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Impact of Different Types of Land Use on Pattern of Herbaceous Plant Community in the Nigerian Northern Guinea Savanna

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

This study was carried out with the aim of finding the pattern of distribution and composition of herbaceous plant with respect to different types of land use in the Nigerian Northern Guinea Savannah. Data on plant species was collected using quadrat. Soil sample was collected using core and analyzed for physicochemical properties. The soil physicochemical properties include Total Nitrogen (%), Available Phosphorus (mg/ kg^{-1}), Exchangeable Potassium (cmol (+)/ kg^{-1}), PH, Organic Carbon (%) and Soil textural class. Different effects of land use, which include trampling, arable cultivation, grazing and mowing affected the floristic structure of plant community and soil physicochemical properties in different ways. Each land use type creates a uniquely different type of plant community. Greater impact on the plant community structure was by trampling and cultivation and lesser grazing and mowing. Species dominance based on the Important Value Index (IVI) was found to be the most important indicator of these land use types, and evenness was the least among these parameters that can be used as an indicator of these land use type. Different land use types create closely related some of the soil physicochemical properties, and yet

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are dominated by different plant species even in contiguous plots, suggesting that the impact of these land use types in shaping plant community structure lays more in their direct impact on the plants rather than indirectly by modifying their local environment. In comparison with Protected Land, grazing and mowing showed relatively no negative impact on the mean soil physicochemical parameters. However, the values of all the soil properties analyzed were largely negatively affected while comparing the Protected Land with the Cultivated and Trampled Lands. Grazing and mowing reduced Species Richness, but greater reduction was by trampling and cultivation. Species diversity was narrowly increased and decreased by grazing and mowing respectively, but largely decreased by trampling and cultivation. Species Evenness was relatively unaffected by trampling, arable cultivation and mowing, but increased by grazing. Such study in a unique geographical region will contribute for cross-biome comparison with similar studies, which is necessary toward generalizations of ecological knowledge for universally unified theories. Knowledge of the pattern of impact of different types of land management as environmental filters of plant species and determinant of plant community structure may be used for prediction, which is very essential for conservation and restoration programmes.

Keywords: Anthropogenic activities; arable cultivation; exchangeable potassium; savanna; grazing; mowing; trampling.

1. INTRODUCTION

Human disturbances resulting from different types of land use can directly affect plant by damaging the plant's conducting tissues and leaves, which may result in growth retardation or death of the plant. By damaging tissues, disturbance makes plants difficult to reach optimal absorption of water and nutrients, which in turn affect the rate of carbon fixation [1]. The degree of this damage and the subsequent death of the plant depend on the type and intensity of the disturbance; plant's resistance to the disturbance due to the fragility of their tissues; their resilience to recover and physiological stress. Anthropogenic activities can also influence plants indirectly by modify their environment, especially their resource base - soil. Among parameters of soil that can be significantly affected by human disturbances include soil physical and chemical properties [2]. Since the performance and success of plants depends partly on the soil composition and characteristics, frequent anthropogenic disturbances thus play a major role in shaping and determining plant community composition and distribution [3,4]. These cause plant communities composition across sites to become more or less heterogeneous in terms of floristic attributes [5,6] and a significant change in any management regime causes a shift in plant composition along these disturbance gradients [7,8]. This is because physiology, morphology, and life history of a plant necessarily constrains it to survival in only a range of environmental conditions, beyond which it must die [9]. Although, it is universally believed that human disturbances generally have negative impacts on plant species richness and diversity, some studies reported that less severely disturbed vegetation provide optimum environments for enhancement of biodiversity [10]. This is because changes in these constraints would favor a few species that would competitively displace many other species from a region [9]. Among the various land-use that affect pant community structure and composition are trampling, arable cultivation, grazing and mowing.

Trampling effects vegetation and as a result of that, plants were broken, bruised or even crushed. Plant response by stem stress avoidance through increased flexibility is the only viable response for many herbaceous plants species [11]. Since only those species capable of regenerating after repeated disturbance become residents of trampled areas, trampling is believed to be one of the environmental selection forces of plant community composition and distribution [12]. Trampling can also brings about changes in soil physicochemical characteristics. Plants growing on trampled areas have to be tolerant to, e.g. soil compaction and its effects on other soil conditions. The impact of trampling on vegetation leading to decrease in species richness and diversity has been widely documented by many studies [12,13]. Results of studies on the effects of trampling on plant communities will provide basic information for outdoor recreation area managers and enable them to allow recreation activities while preserving the integrity of the environment [13].

