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The Impact of Anthropisation on the Floristic Composition, the Structure and Ecological Characterization of the Ngaoundéré Cliff, Cameroon

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I. Introduction

The ecosystem deterioration represents today a biodiversity threat for the destruction of natural environments inevitably leads to scarcity, not to say the extinction of some species (Swaminathan, 1990). The populations growing needs in forestry shortages, some agricultural practices, the bush fires have considerably caused degradation which is more and more characterized by these habitats. This appears through the modification of floristic composition, the vegetation structure and poor natural regeneration of some species (Diatta *et al.,* 2009). Deforestation is one of the blights experienced by most of the forest around the world. It is mostly unbridled in tropical areas where the exploitation of the wood and agriculture are the main sources of wealth. The African continent is also affected by the extension of the forest (4 million of hectares per year). The convention on the biological diversity estimated in 2000 that 54,000 plant species and 5,200 animal species faced extinction, and this is mainly due to human action (SCBD, 2000). In Cameroon, the Adamawa region is the prone to natural and anthropic pressures. Real figures on the occupation of the Ngaoundéré soils showed that the savannah areas have diminished from 10.8% in 2001 in comparison with the one in 1951 (Tchotsoua, 2006). The main factors of that degradation are slash-and-burn cultivation (Zapfack, 2005), the combined effects of deforestation, the bush fires and pasture (Ntoupka, 1994, 1998; Tchobsala, 2011), the hydroelectric and mining exploitation and the population growth (Tchotsoua, 2006). The Ngaoundere cliff is under high anthropic exploitation, that is to say the intensification of farming, the over pasturage, the road constructions, camping and immigrant installations. All these threats contributed to the considerable reduction of the forestry surface of the area and consequently to the overall shape and to the specific resources of the vegetation. In view of this serious degradation of the environment in our planet the safeguarding of biodiversity remains the main tool of the 21st century (SCBD, 2000; UNSECO, 2009). It is for that reason that many research works have been carried out on the management methods, the conservation and the development of the savannahs throughout the Adamawa region (Tchotsoua 1996, 2006; Tchobsala 2011), but it is worth mentioning that no research work has been carried out on the impact of anthropisation of Ngaoundere cliff vegetation which is a non-conventional forested zone. This research has as main objective the study of anthropisation impact on the floristic composition, the structure and ecological characterization of the Ngaoundéré cliff so as to recommend its sustainable protection.

II. Material and Methods

a) Localization of the area of research

The locality of Wack, situated 50Km from Ngaoundere (picture 1) was chosen as the area of the investigation. The climate is a Soudano-Guinean type, mild and fresh with two seasons: the rainy and dry seasons (Yonkeu, 1993). The annual pluviometer

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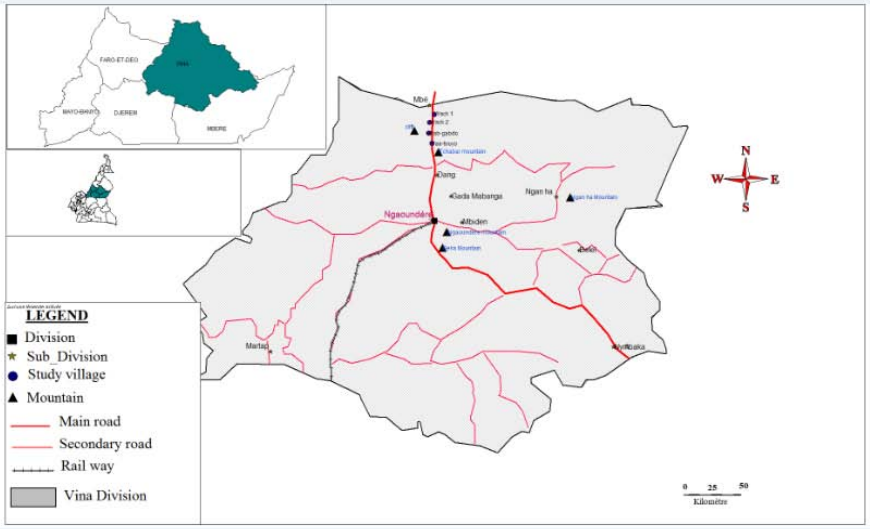
reaches 1479 mm with 9.8% of variation margins. Extreme temperatures vary between 5 and 7°C minima to 30 and 35°C maxima (Mope, 1997). In the Adamawa Region in general and in Ngaoundere in particular the vegetation is made up of very open shrub savannah, with the presence of some species such as *Adansonia digitata, Ziziphus mauritiana, Tithonia diversitfolia, Vitex dononia, Annona senegalensis, Piliostigma thonningii, Entada africana,* all streaming from lateral transition of the dense forest to the graminaceous and herbaceous savannah made up of species such as *Manihot esculenta, Cassia javanica, Annona squamosa, Hibiscus esclentus, Hibiscus sabdarifa, Arachis hypogea, Pennisetum purpureum* (Mopongmetsem, 2005).



Picture 1 : Area of research localization Map

b) Formula notices and ecological description of the vegetation

The collection of anthropisation indexes, dendrometric parameters of the environment were carried out on 24 areas, this is when one is either in or out of the cliff from four different formations of vegetation (fallow lands, farming fields, shrub savannahs, arborescent savannahs). They were carried out on every 300m on areas covering 20mx500m following six straight transects. The experimental system is a complete randomized group with four formations of vegetations (M_1, M_2, M3 and M_4), six transects (T_1, T_2, T_3, T_4, T_5, and T_6) and with four occurrences (R_1, R_2, R_3 and R4) (Table 1). All existing woody species found in small plates were systematically listed and counted. Those species were identified through their scientific names. The unidentified subjects were collected with the help of specialists and built up a herbarium in view of indentifying and confirming the Wakwa herbarium. Ecological depicted standard forms were filled simultaneously with the realization of thriving statement. In each small plate, all the trees species were taken down and for all the 1.30m subjects, the following dendrometric parameters were assessed; the height to draw up the structure of the population, the diameter of the tassel, the tour of the trunk of a tree which is 30cm from the floor to assess the surface of the ground and examine the ligneous distribution depending on the categories of circumferences. For the tassel measuring, two measurements were done at the foot of each tree in accordance with the cardinal points; North- South and East- West and this is the average of the two proportions which represented the diameter of the tassel. For mullicaul subjects, the circumferences of the biggest, the medium and the smallest stems were assessed for the medium circumference is worked out. The geographic details of stock taking thriving small plates were recorded thanks to the GPS

Table 1 : Experimental device

R= notice, T = transect, M = formation of vegetation, 1, 2, 3 and 4 respectively represent fallow land, field, shrub savannah and planted tree savannahs.

	T1	T2	T3	T4	T5	TS6
R1	M1	M1	M2	M2	M4	M4
R2	M1	M1	M3	M3	M3	M4
R3	M1	M2	M2	M3	M3	M4

c) Treatment and analysis of data

The basic knowledge exploited concern the appraisal of the frequency and the affluence of dominance. The frequency here represents the number of subjects of a species on the total absolute frequency of a species depicts the total number of projection where the species is actively involved. According to Braun- Blanquet (1932) training that species and the total amount of reports time 100.

FR (%) = A/B x 100 with, FR (%) = relative frequency, A= processing of the species while B= total number of processing.

This proportion or frequency is to determine the number of subjects made up of accidental species, incidental species, species which are frequent enough, frequent and very much frequent (Table 2).

Tableau 2 : Frequence indices of Braun-Blanquet (1932)

Indices	Frequency	Type of species
I	F < 20	accidental species
II	20 < F < 40	incidental species
III	40 < F < 60	enough species frequent
IV	60 < F < 80	frequent species
V	80 < F < 100	very much frequent species

Excess can refer to the total number of the subjects of each species. The excess of the species can be either absolute or relative. Absolute excess is the total number of subjects from a species out of the total number of subjects in the investigated site. Relative excess is the ratio between absolute excess out of the total number of the subjects of the community.

