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Characterization and structuring of the woody vegetation of Minawao in the Mayo-Tsanaga Department (Far North, Cameroon)

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Abstract

In other to meet the current challenge of the development and sustainable management of Minawao's vegetation, we were asked to first known the characteristic and the structure of this before developing a suitable plan to the extent possible. Locared in the department of Mayo-Tsanaga Farth-Nord Cameroon in the canton of Gawar, Minawao occupies the granito-gneissic base of the Monts-Mandara. A floristic invetory in four 3.75 ha Collection Units was carried out according to the cardinal points compared to the Minawao Camp. For data analysis, Excel, Statgraphics plus 5.0, ENVI 4.5 and XLSTAT we used. Out of and area of 15 ha, we collected 7143 individuals in 57 species 42 genera and 30 families. The most represented species are *Anogeissus leiocarpus* (22.33%), *Acacia polyacantha* (12.29%), and *Balanites aegyptiaca* (6.22%). The horizontal distribution of vegetation represented in the class shows that the first class (]0, 1.5[) is the one with the greatest number of individuals (2,246 individuals) followed by the second (]1.51, 2.5[) for which the number of individuals is 317. The shannon index ranges from 0.07 to 0.08 bit, while Pielou equitability varies from 0 to 0.01. It is clear that overexploitation is real, it is amplified by population growth in this locality, this transletes into the presence of many of the least emerging species. Developing successful development projects within the framework of development to meet this challenge would be more appropriate in the foreseeable future.

Keywords: Characterization, structuring, vegetation, Minawao

1. Introduction

Biodiversity has long served humans, and for centuries it has been considered a multidimensional source of supply. Despite its assets, it is now under threat, disrupted by overexploitation and urbanization. This has attracted the attention of world organizations and researchers to this catastrophic phenomenon. After the Earth Summit on Biodiversity Conservation held in Rio de Janeiro (Brazil) in 1992, Cameroon is now one of the countries that realizes that measures must be taken to protect natural resources. It has adopted the policy of good forest management. With the idea of making the forest a reform that governs the standards of fairness and transparency (from Law No. 94/01 of 20 January 1994) that offers allowances to Aboriginal people (Rock, 1994). Despite the provision of this law, the abuses continue to recur, so the observation is quickly made with global warming, the drying up of water points, the reduction of rainfall, the installation of the desert to mention only these. In some African countries, the origin of savannahs is considered to be the result of degradation due to intensive exploitation of vegetation by local populations (Swaminathan in 1990 quoted by Tchobsala *et al*., 2016a; Klein, 2002). Each year, there are more than 50 to 100 times as many species extinctions worldwide due to anthropogenic actions (CBD, 2000; UN, 2011).Because of these abuses, global warming has become a topical issue. To address this situation, the 2015 Prais Climate Conference, which took place from November 30 to December 12, 2015 at Bourget in France, helped to identify major political issues, this is the case with inclusive and ambitious agreements signed by African countries (Cop21, 2015). Repeated seasonal cycle disturbances over the past few yeras have been noted, in addition to this, the population growth caused mainly by the humanitarian crisis that has driven the populations of Borno (Federal State of Nigeria) and some Cameroonians from the border zone following the abuses of Boko Haram to settle in the secure areas such as the case of the Minawao camp which requires at this very moment an increase of multifaceted resources for the population vulnerable (food, sanitation, crafts, ect…). This galloping demography is correlated with the destruction of the plant cover for the benefit of anthropogenic activities (agriculture, livestock, traditional medicine, and timber exploitation, etc.) (Tchotsoua *et al*., 2000; Tchobsala and Mbolo, 2013).

In order to achieve this at the end of this reflection, which is that of making known to each one the current state of the vegetation of Minawao in order to take adequate measures (sustainable management) vis-à-vis the latter, we will be talking about achieving a number of objectives. Firstly, it will be a question for us to determine the characteristic of the vegetation of Minawao; and secondly, to determine its structure.

2. Materials and Methods

2.1. Presentation of the zone of study

The study took place in the department of Mayo-Tsanaga in the locality of Minawao. The collection of floristic data was carried out in the Collection Units (CU) chosen according to the four cardinal points in relation to the said camp of Minawao. The distance between the camp of Minawao and each of the CU ranges from 400 to 1000 m and each CU has an area equal to 3.75 ha. To the north is CU1, to the south CU2, to the east CU3, and to the west CU4. The camp covers approximately 319 km² of geographic coordinates 10°33’ North latitude and 13°51’ East longitude (UNHCR, 2018). It is limited to the North by Gadala, to the South by Fernde, to the East by Zamay and Wafango, and to the West by Gawar. Temperatures often reach 42°C. Precipitation ranges from 700 to 900 mm per year (Brangeon and Bolivard, 2017)

The soil of this locality is sandy-clay consisting of stony colluvial deposits. The climate is of the Sudano-Sahelian type, characterized by two seasons: the rainy season (June to October) and the dry season (November to May). The Minawao camp is located in a granito-gneissic base area (Brabant and Gavaud cited by Brangeon and Bolivard in 2017)

2.2. Methods

To collect the floristic data, we carried out the floristic surveys in the four Collection Units (CU) of our study area. It was based on ethnobotanical investigations observed directly in the field. In fact, we proceeded by the method of the minimum area which consisted of making a sampling stratified by cluster using the fixed plot size of 5 m x 2500 m considered here as a repetition that indeed is constituted evolutionary Quadras of 5 m x 5 m (Tchobsala *et al*. 2011). In these different Quadras, all the woody feet have been listed.
Some of these species were identified on-site during collection even while others were conducted after harvesting and then verified from the illustrations in Michel *et al*. (2008) in the “Sahel woods”, and «Trees and Shrubs of the Sahel» by Maydell Hans-Jürgen Von (1990). The diameter at chest height (dbh), the diameter of the houppier of each foot were evaluated using a tape meter of 30m long. The height of the shaft was assessed using a pole, the impact inflicted (cut, burn, skinning, pruning, pruning, and much more) on each plant was mentioned if there was.

