Structure and spatiotemporal dynamics of plant cover in Sahelian rangeland of Niger

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Abstract

The extreme north of the south-central region of the Republic of Niger is characterized by a semi-arid climate. Pastoralism constitutes the primary livelihood in this area. This study integrates dendrometric and phytosociological surveys with remote sensing to evaluate changes in floristic composition and structure. Vegetation inventory was conducted on 2,500 m² plots using the Daget and Poissonet method, identifying 16 plant species, including six woody and ten herbaceous species, belonging to five botanical families. The woody species were dominated by Rhamnaceae (6%) and Zygophyllaceae (6%), while Poaceae (44%) and Fabaceae (38%) were the most represented herbaceous families. Diameter class distribution indicated that individuals measuring 20–35 cm comprised nearly 50% of the woody population, with a shape parameter C = 2.17, reflecting a monospecific population dominated by young or small-diameter individuals. Canopy height analysis revealed that trees within the 4–6 m (47.69%) and 2–4 m (24.61%) ranges were predominant.

Analysis of biological and phytogeographic types revealed the dominance of therophytes (56.03%) and hydrophytes (0.47%), while woody species were predominantly pantropical (33.35%) and paleotropical. NDVI MODIS 250 m indicated significant variability in vegetation cover. Specific species contributions to total coverage were quantified as follows: *Alysicarpus ovaliofolius* (54.86%; 164.59 m²), *Zornia glochidiata* (18.04%; 54.14 m²), *Echinochloa colona* (15.11%; 15.11 m²), *Cenchrus biflorus* (4.05%; 12.10 m²), and *Schoenfeldia gracilis* (3.50%; 10.50 m²).

These findings highlight the importance of integrating remote sensing dataset and field dataset to enhance understanding of pastoral resource for the sustainable management of grazing ecosystems in semi-arid environments.

I. Introduction

Natural Sahelian pastures play an essential role in livestock feeding; they constitute the basis and often the entire food supply for ruminants in extensive or even semi-intensive livestock farming (Agonyissa *et al*., 1998 and Sinsin, 1993).

In Niger, natural rangelands constitute the main source of food for around 60% of livestock (Alhassane et al., 2018a; Sitou et al., 2021). For several decades now, botanical and phytosociological studies have been conducted in rangeland areas using relatively comparable methods. Observers have highlighted, particularly where there are strong climatic or human constraints, developments that sometimes lead to considerable modifications. During the same period, climatic fluctuations and significant changes in human occupation of these regions have been recorded (Carriere and Toutain, 1995). The vast majority of fodder consumed by ruminants in tropical Africa still consists of natural pastures. Savannahs, steppes and fallow lands provide the basis for livestock feeding, even in sedentary or intensifying livestock farming (Cesar, 2005). Steppes characterize the Sahelian zone. Although rich in perennial grasses in their original state, current steppes are often devoid of them; Perennial grasses have disappeared from large areas, replaced by annual grasses. The vegetation consists mainly of therophytes (*Cenchrus biflorus, Zornia glochidiata, Alysicarpus ovalufolius, Dactyloctenium eagyptiaca*) and a very sparse woody layer, dominated by thorny plants (Hiernaux and Le Houerou, 2006). The woody stand of the steppes or savannas remains green for a good part of the dry season. The foliage of trees and shrubs then constitutes a valuable source of protein for all animals. In addition, woody plants provide the main food for goats all year round (Cesar, 2005). Vegetation cover and composition are two of the most commonly used groups of indicators in many terrestrial ecosystems. These indicators have been correlated with a large number of ecosystem services including biodiversity and soil and water conservation, habitat for wildlife, food and fiber production (National Research Council, 2000; Millennium Ecosystem Assessment, 2003). The catastrophic decline of the species served as an early-warning signal of problems in the environmental rangeland (Niemi *et al*., 2004). Sahelian populations still remain dependent on renewable natural resources, to the point that the survival and reproduction of these societies depend on the regenerative capacity and diversity of biological resources (Barriere, 1996). However, the ecological particularities of Sahelian ecosystems lead pastoralists who exploit biological resources to adopt strategies that often require permanent or periodic movements of livestock, including transhumance. Many authors have shown that vegetation in the Sahel is related to the most determining environmental factors such as rainfall, substrate, topography, and human exploitation (Le Houerou, 2005; Hiernaux & Le Houerou, 2006; Hountondji *et al*., 2005).