Dominance on the other hand is the collection of the subjects from each species and this is done with the help of percentage. Absolute dominance is the connection with the total earth's surface of the species (STTC) over the total earth's surface of the community time 100 DR = $\frac{STTe}{STTC}$x100

The relative Curtis value importance is the sum of the relative density, the relative frequency and the relative collection. IVCR (%) = FR+DR+DeR with IVCR: Curtis value Importance, FR=Relative frequency, DR=Relative dominance and DeR= Relative density. To get reliable results, we equally undertook to make some density calculations, by species and by the expansion stage of some species.

d) Relative density

The relative density deals with the following formula; D=N/S with N=number of the species in the research area and S= area occupied by the species. To this, the earth's surface was worked out.

e) Earth's surface

The earth's surface was worked out through the formula. Gi=TT D_H^2/4 where Gi is the earth's surface of the species i, D_H being the tassel diameter of the species.

f) Diversity and equitability indices

Specific diversity is tasted with the help of range indexes (Magurran, 1988; Kent and Coker, 1992). In fact, many types of mathematic formula's help to calculate these indexes. Among these are those which were selected and which are of common usage. These are the following;

g) The Shannon indices

The Shannon- Weaver also known as the Shannon – Wiener is an index which helps to assess biodiversity. This index indicates specific resources. The following formula illustrates it;

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

H'; Shannon's biodiversity index, i; medium species; P (i): proportion of a species with regard to the total number of species (S) within the survey milieu (or specific diversity of the milieu) calculated as follows: P (i) = ni/N, where ni is the number of the subject of the species and N the total number of subjects, all species taken together.

The Shannon index is use to quantify the heterogeneity of the biodiversity of a survey area, hence to observe the rapid change in time. This theory should be associated with Simpson's.

h) The Simpson index

The Simpson index (D) is a method which helps to calculate the probability of two randomly selected subjects in a given area should be of the same species

$$D = \sum Ni\ (Ni-1)/N\ (N-1)$$

D = Simpson index; Ni= number of subjects of a given species; N= total number of subjects. The index will vary between 0 and 1. The more will get closer to 0, the more chances of getting different subjects of different species will be high. Besides these two indexes, we can work out the fairness of Pielou (E) which is the reverse of Shannon's index.

i) Jacquard's Similarity ratio

The Jacquard's similarity ratio (PS) (Floch, 2007) allows us to compare the different breeding grounds. It is shown through the following formula;

$$PS = \frac{c}{a+b-c} \times 100$$

Where a= the number of species from list a (breeding ground 1); b= number of species from list b (breeding ground 2); c= number of species common to the two breeding grounds.

The similarity between the housings is represented by the high merit of the index.

j) Hamming distance

The hamming gap proposed by Daget *et al.* (2003) quoted by the Floch (2007) is added to this index to compare the floristic statement. Its can shown through the following formula: H = 100 – PS where PS is the Jacquard's Similarity ratio. The deduced thresholds are divided up in Table 3.

Table 3 : Comparison threshold of floristic statement according to the hamming gap

Threshold	Comparison
H< 20	very low floristic difference
20<H<40	low floristic difference
40<H<60	medium- sized floristic difference
60<H<80	strong floristic difference
80<H	very strong floristic difference

k) Vertical structure of the Ngaoundere woody cliff

The woody subject distribution in terms of diameter and height class was conducted. For the diameter class distribution, Letouzey (1968) method was adopted. In this classification, the subjects are distributed in to four classes:

- the lower stratum made of shrubs with 0 to 10 cm of diameter.
- the stratum with small trees and with 10 to 20 cm of diameter.
- the stratum with mean trees and with 20 to 30 cm of diameter.
- the medium- sized stratum made of trees whose diameter is equal to or greater than 30 cm.

On the basis of result obtain from the height measurements, the subjects were afterwards simplified in greater classes: regeneration, future standard trees, standard trees and great trees.

l) Biological categories

They were worked out according to Raunkiaer (1934) classification, and adapted to tropical regions by Schnell (1971). The phanerophytes (PH) which are plants whose sprouting buds are located at a significant distance from the earth. According to their heights, they have:

a. Phanerophytes including

i. Megaphanerophytes (MgPh), whose heights are around 30 m;
ii. Mesophanerophytes (MsPh), whose heights range between 10 to 30 m;
iii. Microphanerophytes (McPh), whose heights range between 2 to 10 m;
iv. Nanophanerophytes (NnPh), shrubs with heigths under 0.4 to 2 m.
v. Phaneorophytes lianescents (Phgrv. Phgr); voluble plants with gimlets, cramps roots, crawling or supported;
vi. Phaneorophytes epiphytes (Phep).

b. Chameophyts (CH)

i. Chameophytes drawn up (Chd);
ii. Chameophytes prostrate (Chpr);
iii. Chameophytes crawling (Chrp);
iv. Chameophytes climbing (Chgr);

c. Geophytes (G)

Plants whose persistent growths or buds are sheltered in the ground during the bad season:

i. Rhizomateux geophytes (Grh);
ii. Tuberaux geophytes (GB);
iii. Geophytes climbing (Ggr);
iv. Geophytes epiphytes (Gep).

d. Hemicryptophytes (H)

plants which the growths are located at the short-nap cloth of the ground:

e. Theophytes (Th)

Annual plants or at very short growing period, deprived of persistent buds themselves and whose survival is ensured by seeds, they include:

i. Theophytes drawn up (Thd);
ii. Theophytes prostrate (Thpr);
iii. Théophytes scapeux (Thsc).

f. Hydrophytes (Hy); watery plants

Phytogeographical types

The principal phytogeographical types are those admitted for Africa (Lebrun, 1947). The recognized types are the species with broad geographical distribution including:

i. Cosmopolitans (Cos): Species found throughout the whole world;

ii. Pantropicales (Pan): Species known in Africa;
iii. Tropical-American and Asian;
iv. Afro American (AA): Species extended in tropical Africa and America;
v. Paleotropical (Pal): Species present in Africa and tropical Asia, Madagascar and Australia;
vi. Afromalgaches (AM): Species common to the islands of Madagascan and central African areas;
vii. Multi-regional African (PRA): Species whose surface of distribution covers several floristic African areas or two floristic areas which are not in contact.

We also have guineean and soudano zambezian species (G-sz) species including:

i. Sub-Omni guineo-congolese (GC): Species presented in all the floristic guinean area;
ii. Central (CG): Species whose surface of distribution goes from Cameroon to the Democratic Republic of Congo;
iii. Western guineans (WG): Species which are widespread of Western Africa in Western Cameroon;
iv. Cameroon-Congo (CaCo): Species only found in the Cameroonian solid mass and the Congolese basin;
v. Cameroon-Gabon (Ca-Gab): known species only of the forest solid mass Cameroon Gabon-Mayumbe.
vi. Cameroon (Camwood): Species only found in Cameroon.

m) Dissemination types of diaspores

The types of dissemination of diaspores were given according to the classification of Dansereau and Lems (1957). The various types are:

i. Pterochores (Ptéro): Small diaspores with aliform appendices;
ii. Pogonochores (Pogo): Diaspores with feathery or silky appendices;
iii. Slerochores (Scléro): Not fleshy and relatively light diaspores;
iv. Sarcochores (Sarco): Diaspores completely or partially fleshy;
v. Desmochores (Desmo): Diaspores hanging or adhesive;
vi. Ballochores (Ballo): Diaspores expelled by the same plants;
vii. Barrochores (Baro): Not fleshy diaspores;
viii. Pleochores (Pleo): Small diapores with a floating appendix.

n) Statistical analysis of the data

After going through and bringing together the data, a matrix known as the taking down of species was elaborated on the basis of the presence/absence of species on line and steering column for statements. The elaborated matrix was submitted to diversified analysis techniques with the view in aim of highlighting the species dispersion as well as the main plant formations that are brought out. Some variance analysis with the help of the XLSTAT and STATGRAPHICS plus 5.0 software were used to check the gaps between the number processing and the surface. In the presence of significant variance analysis, the medium- sized comparisons were conducted with the help of the Fisher Test. In addition, the difference in composition of the various environments (variety of a formation of vegetation) was tasted with multi varied variance analysis. Parameters such as height, denseness, ground surface and the diameter served as the Principal Component Analysis (PCA).