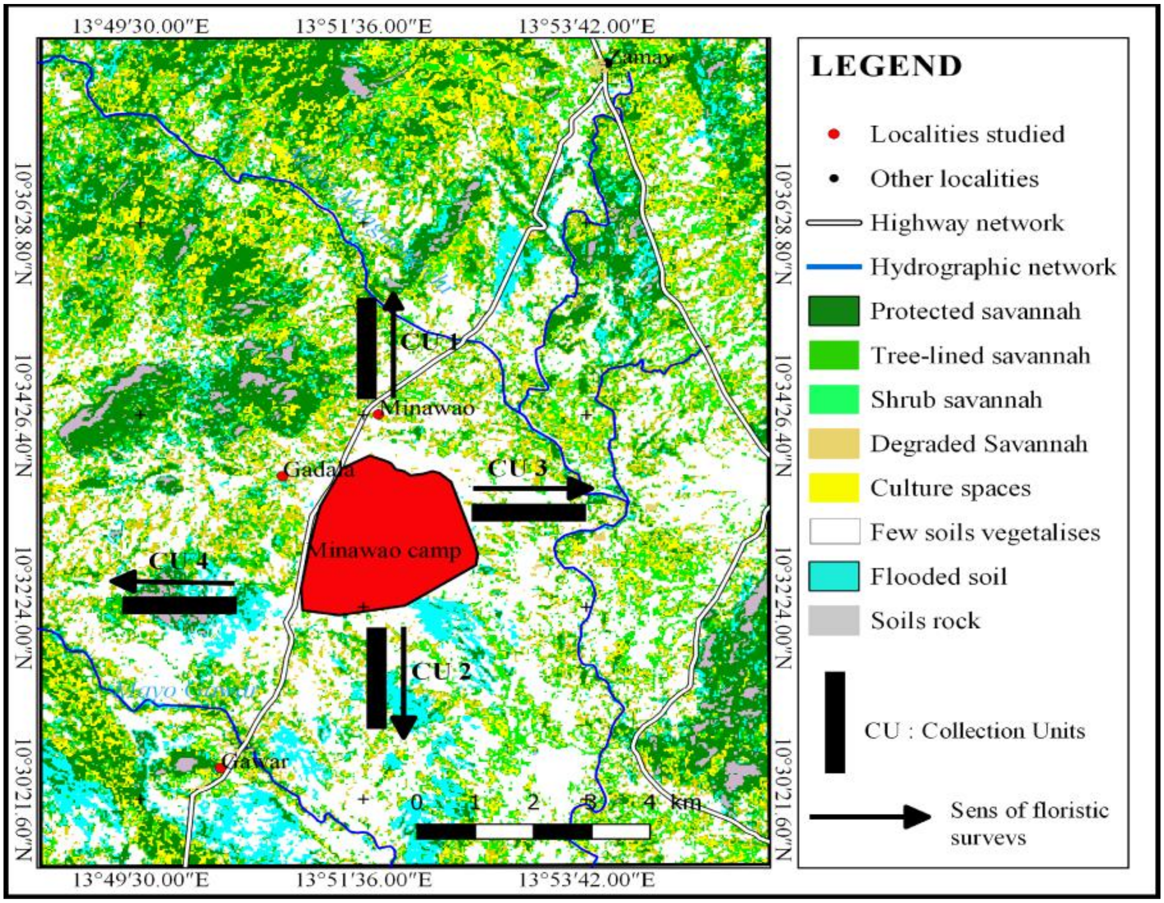

Figure 1: Study Area Location Map

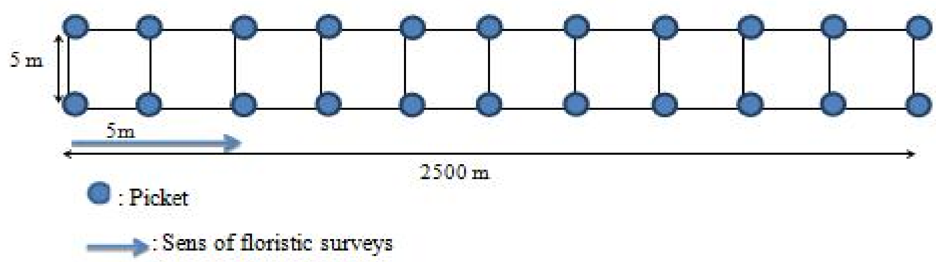

Figure 2: Method of vegetation survey

The Experimental Device is a model of a two-factor Split-plot, the primary factor consisting of four (04) Collection Units (CU1, CU2, CU3, CU4) and the secondary factor consists of three (03) plots that is, three (03) replicates correspond to an area of 1.25 ha for each plot. Our floristic surveys (using the minimum range method) were subsequently carried out in each of the plots following a straight gait in each of the plots. The distance between Minawao camp and these CUs varies considerably, 400 m between camp andCU3, 500 m between CU2 and camp and 1000 m between camp and CU1 and between camp and CU4. As a result, to leave from one collection unit to another, we had oriented ourselves according to the direction of the needle of a watch. It is important to note that CU1 is to the north of the geographically coordinated camp (10°57' North latitude and 13°86' East longitude) is a tree-lined savannah with trees and shrubs scattered across the graminean carpet. The CU2 is on the south side with a geographic coordinate (10°53' North latitude and 13°86' East longitude) is a shrub savannah with a predominance of shrubs on a graminean carpet. The CU3 is eastwards of the geographically coordinated camp (10°55' North latitude and 13°88' East longitude) is a degraded savannah, it has a strong degradation which is expressed by very noticeable empty spaces forming a clear canopy leaving light widely passing. The CU4 is westward of the geographically coordinated camp (10°54’ North latitude and 13°83’ East longitude) is a protected savannah with protected trees on the Graminean carpet (Tchobsala *et al*. 2014; Tchobsala *et al*. 2016).

