

# Assessment of Floristic Diversity at Two Protected Sites on the Outskirts of Sena Oura National Park, Chad

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## Abstract

Two protected sites located on the outskirts of the Sena Oura National Park (PNSO) in West Mayo-Kebbi cover an area of 1800 m<sup>2</sup> is pattern choose in pastoral enclave in both village. This study was undertaken to highlight the floristic diversity of the herbaceous and woody vegetation on these sites in the offing to know the ability of charge into UBT that most support the park peripheral. It took place on two experimental sites on a natural course in two villages: Wazetelan and Massang. The approach used for the study was a survey using the systematic sampling method and a 30 m × 30 m plot. The survey consisted in listing all the taxa in a floristically homogeneous plot, each assigned the Braun-Blanquet dominance abundance coefficient. These surveys revealed a floristic richness of 73 species, 58 genera, including 46 herbaceous and 26 woody species. The Shannon result gives H1' = 0.12 bit for herbaceous species and H2' = 0.44 bit for woody species, meaning that the herbaceous and woody populations of all the surveys have a very low species diversity, as H' < 3 according to the Shannon index assessment threshold. Herbaceous species are divided into 13 families and 33 genera. The most represented families are Fabaceae (27.3%) and Poaceae (21.9%). Most of the other families (1.3%) have only one species, if any. Herbaceous species are divided into 33 genera grouped into 13 families. The most represented families are Fabaces (16 species), 34%, and Poaceae (12 species), 26%. The 26 woody species, most of which come from itinerant surveys, are distributed across 24 genera and 12 families, the most important of which is Fabaceae with 09 species (34.6%). This floristic assessment, in terms of quantity and quality, has enabled us to estimate the carrying capacity of the two pastoral enclaves in Dari and Goumadji cantons,

and to guide the government's actions with regard to rangeland management.

## Keywords

Floristic Diversity, Protected Sites, Periphery, Area Producty, Chad

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## 1. Introduction

In Chad, natural pastures represent the main food resource for livestock, particularly pastoral livestock [1]. These pastoral livestock exploit fodder resources that are often heterogeneous and highly variable in time and space. This variability is significant, and concerns both the quantity and quality of forage. This is the case for our two sites located on the outskirts of the Sena Oura National Park (PNSO).

This park was set up as a protected area at the instigation of the local communities, and is now strictly off-limits to human exploitation. At other times, it was reserved for grazing by wildlife and domestic animals. Created by decree No. 14/PR/2008 [2] of June 10, 2008, Sena Oura National Park covers an area of 73,520 ha. It is located in the Department of Mayo-Dallah, Western Mayo Kebbi Province in Chad [3]. The present study, carried out in the periphery of the PNSO, is of great agro-pastoral potential due to its ecological richness. The peripheral zone of the PNSO, home to an estimated 21,000 inhabitants, is the area where various usage rights are exercised and where the local authorities (Dari and Goumadji cantons), exercise their authority over the various spaces and resources [4]. With climatic disturbances leading to a vertical shift of livestock breeders from the north to the savannah of Chad, this park and its periphery have become the object of attraction for many livestock breeders, causing serious problems for the management of agro-pastoral resources. Such rapid population growth has led to large-scale forest clearance, accelerating the advance of the agricultural front. In addition, farms have become multiactivity and increasingly market-oriented. Seasonal fluctuations in forage availability, both in quantity and quality, often prevent a balance between livestock density and forage resource availability (Hiernaux and L thee) [5]. Our study focuses on the floristic evaluation of these two pastoral sites located on the outskirts of the PNSO, in order to gain a better understanding of the carrying capacity of these elaborate zones.

## 2. Material and Methode

### 2.1. Localisation of Study Area

The periphery of National Park from Sena Oura (PNSO) is situate horse between the department from Mayo-Dallah and Nanaye in the Mayo-kebbi Ouest. It couver a superfy of 1502 km<sup>2</sup>, and is situate between 9°06' and 8°99' of latitude north and 14°53' and 14°99' of longitude westh (**Figure 1**).

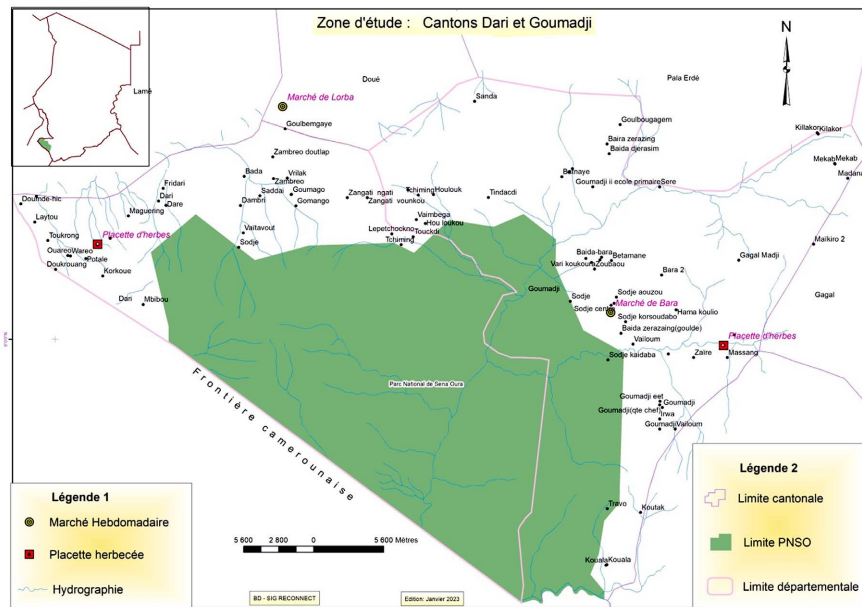


Figure 1. Study sites.

