≥ 10cm girth at diameter at breast (dbh) height was assessed to determine their level of association in the Bagale Forest Reserve, Adamawa State, Nigeria. Fifteen sample plots each measuring 100m x 100m were laid in five fragments, at Tudun Wada (<200m) Holin (200 – 300m), Modire (300 – 400m) Lugga (400 – 500m) and Wurodole (>500m) above sea level. Trees in each quadrat were identified and inventoried and association among them subjected to statistical analysis using Pearson's correlation coefficient. Microsoft Excel software was used. Results showed that positive and negative correlations at (ρ=0.1) and (ρ=0.5) were obtained among these trees in the study area. Studies in synecology of forest reserves is recommended across the country to aid in the study of distribution pattern of trees since such data generated from this exercise will aid in forest management, planning and policy formulation.

Keywords: Relationship, correlation, Bagale Forest Reserve, fragments

INTRODUCTION

In community ecology and phytosociology, an association is a type of ecological community with a predictable species composition, consistent structural appearance which occurs in a particular habitat type (Barbour *et al*; 1999). The term species association was first used by Alexander van Humboldt but was formally adopted by the international Botanical congress in 1910, (Wilner, 2006). An association can be viewed as real, integrated entity shaped either by species interactions or by similar habitat requirements or can be viewed as merely a common point along a continuum (Barbour *et al*, 1999). Inter specific association is when two or more species co-occur either more or less frequently than expected due to chance alone. Positive association between two or more species can occur when both select the same habitat or have the same environmental requirements. Conversely, negative associations can occur if the species have differing ecological requirements (Roxburgh and Chesson,1998). Association, in either the positive or negative direction can occur as a direct consequence of biotic interactions such as mutualism, competition and predation (Legendre and Blanchet, 2008). Association analyses remain a valuable tool in ecological studies as they can be used in generating hypotheses about factors responsible for the patterns and hence can be used in identifying particular patterns that may be worthy of further studies (Usman 2015).

The objective of this study was to assess the degree of species association among the indigenous trees of this reserve after ascertaining whether there is association. Such data so derived will help in forest management and development.

MATERIALS AND METHODS

Study Area

Bagale Forest Reserve is an old reserve within Latitude 9°11" and 9° N and Longitude 12° 20" and 12° 30" E in North–East Nigeria with a total area of 69.4 square miles i.e. about 18, 000 hectares (Fig.1) (Adamawa State Government, 2018).