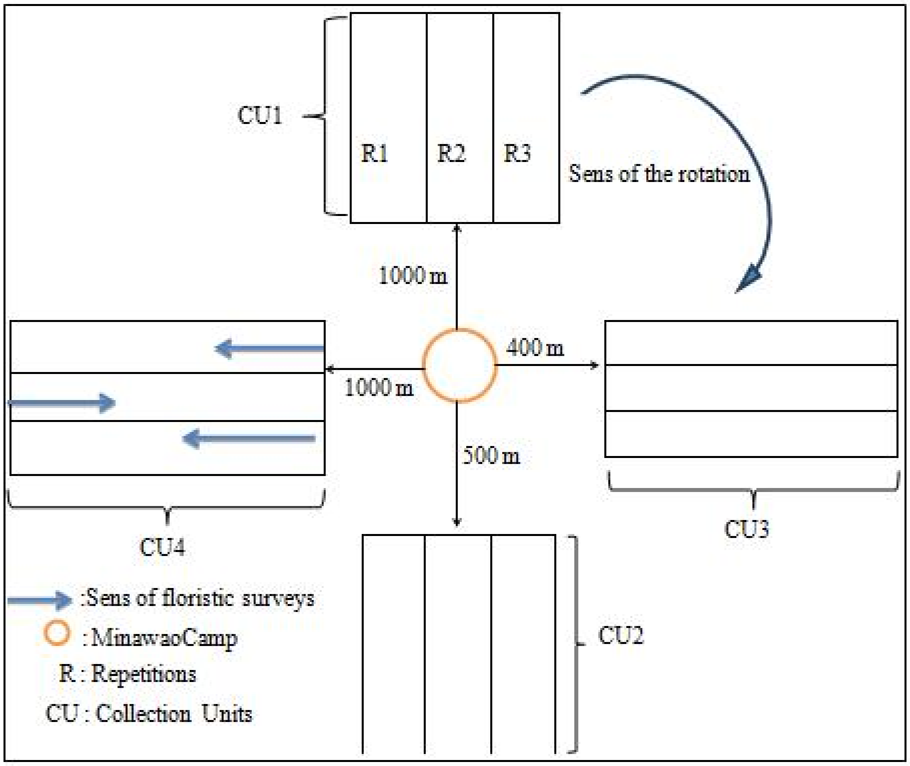

Figure 3: Experimental Device

2.3. Indications of floral diversity

This survey makes it possible to calculate the various biodiversity indices, namely:

➢ **As the Shannon index**, it was possible to measure the specific diversity of species in the different media and the distribution of individuals within these species. This index is calculated using the formula below (Shannon, 1948 ; Shannon and Weaver, 1963, quoted by Danboya *et al.*, 2017) ;

$$ISH = -\sum_{i=1}^{S} (Ni/N)\log 2\,(Ni/N)$$

Ni: number of individuals of a given species, N: total number of individuals, ISH: Shannon index, log2: basic logarithm two (02), i ranging from 1 to S (total number of species).

➢ **The Simpson Interaction Index,** was used to calculate the dominance of a species in a medium and to measure the probability (between 0 and 1) that randomly selected individuals do not belong to the same group. It is calculated as follows:

(Simpson, 1949 quoted by Manfo *et al.*, 2015, Noiha *et al.*, 2015);

$$D = \frac{N(N-1)}{\sum_n (n-1)}$$

N = total number of individuals, n = number of individuals (change from 1 to infinity) in the population of each species;

➢ **The Pielou Index** was used to measure the distribution of species according to their abundance within the same community. Its values range from 0 to 1 (Piélou, 1969 cited by Danboya *et al.*, 2017) ;

$$EQ = \frac{ISH}{\log 2(S)}$$

✓ **Density**

The density is given by the formula: D = N/ S with N = number of species of the study medium and S= area occupied by the species. To this, the burrow surface was calculated.

✓ **Burrowarea**

It is given by the formula: Gi=C 2/4π where Gi is the burrow surface of a species i,
C=circumference of the tree at 1.30 m above the ground.

➢ **Coefficient of similarity of Jaccard**, it allowed to compare the different plots.

It is given by the formula below (Le Floch, 2001);

$$PJ = \frac{c}{a + b - c} * 100$$

Where a= number of listed species a (Medium 1);b = number of listed species b (Medium 2), c = number of species common to both media. The similarity between habitats is expressed by the high value of this index. The distance of Hamming proposed by (Daget *et al*., 1982 quotes from Le Floch, 2001) is added to this index to compare the floristic readings according to the formula: H = 100 - PJ where PJ is the Jaccard index. The thresholds used are shown in Table 1.

Table 1: Comparison Threshold of Floristic Surveys by Hamming Distance

Threshold	Comparison
H< 20	Very low floristic difference
20<H<40	Low Floristic Difference
40<H<60	Medium Floristic Difference
60<H<80	Strong Floristic Difference
80<H	Very strong floristic difference

Frequency was used to determine the proportion of a species to all other species in a population. The absolute frequency of species represents the total number of surveys where the species is present. According to Braun-Blanquet (1932), the relative frequency is the ratio expressed as a percentage between the number of surveys containing this species and the total number of surveys multiplied by 100. FR=A/B x100 with FR (%) = Relative frequency, A= number of treatments containing the species and B = total number of treatments.

According to him, we can then obtain the frequency indices of individuals in accidental species, accessories, quite frequent, frequent and very frequent (Table 2)

Table 2: Frequency indices (Braun-Blanquet, 1932)

Index	frequency	Typical species
I	F < 20	Accidental species
II	20 < F < 40	Accessory species
III	40 < F < 60	Species quite common
IV	60 < F < 80	Frequent species
V	80 < F < 100	Very frequent species

3. Results

3.1. Characteristic of the stand

3.1.1. Floristic wealth

The woody stratum floristic inventory identified a total of 7143 individuals from 42 genera, 57 species and 30 families (Table 3). From this inventory, we find that the highest numbers of species, genera and families are observed in CU1 and the lowest are relatively in CU2. Intermediate values are noted in CU 3 and 4. This reflects an imbalance in floristic distribution between CU. The number of genera varies from 33 in the CU1 to 27 in the CU2;the number of species varies from 41 in the CU1 to 36 in the CU4 on the other hand the number of families is shared equally in the CU1, 2 and 4 with a number of 24 while the CU2 has 19.

Table 3: Number of genera, species and families in different CU

	CU1	CU2	CU3	CU4
Genres	33	27	30	31
Species	41	37	38	36
Families	24	19	24	24

3.1.2. Specific Richness and Abundance of Woods

The specific richness and abundance of woods inventories in the different CU are given in Table 4. As we can see, it has a complete dominance of *Anogeissus leiocarpus* followed by *Acacia ataxacantha*, *Annona senegalensis*, *Acacia nilotica*. The strong dominance of *Anogeissus leiocarpus* in our study area would be due to its strong regenerative power, its mode of anemochoric dissemination and its root system swivel adapted to the medium. They grow in savannas, dry forests and Sudanese-Sahelian to Sudanese-Guinean forest galleries, on generally compact (clayey) soils. It tolerates temporal floods.