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Assessment of the herbaceous layer of the rangelands firstly allow us to diagnose inter- and intra-annual variations in production (seed stock). Then, analyze the responses of these species to variations (degradation, restoration) in pastures (Sitou *et al*., 2025). Understanding the structure of the herbaceous and woody layer at a small scale provides information on the health of a pasture (Cesar, 2005). The main objective of this paper is to combine ground-based measurements with remote sensing and Geographic Information System (GIS) to assess the structure and spatiotemporal dynamics of vegetation in grazing areas. According to Carriere and Toutain (1995), grazed lands constitute along with forest areas is one of the two major reservoirs of diversity, both in biological, ecological, and genetic on the planet. In view of this importance, in this study, we first analysed the spatial-temporal patterns of vegetation cover of the station and then we used ground-based measurement to evaluate the availability of pastoral resources of the station. The interest of this study not only allows us to measure the direction of change in vegetation cover at a small scale over a time series from 2000 to 2023 (24 years); but also, to quantify the qualitative forage availability of plants. This information will enable decision-makers to initiate a plan for exploitation, enrichment and restoration of the site with a view to sustainable development of the livestock system in Niger.

II. Materials and methods

2.1. Study area

This study was conducted on the natural rangelands of the Maradi region located in the South-Central part of Niger between 13° and 15°26' North latitude and 6°16' and 8°36' East longitude (Alhassane *et al*., 2018). The average annual rainfall over the last ten years is 342.7 ± 70.07 mm in the North (Fako rain gauge station) in the North Sahelian bioclimate (Figure 1). The area is characterized by wet season (July to September) with relatively low rainfall varying from 400 to 250 mm per year (Seyni, 2020), and a dry season from October to June, with average minimum and maximum temperatures of 17 °C and 40 °C, respectively per year. The soil in this area is sandy, clayey, sandy-clayey and sandy-loamy (Chaibou, 2020), which is mainly influenced by climate and anthropogenic drivers. The area has therefore potential groundwater, mainly from the Tarka, and surface water, from watercourses with seasonal fossil valley regimes such as ponds (Chaibou, 2020). The department's livestock population is estimated in 2019 at 526.094.5 UBT (DDEL Bermo).

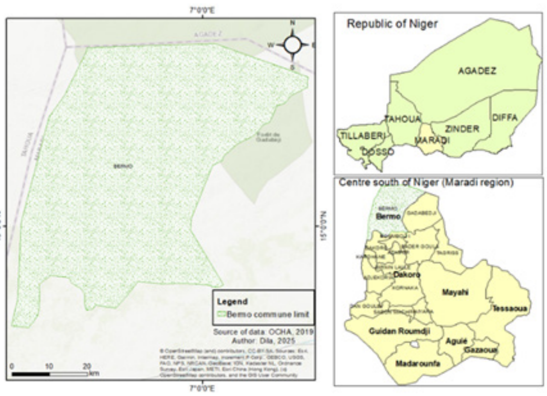

Figure 1: Location of study, Bermo commune in Maradi, Niger (Data, OCHA. 2019 produced by ArcGIS 10.8).

2.2. Data collection and analysis

2.2.1. Spatio-temporal NDVI and rainfall dataset

Using the cloud computing platform Google Earth Engine (GEE) (Gorelick *et al*., 2017), we developed scripts to generate NDVI time series and areas in ha between 2000 and 2023 with five years of intervals. We used ArcMap10.8 to classify NDVI threshold (-1 to 1) into 3 classes (dense vegetation, medium vegetation and low vegetation). Precipitation dataset was provided by CHIRPS (https://data.chc.ucsb.edu, accessed on 01/04/1981 to 30/10/2023). Data information on rainfall is spanning from 1981 to 2023 covering an area from 50° S to 50° N and from 180° E to 180° W with a spatial resolution of 0.05° (5.5 km) and daily, pentadal, and monthly temporal resolution. CHIRPS is specifically designed to monitor drought conditions in areas with complex topography and deep precipitation systems (Mehmood *et al*., 2024).

2.2.2. Ligneous and herbaceous plant dataset

Sampling design: The size of the ecological station A65 (unit) has 3km/3km and it one of the ground points of control installed by the Ministry of animal industry. To inventory the woody vegetation on the station, sampling plots were conducted randomly on the site. Twenty-five (25) plots of 2500 m² (50 m × 50 m) were delimited corresponding to the minimum area proposed by (Boudet 1984) for the study of Sahelian woody vegetation (Figure 2). The plot was distributed randomly within the station. At the level of each plot, parameters such as the height of the tree of woody individuals with diameter at breast height (DBH) ≥ 5 cm and height ≥ 1.30 m, circumference, coverage, diameters D1 and D2 of the crown were measured at the level of each individual encountered (Figure 2). An inventory of woody species and an exhaustive count of all individuals of each species in the plot were characterized on the site.