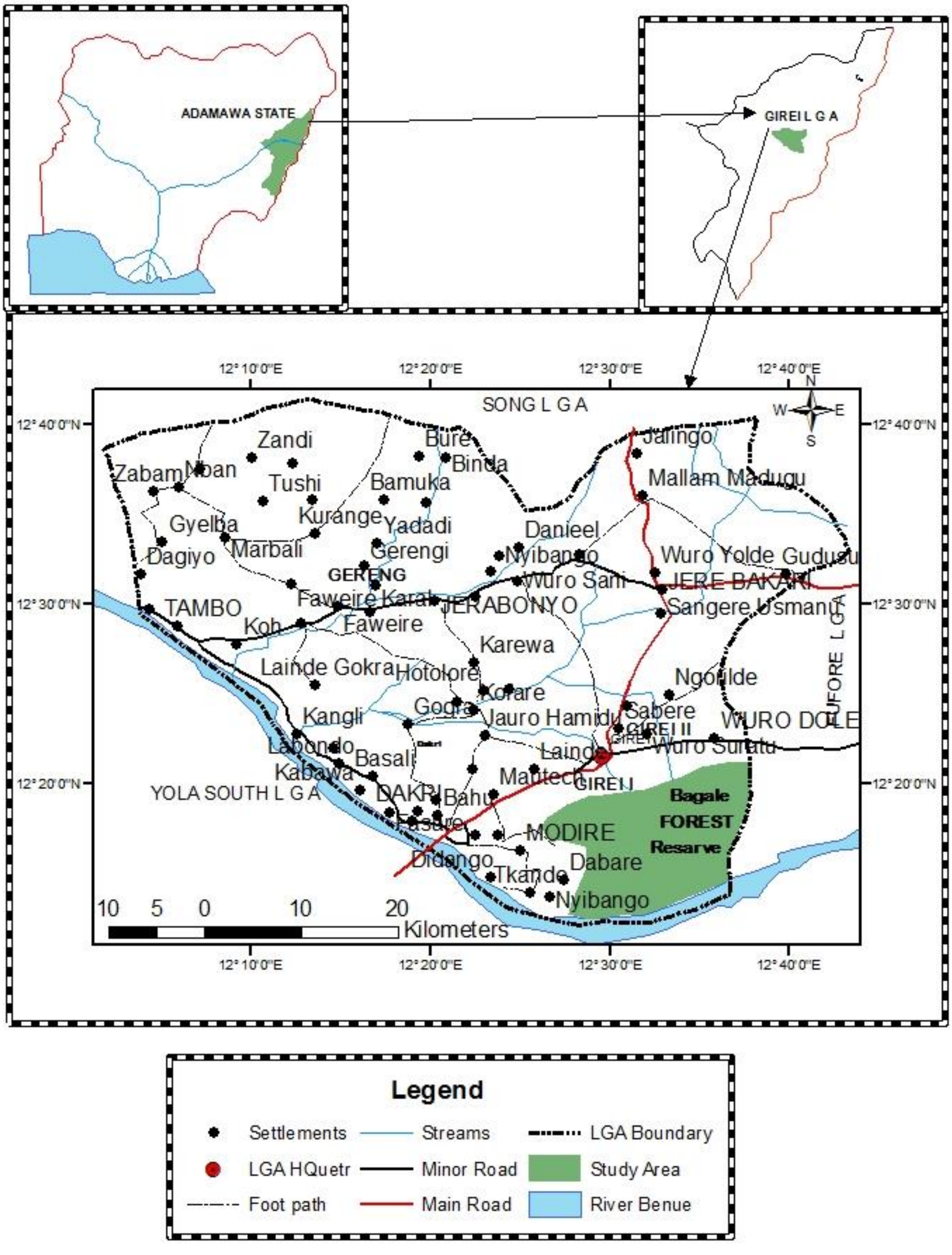

Figure 1: Map of study Area
Source: GIS Laboratory, Geography Department MAUTECH, Yola 2018

The physiography of the reserve is typically undulating, generally of flat plain and a deep to gentle slope surface. The most important landforms are small mountains and flood plains along the River Benue, (Adamawa State Government, 2018). The area experiences two distinct seasons – the rainy and dry and also two distinct types of temperatures, high and low (Mautech, 2018).

The vegetation is Savanna woodland with grass association more or less interspersed with shrubs and trees. It has the characteristics of open biotype with common trees which include, *Burkea africana*, *Tarmarindus indica*, *Acacia senegal*, *Vitex doniana*, *Acacia senegal*, *Vitex doniana*, *Adansonia digitata*. *C*ommon grasses include, *Ipomeatriloba*, *Andropogon gayanus*, *Panicum maximum*, *Tridax procumbens*, *Desmodium salicifolium*. Keay et al, (1964); Naughton and Wolf (1979).

Digital Maps of Study Area

A contour map (Fig.2 and the cross-sectional area of the study area (Fig.3) were produced after *Cayuela et.al* (2006). Elevation above sea level and distance between selected fragments were measured using a 100m tape and Gatmain. GPS. The following fragments were selected and inventoried, Tudun – Wada (<200m), Holin (200 – 300m), Modire (300 – 400m), Lugga (400 – 500m) Wurodole (>500m) above sea level.