III. Results

a) The degradation indications of the Ngaoundere cliff vegetation

You can find in the Ngaoundere cliff oxen attached to pasture and some cow dung in the penning (photo1). These pasture indexes are clear signs that the vegetation of the cliff is in a very vulnerable position, both to native and non native animal's breeders. The cliff bordering population produce bush fire either to hunt or for pasture regeneration (early fire), or to get field ready for culture (late fire). Bush fire cause a lot of damages on woody species. Some inhabitants prefer to completely cut down trees which can serve as cultivating fields or for iron works (photo 2). House, path and road camping (photo3) created at the Ngaoundere cliff make up non negligible anthropisation indications for the rapid cliff degradation. The different anthropisation indication has its origin from the degradation of the Ngaoundere cliff.

Picture 2 shows the distribution of 24 ha for the surface used for experimentation. From this picture there is a clear evidence that 47,87% of 24ha of them are taken up by natural formation and 37,95% of fields found at the cliff take up a considerable portion of the destroyed areas. The setting of intensive farming is the main reason that contributes to the degradation of the culture found at the Ngaoundere cliff.

a) Babullock tied up for pasture b) Cow dung in penning

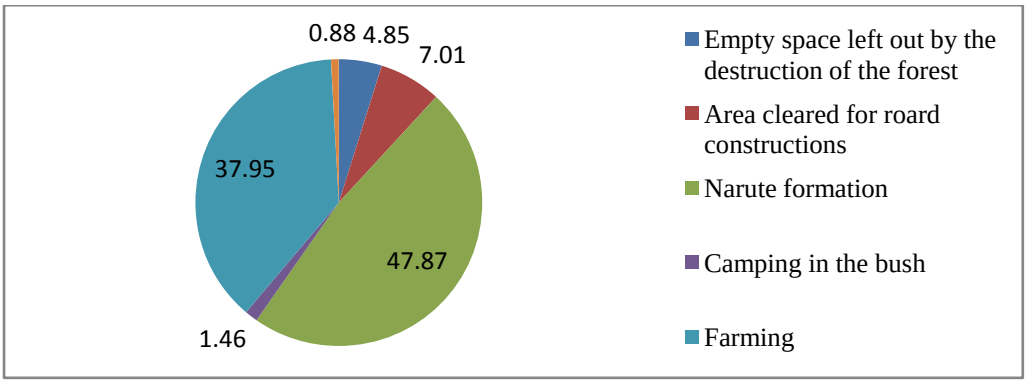
Photo 1 : Cown dung and penning at the Ngaoundere cliff

a) Isobelinia doka burnt b) Isobelinia doka cut down *c) Afzelia africana* cut down

Photo 2 : Burning and cutting down of wood at the Ngaoundere Cliff

a) Maize fields b) Camping c) paths

Photo 3 : Camping, fields, paths inside the Ngaoundere cliff (%)



Picture 2 : destruction of surfaces of the main occupying listed areas

b) Anthropisation indications of woody species in the Ngaoundere cliff

Wood logging, tree barking, animal tracks through dung, grass grazing, paths, bush fires and cultures burn are clear indications for anthropisation. Table 4 shows major indications for extinction species through human activities. They are; wood logging, bush fire and tree barking. Out of the 24ha studied, 113 species destroyed, 27 species burnt and 36 species barked were listed. As for the cut down which is impacted, the *Isoberlinia doka* (17 subjects), is the most solicited. It is followed by the *Grewia flavescens* (15 subjects), the *Daniellia oliveri* (3 subjects), the *Isoberlinia doka* (3 subjects), the *Psorospermum febrifigum* (2 subjects) and *Burkea africana* (1subject). The fallow practice with 40.74% is the most risky species. Concerning the tree barking 16 different types out of the 36 subjects were identified. They are; the *Pterocarpus erinaceus* (14 subjects), the *Piliostigma thonningii* (10 subjects), the *Hymenocardia acida* (8 subjects), the *Securidaca longepedunculata* (6 subjects), the *Grewia flavescens* (5 subjects), the *Phyllanthus muellerianus* (4 subjects), the *Isoberlinia doka* (4 subjects), the *Anogeissus leiocarpus*, the *Bridelia ferruginea*, the

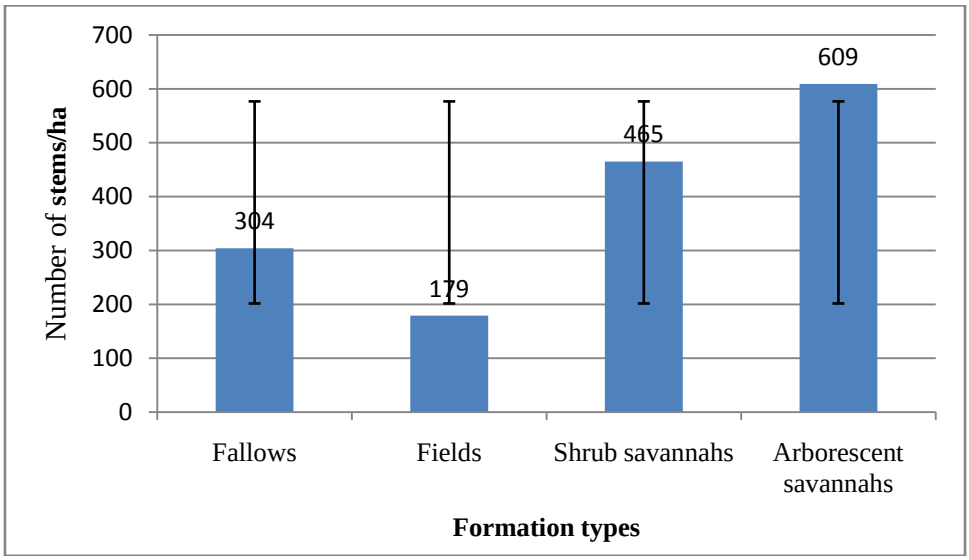
*Entadea africa*na, the *Pterocarpus lucens*, the *Sarcocephalus latifolius, Daniellia oliveri* (2 subjects), the *Sporospermum febrifigum* and the *Sterculia setigera* with one subject each (Table 4).