The inventory of herbaceous species was made (Figure 2) by the linear analysis method or the aligned quadrat point method (Daget & Poissonet,1971; Tchobsala *et al*., 2016) in each plot of (50 m x 50 m). In each plot four (4) aligned quadrat point were installed with one hundred aligned quadrat point in the station. The herbaceous layer was recorded along four lines using a 10 m long string, graduated every 20 cm (Figure 2). The first line is placed 5 cm from the edge of the plot to avoid the edge effect. The equidistance between two lines is 10 m. The lines are arranged parallel to the width of the plot (Alhassane *et al.*, 2018). A tapered rod is used to materialize the line of sight (reading point). Plant-stem contacts are then counted. Each species is counted only once at most per sighting point. Non-floristic parameters were noted in each plot: geographic coordinates, topography and soil type by the tactile method (Idrissa *et al.*, 2020).

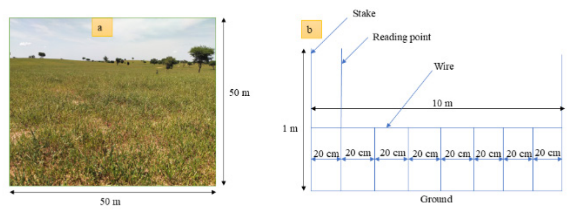

Figure 2: Sampling design of field data collection. From left (a) to right (b) we have plot of woodies inventory and aligned quadrat point method for herbaceous species inventory in A65 site of Bermo commune (Souleymane, 2025).

To assess the living conditions of the trees in the station, the Weibull distribution was used, which is the most appropriate because it is characterized by great flexibility of use and presents a great variability of forms depending on the values taken by its theoretical parameters (Burkhart, 2005). The photos below present the Dendrometrics and phytosociological measurements carried out on the site in September 2024.

Figure 3: Photographs of field data collection during the rainy season (September). From left to right we noted woodies parameters measurement and herbaceous inventory in A65 site, Bermo commune, Maradi, Niger

Data analysis and processing consisted of using software including ArcMAP 10.08, RAWGraph open-source project designed and developed by Density Design, Calibro and Imagi 2013–2021, Minitab 19.1.1 and Excel. These tools made it possible to calculate various indices cited as following.

Diversity indices are the richness and specific diversity of the different groups were characterized using structural indicators (or indices) of diversity within the communities (α diversity) (Habou *et al.*, 2022).

Alpha diversity evaluation is based on:

Shannon-Weaver diversity index (H').

$$H' = -\sum Pi \log2 Pi \quad (1)$$

Pielou eveness index (E).

$$E = H/Hmax \quad (2)$$

where Hmax = log2S

Others structural parameters of species were calculated:
Specific Frequency

$$(FS\ (\%)) = ni \times 100/N \quad (3)$$

Specific Contribution

$$SCi = Fsi \times 100/(\sum Fsi) \quad (4)$$

Specific Index (IS),

Average Species Coverage (ASC)

$$\boldsymbol{ASC} = (\Sigma R\_i)/\mathbb{N} \times 100 \quad (5)$$

Relative Pastoral Value (RPV)

$$RPV = 1/3 \sum Cis \times Is) \quad (6)$$

Biological and phytogeographic spectrum: The biological and phytogeographic spectrum types assess differences in life strategies and geographical distribution within plant communities (Mahamane, 2005). Biological types were defined according to Raunkiaer's method (Raunkiaer, 1934) taken up and readapted to tropical regions (Guinko, 1984; Saadou, 1990). The chorological subdivisions used in the analysis of phytogeographic spectrum were defined by White (1986) used by several authors for African phytochoria (Mahamane, 2005; Inoussa, 2011).