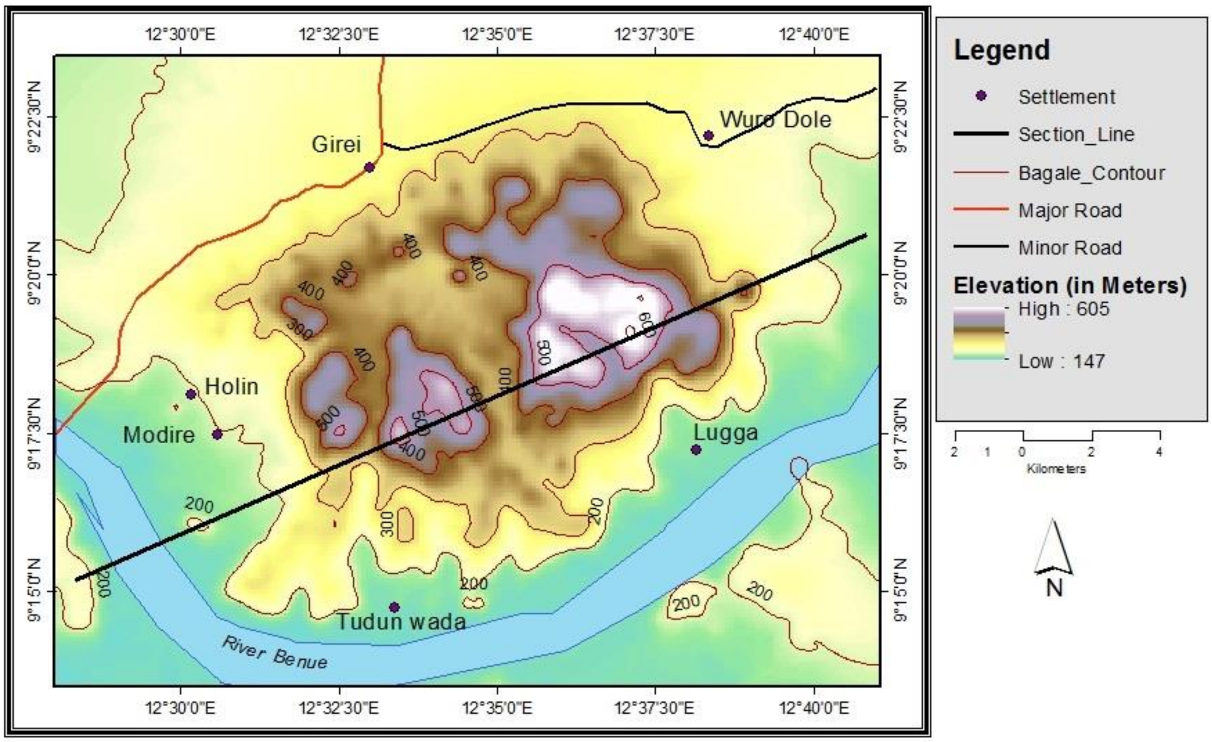

Figure 2: The contour of study area
Source: Department of Geography, Mautech, Yola (2018).

Procedure for data Collection

Three quadrats each 100m x 100m were laid in each of the five segments. Inventory and taxonomic classification of indigenous trees with girth of 10cm and above was carried out, Ghate, U. (2007). Double counting of trees was avoided by numbering each tree with red paint before the commencement of inventory after Ghazan (1989) and Hopkins and Stanfield (1966).