## 2.2. Inventory Method for the Reserve's Woody and Herbaceous Species on the Sites

Inventories of woody and herbaceous species are carried out using [6] sigmatized phytosociological method, based on systematic stratified sampling (phytosociological survey sheet and herbaceous biomass). Sites are selected on the basis of satellite imagery, then surveyed according to topography (plateau, slope and lowland) in plots measuring 30 m × 20 m for the woody stratum (shrubs and trees) and 2 × 10 m × 10 m for herbaceous species. The woody stratum comprises all woody species at least 2 m high, including a shrub and tree stratum with individuals over 5 m tall. The herbaceous stratum comprises all herbaceous plants and woody recruits less than 2 m high.

Ecological characteristics to be collected include formation type, vegetation structure (cover ratio and average height), topography, soil texture and geographic coordinates. Vegetation structure was assessed visually, while geographic coordinates were tracked using GPS (Global Positioning System). Soil texture was assessed by touch by sampling the upper horizon. Our study took place on two 30 m × 30 m plot sites (*i.e.* 900 m<sup>2</sup>) defended on a natural grazing area. The experimental set-up consisted of randomly selected sites: one located in a low-lying area on the banks of a river in the pastoral zone sent for development, and the other in a lightly sloping pastoral zone with clay-loam and clay-sand soils in the villages of Wazetelan and Massang.

### 2.2.1. Herbaceous Species Inventory Method

The survey consisted of listing all the taxa in a floristically homogeneous plot in 4 10 m × 10 m surveys, each assigned the Braun-Blanquet abundance-dominance coefficient. The abundance-dominance coefficients assigned to the species are:

5) species covering 75% to 100% of the survey area, *i.e.* 87.5%; 4) species covering 50 to 75% of the survey area, *i.e.* 63.5%; 3) species covering 25 to 50% of the survey area, *i.e.* 37.5%; 2) species covering 5% to 25% of the survey area, *i.e.* 15%; 1) species covering 1 to 5% of the survey area, *i.e.* 3% and (+) species covering 0 to 1% of the survey area, *i.e.* 0.5%. For rare herbaceous species, an additional inventory was carried out outside the 30 m × 30 m plots in order to obtain an exhaustive list for the plot surveyed. Herbarium samples are also collected for identification and enrichment of the national herbarium at the Institut de Recherche pour l'Élevage et le Développement (IREDD) in Ndjamena.

### 1) Shannon index

The Shannon index has been used for diversity index calculations. The Shannon and Weaver (1949) index is the simplest and most widely used. The higher the value of  $H'$ , the greater the diversity. This index is calculated by the following

formula:  $H' = -\sum_{i=1}^n p_i \cdot \text{Log}(p_i)$ , with:

$H'$  = Shannon biodiversity index;

$i$  = species in the study environment;

$p_i$  = proportion of species  $i$  to the total number of species ( $S$ ) in the study area, or species richness of the study area, calculated as follows:  $p(i) = n_i/N$  where  $n_i$  is the number of individuals of species  $i$  and  $N$  is the total number of individuals of all species.

If  $H' < 3$ , diversity is low; if  $H' > 3$ , diversity is high.

In addition, herbaceous biomass was estimated using the integral method (clear-cutting at peak biomass) in 5 randomly placed 1 m<sup>2</sup> subplots to obtain the quantity of dry matter product (DMP).

### 2.2.2. Woody Species Inventory Method

For the woody species inventory, we carried out an exhaustive count of individuals at both sites (30 m × 30 m), of each species, and measured the dendrometric parameters: trunk diameter at breast height (DBH = 1.30 m), total height (HT) of the individual and the two perpendicular diameters of the crown [7]. All seedlings and non-measurable individuals will be counted throughout the plot as regeneration.

### 2.2.3. Data Processing and Analysis

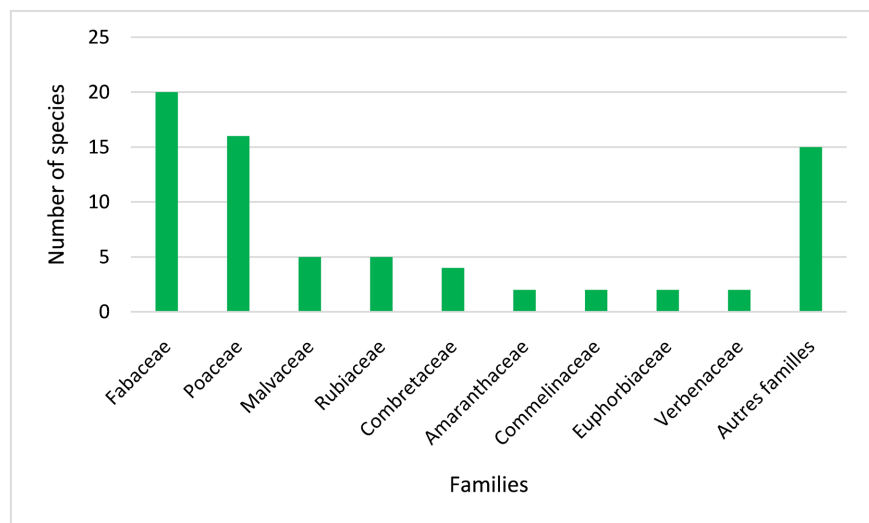
Data processing and analysis were carried out using Excel 2016 software to obtain histograms and dendrometric and phytosociological data. The map of the study area was produced using ArcMap 10.4.1 software.