Table 4: Importance of Curtis value of study area species (%)

Scientific names	DR	DeR	FR	IVC	Scientific names	DR	DeR	FR	IVC
Acacia ataxacantha	1,39	6,35	3,57	11,32	*Entada africana*	0,00	0,01	0,56	0,58
Acacia erythrocalyx	0,00	0,03	0,59	0,62	*Eucalyptus camaldulensis*	0,00	1,45	1,51	2,96
Acacia hokki	0,00	0,03	1,15	1,18	*Faidherbia albida*	5,64	3,43	2,66	11,72
Acacia macrostachya	0,55	1,00	2,06	3,61	*Feretia apodanthera*	0,03	1,84	2,94	4,81
Acacia nilotica	0,86	4,49	2,63	7,98	*Ficus platiphylla*	2,17	1,69	2,38	6,24
Acacia polyacantha	12,29	4,70	3,26	20,25	*Ficus sycomorus*	10,28	1,14	2,03	13,45
Acacia seyal	0,48	4,91	2,70	8,10	*Ficus thonningii*	0,39	0,76	1,51	2,66
Acacia sieberiana	1,53	0,55	1,44	3,52	*Gardenia aqualla*	0,08	0,61	3,02	3,71
Adansonia digidata	0,00	0,25	1,23	1,48	*Grewia flavescens*	0,00	0,05	0,95	1,00
Adenium obesum	0,00	0,06	0,32	0,38	*Haematostaphis barteri*	0,00	0,01	0,37	0,29
Agave sisalana	0,03	0,44	0,87	1,34	*Ipomoea carnea*	0,00	0,24	0,63	0,87
Annona senegalensis	0,34	4,15	3,57	8,06	*Isoberlina doka*	0,00	0,02	0,95	0,97
Anogeissus leiocarpus	22,38	9,49	2,70	34,57	*Jatropha curcas*	0,00	0,56	2,63	3,18
Azadirachta indica	0,37	2,25	2,66	5,28	*Lannea barteri*	0,07	2,62	3,57	6,26
Balanites aegyptiaca	6,22	7,68	1,79	15,68	*Lannea velunita*	0,00	1,40	0,32	1,72
Bauhinia rufescens	0,00	0,30	1,79	2,09	*Parkia biglobosa*	0,00	0,01	0,28	0,30
Borassus aethiopum	2,01	1,00	1,83	4,83	*Piliostigma thonningii*	0,37	3,62	2,38	6,38
Boswellia dalzielii	0,00	0,08	0,91	0,99	*Sclerocarya birrea*	0,45	0,94	2,35	3,74
Calotropis procera	0,10	1,33	2,34	3,78	*Steganotenia araliaceae*	0,00	0,03	0,84	0,87
Capparis sepiaria	0,00	0,59	1,23	1,82	*Sterculia setigera*	0,82	1,14	2,42	4,39
Cassia siamea	0,00	0,03	0,32	0,35	*Strychnos spinosa*	0,00	0,38	0,95	1,33
Cassia singueana	0,14	1,98	2,03	4,15	*Tamarindus indica*	5,05	3,60	2,70	11,35
Celtis integrifolia	0,01	1,02	1,75	2,77	*Terminalia glauscesens*	0,00	0,02	0,63	0,65
Combretum aculeatum	0,12	3,49	0,91	4,52	*Vernonia thomsoniana*	0,02	0,69	2,70	3,41
Combretum collinum	0,25	1,53	2,38	4,16	*Vitex doniania*	0,01	2,52	1,58	4,12
Combretum paniculatum	0,00	0,03	0,56	0,59	*Ximenia americana*	0,00	0,31	0,56	0,87
Combretum tomentosum	0,01	0,03	1,68	1,71	*Ziziphus mauritiana*	0,14	3,86	3,13	7,13
Dalbergia melanoxylon	0,01	3,38	2,98	6,36	*Ziziphus mucronata*	0,00	0,58	1,06	1,64
Diospyros mespiliformis	2,14	2,28	2,03	6,45	*Ziziphus spina-christi*	0,01	3,01	3,09	6,10
					Total	**100**	**100**	**100**	**300**

3.1.3. Distribution of Ecological Preference of Plant Species in the Study Area

Figure 4 shows the frequency histogram of woody species inventoried in the CU studied. This representation makes it possible to restart the species in class: species of frequency index I (Accidental species), of frequency index II (Accessory species), of frequency index III (Species fairly frequent), of frequency index IV (Frequent species), frequency index V (Very frequent species).It appears from this figure that 17.23% of the species recorded belong to the frequency index I or 4.17% in the CU1, 4.65% in CU2, 4.38% in CU3 and 4.03% in CU4, this then reflects the rate of accidental species in the different CU, composed of 11 species among which we can cite some: *Acacia erythrocalyx*, *Acacia sieberiana*, *Adenium obesum*, *Parkia biglobosa*. 25.42% of the species belong to the index of frequency II (Accessory species) or 15 species among which we can mention some: *Adenium obesum*, *Bridelia ferruginea*, *Combretum paniculatum*, *Entada africana*, 18.64% Frequency Index III (Species quite common) or 11 species among which we can cite some: *Acacia erythrocalyx*, *Acacia Hokki*, *Acacia sieberiana*, *Agave sisalana*, *Borassus aethiopum*, *Cassia siamea*, 15.25% Frequency index IV (Frequent species) the equivalent of 9 species that are nothing other than: *Bauhinia rufescens*, *Boswellia dalzielii*, *Calotropis procera*, *Capparis sepiaria*, *Ficus platyphylla*, *Ficus sycomorus*, *Ficus thonningii*, *Jatropha curcas*, *Vitex doniania* and finally 40.67% of frequency index V (Very common species) composed of 24 species. These include: *Acacia ataxacantha*, *Acacia macrostachya*, *Acacia nilotica*, *Acacia polyacantha*, *Acacia seyal*, *Adansonia digidata*, *Annona senegalensis*. Such a structure reflects the heterogeneity of the vegetation of our area study, which expresses in a way the over-exploitation of this area.