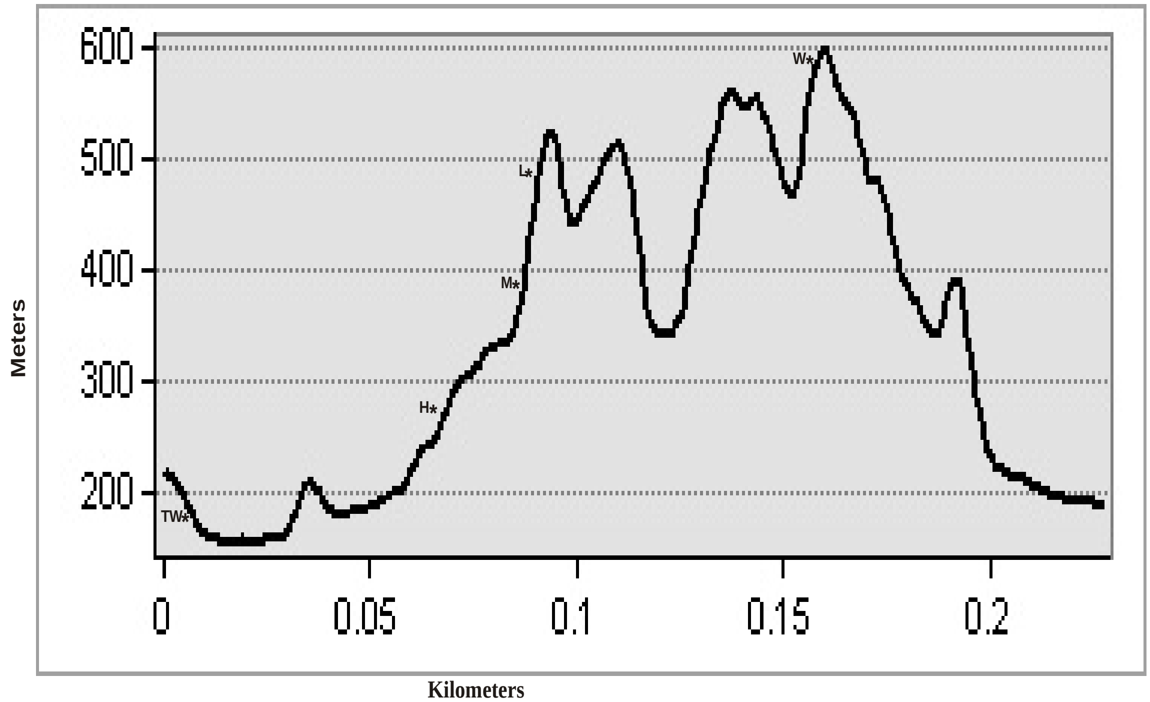

Fig. 5: Cross section of Bagale Hills Forest Reserve along a Section line from SW to NE

T/W=Tudun Wada, H=Holin, M=Modire, L=Lugga, W=Wurodole

Source: Department of Geography, MAUTECH, Yola.

Figure 3: Cross-section of study area

Statistical Analysis

Pearson's correlation coefficient was used to analyze the inventoried identified trees.
The formula used was

$$\rho_{xy} = \frac{E(XY) - E(X)E(Y)}{\sqrt{E(X^2)} - E(X)^2\sqrt{E(Y^2) - E(Y)^2}}$$

Legendre and Blanchet (2008)
Where:
P = expectation
X and Y = variables to be correlated
Microsoft Excel was used to run the analysis.

RESULTS

The survey yielded 312 individual trees which were grouped into 45 tree species with positive and negative relationships (association). Table 1 shows that among the positive relationships, some highly positive relationship (p ≥ 0.01) include those between *Afzelia africana* and *Pericopsis laxiflora*, *Entanda africana; Faidherbia albida*, and *Anogeissus leiocarpus*, *Ceiba pentandra*, *Acacia Senegal* and Balanites aegyptiaca, Grewia mollis, Boswelii dalzielli and *Deterium microcarpum*, *Hymenocardia acida*, *Ceiba pentandra*, and *Daniella oliverii*, *Detarium microcarpum*,Grewia *mollis*. Other positive relationships are also revealed in the table 1.