## 3. Results

### 3.1. Floristic Richness and Vegetation Types of the Sites

The vegetation on the outskirts of the PNSO is of the savannah type. They comprise a continuous herbaceous stratum composed of perennial cespitose grasses and annual grasses. The herbaceous stratum may be supplemented by one or more

woody strata. All these formations, rich in grasses and woody plants, are excellent pastures for livestock. The inventory work carried out enabled us to describe the characteristics of the two sites, and to carry out 4 surveys for herbaceous flora, 10 surveys for herbaceous biomass and 2 surveys for woody flora and biomass. These surveys revealed a floristic richness of 72 species and 58 genera, including 46 herbaceous and 26 woody species. Herbaceous species are divided into 13 families and 33 genera. The most represented families are Fabaceae (20 species), *i.e.* 27.3%, and Poaceae (16 species), *i.e.* 21.9%. Most of the other families have only one species (grouped together under the name of other families), representing 0.13% (Figure 2).



**Figure 2.** Overall distribution of species in the different families.

The 26 woody species, most of which come from itinerant surveys, are distributed in 24 genera and 12 families. The most represented family is Fabaceae with 09 species (34.6%), of which the main representative species are: *Acacia nilotica*, *Azelia africana*, *Burkea africana*, *Daniella oliveri*, *Detarium microcarpum*, *Dichrostachys cinera*, *Pericopsis laxiflora*, *Piliostigma thoningii* and *Prosopis africana*, followed by the other families with 08 species or 30.7% (Figure 3).

### 3.2. Shannon Index for All Plots

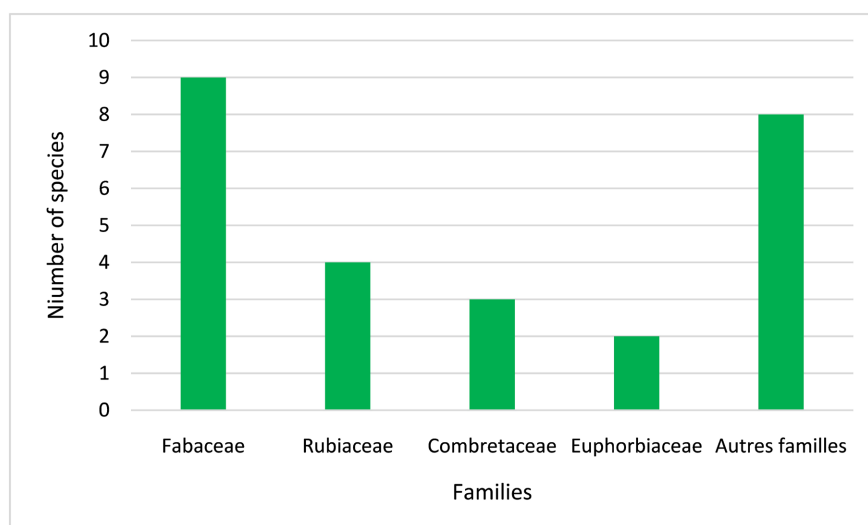
$H' = -\sum_{i=1}^n p_i \cdot \text{Log}(p_i)$  Applying this formula gives:  $H1' = 0.12$  bit for herbaceous species and  $H2' = 0.44$  bit.

Thus, the herbaceous and woody stand of all the surveys has a very low species diversity, as  $H' < 3$  according to the Shannon index assessment threshold.

. Shannon index for all plots

$H' = -\sum_{i=1}^n p_i \cdot \text{Log}(p_i)$  Applying this formula gives:  $H1' = 0.12$  bit for herbaceous species and  $H2' = 0.44$  bit.

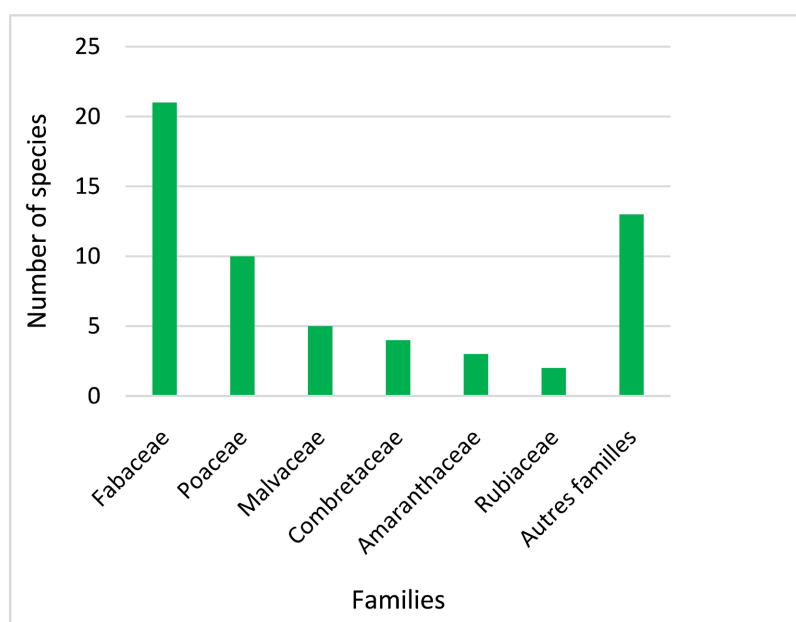
Thus, the herbaceous and woody stand of all surveys shows very low species diversity, as  $H' < 3$  according to the threshold Shannon index of evaluation.