The Weibull distribution was used to represent the theoretical structure of each population of the species (Morou, 2010; Karim, 2001). It is based on the probability density function of the Weibull distribution F and is presented in the form below:

$$F(x) = c\ /\ b[(x-a)\ /\ b]^{c-1}\ exp[-[(x-a)/b]^c] \quad (7)$$

III. Results and discussion

3.1. Spatio-temporal pattern of vegetation cover of MODIS NDVI and rainfall

Spatial patterns of vegetation cover were classified into three classes: dense vegetation between 0.15–0.20 NDVI value, medium vegetation cover between 0.14–0.15 NDVI value and low vegetation cover between 0.01–0.14 NDVI value. Among the five (5) periods with five (5) years of interval, the trend of vegetation cover evolved from South to North with variability observed during certain period (2000–2004, 2005–2009, and 2015–2019). Most of the positive change of vegetation cover density (Table 1) is recorded during the 2010‒2014 and 2020‒2013 with respectively 49.95 % and 50.57 %. The improvement observed in rainfall conditions from the mid-1990s, even if it remains moderate, has led to an increase in plant cover perceptible by remote sensing, called "regreening" of the Sahel (Fensholt and Rasmussen, 2011; Anyamba *et al*., 2014; Dardel *et al*., 2014). In fact, impacts of recent trends and variability of climate on ecosystems can be observed using long-term NDVI time series (Forkel *et al*., 2013). However, some areas in western Niger are characterized by negative trends (Lebrun, 2022).

The result in percentage of vegetation cover classes evolvement during the period displayed on the Table 1 below. It indicated vegetation cover quantity according to the threshold.

Table 1: Dynamics of vegetation cover over 23 years in A65 site of Bermo commune, Maradi, Niger

	Vegetation classes (%)		
Periods	Dense	Medium	Low
2000‒2004	44.19	34.92	20.89
2005‒2009	41.45	31.85	26.70
2010‒2014	49.95	26.54	23.51
2015‒2019	42.22	41.93	15.85
2020‒2023	50.37	26.43	23.20

Sources : https://appeears.earthdatacloud.nasa.gov

3.1.1. Rainfall variation: The analysis of rainfall trends across the entire municipality shows a positive and significant trend (p-value = 0.01) of precipitation. Indeed, there is interannual variability in rainfall across the municipality both positive and negative state of rainfall. For instance, before the 1990 period, we observed low precipitation (120 mm of seasonal rainfall). At the end of 1990 period, rainfall conditions started to improve and reach 380 mm during the three months (July-August and September) of wet season. This variability reflected by a baseline rainfall amount at the level of the years 2000, 2004, 2009, and 2017. However, some years are rainier than others, such as 2003, 2010, and 2021. According to the OCDE / CSAO (2008). Since the mid-1990s, there has been a return to better rainfall conditions in the Sahel region. This trend is particularly marked in the Eastern Sahel (Niger, Northern Nigeria, and Chad). This return to better rainfall is accompanied by greater interannual variability in rainfall.

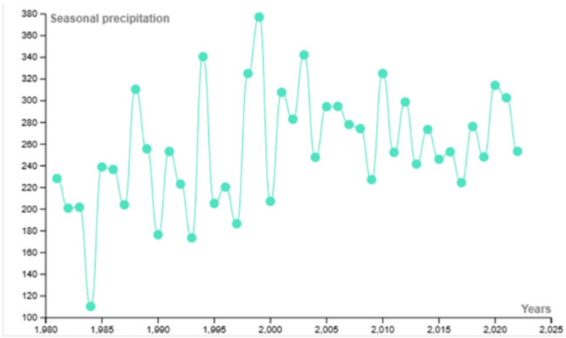

Figure 4: Precipitation variation over the last 24 years. Source (https://data.chc.ucsb.edu, accessed on 01/04/1981 to 30/10/2023).

3.1.2 Temporal profile of maximum NDVI: The analysis of the trend curve for vegetation cover density express by the maximum NDVI of the site shows a highly significant positive trend over the time series (p-value=0.003). However, variability is observed from one year to the next. The years 2004, 2009, and 2017 experienced a significant decline in vegetation cover density. This decline was also observed for rainfall in the area, which declined over the period. It is noted that from 2000 to 2009, the amount of vegetation cover at the site was lower compared to the period from 2010 to 2023. The main factor behind this regreening of vegetation is the annual cumulative rainfall, which is once again tending towards the normal of the 1900‒2015 period. It should be noted that the intensity of the rainfall is higher than before (Luc, 2021). The regreening trend across the Sahel is confirmed by a study using satellite data and field surveys over three decades (1981-2011) with strong significance (Dardel *et al*., 2014). However, some areas are characterized by negative trends, particularly in western Niger. From a phenological point of view, the increase in the NDVI signal would be mainly due to the extension of the herbaceous cover. The evolution of woody plants is more difficult to measure because this type of vegetation is more isolated (only about 5% of the total plant cover in the Sahel), which increase its susceptibility to biases-related to the spatial resolution of satellite sensors (Lebrun, 2022). This regreening is attested mainly by remote sensing and was mainly due to herbaceous plants from 1990 to 2010. Since then, it has been driven by trees (which take longer to grow, and therefore to be seen from satellites). This is noticeable both in regions where no RNA (Assisted Natural Regeneration) or NGO action has been effective and where they have acted (Luc, 2021).