Table 1: Species with highly positive relationship

Species	Relationships with other species
Faidherbia albida	AL.982** CB 1.00**
Acacia senegalensis	BE 1.00** GM 1.00***
Pterocarpus leiocarpus	AZ .935** BW 1.00***
Afzelia africana	PL .935*** BW .888* CP .917* DM .889* EF .980** GM .917* HY .956*
Annona senegalensis	CS 1.0** CX 1.0** DS 919*
Anogeissus leiocarpus	FA .982** CM .982**
Burkea africana	AS 1.00** GM 1.0** KA 1.0**
Boswelii dalzelii	PL .935* AZ .888* CP .943* DO .959* DM .969** FI .943* GM .943* HY .986**
Cassia singueana	AN 1.00* CP .919* ID 1.00**
Ceiba pentandra	PL .998* AZ .917* BW .943* DO .988** DM .993 EF 943* GM 1.0**
Commiphora africanna	AA 1.0** AL .982
Combretum molle	CS .919* ID .919* HY .919
Crossopteryx febrifuga	HY .919*
Danielii oliverii	PL .985** AZ .911* BW .959** CP .988** DM .989** EF .923* GM .988** HY .904*
Detarium microcarpum	PL .985** AZ .911* BW .959** CP .988** DM .989** EF .923* GM .988** HY .916*
Entanda africana	PL .961** AZ .980** CP 1.0** DO .923* DM .904* GM .943*
Ficus ingens	CP 1.0**
Grewia mollis	AS 1.0** BE 1.0** KG 1.0**
Isobeline doka	AN 1.0** CS 1.0** CP 911*
Kigelia africana	AS 1.0** BE 1.0** GM 1.0*
Lannea acida	AZ .956* EF .959** KA 1.0**
Maerua angolensis	AS 1.0** BE 1.0**
Oncoba spinosa	PL .998** AZ .917* BW .943* CP 1.0** DO .988** DM .993* GM 1.0**
Pterocarpus erinaceus	KA .910*
Prosopis africanna	AS .910* BE .910*
Sclerocarya birrea	GM .900*
Sarcociphalus lalifolius	GM .925*
Steculia setigera	AA 1.0** AL .982** CM 1.0**
Tamarindus indica	GM 1.0**
Terminalia glaucescens	PL .897* CP .900* DM .894* GM .900

Source: Field survey 2016

**Correlation is significant at the 0.01 level (2 – tailed)

*Correlation is significant at the 0.05 level (2 – tailed)

Table 2 reveals species with highly negative associations with significant correlation at (ρ=0.01). *Pericopsis laxiflora*, *Afzelia africana*, *Ceiba pentandia*, *Daniellia oliverii*, *Detarium microcarpum*,and*Pterocarpu serinaceus*, had negative associations (ρ=0.01) with *Ficus ingens: Hymenocardia acida Maerua angolensis* had negative associations at (ρ=0.05). *Ficusingens* was negatively associated with *Pericopsis laxiflora*, *Daniellia oliverii*, and *Detarium micrcarpum* at (ρ=0.01). *Ficu singens* had negative associations (ρ=0.05) with *Afzelia africana*, *Boswelii dalzielii*, and*Entanda africana* highly negative relationship.

Table 2: Species with highly negative relationship

Species	Relationships with other species
Pericopsis laxiflora	F1 - .998**
Afzelia africana	F1 - .917**
Ceiba pentandra	F1 – 1.00**
Danielii oliverii	F1 - .993**
Detarium microcarpum	F1 - .993**
Entanda africana	F1 - .943*
Hymenocardia acida	F1 - .943*
Hymenocardia acida	PL - .998** AZ .917* BW - .943* DO - .998** DM - .993** EF - .943*
Maerua angolensis	F1 - .875*
Ficus ingens	F1 - .812*
Pterocarpus leiocarpus	F1 – 1.00**
Terminalia glaucescens	F1 - .900*

Source: Field survey 2016
**Correlation is significant at the 0.01 level (2 – tailed)
*Correlation is significant at the 0.05 level (2 – tailed)

DISCUSSION

There are two main types of associations which could be positive or negative associations between two or more species can occur when both select the samehabitat or have the same environmental requirements. Conversely, negative associations can occur if the species have differing ecological requirements (Roxburgh and Chesson, 1998; Legendre and Blanehet, 2008).

Theassociation either positive or negative could also arise as a result of species chosing the same habitat due to some peculiarities (Barbour *et al.*, 1999). Raziavi *et al.*, (2012), Wilner, (2006) has shown that the ability of species to choose habitats is also dependent on how the site can be provided the necessary conditions.

The non-significant associations in this study have resulted to the effect of altitude on the trees as the latter may not be able to perform optimally as the altitudes change along the gradient, Usman (2015).