Table 4 : Indications of anthropisation of woody species in the Ngaoundere cliff

Species	Wood logging				Fire				Tree burking				Wood logging	Fire	Tree burking	total
	M1	M2	M3	M4	M1	M2	M3	M4	M1	M2	M3	M4				
Isoberlinia doka	9	2	4	2	1	0	1	1	4	0	0	0	17	3	4	24
Grewia flavescens	8	4	3	0	0	0	0	0	3	2	0	0	15	0	5	20
Daniellia oliveri	7	3	0	0	1	2	0	0	0	0	0	0	10	3	2	15
Piliostigma thonningii	5	0	0	0	0	0	0	0	4	6	0	0	5	0	10	15
Terminalia laxiflora	1	2	1	1	3	3	1	0	0	0	0	0	5	7	0	12
Bridelia scleroneura	4	2	0	1	0	0	0	0	0	0	0	0	7	0	3	10
Terminalia glaucescens	2	2	1	1	1	0	0	3	0	0	0	0	6	4	0	10
Hymenocardia acida	1	0	0	0	0	0	0	0	0	4	0	4	1	0	8	9
Securidaca longepedunculata	0	1	2	0	0	0	0	0	3	0	3	0	3	0	6	9
Afzelia africana	0	3	4	2	0	0	0	0	0	0	0	0	9	0	0	9
Sarcocephalus latifolius	2	1	1	1	0	0	0	0	1	2	0	0	5	0	3	8
Sterculia setigera	2	0	0	0	0	0	0	0	1	4	0	0	2	0	5	7
Vitellaria paradoxa	3	0	0	0	4	0	0	0	0	0	0	0	3	4	0	7
Anogeissus leiocarpus	0	0	0	0	1	0	2	0	0	3	0	0	0	3	3	6
Phyllanthus muellerianus	1	1	0	0	0	0	0	0	4	0	0	0	2	0	4	6
Pseudocedrela kotschyii	0	0	1	1	0	0	0	0	4	0	0	0	2	0	4	6
Psorospermum febrifugum	0	2	0	1	0	0	0	2	0	1	0	0	3	2	1	6
Bridelia ferruginea	3	2		0	0	0	0	0	0	0	0	0	5	0	0	5
Entada africana	1	1	0	0	0	0	0	0	2	1	0	0	2	0	3	5
Pterocarpus lucens	0	1	0	1	0	0	0	0	0	0	0	0	2	0	3	5
Pterocarpus erinaceus	1	1	1	0	0	0	0	0	1	0	0	0	3	0	1	4
Strychnos spinosa	1	1	0	2	0	0	0	0	0	0	0	0	4	0	0	4
Burkea africana	0	0	0	0	0	0	1	0	0	0	0	2	0	1	2	3
Steganotaenia araliacea	2	0	1	0	0	0	0	0	0	0	0	0	3	0	0	3
Lophira lanceolata	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
Terminalia macroptera	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
Stereospermum kunthianum	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Total	57	27	16	13	11	5	5	6	15	19	0	2	119	27	67	213

c) *The structure of the vegetation according to the population of vegetation densities*

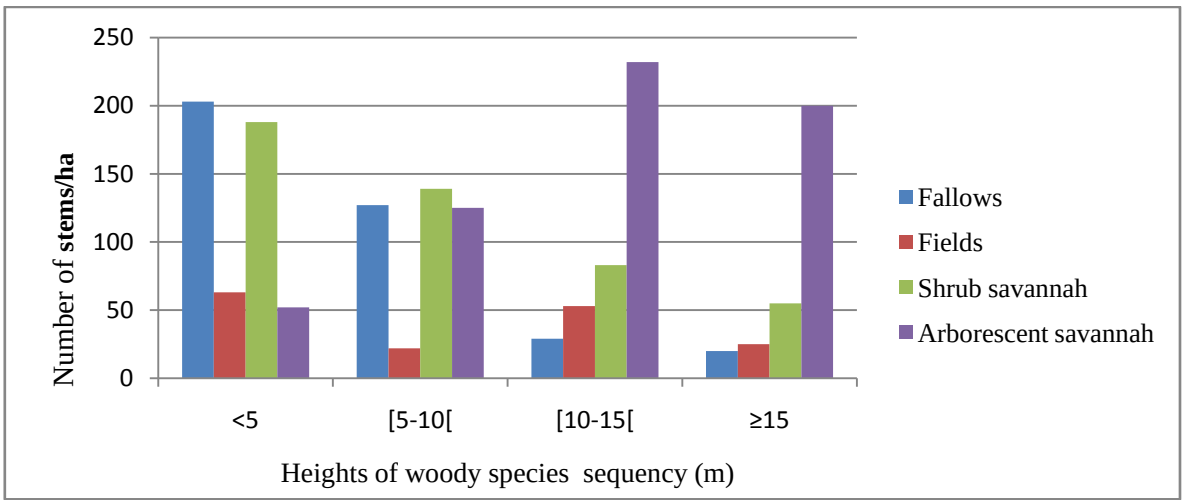
The global denseness of woody species varies from 179 stems/ha in fields which have 609 stems/ha in savannahs planted with trees and that shows subjects listed. There is an irregular distribution of woody species in the different formations of vegetation (picture 3).



Picture 3 : Denseness of different formation (stems/ha)

d) Vertical structure of different woody formations of vegetation

Picture 4 shows the distribution of woody plants with high class. The subjects whose height is inferior to 5m are more numerous in the vegetation. This explains a high regeneration of woody species in the area. This regeneration is highlighted with fallow lands and shrub savannah where the stems of the regenerations were 203 and 188 respectively. The woody plants whose height exceeds 15cm are less represented in the fallow lands (20 stems/ha) and shrub savannah (55 stems/ha), unlikely to areas planted with trees (200 stems/ha) where the species are well depicted. The study of the variance at threshold of 5% shows that there is a significant difference between the height of wood plants within the different experimentation milieu (0.023<0.05)

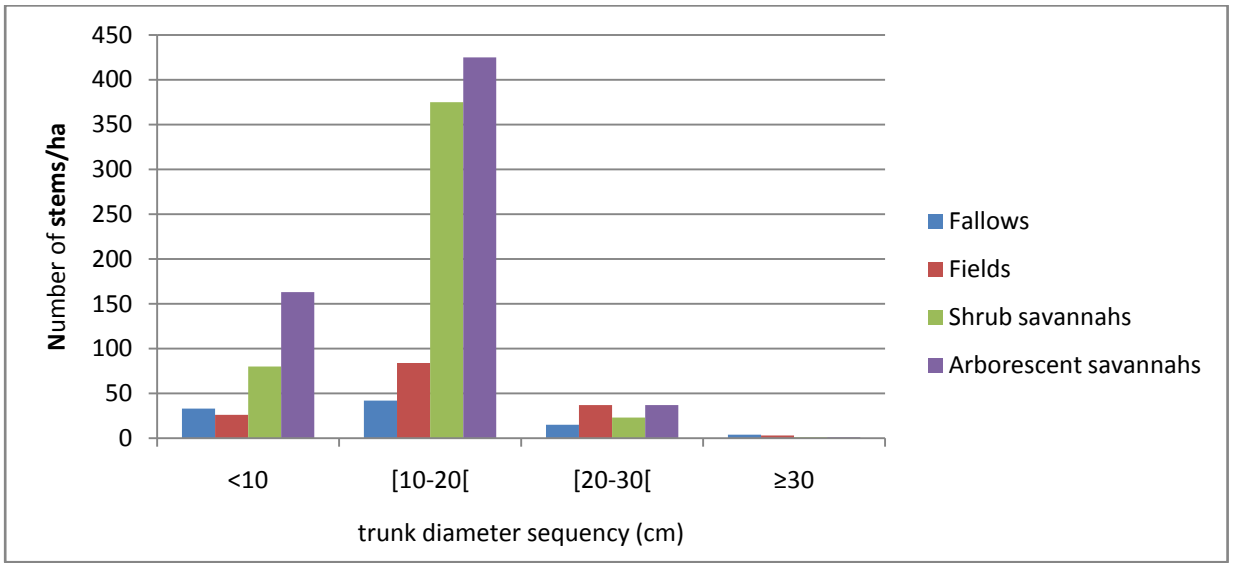


Picture 4 : Distribution of heights of stems species of different formations of vegetation

e) Distribution of horizontal structure of woody species of the different formations of vegetation

The vegetation is dominated by subjects whose diameter is between 10 to 20 cm. This category is highly presented in the planted trees savannahs (425 stems/ha and the shrub savannah (375 stems/ha). In the fallow lands and fields, the number of subjects in the category is 42 stems/ha and 84 stems/ha respectively. The high diameter woody species to 30cm are less important in the vegetation. Those whose diameter varies between 20 to 30 cm are mostly found in fields and in savannahs planted with trees (picture 5).

The threshold analysis of the variance of 5% has shown that there is no significant different between the diameters of woody species in the different formation of vegetation ($p < 5\%$) planted tree savannahs have medium diameter and the highest ones follow and then the fields. The fallow lands have medium and less diameters.