Arable cultivation, which entails tillage, is another environmental filter that potentially modifies plant species composition and diversity of an area both directly, by locally eliminating plants species, and indirectly by altering environmental conditions. These environmental conditions include soil characteristics and soil organisms that influence nutrients cycling in ecosystems [14,15]. Plant community composition and diversity changes rapidly upon tillage, and this is thought to reflect a relaxation of competition due to the elimination of dominant species, which takes time to reestablish, while conserving certain characteristics such as large number of rare species [16,17]. There is a need to understand the pattern of plant community changes as a result of cultivation for better conservation purposes.

Grazing is also another important force of selection affecting plant community structure. Species richness, diversity and evenness were found to be closely related to grazing [18,19]. Grazing disturbances include defoliation, soil compaction and mineralization by deposit of urine and feces. It also influence light availability and reduce the dominance of C4 grasses, which enhanced species richness, diversity and community heterogeneity. Small-scale community heterogeneity is also created by directly affecting plant community dominance [20,21]. Heavier grazing reduced total plant cover and substantially altered the species and functional composition of plant community [22,23]. However, low-intensity grazing is thought to have positive effects on plant species richness, composition and diversity through consumption of vegetation, redistribution of nutrients via deposition of dung and urine, soil compaction and erosion and dispersal of seeds. These bring about the alteration and creation of habitats more suitable for other species [24].

Mowing reduces plant performance by removing various amounts of plant tissue. This may lead to the death of an individual or, to a change in its resource allocation, rate of photosynthesis, growth and reproduction. At the community level, mowing damage affects species composition by affecting the relative competitive abilities of plant species, thereby serving as significant selective factors in grasslands. The negative impact of damage on some species may provide competitive advantage to others and altering interactions among different species because of the important influence of variation in soil fertility and habitat productivity may have on community composition [25,26].

Although the significance role of disturbance forming, maintaining and altering floristic characteristic of plant communities is generally accepted, studies on the pattern of floristic changes by different types of land use in the same locality are usually scarce. In addition, it is widely documented that abandonment of traditionally managed grasslands will leads to reduced species diversity and disappearance of many typical grassland species. At the moment, Nigerian's biodiversity is seriously under threat of such land management complex [27,28]. It is also widely believed that maintenance of land use that has created the grasslands in the first place is necessary to prevent succession, and a fundamentally prerequisite to future conservation of the grasslands [29,30,31]. These reasons necessitate this study. This study was generally aimed to find how different land uses (cultivation, trampling, grazing and mowing) affect the floristic structure of plant communities in the Nigerian northern Guinea Savanna ecological zone. Specifically, to find the impacts of each land use type on some soil physicochemical properties and how different plant species' respond in terms of dissimilarity index; importance value index; species richness; species evenness and species abundance.

2. METHODOLOGY

2.1 Study Area

The study area was the Yelwa campus of Abubakar Tafawa Balewa University in Bauchi metropolis (Fig. 1). It is located between latitude 100 17I north, longitude 80 49I east and at an altitude of 690.2 m above sea level in the northern Guinea Savanna ecological zone of Nigeria [32]. The soils in this area are generally classified as Alfisols [33]. The climate is characterized by rainy season that starts in April and ends in October, with the amount of rainfall of 1300 mm per annum [34].

There are various types of human activities taking place in the campus, which may play a major role in shaping the floristic composition and diversity of plant communities. The different areas identified with these activities include areas of trampling, cultivation, mowing and grazing. These land managements have been there for more than a decade. There is also an area that was well protected from human and animal interferences- the meteorological center of the Department of Agriculture of the university. This protected area was included in the study to serve as a control for comparisons with the various disturbed areas. There is no any apparent dispersal barrier of plants propagules between these areas of different land-use. The topography of the study area is relatively flat; bare of trees and non-rocky. All the sampling plots were situated within an area of about 500m^2, some of which are even contiguous.

2.2 Floristic Data and Soil Sample Collection

Floristic data was collected by using 50-by-50 cm quadrat, which is most suitable for small herbs [35]. The quadrat was randomly thrown twice at each of the cardinal points and at the center, making ten samples in each area identified with unique land use. The number of plant species in each quadrat was counted and recorded. Plant that form rosette, like *Eleusine indica,* the whole rosette was regarded as one. While rhizomes, like *Cyperus rotundus,* the aerial parts were regarded as individual entities regardless of their underground connectivity. Stolons were counted at their radiating points single plants.