Hernan dez *et al.*, (2014) assessed spatiotemporal rates, patters and determinants of biological invasions in forest ecosystems; they observed that Acacia species are among the most widespread inversive plants in Europ and two of the most aggressive are *Acacia dealbatalink* and *Acacia* melamo xylon R. Br, in W, T. Aiton. These species by virtue of association have become widely naturalized and have become an environmental problem in South-western Europ (Carballeira and Reigosa, 19999; Hussain *et al.*, 2011). Where they pose a threat to native species and have been declared invaders (Sanz-Elorza *et al.*, 2004). A combination of environmental factors and connectivity between Acacia plantations are identified as the main in this study several tree species show positive and very highly correlated associations which means they have similar ecological needs, Razavi *et al.*, (2012).

Factors associated with their spread into new areas, Hemandez *et al.*, (2014). A Combination of disturbances and biotic factors associated with stand structure (total basal areas, richness and tree cover) appear to determine the vulnerability or resistance of some forest to their spread (Sanz-Horza *et al.*, 2004). Acacia species are spreading rapidly and are becoming the dominant tree species aross large areas of forest in NW Spain Henandez *et al.*, (2014).

Some authors Huang, 2002; Eilu *et al.*, 2004; Jones *et al.*, 2006; Jabeen and Ahmad, 2009; Tavili *et al*, 2009; Zhang *et al*, 2012; Bright *et al.*, 2005;Huan *et al.*, 2011) in numerous studies, have shown that the distribution of vegetation types and floristic patterns are most associated with environmental factors, including local variables/topographic factors (elevation, slop aspect, slope degree), soil factors (a soils physical and chemical properties), and factors related to human impact. In general, the distribution of vegetation patterns is mainly controlled by soil factors consisting of organic Carbon, total nitrogen, and clay as well as topographic factors such as elevation. Arekhi et al., 2010; GNguyen et al., (2015).

Buba (2015) studied how the association among three tree species, *Daniellia oliverii, Vitellaria paradoxa, Parkia biglobosa* impacted on the diversity richness and composition of the herbaceous layer beneath them. He opined that, species richness and diversity were higher under all the three-tree species than under all the outside their crowns which was in turn higher than the highest species richness and diversity both within and outside its crown zone, followed by *Vitellaria paradoxa,* and *Parkia biglobosa.* The result also revealed that the same tree species wih different sizes led to different herbaceous species, richness, diversiy and composition under and around the trees crowns. *Parkia biglobosa* and *Vitellaria paradoxa* trees with smaller size showed higher species richness and diversity under their crowns than the bigger ones. The dissimilarity of species composition differs between the inside and outside crown zones of the individuals of the same tree species and among the different tree species and the open field. Buba (2015).
However generally, studies involving such interactions in the guinea savanna should include consideration of elements of competition and facilitation by trees, climate and seasonal variability, stages of succession, soil type, tree density and varying other biotic and abiotic complexities in both time and space, Simons *et al.,* (2008); Scholes and Archer (1997). Therefore, the result of this study is not conclusive.

CONCLUSION
A study on tree species association among five fragments Tudun Wada, (< 200m), Holin (200 – 300m), Modire (300 – 400m), Lugga (400 – 500m) and Wuro dole (> 500m) above sea level at different altitudes was carried out in Bagale Forest Reserve, Adamawa state, Nigeria. Three quadrates, each measuring 100m X 100m were laid in each quadrat at different distances. Trees in each quadrat were inventoried and identitied and Pearson's correlation coefficient was used for data analysis with the aid of Microsoft Exel and SPSS. Results revealed positive and negative correlations among the trees. Within the associations, there was a preponderance of highly positive correlations ($p \geq 0.01$). While others in this category were positive, ($p > 0.05$). a few of the entire tree species were highly negatively correlated ($p \geq 0.05$).

ACKNOWLEDGEMENT
The author is grateful to Mr. Haruna Dumne and Mr. McDonald Iheanacho for their support in data collection on the field.