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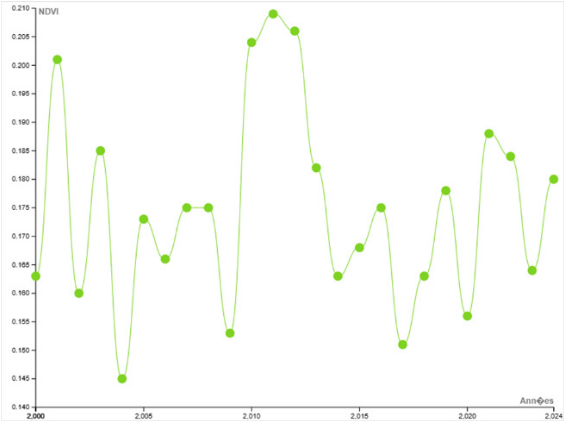

Figure 5: Variation of NDVI-max from 2000 to 2023 in the A65 site, the municipality of Bermo, Maradi, Niger (https://appeears.earthdatacloud.nasa.gov)

3.2. Correlation between NDVI and precipitation

The Figure 6 shows a positive correlation between NDVI and rainfall. As rainfall increases, vegetation cover develops more and more on the type. This relationship, using the Mk test, shows a positive correlation between rainfall, which is an independent variable, and NDVI, which is a dependent variable. Rainfall is a limiting factor, especially in arid-arid areas with precarious climatic characteristics.

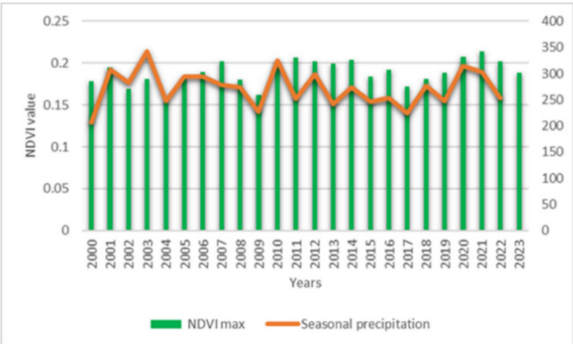

Figure 6: Relationship between NDVI and precipitation from 2000 to 2023, in the A65 site, the municipality of Bermo, Maradi, Niger.

3.3. Demographic structure of the woody stand

3.3.1. Height structure classes of species

The analysis of the height structure of the species allowed to classify the different species inventoried on the site according to their height. The value of the shape parameter c of the Weibull distribution (Kalkai *et al.*, 2016) is between 1 and 3.6, reflecting a monospecific stand characteristic of a population with a low height of 4–6 m of individuals (*Acacia seyal, Acacia tortilis var. raddiana, Balanites ægyptica, Ziziphus spina-Christi*. This stand presents a possibility of regeneration in an aging population (*Acacia tortilis Var.raddiana, Balanites ægyptiaca*). However, this distribution is not unique to the woody species since a species can have different heights depending certainly on the level of vegetative growth of the species. This is also indicative of a stand dominated by a shrubby plant formation.

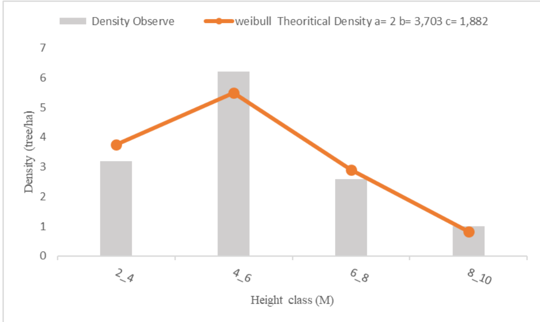

Figure 7: Vertical structure of woodies species A65 site, in Bermo commune, Maradi, Niger.