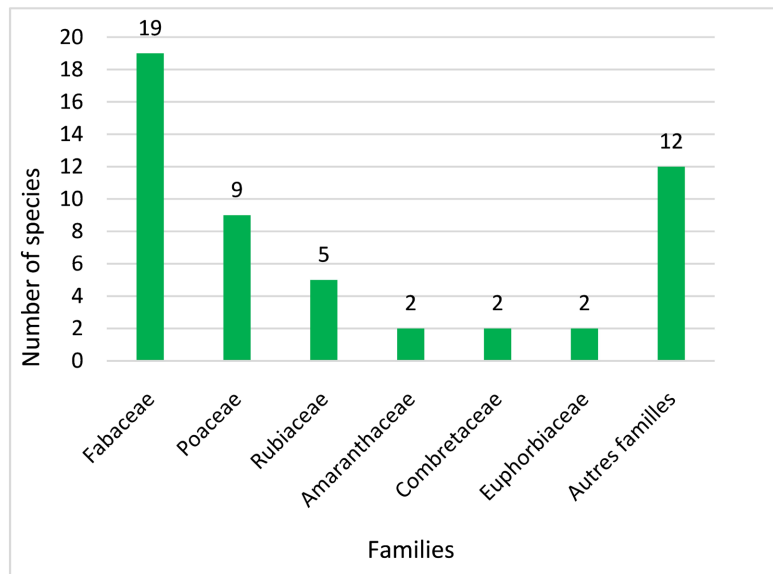
**Figure 3.** Distribution of the woody family.

### 3.3. Species Diversity at the Sites

Generally speaking, the Massang site contains 59 species in 53 genera and 19 families. The majority of woody species are the result of itinerant surveys. The Fabaceae family is very abundant (21 species), *i.e.* 39.6%, followed by the Poaceae (10 species), *i.e.* 18.86%. The other families have only one species, representing 1.69% (Figure 4 and Figure 5). The Wazetelan site contains 54 species in 43 genera and 18 families. Fabaceae contain 19 species with 35%, followed by Poaceae with 09 species and 16.6%. The other families are represented by just one species each, *i.e.* 0.18%. The large number of woody species is due to the itinerant inventories. The difference between these two results is linked to soil texture: the soil at the Massang



**Figure 4.** Massan's site.



**Figure 5.** Wazetelan's site.

site is silty-clayey, which is conducive to the development of several species, whereas that at the Wazetelan site is sandy-clayey. There species Fabacea is very dominant.

### 3.4. Structure of Adult Individuals at Both Sites

A total of 1725 stems were surveyed in the 02 900 m<sup>2</sup> plots sampled, including 08 stems with diameter at breast height (dbh)  $\geq$  5 cm (adult individuals) and 1717 stems from the juvenile population (regenerations). All these individuals belong to 21 species, 19 genera in 10 families, the most important of which are Fabaceae with 5 species (23.8%), Rubiaceae with 4 species (19%) and Combretaceae with 3 species (14.28%).

These results show that, overall, the plant formations at both sites have a high density of small-diameter woody species of relatively low height.

The 08 adult species are represented by: *Combretum glutinosum*, *Crossopterix febrifuga*, *Detarium microcarpum* and *Piliostigma thoningii*.

**Figure 6** shows number of stems per hectare by diameter class at both sites.

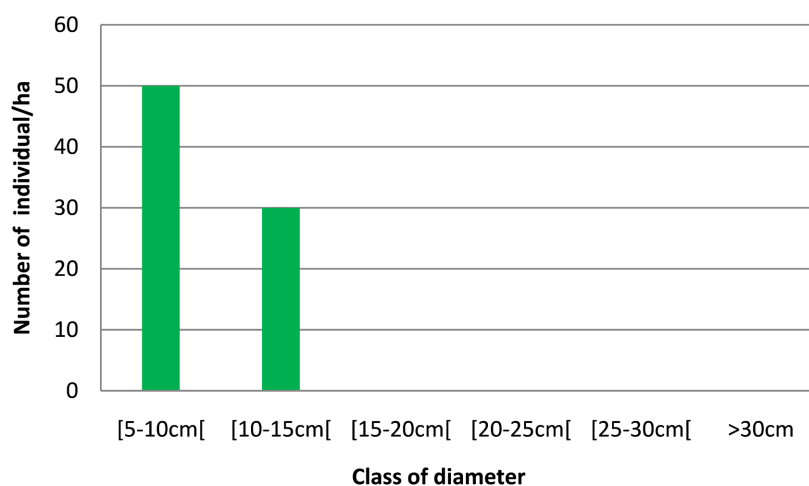
### 3.5. Regeneration Structure

**Figure 7** shows the distribution of individuals by height class. Analysis shows a high proportion of juvenile trees (classes 1, 2 and 3). The regeneration of (1 - 1.5 cm) is important.