Table of the sum of each of the species in all the ten quadrats was made for each of the sampling areas. Specimens of all the plant species were taken and their identification was made in the herbarium of the Abubakar Tafawa Balewa University. Nomenclature used of species and family names follows the African Plants Database (APD), as was adopted by the West African plants - A Photo Guide [36].

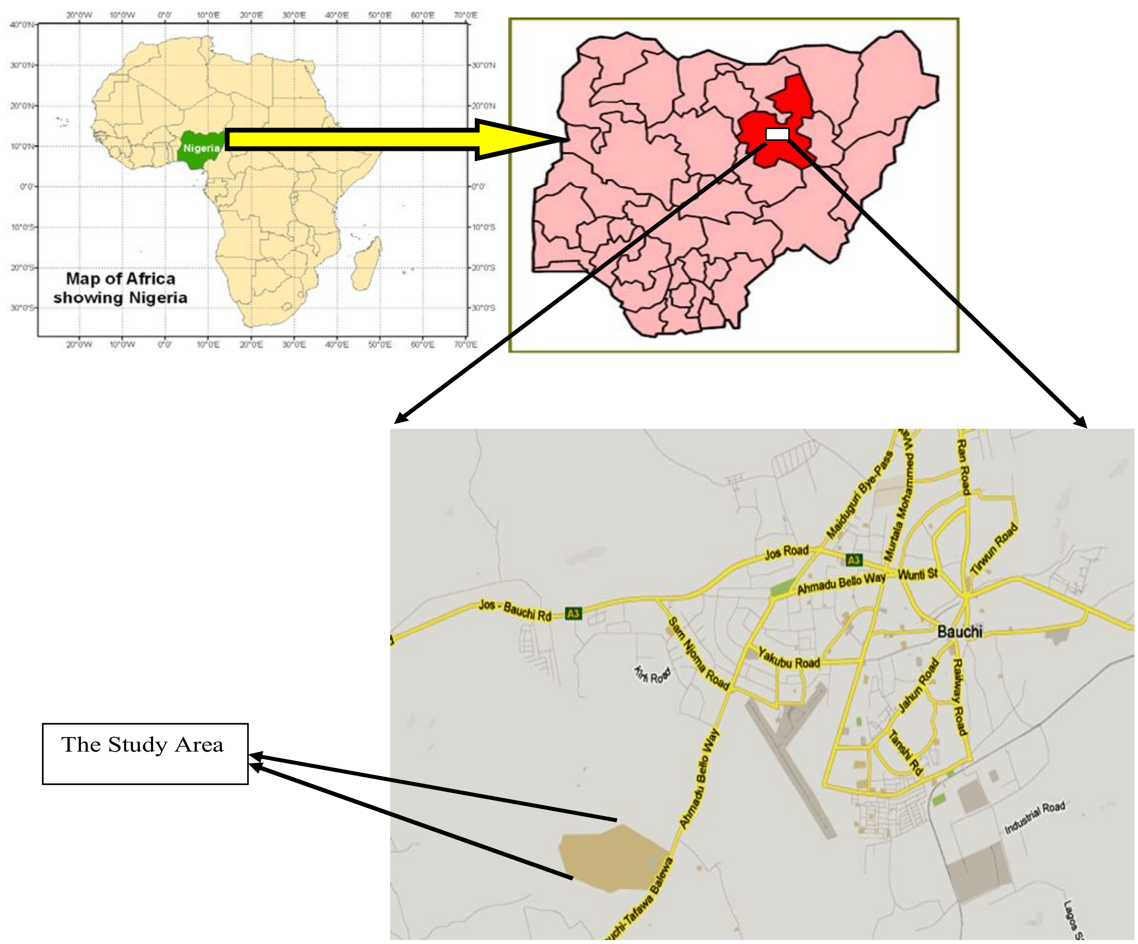

Fig. 1. Map of the study area

In addition, at the center of each of the quadrats a soil sample was collected at the depth of 15 cm, using soil sampling core. The ten soil samples of each site were pooled together to form a single sample composite. All samples were immediately sun-dried and transported to soil laboratory of Abubakar Tafawa Balewa University for analyses following a standard procedure described by [37]. The samples were analysed for Total Nitrogen (%); Available Phosphorus in milligrams per kilogram (mg/ kg^{-1}); Exchangeable Potassium (cmol (+)/ kg^{-1}); Organic Carbon (%); PH and percentages of sand, clay and silt for the soil textual class. These are some of the most important indicators of soil characteristics and the most commonly limiting factros of plants' distribution and performance [8,9,38]. The soil textual class was described by USDA soil textual triangle (Available:http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/nedc/training/soil/?cid=nrcs142p2_054253).