Table 2: Woody species for each height class, during field inventory in 2024 in Bermo commune, Maradi, Niger

Height class (m)	Species
2–4	*Acacia seyal, Acacia tortilis var. raddiana, Balanites ægyptica, Ziziphus spina -Christi*
4–6	*Acacia seyal, Acasia tortilis var. raddiana, Balantes ægyptiaca, ziziphus spina-Christi*
6–8	*Acacia nilotica, acacia senegalensis, Acacia tortilis Var. raddiana, Balanites ægyptiaca*
8–10	*Acacia tortilis Var.raddiana, Balanites ægyptiaca*

3.3.2. Diameter structure classes of species

Referring to the interpretation key of diameter structures according to the values of the shape parameter c of the Weibull distribution, it is easy to understand that the site presents a positive asymmetric or right asymmetric distribution, characteristic of monospecific artificial stands with a relative predominance of young individuals and small diameter. It can also be characteristic of populations with low regeneration potential due to exogenous actions especially in small diameter classes (Kakai et al., 2016). The characteristic species are: *Acacia tortilis var. raddiana, Acasia seyal, Balanites ægyptiaca, Ziziphus spina-Christi, Balanites ægyptiaca, Acacia senegalensis*. Then followed by species of 20–25 cm and 30–35 cm in diameter. This diameter structure is of major interest not only for soil protection but also for the production of biomass necessary for livestock feed.

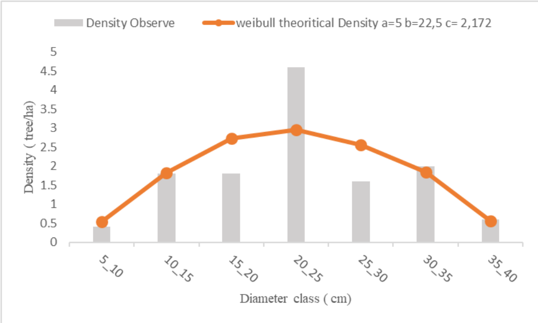

Figure 8: Diameter histograms of woody species distribution in A65 site, in Bermo commune, Maradi, Niger

Alhassane *et al*. (2017) found similar results on the rangelands of the Maradi region, explaining that among the most important species are *Piliostigma reticulatum (DC) Hochst, Combretum micranthum G. Don., Balanites aegyptiaca (L.) Del., Acacia senegal (L.) Willd. and Guiera senegalensis J.F. Gmel. The species Faidherbia albida Del. and Acacia tortilis (forsk.) Hayne subsp. Raddiana* (Savi.) Brenan. The most palatable according to him are the most pruned for animal feed. This form of use of woody plants has affected the populations of these two species which are becoming increasingly rare in the region, especially in the south, except in agroforestry parks where they are maintained by farmers.

Table 3: Woody species for each diameter class, during field inventory in 2024 in Bermo commune, Maradi, Niger

Diameter class (cm)	Species
5-10	*Acasia seyal, Acacia tortilis var. raddiana, Balanites ægyptica*
10-15	*Balanites ægyptica, Acasia seyal,Ziziphus spina-Christi,Aacacia tortilis var. raddiana*
15-20	*Aacacia tortilis var. raddiana, Acacia seyal,Balanites ægyptiaca*
20-25	*Aacacia tortilis var. raddiana, Acasia seyal, Balanites ægyptiaca, Ziziphus spina-Christi*
25-30	*Balanites ægyptiaca,Acacia senegalensis*
30-35	*Balanites ægyptica,Acasia tortilis var .raddiana*
35-40	*Balanites ægyptica*

3.4 Taxonomies diversity and spectrum of species

3.4.1. Herbaceous family species

The floristic composition analysis carried out on the 20 sample plots installed on the site made it possible to identify ten (10) plant species. These species belong to different woody and herbaceous families. Thus, the species are divided into five different families (Figure 9). The Poaceae, with seven (7) species or 70%, are the most abundant. They are followed by the Fabaceae, with 2 species or 20%. The Malvaceae family represents the least bundant, with one species or 10%. The table below summarizes the floristic composition on the site.