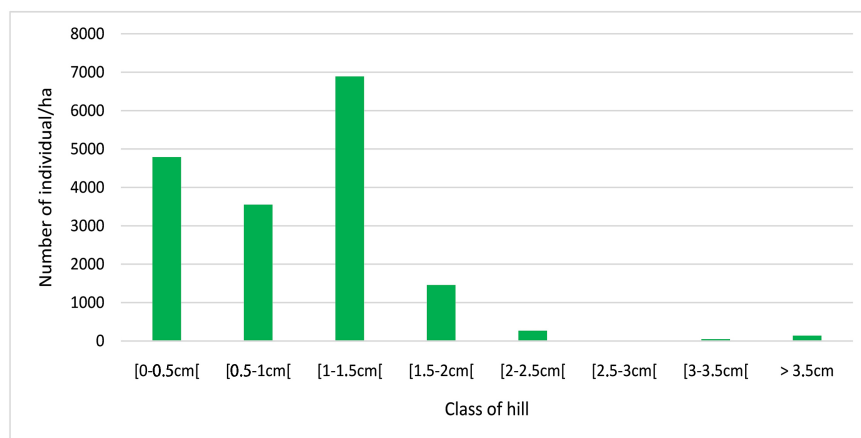
### 3.6. Species Diversity at the Sites

Overall, the Massang site contains 59 species in 53 genera and 19 families. The majority of woody species are the result of itinerant surveys. The Fabaceae family is very abundant (21 species), *i.e.* 39.6%, followed by the Poaceae (10 species), *i.e.* 18.86%. The other families have only one species, representing 1.69% (**Figure 8**

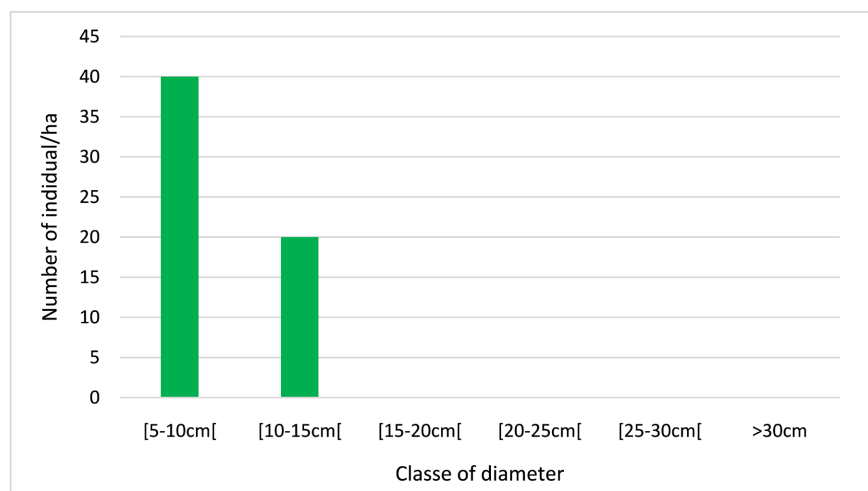
and **Figure 9**). The Wazetelan site contains 54 species in 43 genera and 18 families.



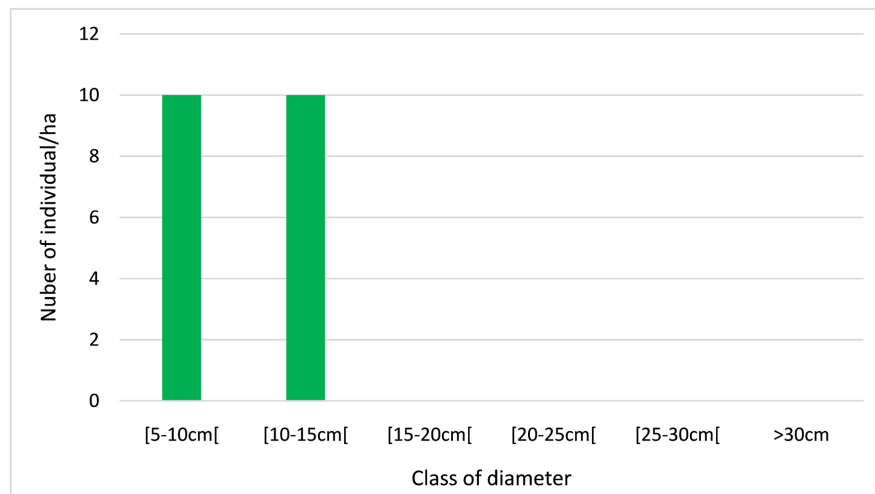
**Figure 6.** Number of stems per hectare.



**Figure 7.** Distribution of individuals by height class.



**Figure 8.** Individual adult site of Massang.



**Figure 9.** Individual adult of Wazetelan.

Fabaceae contain 19 species with 35%, followed by Poaceae with 09 species and 16.6%. The other families are represented by just one species each, *i.e.* 0.18%. The large number of woody species is due to the itinerant inventories. The difference between these two results is linked to soil texture: the soil at the Massang site is silty-clayey, which is conducive to the development of several species, whereas that at the Wazetelan site is sandy-clayey.

### 3.7. Structure of Adult Individuals at Both Sites

A total of 1725 stems were surveyed in the 02 900 m<sup>2</sup> plots sampled, including 08 stems with diameter at breast height (dbh)  $\geq$  5 cm (adult individuals) and 1717 stems from the juvenile population (regenerations). All these individuals belong to 21 species, 19 genera in 10 families, the most important of which are Fabaceae with 5 species (23.8%), Rubiaceae with 4 species (19%) and Combretaceae with 3 species (14.28%) (**Figure 10** and **Figure 11**) then the diameter more high is (1 - 1.5 cm).