2.3 Data Analyses

One sample t-test was used to calculate standard deviation on the soil physicochemical data and also compare floristic parameters at α = 0.05 using MINITAB 11.12 (1996) Minitab. Inc.

The plant species Important Value Indexes (IVI) were calculated using Microsoft Office Excel 2007. Other plant species parameters for describing plant community were calculated using the software Community Ecology Parameter Calculator (ComEcoPaC) Version 1.0 [39]. According to the designer, formulae used by this software were as follow:

Dominance – Di

$$Di = \frac{ni}{N} . 100\%$$

Where

n_i = abundance (number) of species *i*, and
N = total (number) abundance in sample

Shannon-Wiener diversity index - H'

$$H' = \sum_{i-1}^{s} Pi . log_2 Pi$$

Where *S* = species richness (number of species), p_i = proportion of species *i* and $p_i = \frac{n_i}{N}$ (n_i = abundance of species *i*, *N* = total abundance).

Eeveness (E) and Corrected Eveness (E')

$$E = \frac{H'}{H_{\max}}$$

and

$$E' = \frac{H' - H'_{\min}}{H'_{\max} - H'_{\min}}$$

Where

$$H'_{\max} = \log_2 S$$

and

$$H'_{\min} = -\frac{N-S+1}{N}\log_2\frac{N-S+1}{N} + \frac{S-1}{N}\log_2 N$$

Simpson's index - D

$$D = \sum_{i-1}^{s} P_i^2$$

Where *S* = species richness, p_i = proportion of species *i*

Jaccard's similarity index

$$Ja = \frac{S_{12}}{S_1 + S_2 - S_{12}}$$

Where S_{12} = number of species present in both samples (joint occurences).

S_1 (S_2) = number of species present in sample one and (sample two).

Jaccard's Dissimilarity index = 1- similarity index [35].

Sörensen's similarity index – So

$$So = \frac{2S_{12}}{S_1 + S_2}$$

S_{12} = number of species present in both samples (joint occurences)

S_1 (S_2) = number of species present in sample one and (sample two).

Sörensen's Dissimilarity index = 1- similarity index [35].

2.4 Importance Value Index

This index is used to determine the overall importance of each species in the community structure, which affect the survival and abundance of many other species in the community. The elimination or addition of such species, results in a significant shift in the composition and structure of the community [40]. The IVI was determined as the average of the sum of relative density (RD), relative frequency (RF), and relative dominance (Rdo), each expressed as a percentage. IVI = sum of (RF+RD+RDo)/3 [41]. The formulas used to calculate RD, RF, RDo for the importance value index (IVI) were as follows:

Relative Dominance: Percentage of the individuals of given species in the sample:

$$Di = \frac{ni}{N}.100\%$$

Where n_i = abundance (number) of species i, and N = total (number) abundance in sample.

Relative frequency: Frequency/ Total frequency of all species

Relative Density = Density/ Total density of all species

Frequency = Number of quadrats in which species occurred / Total number of quadrats studied x 100

Density = Total number of individuals of a species in all quadrats / Total number of quadrats studied.

3. RESULTS

The result of this study revealed that the five sites with different management practices differ in terms of the parameters of their soil physicochemical attributes (Table 1). The mean values of the physical and chemical properties of the soils in these sampling sites were found to be statistically different (α = 0.05). Higher percentages of Total Nitrogen were obtained in Grazed Land, Mowed Land and Protected Land (0.11, 0.11 and 0.09 respectively), while Trampled Land and Cultivated Land revealed less values (0.07 and 0.04 respectively). The values of Available Phosphorus were also found to be higher and similar in Protected Land, Mowed Land and Grazed Land (14.37, 13.06 and 12.98 respectively). These values leaved a wide gap compared with that of Trampled Land and Cultivated Land, which was 5.15 and 3.13 respectively. However, the reversed of these values were obtained for Exchangeable Potassium. The values were slightly higher in Trampled Land and Cultivated Land (0.31 and 0.24 respectively) but lesser in Grazed Land, Protected Land and Mowed Land, which was (0.21, 0.19 and 0.17). However, their PH values were all slightly acidic and narrowly above 6.0. The percentages of Organic Carbon were greater and similar in Grazed Land, Protected Land and Mowed Land, which was 1.64, 1.40 and 1.31 respectively. However, in Trampled Land and Cultivated Land it was 0.82 and 0.11 respectively. Soil textural class was Loamy Sand in Grazed Land, Protected Land and Mowed Land, while it was Sandy Loam in Trampled Land and Cultivated Land.