Picture 5 : Distribution of woody species according to the trunk diameter

f) Earth surface of the different formations of vegetation

As the other dendrometeric parameters, the highest earth surface can be noticed in the planted trees savannah (7830.29m^2/ha), followed by those of the shrub savannahs (7162.93m^2/ha). The fallow land occupy small earth surface, that is 4936.10m^2/ha; and this is due to the fact that it is mostly made up of discharges. The slow earth surface of the fields (5153.33m^2/ha) is due to the scarcity of trees destroyed to the benefit of corps (picture 6) statistic analysis reveal a highly significant different between the various formations of vegetation ($0.024<0.05$).

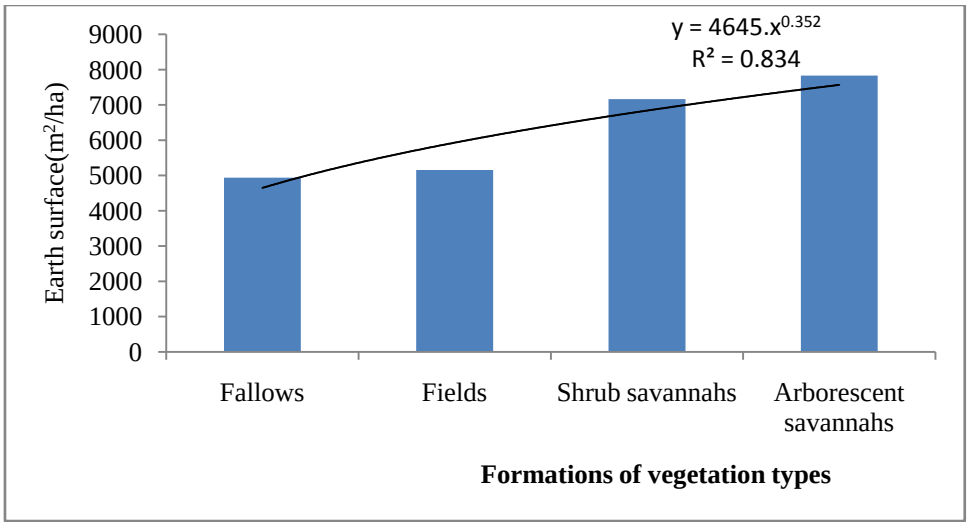


Figure 6 : Earth surface of the different formations of vegetation

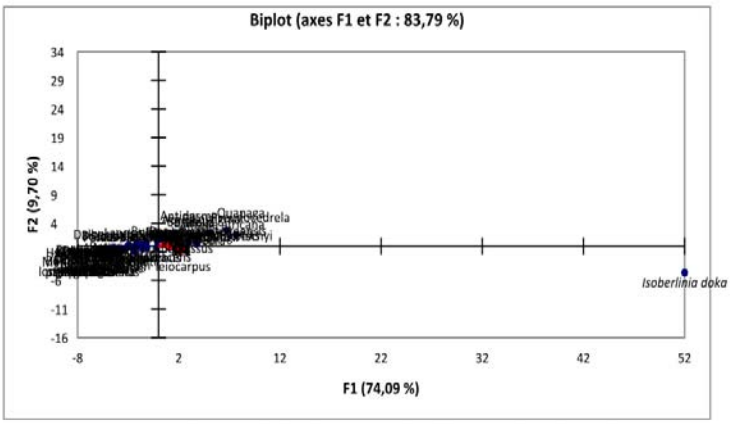
g) The correlation between the dendometric parameters and the cliff vegetation

The Principal Analysis in of component (PAC) between the tree heights, the chest rising height and the earth surface, shows a great correlation (R=0.948, P=0.05) between the earth surface of the fields and the fallow lands; between the chest rising height and the earth surface of fallow lands (R=0.927, P=0.05) (Picture 7). According to the height, the diameter and the earth surface, the species are classified as clouds vertically and horizontally. These species are represented at a 83.79% rate according to F_1 and F_2. Vertically the information's are concentrated in F1 with a high correlation rate of 09%. Horizontally, on the other hand (F2), there is only 9.70% correlation rate between the various species (Table 5). One can say through this analysis that the main constituent of the *Isolerlinia doka* specie shows height, diameter of the earth surface which is more important than the other species and this shows its isolation from the other species.

Table 5 : Analysis of the correlations between the height, the diameter and the earth surface of the species in the four formations of vegetation of the Ngaoundere cliff.

H: height, D: diameter and ST: earth surface; 1, 2, 3 and 4 respectively represent fallow land, field, shrub savannah and planted tree savannahs

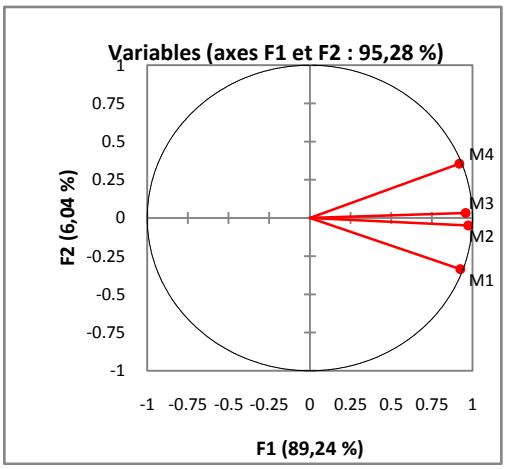
Variables	H1	H2	H3	H4	D1	D2	D3	D4	ST1	ST2	ST3	ST4
H1	1	0,634	0,698	0,753	0,709	0,662	0,662	0,665	0,631	0,654		0,653
H2	0,634	1	0,709	0,516	0,484	0,614	0,558	0,448	0,405	0,550		0,430
H3	0,698	0,709	1	0,644	0,591	0,616	0,755	0,532	0,494	0,551		0,535
H4	0,753	0,516	0,644	1	0,652	0,584	0,632	0,646	0,529	0,539		0,652
D1	0,709	0,484	0,591	0,652	1	0,902	0,869	0,791	0,927	0,899		0,862
D2	0,662	0,614	0,616	0,584	0,902	1	0,895	0,848	0,866	0,920		0,855
D3	0,662	0,558	0,755	0,632	0,869	0,895	1	0,849	0,784	0,837		0,818
D4	0,665	0,448	0,532	0,646	0,791	0,848	0,849	1	0,723	0,786		0,854
ST1	0,631	0,405	0,494	0,529	0,927	0,866	0,784	0,723	1	0,948		0,895
ST2	0,654	0,550	0,551	0,539	0,899	0,920	0,837	0,786	0,948	1		0,891
ST3	0,662	0,500	0,704	0,531	0,810	0,857	0,898	0,803	0,840	0,889		0,869
ST4	0,653	0,430	0,535	0,652	0,862	0,855	0,818	0,854	0,895	0,891		1

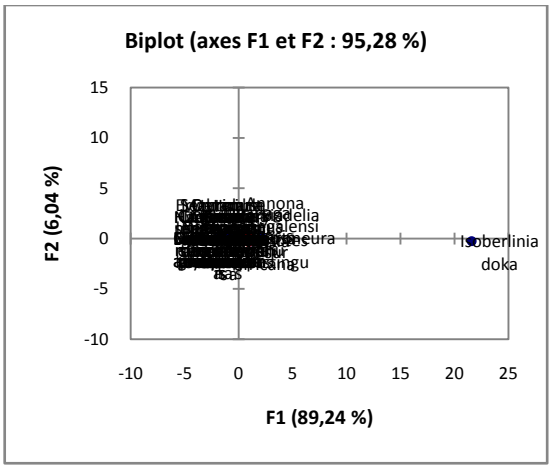


Picture 7 : Stat metric correlation (Person c_n) of the tree dendometric parameters

h) Dispersion modes of the Ngaoundere cliff woody species

Picture 8 shows the analysis in the main component of the species files/statement within the different formations vegetation. The analysis of the main element carried out on the species files statement helps to depict the characteristics of woody species in the different files according to their presence. The perception of the files and species on the factor analysis of axis 1 and 2 helps to merge the woody species with similar characters. The analysis relies on three axes F1, F2, F1 and F2 are valuable percentages and are as follows; 89.24%, 6.04% and 95.28% respectively. One notices that axis F2 helps for a better dispersion of areas of some species. The fallow lands (M_1) and the fields (M_2) have a high correlation; that is they show some species which are similar (Picture 13a). There is also a correlation, highly and significantly recognized between the shrub savannahs (M_3) and arborescent savannahs (M_2) ($p \leq 0.001$). The two formations of vegetation have similar species. The M_4 group shifted forward compared with the other formations of vegetation but close to shrub savannahs. It shows some similar species to shrub savannahs. This helps us to conclude that the shrub savannah are less affected by anthopisation and hence full in consideration in terms of species. As the species are put together at the beginning and form signs like clouds (Picture 13b). This shows that the species are less diversified in the different formation of vegetations. There are therefore and in most cases accidental species. However, the *Isobalinia doka* shows a dispersion which is shifted forward from the other species and this is justified through the abundance and high diversity in the different statements.