Acronyms and interpretation of species names
AD=*Adansoniadigitata*
AL=*Anogeisusleiocarpus*
AN=*Annona senegalensis*
AS=*Acacia senegal*
AZ=*Afzeliaafricana*
BA=*Burkeaafricana*
BE=*Balaniteaegyptiaca*
BW=*Bosweliadalzielii*
CA=*Commiphoraafricana*
CM=*Combretum molle*
CP=*Ceiba pentandra*
CS=*Cassia singueana*
CX=*Crossopteryxfebrifuga*
DM=*Detariummicrocarpum*
DO=*Daniela oliverii*
DS=*Dioscorea species*
EF=*Entandaafricana*
FA=*Faidherbia albida*
FI=*Ficus ingens*
GM=*Grewia mollis*
GS=*Grewia species*
HY=*Hymenocardia acida*
ID=*Isobelina doka*
KA=*Kigelia africana*
LA=*Lannea acida*
MA=*Maerua angolenses*
ON=*Oncoba spinosa*
PA=*Prosopis africana*
PL=*Pericopsis laxiflora*
PT=*Piliostigma thonningii*
SC=*Sclerocarya birrea*
SL=*Sarcociphalu slalifolius*
SS=*Steculia setigera*
TG=*Terminalia glaucescens*
TI=*Tamarindus indica*
VD=*Vitex doniana*
VP=*Vitellaria paradoxa*
XA=*Ximenia americana*

REFERENCES

Adamawa State of Nigeria (2018). Ministry of Environment.

Anton, F,. Marcus, B. and Clous, B (2011). Altitudinal gradients in Biodiversity Research: The state of the Art and Funiture Perspectives under Climate Change Aspects. *Waldokologic* Landschifts Forschung, Und Naturschaltz. 11 pp. 35-47.

Arekhi, S., Heydari, M., Poorbabaei, H., (2010) Vegetation – Environmental relationships and ecological species groups of the ilam oak forest landscape, Iran. *Caspian J. Env. Sci.* 8: 115 -125.

Barbour, M.G., Jack, H. B., Wanna, P., Frank S.G., Mark, W.S. (1999). *Terrestrial Plant Ecology, (3rd Ed.).Addision Wesley, Longman.*

Bello, A.G., Isah, A.D., Ahmad, B. (2013) Tree Species Diversity analysis of Kogo forest Reserve in North-Western Nigeria.*International Journal of Plant, animal and environmental* sciences. Vol.3. Issue 3, pp. 189 – 196.

Carballeira, A., Reigosa, M.J., (1999) Effects of natural leachates of *Acacia dealbata* link in Galicia (NW Spain). *Bot. Bull.* Acad. Sin 40, 87 – 92.

Cayuela, L,D.J.Golicher, J., Sales, Rey and J.M. Rey – Benayas (2006b). Classification of a complex landscape using Dempster– Shafer theory of evidence *International Journal, of Remote Sensing* 27:1951 – 1971

Eilu, G., Hafashima, DLN, Kasenene, J.M. (2004) Density and Species diversity of Tress in four tropical forests of the Albertine rift Western Uganda. *Diversity &Distributions* 10: 303 - 312.

Enight, N.J., Miller, B.P., Akh ter, R. (2005) Desert vegetation and vegetation-environment relationship in Kirthar National Park Sindh, Pakistan *Journal* of *Arid Environments* 61: 397 – 418.

Ghate, U (2007). Field Guide to Indian Trees, RTF, India 269 Pp

Ghazan, S.A. (1989) *Savanna Plants of Africa*, Macmillan, U.K. 655pp

Hoang, V.S., Baas, P., KeBler, P.J.A. Slik, J.W.F. Steege, H.T. Raes, N. (2011) Human and environmental influences on plant diversity and composition in Ben En National Park, Vietnam. *Journal of Tropical Forest Science* 23: 328 – 337.

Hopkins. B and D.P. Stanfield (1960) *Savanna trees of Nigeria*, Ibadan, University Press 39pp

Huang, K.Y. (2002) Evaluation of the topographic sheltering effect on the spatial pattern of Taiwan Fir using cereal photography and GIS. *Int.Jor.* of *Remote Sensing*. 23: 2051 – 2069.