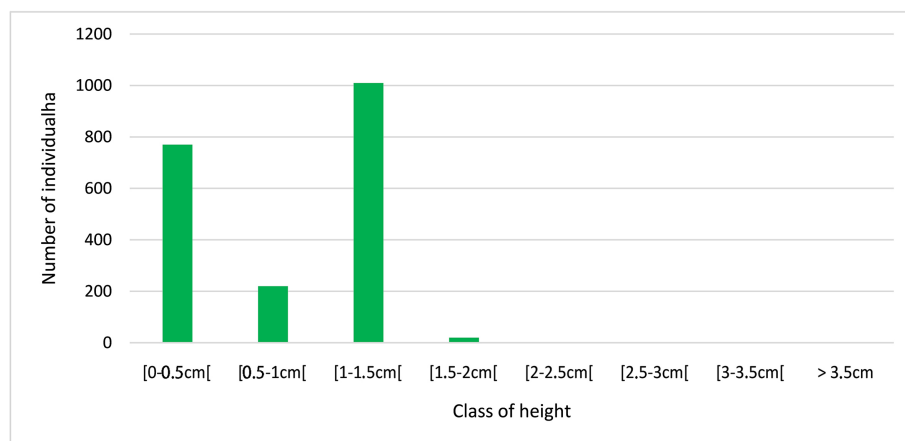
These results show that, overall, the plant formations at both sites have a high density of small-diameter woody species of relatively low height.

The 08 adult species are represented by: *Combretum glutinosum*, *Crossopterix febrifuga*, *Detarium*.

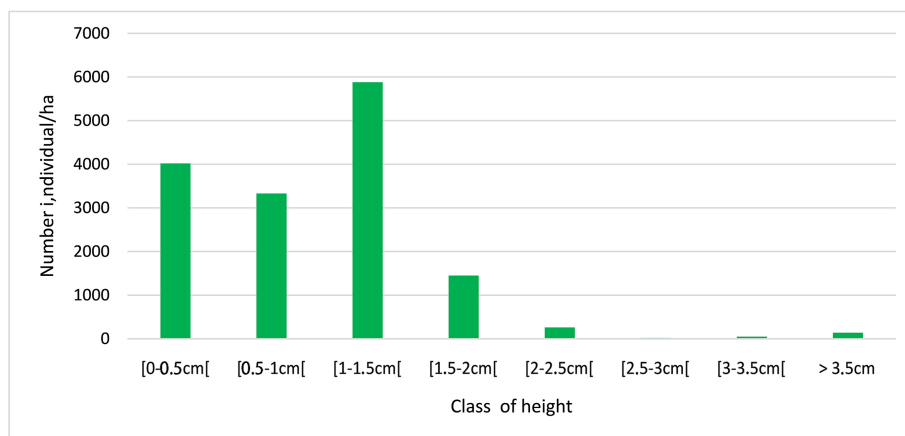
### 3.8. Structure of Adult Individuals at the Sites *Microcarpum* and *Piliostigma thoningii*

The individuals at the Massang site comprise 208 stems, including 06 adults (2.8%) and 202 from the regeneration class (97.2%). They are divided into eleven species, nine genera and five families. The species with a diameter greater than 5 cm are: *Combretum glutinosum*, *Crossopterix febrifuga* and *Detarium microcarpum*. However, these species are relatively young (see **Figure 8**). At the Wazetelan site, 1517 stems were counted. On this site, the woody plants are almost entirely regenerated. A total of 1515 individuals were regenerated (99.86%) and 02 adults (1.14%) (**Figure 12**). The structure of adult individuals is represented by a single species: *Piliostigma*

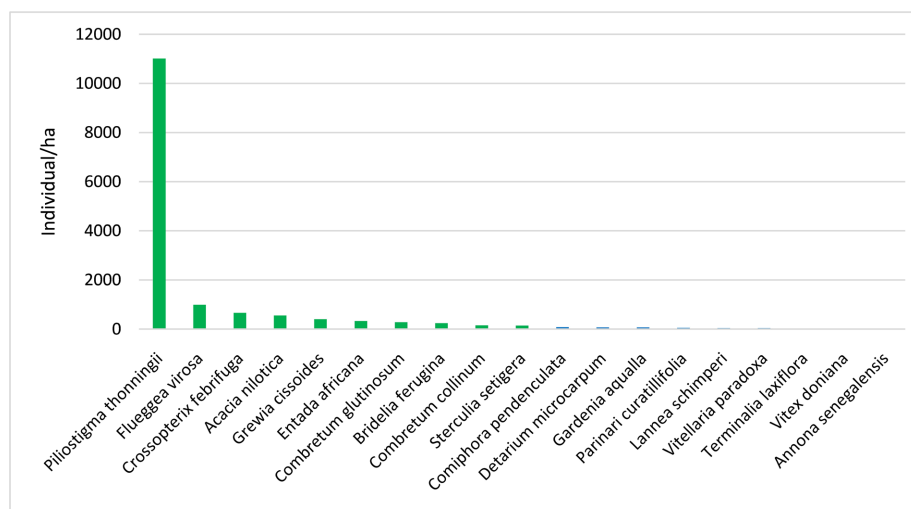
*thonningii*, i.e. 10 individuals/ha, respectively in the first two classes. Also the *Pilostigma thonningii* is abundantdance about other species.