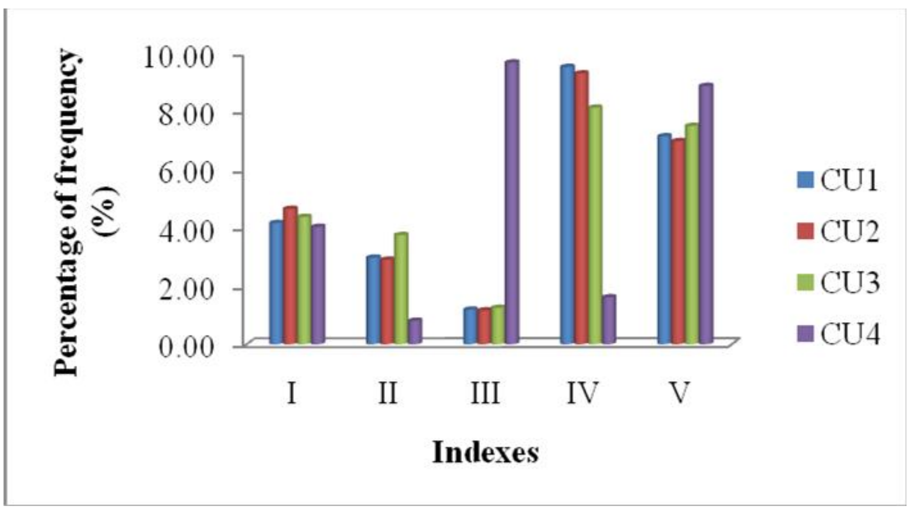

Figure 4: Inventoried Species Frequency Index

3.1.4. Biological diversity of plant groups

Table 5 presents the values of the indices of floristic diversities (Shannon Indices (ISH), Pedestrian Equitability (EQ), Simpson Index (D)). This table shows that the values of the Shannon and Pielou Equitability indices do not really vary according to the CU, whereas those of Simpson vary considerably according to the CU. As a result, the Shannon Index of the different CU ranges from 0.07 to 0.08. Of all these CU, the CU4 is the most diversified, its Shannon index is 0.08, whereas the grouping set of the other three CU (CU1, CU2, CU3) each have an index value of Shannon equal to 0.07, they are therefore the least diversified.

As for the Pielou Equitability Index, the grouping of the three CU are identical (CU1, CU2, CU4), they each have a value equal to 0.01 except theCU3 of which it is practically nil. The Simpson index varies from 0.00 to 1.79 depending on the different CU. CU1 has the highest index, it is valued at 1.79, followed by CU3 (0.02) then CU2 (0.01), and finally CU4 (0.00). We find that three CU show almost zero Simpson index values (CU2, CU3, CU4) except for CU1 with an index value of 1.79.

This result reflects the probability that a species will dominate in the CU1 given its value which is greater than 1 compared to the other three CU which, on the other hand, have a probability substantially equal to 0, evidence that there is a low dominance of a species in these CU.

Table 5: Floristic diversity index

	CU1	CU2	CU3	CU4
ISH	0,07	0,07	0,07	0,08
EQ	0,01	0,01	0,00	0,01
D	1,79	0,01	0,02	0,00

3.1.5. Similarity between plant groups

Table 6 shows the degree of similarity between the different CU studied by the Jaccard index (J) and the distance of Hamming (H). The closer the Jaccard index value is to 100, the more similar the CU considered. This table shows that CUs 1 and 4 are the most similar (70.21%) while CU 3 and 4 are the most similar (51.92%). CU 2 and 3 also have a significant number of common species. In addition, CU with high similarity reflect floristic richness. On the other hand, the floristic difference is small between CU 1 and 2 (H=34.00), 1 and 4 (H=29.79), and between 2 and 3 (H=32.65). It is average between CU 1 and 3 (H = 45.45), 2 and 4 (H = 42.86), and at the end 3 and 4 (H = 48.08).

Table 6: Degree of similarity between CU

	CU1		CU2		CU3		CU4	
	J	**H**	**J**	**H**	**J**	**H**	**J**	**H**
CU1	100	0						
CU2	66	34	100	0				
CU3	54,55	45,45	67,35	32,65	100	0		
CU4	70,21	29,79	57,14	42,86	51,92	48,08	100	0

3.1.6. Multiple Matrix Correspondance Analysis

Figure 6 (a) and (b) present the Main Component Analysis (CPA). This analysis can be used to study the distribution of species in the CU studied. This species distribution is based on the factorial plane of axes 1 and 2. It also makes it possible to group woody species that have similar correlations. The analysis of the main component variables (PCA) shows that species such as *Anogeissus leiocarpus*, *Piliostigma thonningii*, *Balanites aegyptiaca*, *Acacia ataxacantha*, *Ziziphus mauritiana*, *Acacia seyal*, *Annona senegalensis*, *Faidherbia albida*, *Acacia nilotica*, *Diospyros mespiliformis and Acacia polyacantha* are the most represented. The species scattered in this figure are very dense, one has the chance of encountering them in all study areas and their correlation with cloud-clustered species is weak. The least represented species form clouds around these two axes (f1: 68.88% and f2: 95.69%). Species depicted as clouds are less dense, they cannot be encountered anywhere in the CU of our study area. These species have high correlations between them. We find that CU 1 and 4 are important and positively correlated with very similar species. However, CU 2 and 3 are correlated weakly and negatively with very similar species. In addition, CU 1 and 4 are opposed to CU 2 and 3 in relation to the x-axis. The positive correlation of CU4 which is the protected savannah and CU1 which is the wooded savannah, implies that the mechanism of resiliency and dissemination operate easily in these two types of formations, both of which have a great floristic richness similar to other plant formations, namely: the shrub savannah (CU2) and the degraded savannah (CU3), both of which are subject to very strong anthropogenic pressure, thus slowing down ecological resilience. To this end, there is tangible evidence of the strong pressure exerted by residents and largely refugees on the shrubby savannah and degraded savannah of the locality of Minawao.