With respect to plant community parameters, the result of this study revealed that the five different sites with different management practices were occupied by different species composition. Although some of the species were found on more than one site, none of the species were found to occupy all the five sites (Table 2).

Table 1. Soil physicochemical parameters of the five different sites with different management practices. Values of standard deviation (StDev) with (*) are significant at α = 0.05

Soil physicochemical parameters	Protected land	Trampled land	Mowed land	Cultivated land	Grazed land	StDev
Total nitrogen (%)	0.09	0.07	0.11	0.04	0.11	0.03*
Available phosphorus (mg/ kg^{-1})	14.37	5.15	13.06	3.13	12.98	5.19*
Exchangeable potassium (cmol (+)/ kg^{-1})	0.19	0.31	0.17	0.24	0.21	0.05*
PH	6.48	6.76	6.11	6.08	6.58	0.30*
Organic carbon (%)	1.40	0.82	1.31	0.11	1.64	0.61*
Soil textural class	Loamy sand	Sandy loam	Loamy sand	Sandy loam	Loamy sand	

Table 2. Plant species composition and dominance based on Important Value Index (IVI) of the five different sites with different management practices (RF = Relative Frequency; RD = Relative Density; RDo = Relative Dominance; IVI = Importance Value Index)

Plant species	Trampled land				Protected land				Mowed land			
	RF	RD	RDo	IVI	RF	RD	RDo	IVI	RF	RD	RDo	IVI
Acalypha segetalis												
Alysicarpus rugosus					0.01	0.1	0.17	0.09				
Andropogon gayanus					0.01	0.4	0.43	0.28	0.3	7.6	6.70	4.9
Apera interrupta	0.05	0.4	0.97	0.47								
Aristida mutabilis												
Biophytum umbraculum									0.1	8.2	7.23	5.18
Borreria chaetocephala					0.01	0.1	0.17	0.09				
B. ocymoides					0.01	0.1	0.17	0.09				
Brachiaria distichophylla					0.05	2.5	2.67	1.74	0.7	4.4	3.88	2.99
Bulbostylis coeleotrichia					0.04	8.1	8.65	5.6	0.4	0.6	0.53	0.51
Cassia mimosoides					0.06	1.2	1.28	0.85				
C. tora												
Chloris pilosa									0.9	4.3	3.80	3.0
Chrysanthellum indicum									0.05	1.7	1.50	1.08
Commelina diffusa												
Crotalaria glauca					0.08	5.1	5.45	3.54				
C. ononoides					0.02	0.4	0.43	0.28				
Cyanotis angusta					0.02	0.7	0.75	0.49	0.01	0.1	0.09	0.07
Cymbopogon citratus					0.02	0.3	0.32	0.21				
Cymbopogon dactylon	0.18	3.9	9.49	4.52	0.07	3.6	3.85	8.15	0.05	1.3	1.15	0.83
Cyperus difformis	0.26	20.8	50.61	23.89								
C. rotundus					0.04	4.1	4.38	0.52				
Dactylotaenium aegyptium	0.11	2.7	6.57	3.13					0.02	0.4	0.35	0.26
Digitaria longiflora					0.03	0.5	0.53	0.35	0.02	0.3	0.26	0.19
Eleusine indica	0.24	8.5	20.68	9.81								
Euphorbia hirta									0.01	0.1	0.09	0.07
E. hypericifolia									0.4	0.4	0.5	0.43
Fleurya aestuans					0.04	1.9	2.03	1.32				
Indigofera hirsuta					0.04	0.7	0.75	0.5				
Ipomea eriocarpa					0.02	0.2	0.21	0.43				
Leucas martinicensis												
Pandiaka angustifolia					0.07	4.0	4.27	2.78				
Paspalum scrobiculatum					0.04	3.3	3.53	2.29	0.11	45.8	40.39	28.77
Pennisetum pedicellum					0.07	2.6	6.78	3.15				

Plant species	Trampled land				Protected land				Mowed land			
	RF	RD	RDo	IVI	RF	RD	RDo	IVI	RF	RD	RDo	IVI
Sesbania dalzielii					0.01	0.1	0.17	0.09				
Setaria pumila					0.06	4.0	4.27	2.74	0.01	0.1	0.09	0.07
Sida ewiesner									0.04	0.5	0.44	0.33
Spermacoce stachydea					0.04	5.0	5.34	3.46				
Tephrosia pedicellata					0.08	38.7	41.35	26.71	0.02	0.5	0.44	0.32
Tridax procumbens	0.03	0.1	0.24	0.12	0.01	0.1	0.17	0.09	0.11	8.5	7.50	5.37
Walteria indica												
Zornia glochidiata	0.13	3.4	8.27	3.93	0.07	5.5	5.88	3.82	0.11	28.4	25.04	17.85

Table 2 continued….