**Figure 10.** Distribution of ligneous in height Masan.



**Figure 11.** Distribution of ligneous in height Wazetlan.



**Figure 12.** Distribution of lignous include the species abundantdance both sites.

## 4. Herbaceous Data Inventory

### 4.1. Inventory of Overall Data from Both Sites

The species inventoried on the two sites and in 4 10 m × 10 m surveys included 28 species and 24 genera in 10 families (**Table 1**). The most represented families are Poaceae and Fabaceae, with 09 and 06 species respectively.

**Table 1.** Herbaceous species inventoried in 10 m × 10 m plots at both sites.

Species	Cover 100%	Height (m)	Phénology	Family
<i>Hypparrhen iarufa</i>	5	2.3	fe3fr3	Poaceae
<i>Schizachyrium sanguineum</i>	5	2.5	fe3fl3fl3	Poaceae
<i>Crotalaria ononoides</i>	2	0.7	fe3fr1	Fabaceae
<i>Leptochloa caeruleascens</i>	2	1.2	fe3fl3fl1	Poaceae
<i>Lepidagathis lutescens</i>	+	1.2	fe3fl3fl1	Acanthaceae
<i>Alternanthera sessilis</i>	+	0.6	fe3fl3fr2	Amaranthaceae
<i>Pandiaka involucrata</i>	+	0.6	fe3	Amaranthaceae
<i>Aneilema sinicum</i>	+	0.3	fe3fr3	Commelinaceae
<i>Cyanotis lanata</i>	+	0.2	fe3fr3	Commelinaceae
<i>Floscopaleithyrsa</i>	+	0.2	fe3fr3	Commelinaceae
<i>Ipomoea</i> sp.	+	0.3	fe3fr3	Convolvulaceae
<i>Cassia mimosoides</i>	+	0.2	fe3fr3	Fabaceae
<i>Indigofera bracteolata</i>	+	0.4	fe3fr3	Fabaceae
<i>Indigoferacolutea</i>	+	0.5	fe3fr3	Fabaceae
<i>Indigoferaspicata</i>	+	0.3	fe3fr3	Fabaceae
<i>Tephrosia bracteolata</i>	+	0.6	fe3fr2	Fabaceae
<i>Hyptis</i> sp.	+	0.8	fe3	Lamiaceae
<i>Hibiscus aspera</i>	+	1.1	fe3fr1	Malvaceae
<i>Melochia corchorifolia</i>	+	0.5	fe3fr2	Malvaceae
<i>Urenalobata</i>	+	0.5	fe3fr2	Malvaceae
<i>Andropogon tectorum</i>	+	0.9	fe3fr3	Poaceae
<i>Hypparrhenia subplumosa</i>	+	1.5	fe3fr3	Poaceae
<i>Loudetia togoensis</i>	+	1	fe3fl3fr1	Poaceae
<i>Panicum maximum</i>	+	0.6	fe3fr3	Poaceae
<i>Panicum pensum</i>	+	0.4	fe3fr3	Poaceae
<i>Pennisetum pedicelletum</i>	+	0.2	fe3fr3	Poaceae
<i>Spermacoce stachydea</i>	+	0.4	fe3fr3	Rubiaceae
<i>Ampleliocissus multistriata</i>	+	0.1	fe2	Vitaceae

NB: Fe = foil (fe1, fe2, fe3); Fl = flower (fl1, fl2, fl3); Fr = fruit (1, 2, 3); 1 = beginning, 2 = full, 3 = end.

## 4.2. Inventory of Herbaceous Phytomass Data by Site

### 4.2.1. Herbaceous Species at Massang Site

15 species and genera in 07 families were inventoried in the 0.5 - 1 m<sup>2</sup> squares, before clear-cutting (**Table 2**).

**Table 2.** Species present in the five 1 m<sup>2</sup> squares of the Massang site.

Species	Recover 100%	Height (m)	Phenology	Family
<i>Schizanthyrium sanguineum</i>	5	2.5	fe3fl3fl3	Poaceae
<i>Crotalaria ononoides</i>	2	0.7	fe3fr1	Fabaceae
<i>Leptochloa caerulescens</i>	2	1.2	fe3fl3fl1	Poaceae
<i>Alternanthera sessilis</i>	+	0.6	fe3fl3fr2	Amaranthaceae
<i>Cassia mimosoides</i>	+	0.3	fe3	Fabaceae
<i>Hibiscus aspera</i>	+	1.1	fe3fr1	Malvaceae
<i>Hyptis</i> sp.	+	0.8	fe3	Lamiaceae
<i>Indigofera spicata</i>	+	0.3	fe3fr3	Fabaceae
<i>Lepidagathis lutescens</i>	+	1.2	fe3fl3fl1	Acanthaceae
<i>Loudetia togoensis</i>	+	1	fe3fl3fr1	Poaceae
<i>Melochia corchorifolia</i>	+	0.5	fe3fr2	Malvaceae
<i>Pandiaka involucrata</i>	+	0.6	fe3	Amaranthaceae
<i>Spermacocestachydea</i>	+	0.3	fe3fr3	Rubiaceae
<i>Tephrosia bracteolata</i>	+	0.6	fe3fr2	Fabaceae
<i>Urenalobata</i>	+	0.5	fe3fr2	Malvaceae

### 4.2.2. Herbaceous Plants at the Wazetelan Site

In the five 1 m<sup>2</sup> squares, the inventory recorded 15 species, 12 genera and 06 families (**Table 3**).