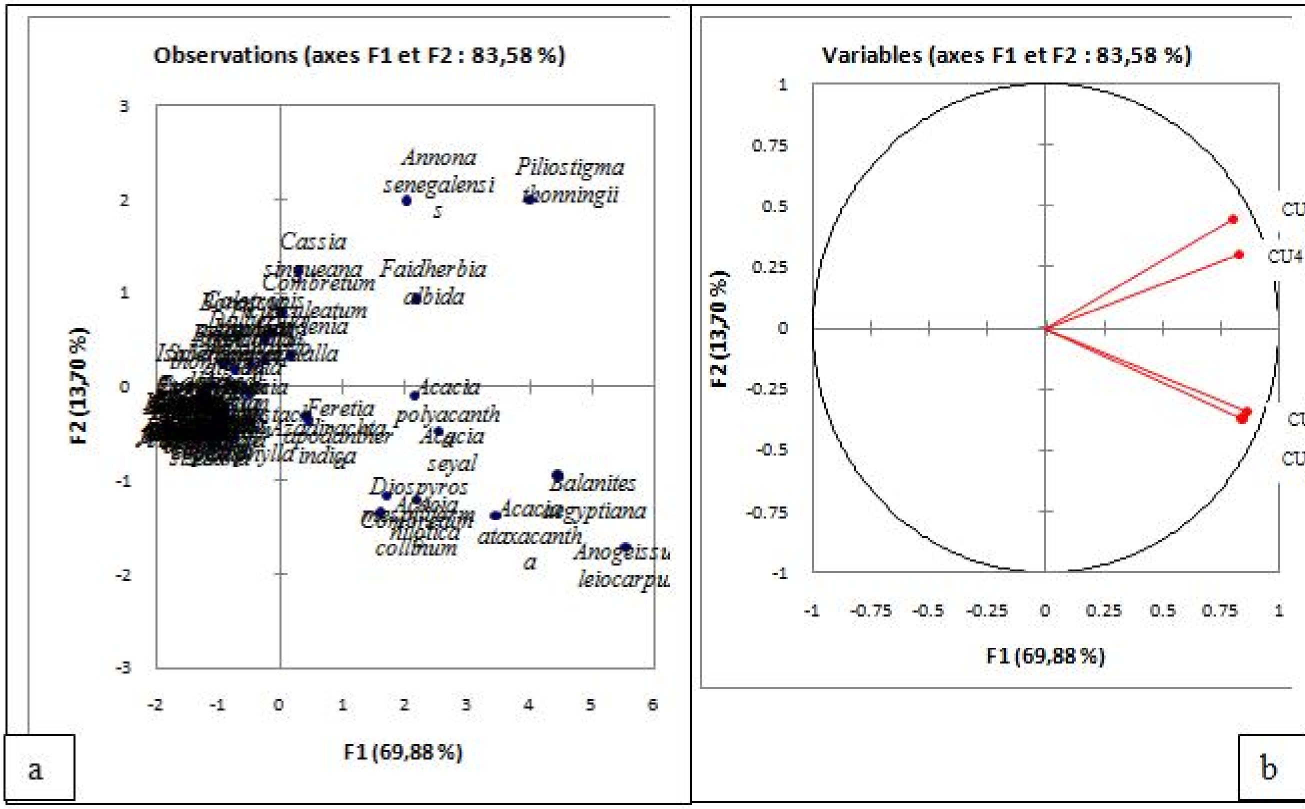

Figure 6 (a) and (b): Analysis of Main Component Variables

3.2. Structuring the Study Area Stand

3.2.1. Vertical structure of stand

The vertical structure or stand height of our study area is classified at intervals ranging from [0-1.5[to [18.51-19.50[(Figure 7a). Individuals belonging to the class [0-1,5[are more numerous than individuals in the class [18,51-19,50[. The representative histogram of the vegetation has an "L" structure. This structure is the result of a high pressure of wood removal on the vegetation. However, repeated cuts of wood do not allow the vegetation to recover quickly.Intense wood cuts on the same plot result in a large number of seedlings of less than 2.50m in size and small in diameter in all CU due to the intensity of cuts compared to adult subjects.This would justify the structure of the stand in "L" also in the detailed illustration, elucidated by the representative histogram of Figure 7b. There is a regeneration of tree strata in plant communities.This is more visible in two plant formations: the protected savannah (CU4) and the shrub savannah (CU2). This is because of their ability to terminate themselves more easily than other plant formations, which relate either to the favourable microclimate or to the quality of the permissive soil.

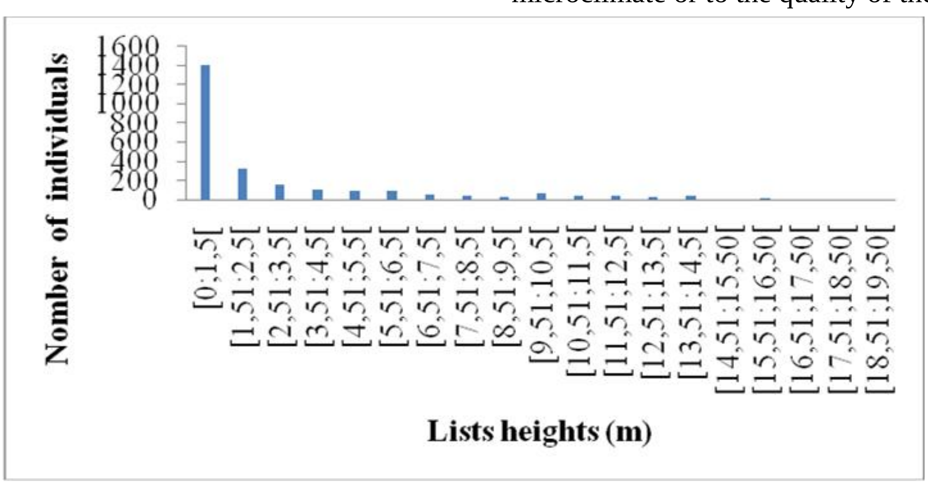

Figure 7a: Structure of stand by height

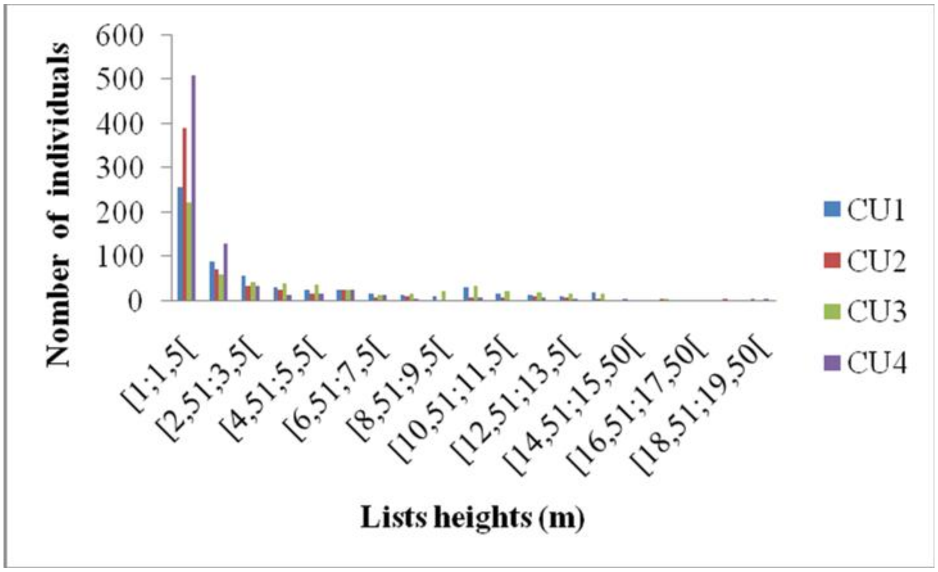

Figure 7b: Structure of Height Classes by CU

3.2.2. Horizontal distribution of stands

The horizontal distribution or diameter of wood at chest height (dbh) of the stand of our study area is classified according to the intervals from [0-1.5[to [4,51-5,5[. The settlement of our study area largely reflects the first class, which is nothing more than [0-1.5[(2,246 individuals) and then falls to 1.51-2.5[(317 individuals).The remaining classes show almost identical values (Figure 8a). The structure of the horizontal distribution of the stands of the different CU is in "L", it is a sign of the high exploitation of the vegetation of our study area. Nevertheless, we can see that the fewer individuals have reduced circumference the more significant their workforce is. Furthermore, these results express the fragility of the vegetation of the different CU that draws the histogram in the form of an "L" (Figure 8b). Among these different plant formations, this would justify the superiority of the protected savannah (CU4) in class number [0-1,5[compared to other plant formations, it is the fact that it has all the potentialities remarkable to the resilience of the protected gender savannah (competition between individuals, specific interaction etc.). When the large number of the class [1,51-2,5[in the wooded savannah (UC1) compared to other plant formations, it would be due to the high adaptability capacity of the species belonging to this class. The regeneration of plants in general is very slow in this locality, this because of repeated abusive activity on the trees that make up these different plant formations.