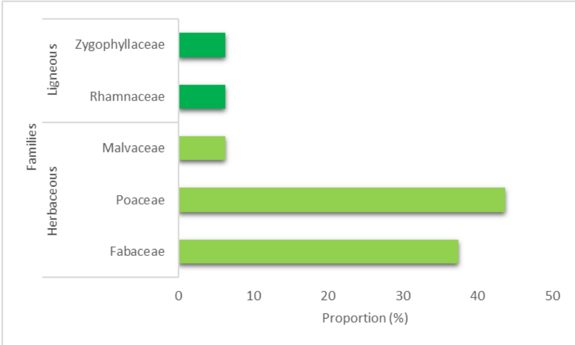

Figure 9: Proportion of species families in A65 site, inBermo commune, Niger.

Table 4: Families number of species in (%), survey in A65 site in 2024, Bermo, Maradi, Niger

N°	Families	Number of species	Number of species (%)
1	Poaceae	7	70
2	Fabaceae	2	20
3	Malvaceae	1	10

3.4.2. Phytogeographical and Biological spectrum types

Phytogeographical spectrum type: the characterization of the site based on the listed species made it possible to understand the phytogeographic spectrum to which the identified species belong (Figure 10). Thus, the majority of the identified species belong to pantropical species with a dominance of approximately 50% (raw spectrum) of pantropical species for an overlap of approximately 33% (weighted spectrum). This was followed by African multiregional species with a raw spectrum of 30% and a weighted spectrum of 5%. Paleotropical species composed of 10 % raw spectrum and 20% weighted spectrum are also found on the site. In addition, Sudanian-Zambesian species are also found with a raw spectrum of approximately 20 % while the weighted spectrum is practically zero. This demonstrates a specificity in the Sahelian zone. Since Sudanian-Zambesian species are endemic to areas with high rainfall, particularly in the western part of Niger.

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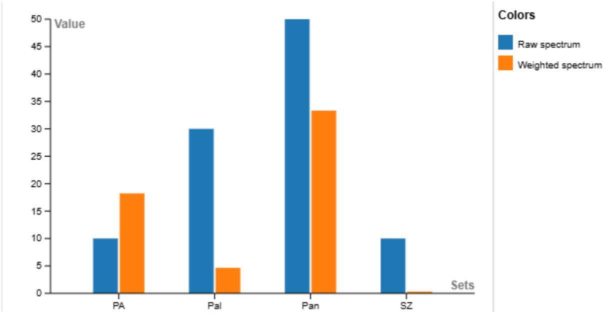

Figure 10: Phytogeographical classification type. Pan: Pantropical species; PA: Pluriregional African species; Pal: paleotropical species, SZ: Sudanian-Zambesian

Biological spectrum types: The classification of species into biological types provides information on plant formation, its origin, and its transformations (Cesar, 2005). Indeed, we note the presence on the site of two biological types: the most important therophyte species (Th) with a dominance estimated at 90% of the species (raw spectrum) and a coverage of 55% (weighted spectrum). Then, the hydrophyte species (Hy) of low representation with a raw spectrum of around 9% with a zero weighted spectrum (Figure 11). Consequently, we can conclude that the site is essentially dominated by annual species. César (2005) states that *The Sahel and young fallow land are the domain of annuals*. The same author expressed that *degradation always results in a decrease in perennials in favor of therophytes, and sometimes by an increase in phanerophytes*.

3.5. Biological forms, Species frequency, Species contribution, Relative pastoral values and Alpa diversity

The Table 5 below lists a number of characteristics of the woody forage species on the site. In total, three (3) of the species listed on the site have a higher food intake for animals. In fact, these species are evaluated according to their high specific frequencies, a more or less significant specific contribution. All these species belong to two families: Fabaceae with the species *Alysicarpus ovaliofolius* being the most dominant on the site with a higher specific frequency (2149), a specific contribution of 54.87% is an average coverage of 31.87%. The species *Zornia glochidiata* with a specific frequency of 707, a contribution of 18.05% is an average coverage of 18.22%. The species *Echinochloa colona* from the Poaceae family has a specific frequency of 592, or 15.11% specific contribution for a low average coverage of 0.47. On the other hand, other species of the Poaceae family are moderately dominant on the site: *Cenchrus biflorus* with a specific frequency equal to 158 with 4.03% specific contribution and a low recovery of 4.03; *Scheonifeldia gracilis* with a specific frequency equal to 158, i.e. 3.50% specific contribution and a lower average recovery of 0.25. The other species including: *Aristida mutabilus* and *Panicum laetum, Eragrotus tremula*, *Dactylectenium aegyptiaca* and *Corchorus tridens* are of low food contribution to the animals grazing on the site with a lower specific frequency of around 2 to 86 and a specific contribution of 0.06 to 2.20% for a recovery of 0.002 to 0.02. These results corroborate those of Alhassane *et al.* (2017), showing that among the herbaceous plants, the most palatable are *Alysicarpus ovalifolius; Aristida mutabilis; Cenchrus biflorus; Dactyloctenium aegyptica; and Schenefeldia gracilis*. the same author explained that outside of the northern rangelands, located in pastoral areas with less animal pressure, these species are becoming increasingly rare on rangelands due to their high selectivity by livestock. This results in a significant proliferation of invasive species of no pastoral interest, such as *Sida cordifolia; Acanthospermum hispidum*, and an increase in bare areas in places, very often crusted, promoting soil and organic matter depletion.