Plant species	Cultivated land				Grazed land			
	RF	RD	RDo	IVI	RF	RD	RDo	IVI
Acalypha segetalis	0.02	0.6	2.11	0.91				
Alysicarpus rugosus								
Andropogon gayanus								
Apera interrupta								
Aristida mutabilis					0.06	8.5	11.20	6.59
Biophytum umbraculum								
Borreria chaetocephala					0.1	6.3	8.30	4.9
B. ocymoides								
Brachiaria distichophylla	0.04	0.2	0.70	0.31	0.09	4.3	5.67	3.35
Bulbostylis coeleotrichia								
Cassia mimosoides								
C. tora					0.06	2.0	2.64	1.57
C. pilosa								
Chrysanthellum indicum					0.03	1.1	1.45	0.86
Chloris robusta					0.04	1.4	1.84	1.09
Commelina diffusa	0.04	0.8	2.81	1.23	0.01	1.3	1.71	1.01
Crotalaria glauca					0.03	0.2	0.26	0.16
C. ononoides					0.04	1.4	1.84	1.09
Cyanotis angusta	0.21	3.8	13.33	5.78				
Cymbopogon citratus								
C. dactylon					0.01	0.7	0.92	0.54
Cyperus difformis								
C. rotundus								
Dactylotaenium aegypiacum	0.11	0.7	2.46	1.09	0.1	18.4	24.24	14.25
Digitaria longiflora	0.13	1.2	4.21	1.85	0.05	2.2	2.56	1.6

Plant species	Cultivated land				Grazed land			
	RF	RD	RDo	IVI	RF	RD	RDo	IVI
Eleusine indica								
Euphorbia hirta					0.05	1.9	2.50	1.48
E. hypericifolia								
Fleurya aestuans								
Indigofera hirsuta								
Ipomea eriocarpa	0.04	0.1	0.35	0.16	0.01	0.1	0.13	0.08
Leucas martinicensis	0.21	13.1	45.96	19.76				
Pandiaka angustifolia								
Paspalum scrobiculatum								
Pennisetum pedicellum					0.03	0.3	0.4	0.24
Sesbania dalzielii								
Setaria pumila					0.04	1.9	2.50	1.48
Sida ewiesner								
Spermacoce stachydea	0.19	8.0	28.07	12.09				
Tephrosia pedicellata					0.04	2.0	2.64	1.56
Tridax procumbens					0.05	0.9	1.19	0.71
Walteria indica					0.05	4.0	5.27	3.11
Zornia glochidiata					0.08	17.0	22.40	13.16

Most of the species occupies only one or two sites. In terms of the species Importance Value Index (IVI), no one of species was found to be dominant in more than one site, i.e. each of the five sites were dominated by unique species. Considering the first three species with the highest values of IVI, The Trampled Land was dominated by *Cyperus difformis* (23.89), *Eleusine indica* (9.81) and *Cynodon dactylon* (4.52). The dominant species in Protected Land were *Tephrosia pedicellata* (26.71), *Cynodon dactylon* (8.15) and *Bulbostylis coeleotrichia* (5.6). In the Mowed Land, the dominant species were *Paspalum scrobiculatum* (28.77), *Zornia glochidiata* (17.85) and *Tridax procumbens* (5.37). The Cultivated Land was dominated *Leucas martinicensis* (19.76), *Spermacoce stachydea* (12.09) and *Cyanotis angusta* (5.78). The dominant species in the Grazed Land were *Dactyloctenium aegyptium* (14.25), *Zornia glochidiata* (13.16) and followed by *Aristida mutabilis* (6.59).

Comparison among the five different sites with different land use for dis(similarity) indices indicates that they were all uniquely different from one another by the Jaccard's and Sörensen's dissmilarity Index (Table 3). The Dissimilarity values among all the five sampling sites ranges from 0.64 to 0.94. The Jaccard's dissimilarity Index shows that the highest dissimilarity was between the Trampled and Cultivated Lands in one hand and the Mowed, Grazed and Protected Lands in the other hand. The values of the dissimilarity ranges from 0.79 to 0.94. But among the Mowed, Grazed and Protected Lands, the value range was 0.64-0.68.