Picture 8A : Dispersion of the nations of vegetation *Picture 8B :* Dispersion of woody species

Picture 8 : Analysis in of component (PAC) of species dispersion in the different statements

i) Floristic composition of the cliff vegetation

24 notices were carried out different formation of vegetation of the cliff. For that purposes 1557 woody subject were divided into 73 species, 61 genders and 33 families were listed (Table 6). Arborescents savannahs are the most important groups in the biodiversity with 609 subjets, 64 species, 58 genders and 30 families. They are followed by the shrub savannah which has 465 subjects, 58 species, 56 genders and 28 families. As for the disrupted environment caused by man the biodiversity is poor. The fallow lands have 304 subjects, 51 species, 42 genders and 28 families. The fields have 179 subjects, 48 species, 53 genders and 28 families. This brings out the fact that the number of subjects in the arborescents savannahs is the double of the fields.

Table 6 : Floristic composition of the cliff vegetation

	Fallow	Fields	Shrub savannahs	Arborescent savannahs
Subjects	304	179	465	609
Species	51	48	58	64
Gender	42	53	56	58
Famillies	28	22	28	30

j) Ecological characterization of woody plant species of the vegetation

The analysis of the rich floristic species helps to indentify 73 species in the whole plates. Table 7 shows the exhaustive list of identified species, the frequencies, the densities, the affluences and the importance of the value of Curtis. The most frequent species are found in the area are: *Isoberlinia doka* and *Vitellaria paradoxa* which show an absolute frequency of 87.50% rate. Globally, many species are threatened. Among them we can name the *Breonadia salicina,* the *Ceiba Pentandra*, the *Combretum glutinosum*, the *Croton zambesicus*, the *Cussonia arborea*, the *Diospyros mespiliformis*. The area is dominated by the *Isoberlina doka* with a relative density of 3.98% the same specie shows the importance value of Curtis which reaches 50.91% of rate. It is followed by the *Pterocarpus lucens* (32.04%)

Table 7 : Number of subjects of species, frequency, density, dominance and importance value of Curtis

NI: Number of subjects; FRe: relative frequency; DeR : relative density; DR: relative dominance; IVCR: relative importance value of Curtis

Species	NI	FRe	DeR	DR	IVCR	Species	NI	FRe	DeR	DR	IVCR
Acacia ehrenbergiana	3	0,57	0,16	0,21	0,95	*Lannea acida*	15	1,52	0,47	0,89	2,87
Acacia polyacantha	15	1,52	0,74	0,89	3,14	*Lannea barteri*	13	1,7	0,85	0,48	3,03
Acacia tortilis	3	0,38	0,01	0,21	0,6	*Securidaca longepedunculata*	4	0,04	0,13	0,55	
Afzelia africana	33	2,84	1,69	2,19	6,73	*Lophira lanceolata*	14	0,19	0	0,13	0,32
Anogeissus leiocarpus	56	1,7	0,95	0,89	3,54	*Mangifera indica*	3	0,95	1,06	0,69	2,7

Antidesma venosum	13	1,33	0,25	0,76	2,33	*Maytenus senegalensis*	1	0,38	0,01	0,13	0,52
Annona senegalensis	12	2,84	0,24	2,13	5,2	*Mitragyna inermis*	36	0,19	0	0	0,19
Borassus aethiopum	23	1,33	0,32	0,48	2,12	*Monotes kerstingu*	1	1,52	3,21	2,54	7,26
Burkea africana	14	1,52	1,64	1,37	4,53	*Neocarya macrophylla*	2	0,38	0,18	0,13	0,69
Bombax costatum	19	1,52	0,97	1,1	3,59	*Nauclea gilletii*	22	0,19	0,03	0,07	0,29
Breonadia salicina	1	0,19	0	0	0,19	*Uapaga togoensis*	29	0,38	1,17	1,52	3,07
Bridelia ferruginea	50	2,08	0,18	1,1	3,37	*Parkia biglobosa*	22	2,84	2,38	1,65	6,87
Bridelia scleroneura	20	3,03	0,65	2,95	6,63	*Phyllanthus muellerianus*	30	2,08	0,09	1,04	3,21
Ceiba pentandra	3	0,19	0,32	0,21	0,73	*Piliostigma thonningii*	34	2,08	0,27	1,3	3,66
Combretum glutinosum	1	0,19	0,05	0,07	0,31	*Pseudocedrela kotschyi*	41	2,65	1,44	1,99	6,08
Cussonia arborea	8	0,19	0,2	0,35	0,74	*Pterocarpus erinaceus*	130	2,65	3,99	2,95	9,59
Croton pseudopulchellus	9	0,76	0	0,07	0,82	*Pterocarpus lucens*	66	3,22	20,64	8,17	32,03
Croton zambesicus	1	0,19	0,01	0,07	0,27	*Sarcocephalus latifolius*	2	3,41	2,49	3,84	9,74
Crossopteryx febrifuga	5	0,95	0,16	0,41	1,52	*Sporospermum febrifigum*	6	0,76	0,04	0,28	1,08
Dalbergia boehmii	11	1,52	0,33	0,63	2,47	*Steganotaenia araliacea*	28	1,89	0,25	1,24	3,38
Daniellia oliveri	20	2,08	0,9	1,04	4,02	*Stereospermum kunthianum*	10	2,08	0,71	1,65	4,44
Detarium microcarpum	10	0,57	0,26	0,54	1,37	*Sterculia setigera*	26	0,95	0,18	0,69	1,81
Diospyros mespiliformis	1	0,19	0,02	0,07	0,27	*Strychnos innocua*	3	0,38	0,01	0,21	0,61
Entada abyssinica	1	2,08	0	0	2,08	*Strychnos spinosa*	17	2,08	0,21	1,1	3,4
Entada africana	30	2,08	0,91	1,52	4,51	*Syzyguim guineense* var. *guineense*	6	0,57	0,12	0,41	1,1
Erythrophleum africanum	2	0,38	0,17	0,13	0,68	*Syzyguim guineense* var. *macrocarpum*	7	0,57	0,49	0,21	1,28
Ficus platyphylla	6	1,14	0,24	0,41	1,79	*Terminalia glaucescens*	124	3,41	3,6	7,48	14,49
Ficus synomorus	21	0,95	0,45	0,28	1,68	*Terminalia laxiflora*	158	2,65	5,68	9,47	17,81
Ficus sur	7	1,14	0,65	1,37	3,15	*Terminalia macroptera*	10		0	0	0,76
Ficus trichopoda	6	0,95	0,39	0,41	1,75	*Trichilia emetica*	3	0,57	0,15	0,21	0,93
Ficus vogelii	9	1,33	1,55	0,63	3,5	*Vernonia amygdalina*	7		0,01	0,35	1,31
Gardenia aqualla	17	1,89	0,24	0,89	3,03	*Vitelleria paradoxa*	96	3,98	3,61	5,63	13,22
Grewia flavescens	39	2,65	0,15	0,96	3,75	*Vitex donania*	19	1,89	0,73	1,04	3,66
Gyrocarpus americanus	1	0,19	0	0	0,19	*Vitex madiensis*	1	0,19	0	0	0,19
Hymenocardia acida	2	0,38	0	0,07	0,45	*Ximenia americana*	10	1,14	0,45	0,69	2,28
Isoberlinia doka	286	3,98	30,09	16,8	50,9	*Ziziphus mauritiania*	1	0,19	0	0,07	0,26
Khaya senegalensis	6	1,52	0,52	0,41	2,44	Total	1557	100	100	100	300

k) Ecological characterization of species according to the formations of vegetation