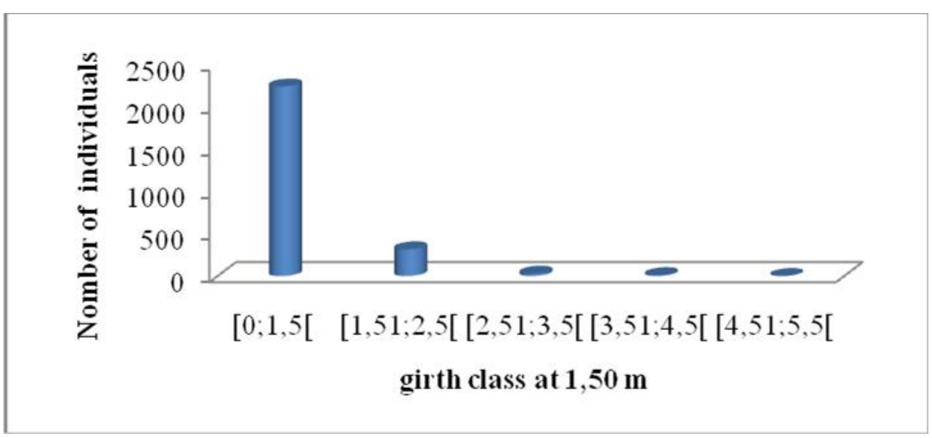

Figure 8a: Structure of stand according to dbh

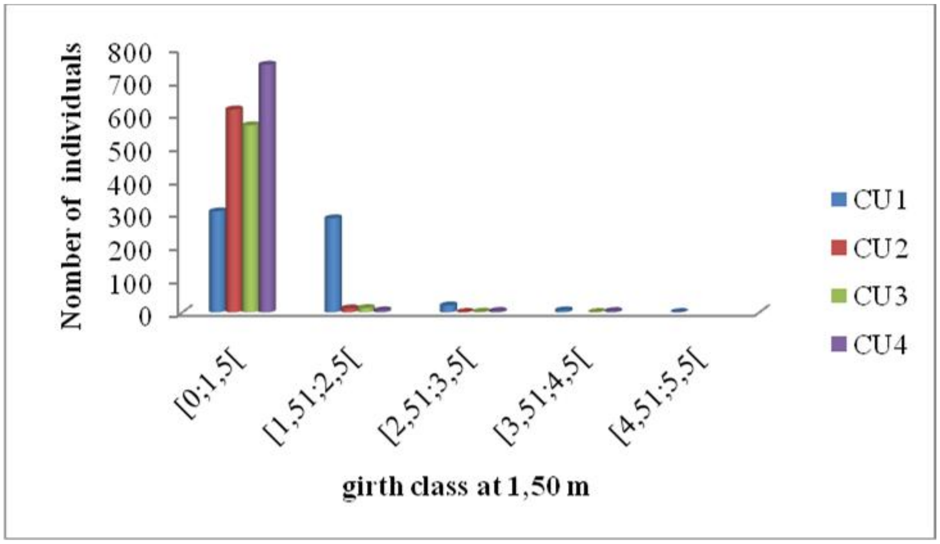

Figure 8b: Structure of Height Classes by CU

3.2.3. Vertical distribution of the stand

The following figure shows the diameter of the stand cutter in the area of our study (Figure 9a). This figure shows the number of individuals according to the different classes. The class with the high number of individuals is that of [1-2[having a number of individuals equal to 1693 and falls from the class [3-4[with a number of 423 individuals thus pursuing to the last class [23-24[(2 individuals). We find that the histogram representative of the stand structure of the houppier is in "L". This reflects the repeated exploitation of vegetation which therefore has an impact on the flowering of plants; Moreover, the cable tree is less developed. There is also a passive resilience of the flora caused by the quasi-drying of the water table, which is probably one of the factors underlying its growth. There is then a close link between the stand structure as a function of the houppier and the different classes of the houppier as a function of the CU which is now the very reflection of the histogram in the form of "L" (Figure 9b).