In terms of the Species Richness or the count of individual species, the highest number of species was found in Protected Land and Grazed Land with 27 and 20 species respectively (Table 4). The least was in Cultivated Land and Trampled Land with 9 and 8 number of species, while the Mowed Land has 18 number of species. Number or abundance of individual plant was higher in Mowed Land (1134), Protected Land (936) and Grazed Land (759), while it was least on Trampled Land (411) and Cultivated Land (285). The Shannon-Wiener Diversity Index (H') revealed that Species Diversity was higher on Grazed Land and Protected Land (3.39 and 3.28 respectively) and less on Trampled Land and Cultivated Land (2.09 and 2.08 respectively), while on Mowed Land it was 2.60. These values were all significantly different at α = 0.05.

Table 3. Similarity Indices of the five sites with different management practices. Dissimilarity values in parenthesis

Jaccard's index	Protected land	Mowed land	Cultivated land	Grazed land
Trampled land	0.13 (0.87)	0.18 (0.82)	0.06 (0.94)	0.17 (0.83)
Protected land		0.32 (0.68)	0.16 (0.84)	0.34 (0.66)
Mowed land			0.17 (0.83)	0.36 (0.64)
Cultivated land				0.21 (0.79)
Sörensen's index				
Trampled land	0.23 (0.77)	0.31 (0.69)	0.12 (0.88)	0.29 (0.71)
Protected land		0.49 (0.51)	0.28 (0.72)	0.51 (0.49)
Mowed land			0.30 (0.70)	0.53 (0.47)
Cultivated land				0.35 (0.65)

Table 4. Plant species richness, diversity, evenness, abundance and other floristic parameters of the five sites with different management practices. Values of Standard Deviation (StDev) with (*) were significant at α = 0.05

Plant species parameters	Trampled land	Protected land	Mowed land	Cultivated land	Grazed land	StDev
Species richness	8	27	18	9	20	7.96*
Species abundance	411	936	1134	285	759	355*
H' (Shannon diversity index)	2.09	3.28	2.60	2.08	3.39	0.63*
D (Simpson's index)	0.32	0.20	0.25	0.31	0.14	0.08*
E (Evenness)	0.696	0.690	0.623	0.657	0.784	0.24*

4. DISCUSSION

It was already widely documented that land use or human activities can affect soil physicochemical properties and plant species distribution [5]. The current study on five sites with different management practices in the Nigerian northern Guinea Savanna revealed the pattern of impact of different land use on soil properties and on herbaceous plants' composition and their other ecological parameters. The human activities include trampling, arable cultivation, grazing and mowing. In addition, an undisturbed area was included in the analyses.

Protected Land, Grazed Land and Mowed Land were all similar in terms of the mean values of all the analyzed physical and chemical properties of their soils, which include Total Nitrogen (%), Available Phosphorus (mg/ kg^{-1}), Exchangeable Potassium (cmol (+)/ kg^{-1}), PH, Organic Carbon (%) and Soil textural class. This implies that grazing and mowing here has very little or no significant impact on soil physicochemical properties. However, large difference in the values and nature of these soil properties was observed between the Protected Land in one hand and Cultivated and Trampled Lands on the other hand, but the difference was greater in Cultivated Land than in Trampled Land. Here the result suggests that arable cultivation has the highest negative impact on soil properties and lesser by trampling. Many studies already reported that anthropogenic activities could modify plant environment, particularly soil [2]. Elsewhere, studies showed that mowing increases soil PH, but lowers phosphorus and nitrogen [42]. Dong et al. [43] and Mofidi et al. [44] found that over grazing decreases soil organic matter, total nitrogen, available potassium and pH. Such was also the impact of tillage as reported by Neugschwandtner et al. [45] and the impact of trampling reported by Nazarporfard & Etemad [46].