The Table 8 shows that the *Isoberlina doka* is present in the importance value of great necessity in almost all the four formations of vegetation. It respectively shows M1 (43.95%), M2 (67.63%), M3 (35.22%) and M4 (34.65%) in the fallow lands, the fields, the shrub savannahs and the arborescent savannahs. This species easily fits all the anthropic pressure thanks to its dull regeneration ability. Its relative density is 3.67% of subjects/ha for fallow lands, 31.43% of subjects/ha for fields and farming, 3.38% of subjects/ha for shrub savannahs and 4.19% of subjects/ha for the arborescent savannahs. This species has an important and relative collection in the cliff M1 (36.61%), M2 (31.4%) M3 (27.08%) and M4 (27.08%) in the fallow lands, the fields, the shrub savannahs and planted tree savannahs respectively.

Table 8 : Frequency, density, dominance and importance relative value of Curtis of species in the different formations of vegetation of the Ngaoundere cliff

ESpeciess	FR				DeR				DR				IVCR			
	M1	M2	M3	M4	M1	M2	M3	M4	M1	M2	M3	M4	M1	M2	M3	M4
Acacia ehrenbergiana	1,83	0	0	0,68	1,84	1	0,68	0	0,13	1	0	0	3,8	2	0,68	0,68
Acacia polyacantha	1,83	1,59	1,6	2,03	1,84	2,09	2,03	0,6	1,08	2,09	0,13	0,13	4,75	5,76	3,74	2,75
Acacia tortilis	0,92	0,79	0,8	0	0,92	0,04	0	0	0	0,04	0	0	1,83	0,87	0,79	0
Afzelia africana	1,83	3,97	4	2,03	1,84	1,86	2,03	3,59	1,5	1,86	1,57	1,57	5,17	7,69	7,57	7,19
Anogeissus leiocarpus	1,83	0	0,8	2,03	1,84	0,46	2,03	2,4	0,37	0,46	0,39	0,39	4,04	0,92	3,21	4,81
Antidesma venosum	1,83	0,79	0,8	0	1,84	0,5	0	2,99	2,15	0,5	0,2	0,2	5,82	1,79	1	3,2
Annona senegalensis	3,67	1,59	1,6	2,03	3,67	0	2,03	4,19	0	0	0,23	0,23	7,34	1,6	3,84	6,45
Borassus aethiopum	1,83	2,38	2,4	0,68	1,84	0,21	0,68	0,6	1,08	0,21	1,48	1,48	4,75	2,8	4,53	2,75
Burkea africana	0	2,38	2,4	0	0	0,03	0	3,59	0,15	0,03	0,02	0,02	0,15	2,45	2,4	3,62
Bombax costatum	0,92	0,79	0,8	2,7	0,92	0	2,7	1,2	1,21	0	0	0	3,04	0,79	3,5	3,9
Breonadia salicina	0	0,79	0,8	0	0	0,07	0	0	0,07	0,07	0,72	0,72	0,07	0,93	1,51	0,71
Bridelia ferruginea	3,67	2,38	2,4	1,35	3,67	0,65	1,35	1,8	0,6	0,65	1,42	1,42	7,94	3,67	5,16	4,57
Bridelia scleroneura	3,67	2,38	2,4	3,38	3,67	0,64	3,38	2,4	1,88	0,64	3,04	3,04	9,22	3,67	8,8	8,82
Ceiba pentandra	0	0	0	0,68	0	1,56	0,68	0	0	1,56	0	0	0	3,11	0,68	0,68
Combretum glutinosum	0,92	0	0	0	0,92	0,28	0	0	0	0,28	0	0	1,83	0,56	0	0
Cussonia arborea	0,92	0	0	0	0,92	0,38	0	0	0	0,38	0,36	0,36	1,83	0,76	0,36	0,36
Croton pseudopulchellus	0,92	1,59	1,6	0	0,92	0	0	0,6	0	0	0	0	1,83	1,59	1,59	0,6
Croton zambesicus	0	0	0	0,68	0	0	0,68	0	0	0	0,04	0,04	0	0	0,72	0,72
Crossopteryx febrifuga	0,92	0	0	2,03	0,92	0	2,03	0,6	0	0	0,61	0,61	1,83	0	2,64	3,24
Dalbergia boehmii	1,83	1,59	1,6	0,68	1,84	0,9	0,68	2,4	0,12	0,9	0,23	0,23	3,79	3,38	2,49	3,3
Daniellia oliveri	3,67	3,17	3,2	2,03	3,67	2,62	2,03	0	0,79	2,62	1,17	1,17	8,13	8,42	6,37	3,2
Detarium microcarpum	0	0	0	2,03	0	0,06	2,03	0	0	0,06	0,32	0,32	0	0,12	2,34	2,34
Diospyros mespiliformis	0	0	0	0	0	0	0	0,6	0	0	0	0	0	0	0	0,6
Entada abyssinia	3,67	2,38	2,4	2,7	3,67	0	2,7	0	0	0	0	0	7,34	2,38	5,08	2,7
Entada africana	3,67	2,38	2,4	2,7	3,67	0,16	2,7	0	0,23	0,16	2,46	2,46	7,57	2,7	7,55	5,17
Erythrophleum africanum	1,83	0	0	0	1,84	0	0	0	0	0	0,27	0,27	3,67	0	0,27	0,27
Ficus platyphylla	0,92	0,79	0,8	2,03	0,92	0	2,03	0,6	0,34	0	0,7	0,7	2,18	0,79	3,52	3,32
Ficus synomorhus	2,75	0	0	1,35	2,75	1,57	1,35	0	0,9	1,57	0,65	0,65	6,4	3,13	2	2
Ficus sur	0,92	0,79	0,8	2,7	0,92	1,75	2,7	0	0,39	1,75	0	0	2,23	4,29	3,5	2,7
Ficus trichopoda	0	0	0	2,03	0	0	2,03	1,2	0,07	0	0,41	0,41	0,07	0	2,44	3,64
Ficus vogelii	0	0,79	0,8	1,35	0	3,28	1,35	2,99	1,9	3,28	0,16	0,16	1,9	7,35	2,31	4,51
Gardenia aqualla	1,83	0,79	0,8	1,35	1,84	0,4	1,35	3,59	0,08	0,4	0,5	0,5	3,75	1,58	2,64	5,44
Grewia flavescens	3,67	2,38	2,4	2,7	3,67	0	2,7	1,8	0,12	0	0,49	0,49	7,46	2,38	5,58	4,99
Gyrocarpus americanus	0	0	0	0,68	0	0	0,68	0	0	0	0	0	0	0	0,68	0,68
Hymenocardia acida	1,83	0	0	0	1,84	0	0	0	0	0	0,02	0,02	3,67	0	0,02	0,02
Isoberlinia doka	3,67	4,76	4,8	3,38	3,67	31,43	3,38	4,19	36,61	31,4	27,08	27,08	43,95	67,63	35,22	34,65
Khaya senegalensis	0	2,38	2,4	0	0	0	0	3,59	1,1	0	0,91	0,91	1,1	2,38	3,29	4,51
Lannea acida	0,92	1,59	1,6	2,7	0,92	0,29	2,7	0,6	0,16	0,29	0,95	0,95	2	2,17	5,24	4,25
Lannea barteri	2,75	0,79	0,8	0,68	2,75	0,5	0,68	2,99	1,79	0,5	0,67	0,67	7,29	1,8	2,14	4,34
Securidaca longepedunculata	0,92	0	0	0,68	0,92	0	0,68	0	0,24	0	0	0	2,07	0	0,68	0,68
Lophira lanceolata	0	0	0	0,68	0	0	0,68	0	0,46	0	0	0	0,46	0	0,68	0,68
Mangifera indica	0,92	1,59	1,6	0,68	0,92	0	0,68	1,2	0	0	0,08	0,08	1,83	1,59	2,34	1,95
Maytenus senegalensis	0	0,79	0,8	0,68	0	0	0,68	0	0	0	0	0	0	0,79	1,47	0,68
Mitragyna inermis	0	0	0	0	0	1,78	0	0,6	5,37	1,78	2,91	2,91	5,37	3,56	2,91	3,51
Monotes kerstingu	0,92	0,79	0,8	0	0,92	0	0	4,19	0	0	0,11	0,11	1,83	0,79	0,9	4,3
Neocarya macrophylla	0	0,79	0,8	0,68	0	0	0,68	0	0,33	0	0,3	0,3	0,33	0,79	1,77	0,98
Nauclea gilletii	0,92	0	0	0	0,92	0	0	0	0	0	3,4	3,4	1,83	0	3,4	3,39
Ouapaga togoensis	0	0	0	0	0	2,29	0	1,2	1,23	2,29	5,02	5,02	1,23	4,59	5,02	6,22
Parkia biglobosa	1,83	3,97	4	2,03	1,84	0	2,03	2,99	0,19	0	0,07	0,07	3,86	3,98	6,07	5,09
Phyllanthus	0	2,38	2,4	3,38	0	0	3,38	2,4	0,5	0	0,4	0,4	0,5	2,38	6,16	6,18