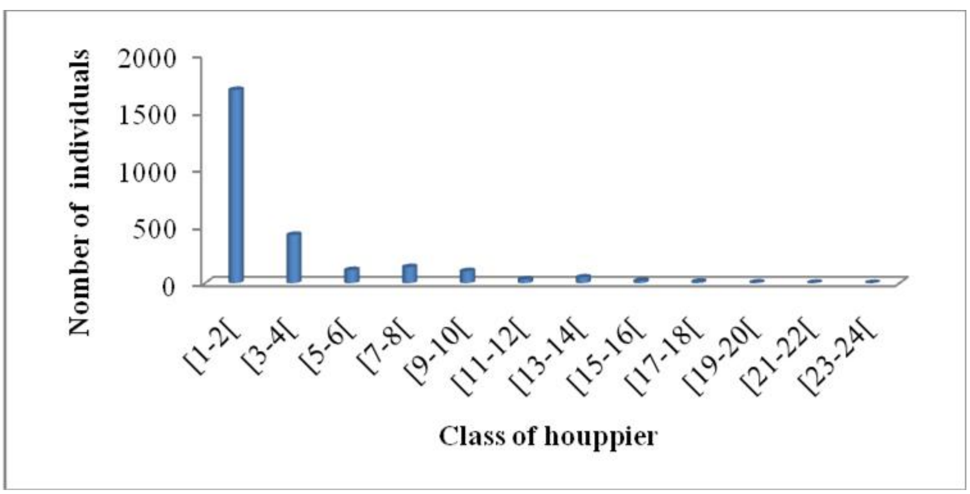

Figure 9a: Structure of stand as a function of cutter

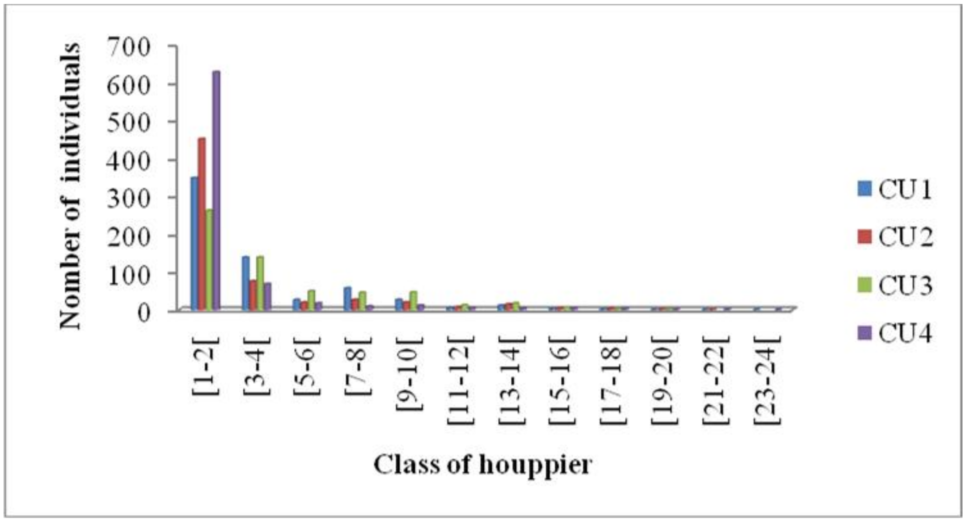

Figure 9b: Structure of Cloaks by CU

4. Discussion

4.1. Floristic wealth

The vegetation of Minawao is crowned with a floristic richness testifying to a remarkable diversity despite the influence of the anthropogenic actions found there. Several species are represented in this oversized savannah where competition is a constraint for which among them wants to survive. For those who have developed their adaptability, we found them on site, to say that they were collected. In total we have inventoried 7143 individuals belonging to 42 genera, 57 species and 30 families. These results differ from those of Nyasiri (2018) who for him identified 66 genera, 87 species, 39 families in the forest landscapes of the cliff of Ngaoundéré (Adamaoua-Cameroon).The greatest floristic richness of the cliff compared to that of Minawao would be explained by the fact that Minawao has a Sudano-Sahelian climate while the forest landscapes of the cliff has a sudano-type climate Guinean which immediately marks an obvious biodiversity. As we can see, we are here in one case of two ecologically different zones, in addition to climatic factor, is added to this the edaphic factor (soil state), the dissemination of diaspores, competition between species without discarding the climate factor.

4.2. Similarity between plant groups

In the plant groupings subject to our assessment, the results obtained correspond to those of Nyasiri (2018) who found that the values of Jaccard indices obtained are different between plots, This reflects a difference between CU due to the influential factors of the individuals that make up them (climate, nature of the soil, rainfall, anthropogenic actions).In terms of the distance from Hamming, Ntoupka (1999) in the Laf Reserve, found two forms of floristic difference between plant formations (fields, bushes, and pastures), it is: the strong floristic difference and the mean floristic difference. The strong similarity between CU1 (wooded savannah) and CU4 (protected savannah) would be explained by the fact that in this locality, the disseminator effect is present despite the similarity gap between the other CU: CU3 (degraded savannah) and CU4 (protected savannah), CU2 (shrub savannah) and CU3 (degraded savannah).Based on these results, we understand that the protected savannah is the richest of all the savannahs mentioned here, it is probably that it really meets its qualification. The small floristic difference between CU1 (tree savannah) and CU2 (shrub savannah), between CU2 (shrub savannah) and CU3 (degraded savannah) reflects a large number of species similar in that they have many more common species. There is a reconciliation between these results and those of us, because we have had a small floristic difference and an average floristic difference. The presence of the mean floristic difference thus expresses the floristic shade between the CU hence the floristic diversity. The anthropogenic action would in fact be the main cause of this difference without neglecting the climatic factor see edaphic.

4.3. Vertical structure of stand

The degradation of the savannah is at least visible, the repeated cuts prevent the vegetation from regenerating rapidly. This result is consistent with that of Tchobsala (2011) in the peri-urban savannah of Ngaoundéré and Jiagho (2018) in Waza National Park which both had the histogram representative of the vertical vegetation structure of their "L" study area while Haiwa (2018) had an overturned "U" structure. For this purpose, the variance analysis detects a very highly significant difference between classes (0.001< 0.01) on the one hand and significant between individuals on the other (P< 0.05).

4.4. Distribution of the stand

The vegetation of this locality is represented much more by shrubs, the individuals that make up it are under anthropogenic pressure and at the same time ancillary to the climatic vagaries. The findings are consistent with those of Haiwa (2013) in the Department of Mayo-Kani (Township of Lara) who presented the histogram representative of the structure of the houppier of the vegetation in "L". It should also be noted that the illustration of this histogram in this way is proof that these species are under the resiliency. For this purpose, the variance analysis detects a very highly significant difference between classes (0.001< 0.01) and significant between CU (P< 0.05).

Conclusion

This study enabled us to make known to each other the current state of the vegetation of Minawao in order to make adequate arrangements (sustainable management) vis-à-vis it. By focusing on the different descriptible analyses of vegetation, we have achieved expected results. The structure is really that of an exploited vegetation, the least emerging shrubs are the most dominant. In addition, the floristic inventory of the woody stratum identified a total of 7143 individuals belonging to 42 genera, 57 species and 30 families. In general, the "L" gaits of histograms would translate the pressure on the vegetation as well as the regeneration of the vegetation. However, it does not omit the appearance of the actual presence of individuals in the small height and diameter classes. Indeed, individuals of small diameter and low height are the most abundant in CU4 compared to other CU. For individuals whose dbh is 1.30m from the ground, they are very representative for small classes than other classes ([0;1.50[;[1.51;2.5[). There is then an effective presence of the individuals composing the classes of small height and small diameter. Indeed, individuals of small diameter and low height are the most abundant in CU4 compared to other CU. Similarly for individuals whose dbh is 1.30m from the ground, they are also very representative for small classes as for other classes ([0;1.50[;[1.51;2.5[)). To hope for a sustainable management approach, a number of programs may well improve the situation. First, to train volunteers in each village concerned on the ba sis of forest management; second, to promote the promotion of local products so as to emphasize the risk of a possible deadline and ultimately to domesticate the species most sought by the local community in order to promote a cultural richness worthy of the name.

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