With respect to plant distribution and composition, the result showed that each of the four land uses create a uniquely different plant community. Judged by the Important Value Index (IVI), which takes into account species Relative Frequency, Relative Density and Relative Dominance, the Trampled Land was dominated by *C. diformis* and *E. indica*. The dominant species in Protected Land were *T. pedicellata* and *C. dactylon*. In the Mowed Land, the dominant species were *P. scrobiculatum* and *Z. glochidiata*. The Cultivated Land was dominated *L. martinicensis* and *S. stachydea*. The dominant species in the Grazed Land were *D. aegypiacum* and *Z. glochidiata*. It should be recalled that all these lands were situated within an area of about $500m^2$, without any dispersal barrier. Some of these lands were even contiguous. This means that trampling, arable cultivation, grazing and mowing are very strong filters that determines distribution and composition of plant communities in this region. In addition, the Protected, Grazed and Mowed Lands were very similar in their soil physicochemical properties and yet dominated by different plant species despite their proximity. It can thus be concluded that the impact of these land use types in shaping plant community structure lays more in their direct impact on the plants rather than indirectly by modifying their soil physicochemical properties.

The result of the analyses of similarity and dissimilarity (Jaccard's Index), which takes into account the differences in species composition between two sites; indicate that there are more dissimilarity than similarity among all the sites understudy. Compared with the Protected Land, the dissimilarity was greater with the Cultivated and Trampled Lands and less with Grazed and Mowed Lands. Evenness Index is a value that shows the degree of variation or similarity in the pattern of species distribution among different sites. In this study the values of the Evenness Index was found to be relatively the same, except for the Grazed Land, which was slightly higher.

Species Richness was highest in the Protected Land followed by Grazed Land and then by the Mowed Land. However, there was a wider difference in the Species Richness when comparing the Protected Land with the Cultivated and Trampled Lands than with Grazed and Mowed Lands. Also, in terms species diversity index (Shannon-Wiener diversity index), which takes into account both the Species Richness and their Relative Abundance, the values was found to be higher in, but with narrow differences among Protected, Grazed and Mowed Land. However, the differences were wide while comparing the Cultivated and Trampled Lands with the Protected Land. All these results emphasizes that the different human activities affect these plant communities in a different way, with cultivation and trampling having the greater negative impacts.

The plant community parameters analyzed in this study were dominance based on IVI, dissimilarity, species richness diversity, evenness and the soil physicochemical properties. Among all these plant community parameters analyzed, the species dominance based on the IVI was found to be the most important indicator of these land use type. Because, by their IVI, the entire sites appeared to be distinctively different plant communities, while all other parameters showed some similarities among them. In addition, evenness was the least among these parameters that can be used as an indicator of these land use type, because the values of evenness were relatively the same in all the sites.

Studies revealed that trampling and cultivation severely causes physical damage to plants by removal of growing tips and crushing [12], leading to decline in species richness and diversity and change in plant species composition [11,13]. Arable cultivation was also reported to potentially modifies plant species composition and diversity of an area both directly, by locally eliminating plants species, and indirectly by altering soil characteristics [14,15]. These brings about plant community composition and diversity to change rapidly, relaxing competition due to the elimination of dominant species which takes time to re- establish [16,17]. Low-intensity grazing is thought to have positive effects on plant species richness, composition and diversity through herbivore 'ecosystem engineering', which includes redistribution of nutrients via deposition of dung and urine, soil compaction and erosion, dispersal of seeds. These brings about the alteration and creation of habitats more suitable for other species; reducing the abundance of competitive dominants; allows the introduction of weeds and thereby maintaining species richness [18,24]. It may also maintain plant species richness by preventing dominant plants from reducing diversity [20]. Studies also showed that the negative impact of mowing on some species may provide competitive advantage to others and bring about changes in plant species composition richness and diversity, rather than reducing them [25,26]. Many studies reported that, as the performance and success of plants depends partly on the soil composition and characteristics, frequent anthropogenic disturbances play a major role in shaping and determining plant community composition and distribution [3]. These cause plant communities across different sites to become more or less heterogeneous in terms of species richness and diversity and cause a shift in plant composition along these disturbance gradients [7].

5. CONCLUSION

Different types of land use, which include trampling, arable cultivation, grazing and mowing affected the floristic structure of plant community and soil physicochemical properties in different ways in the Nigerian northern Guinea Savanna. Each land use type creates a uniquely different type of plant community despite their proximity and the absence of dispersal barrier. Greater impact on the plant communities was by trampling and cultivation and lesser grazing and mowing. Among different plant community parameters, the species dominance based on the Important Value Index (IVI) was found to be the most important indicator of these land use types, and evenness was the least among these parameters that can be used as an indicator of these land use type. In addition, different land use types may create similar soil physicochemical properties and yet be dominated by different plant species in even contiguous plots. This suggest that the impact of these land use types in shaping plant community structure lays more in their direct impact on the plants rather than indirectly by modifying their environment, namely, soil physicochemical properties.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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