**Table 3.** Herbaceous species inventoried in the five 1m<sup>2</sup> squares on the Wazetelan site

Species	Recover = 80%	Height (m)	Phenology	Family
<i>Hypparrhenia rufa</i>	5	2.3	fe3fr3	Poaceae
<i>Ampleliocissus multistriata</i>	+	0.1	fe2	Vitaceae
<i>Andropogon tectorum</i>	+	0.9	fe3fr3	Poaceae
<i>Cassia mimosoides</i>	+	0.2	fe3fr3	Fabaceae
<i>Cyanotis lanata</i>	+	0.2	fe3fr3	Commelinaceae
<i>Floscopaleithyrsa</i>	+	0.2	fe3fr3	Commelinaceae
<i>Hypparrhenia subplumosa</i>	+	1.5	fe3fr3	Poaceae
<i>Indigofera braeeteolata</i>	+	0.4	fe3fr3	Fabaceae
<i>Indigofera colutea</i>	+	0.5	fe3fr3	Fabaceae

## Continued

<i>Ipomoea</i> sp.	+	0.3	fe3fr3	Convolvulaceae
<i>Aneilema sinicum</i>	+	0.3	fe3fr3	Commelinaceae
<i>Panicum maximum</i>	+	0.6	fe3fr3	Poaceae
<i>Panicum pensum</i>	+	0.4	fe3fr3	Poaceae
<i>Pennisetum pedicelletum</i>	+	0.2	fe3fr3	Poaceae
<i>Spermacoce stachydea</i>	+	0.4	fe3fr3	Rubiaceae

## 5. Discussion

This study enabled us to assess the floristic diversity of the 1800 m<sup>2</sup> experimental sites on the outskirts of the PNSO. The results of our research yielded 46 herbaceous species, divided into 33 genera and 13 families, compared with 137 herbaceous species, divided into 94 genera and 33 families, obtained by Isaac [8] in Manda National Park in southern Chad, surveys carried out over a total area of 60,000 m<sup>2</sup>. The most represented families are Fabaceae 27.3% and Poaceae 21.9%. These results are similar to those obtained by Nkongmeneck [9] and Ekobo [10], who listed the Poaceae as the most represented family at 26.5%, with 18 families out of a total of 68. And the graminoid stand, comprising Poaceae, Cyperaceae, Fabaceae, Commelianceae and Malastomataceae, accounts for 60.3% of the species surveyed. These results also corroborate those of Yaméogo [11] in the Vipalgo terroir, whose study found that species from the Poaceae family were the most numerous, followed by legumes and Cyperaceae. These results of the floristic composition of the natural pastures set aside at two sites, Wazetelan and Massang, are similar to those obtained by Sawadogo [12] in the pastures of the Tiogo classified forest, INERA [13] in the northern Sudanian zone of Burkina Faso and INERA [14] in the province of Kadiogo. These results corroborate to those Ehlu *et al.* [15] who have found 89 plant species belonging to 70 genera and 28 families were recorded within the NCF with dominant species are: *Heteropogon contortus* (L.) P.Beauv. and *Combretum collinum* Fresen on 20 plots of 50 m × 20 m on the *Nakpadjouak* Community Forest (NCF) in Tami (Togo, West Africa). However, the number of species inventoried is lower than that obtained by the latter. This may be explained by the fact that our study does not cover the same areas as these authors. The proportion of graminoid stands in the vegetation surveys carried out in our study proved to be very high, which justifies the quality of grazing in these sites, hence the attraction of transhumant herders Descoings [16]. The richness of these ecosystems in grasses also justifies the wealth of wildlife in these two cantons (Dari and Goumadji). Distribution histograms were used to characterize the natural environments, reflecting the quantitative and qualitative richness of the environment in terms of the dominance or abundance of the species encountered. The study also made it possible to characterize the vegetation in terms of abundance and dominance. From the point of view of dominance, the poaceae species influences the physiognomy of the two sites studied in the two cantons. The study

shows that the species inventoried on the two sites and in 4 surveys of 10mx10m, contain 28 species, 24 genera in 10 families. It goes without saying that inventories remain the only means of valuing a given environment Melom [17]. The most represented families are Poaceae and Fabaceae, with 09 and 06 species respectively. Lastly, the study revealed that the two protected sites on the outskirts of the PNSO are more diverse than they are rich. Thus, the apparent homogeneity of the physiognomy of the two sites, sometimes due to the dominance of a single species, conceals the reality of the great floristic diversity of these ecosystems.

## 6. Conclusion

This article focuses on the floristic assessment outside the legal boundaries of the Sena Oura National Park on two protected sites in Canton Dari and Canton Goumadji. The proportion of graminoid and woody stands in the vegetation surveys was found to be very high, which justifies the quality of grazing on these sites, hence the attraction of transhumant herders. The vegetation is characterized by the dominance of poaceae species for graminoids and *Piliostigma thonningii* for woody species, which have influenced the physiognomy of both sites. The total cover of herbaceous plants in the ten yield squares will enable us to determine the carrying capacity of the pastoral areas in terms of UBT, which will be determined by laboratory analysis of the quantity of dry matter.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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