Jabeen, T., Ahmad S.S. (2009) Multivariate analysis of environmental and vegetation data of Ayub National Park, Rawal Pilidi: *Soil &Environment* 28: 106 – 112.

Jones, M.M, Tuomisto, H, Clark, D.B., Olivas, P. (2006) Effects of mesoselale environmental heterogecity and dispersal limitation on floristic variation in rainforest ferns, Journal of Ecology 94: 181 – 195.

Keay, R.W.J, C.F.A., Onochie and D.P. Stanfield (1964) Nigerian Trees, keys to the General and index. Volume 1, Revised and Reprinted Pp31 – 317

Laura, H., Jesus, M.F., Isabel, C., Antonio, V. dela C., (2014) Assessing spatio temporal rates, patterns and determinants of biological invasions in forest ecosystems; The case of Acacia species in NW Spain. Forest Ecology and Management 329 (2014) 206 – 213.

Legendre, P., and Blanchet, F.G., (2008) *Species Association.* University of Alberta, Edmond. Pp 1 – 11, as cited in Usman, A. (2015) Biodiversity and Species association along altitudinal gradients of the Atlantika Mountain range at Koma, Adamawa State, Nigeria. Unpublished Ph D dissertation submitted to the Department of Forestry, ModibboAdama University of Technology, Yola. Adamawa State, Nigeria.

Simmons, M.T. Simmons, S.R. Archer, W.R. Teague, and R.J. Ansley (2008) "Tree *(Prosopis glandulosa)* effects on grass growth, an experimental assessment of above and below ground interactions in a temperate Savanna". *Journal of Arid* Environments. 72, No.: 4, pp. 314 – 325.

Mautech, (2018), Meteorological Station.

Naughton J.S. and Wolf L.L. (1979) *General Ecology* 2nd Edition. Holt Rineheart and Winston Inc. U.S.A Pp 1 – 702.

Nguyen, J.V., R.Mitlohner, Nguyen, V.B. and T. Van Do (2015). Environmental Factors Affecting the Abundance and Presence of Tree Species in a Tropical Lowland Lime-stone and Non-Limestone Forest in Ben En National Park, Vietnam. *Journal of Forest* and Environmental Science.

Razavie, S.M., Mattaji, A., Rahmani, R. Naghari, I. (2012). The Assignment of Plants Species Importance Value (5IV) in Beach (*Fagus orientalis*) Forests of Iran. (A case study: Nav District 2 of Asale, Guilan Province). *International Research. of Applied Sciences* Vol.3(2), 433 – 439.

Roxburgh, S.H and Chesson, f (1998). A new method for detecting species associations with spatially correlated data. *Ecology* 79(b): 2180 – 2192.

Sanz-Elorza, M., Dana, E.D. Sobrino, E. (2004) Atlas de las plantas aloctonas invasoras de la Espana Madrid, D.G. de la Biodiversidad, Ministeri de medio Ambiente, pp. 384.

Scholes, R. J. and S.R. Archer (1997) “Tree-grass Interactions in Savannas.” Annual review of 52,53. *Ecological* and *Systematics.* Vol. 28. Pp. 517 – 544. View at Publisher. View at Google Scholar.

Tavili, A, Rostam pour, M., Zare Cha houki, M.A., Farzadmer, J. (2009). CCA application for vegetation-environment relationships evaluation in arid environment (Southern Khorasan rangelands). *Desert* 14: 101 -111.

Usman, A. (2015) Biodiversity and Species Association along altitudinal gradients of the Atlantica mountain range at Koma, Adamawa state, Nigeria. Unpublished Ph.D Thesis, Modibbo Adama University of Technology, Yola. Adamawa state, Nigeria. 140p.

Zhang, H, Qian, Y., Wu, Z., Wang, Z. (2012). Vegetation-environment relationships between Northern slope of Karlik mountain and Naomaohm Basin, East, Taianshan Mountains. *Chiness Geographical Science* 22: 288 – 301.