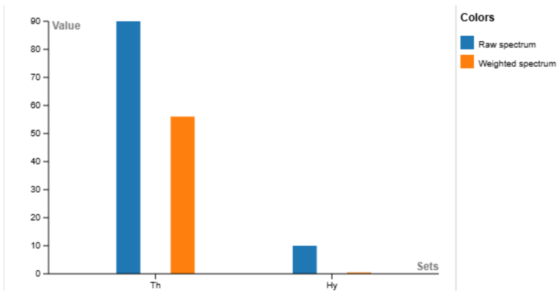

Figure 11: Biological classification type in A65 site/Bermo commune, Maradi, Niger.

Table 5: Evaluation of pasture in A65 site in 2024, Bermo commune, Niger republic

Family	Species	SF	SI	SCi (%)	ASC	RPV	H'
Fabaceae	*Alysicarpus ovaliofolius*	2149	3	54.87	31.87	164.60	0.47
	Zornia glochidiata	707	3	18.05	18.22	54.15	0.52
Poaceae	*Echinochloa colona*	592	1	15.11	0.47	15.11	0.06
	Cenchrus biflorus	158	3	4.03	4.37	12.10	0.29
	scheonifeldia gracilis	137	3	3.50	0.25	10.50	0.03
	Aristida mutabilus	86	3	2.20	0.025	6.59	0.005
	Panicum laetum	79	3	2.01	0.3	6.06	0.04
	Eragrotus tremula	4	3	0.10	0.12	0.30	0.02
	Dactyloctenium aegyptica	3	3	0.08	0.82	0.23	0.09
Malvaceae	*Corchorus tridens*	2	1	0.06	0.002	0.06	0.005

SF = Specific Frequency; **SI**: *Specific Index*; **SCi** = Specific Contribution**;** **ACC** = Average Canopy Cover; **SRV** = Species Relative Value**;** **H'**= Species Diversity

3.6. Assessment of the forage quality

The analysis shows that the site has low species diversity with H' = 1.52 and an uneven distribution of species, as the E index is 0.35. The most represented species on the site is mainly *Alysicarpus ovaliofolius* followed by *Zornia glocidiata*. Furthermore, it can be deduced that the site has a high cover, as it has an average cover of 97.75% of species for a pastoral value of 53.93 (Table 6).

Table 6: Some parameters indicators of quality of pasture

IC	E	H max (bits)	H' (Bit)	R (%)	VP
0.01	0.35	4.32	1.52	97.75	53.93

VP: pastoral value of the pasture, CI: confidence interval, E: Pielou eveness index, H': Shannon-Weaver diversity index, H max: maximum diversity, R: grass cover

IV. Conclusion

This study has revealed the current state of pasture resources of A65 site and bring out the quantity and quality of woody, and herbaceous species of the rangeland. The spatiotemporal dynamics of the rangeland has showed a positive and significant trend of vegetation cover with interannual variation of vegetation cover over the time series. The result of ground data measurement has given the structure and distribution of the herbaceous and woody forage species of the site. The biological and phytosociological spectrum confirmed a dominance of therophytes, indicating a dominance of annual species on the site. The herbaceous species such as *Alysicarpus ovalifolius; Aristida mutabilis; Cenchrus biflorus; Dactyloctenium aegyptica; and Schenefeldia gracilis* indicators of good pasture deserve regular monitoring and surveillance because of their palatability in animal feed. Distribution analysis of Weibull demonstrated an asymmetric distribution, characteristic of monospecific artificial stands with a relative predominance of young individuals, small diameter, and a population with a low height of 4-6 m of individuals. Poor pasture could prove valuable in an area with low potential. Thus, there is a need further research on predicting the ecological stability of a stand in the long term in order to better adapt pasture management options**.**

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