muellerianus																
Piliostigma thonningii	2,75	3,17	3,2	2,03	2,75	3,65	2,03	0,6	0,59	3,65	1,61	1,61	6,1	10,47	6,81	4,23
Pseudocedrela kotschyi	0,92	3,17	3,2	2,03	0,92	1,73	2,03	4,19	2,62	1,73	8,16	8,16	4,45	6,64	13,37	14,38
Pterocarpus erinaceus	1,83	0,79	0,8	4,05	1,84	12,41	4,05	3,59	17,25	12,4	4,98	4,98	20,92	25,62	9,82	12,62
Pterocarpus lucens	1,83	3,17	3,2	4,05	1,84	1,34	4,05	3,59	1,68	1,34	2,32	2,32	5,35	5,86	9,55	9,97
Sarcocephalus latifolius	4,59	3,97	4	2,7	4,59	0	2,7	2,4	0	0	0,03	0,03	9,17	3,97	6,7	5,13
Sporospermum febrifigum	0	1,59	1,6	1,35	0	0,37	1,35	0	0	0,37	0	0	0	2,33	2,94	1,35
Steganotaenia araliacea	1,83	1,59	1,6	2,03	1,84	0	2,03	1,8	0,13	0	1,34	1,34	3,8	1,59	4,95	5,16
Stereospermum kunthianum	0	0,79	0,8	2,7	0	0,8	2,7	4,19	0	0,8	0,1	0,1	0	2,39	3,6	7
Sterculia setigera	0	0,79	0,8	1,35	0	0,58	1,35	1,2	0,35	0,58	0,53	0,53	0,35	1,96	2,67	3,08
Strychnos innocua	0	0,79	0,8	0	0	0	0	0,6	0	0	0,01	0,01	0	0,79	0,81	0,61
Strychnos spinosa	3,67	2,38	2,4	1,35	3,67	0	1,35	1,2	0,46	0	0,51	0,51	7,8	2,38	4,24	3,06
Syzyguim guineense var guineense	0	0,79	0,8	1,35	0	0	1,35	0	0	0	0,16	0,16	0	0,79	2,31	1,51
Syzyguim guineense var macrocarpum	0	2,38	2,4	0	0	2,51	0	0	0	2,51	0,02	0,02	0	7,41	2,4	0,02
Terminalia glaucescens	3,67	3,17	3,2	3,38	3,67	7,09	3,38	3,59	2,05	7,09	3,92	3,92	9,38	17,36	10,48	10,9
Terminalia laxiflora	4,59	3,97	4	1,35	4,59	5,76	1,35	1,2	8,54	5,76	11,94	11,94	17,71	15,48	17,26	14,49
Terminalia macroptera	0,92	1,59	1,6	0,68	0,92	0	0,68	0	0	0	0	0	1,83	1,59	2,26	0,68
Trichilia emetica	0	0,79	0,8	0	0	0	0	1,2	0	0	0,66	0,66	0	0,79	1,45	1,86
Vernonia amygdalina	0	1,59	1,6	1,35	0	0	1,35	0,6	0,14	0	0	0	0,14	1,59	2,94	1,95
Vitelleria paradoxa	3,67	3,97	4	4,05	3,67	6,59	4,05	4,19	0,37	6,59	3,69	3,69	7,71	17,15	11,71	11,94
Vitex donania	2,75	2,38	2,4	0,68	2,75	0	0,68	2,4	2,25	0	0,4	0,4	7,75	2,38	3,45	3,47
Vitex madiensis	0	0	0	0,68	0	0	0,68	0	0	0	0	0	0	0	0,68	0,68
Ximenia americana	0	0	0	2,03	0	0,36	2,03	1,8	0,44	0,36	0,13	0,13	0,44	0,73	2,16	3,95
Ziziphus mauritiania	0	0	0	0,68	0	0	0,68	0	0	0	0	0	0	0	0,68	0,68
Total	100	100	100	100	100	100	100	100	100	100	100	100	300	300	300	300

l) Composition and ecological characterization of the diversity of botanic Families

The species are divided into 33 families. Those families are neither equal nor share the same diversity. While some families are representative with one genus and only one species, some are on the other hand represented by many species. The Cesalpiniaceae and the Euphorbiaceae families have each 7 geniuses; the Mimosaceae and the Rubiaceae have each 6 genus; the Combretaceae and the Moracea have 5 genuses each. The table 9 recapitulates the families in the decreasing order and diversity. The fact that a family has many geniuses does not necessarily mean that it is highly diversified. The Meliaceae which has 2 geniuses and 2 species only have 9 subjects; that is a relative density of 0.01% rate. The Moraceae, with 2 genues and 5 species have 49 subjects with a relative density of 0.02% close that of Meliaceae. The Ebenaceae, Hermandiaceae, Hymenocardiaceae and Rhamnaceae are represented each by only one subject; the Cesalpiniaceae, with 7 genuses and 7 species are the most numerous at the cliff. Their relative density is 27.80% of rate.

Table 9 : Density, Dominance, importance value de Curtis and the number of subjects, species, geniuses and family.

Familles	NG	NE	NI	FR	DeR	DR	IVCR	Familles	NG	NE	NI	FR	DeR	DR	IVCR
Anacardiaceae	2	3	31	3,45	2,54	1,31	7,29	Hymenocardiaceae	1	1	1	0,94	0	0,13	1,08
Annonaceae	1	1	12	7,05	0,76	4,06	11,9	Loganiaceae	1	2	20	0,7	0	0,06	0,78
Apiaceae	1	1	28	4,7	0,81	2,36	7,86	Malvaceae	1	2	4	1,17	0	0,13	1,31
Araliaceae	1	1	8	0,47	0,66	0,66	1,79	Meliaceae	2	2	9	1,57	0	0,18	1,76
Arecaceae	1	1	23	3,29	1,02	0,91	5,22	Mimosaceae	4	7	115	8,14	4,6	4,15	16,94
Asteraceae	1	1	7	2,35	0,04	0,66	3,05	Moraceae	2	5	49	1,16	5,6	5,19	11,95
Bignoniaceae	1	1	10	5,17	2,27	3,15	10,6	Myrtaceae	1	2	13	5,36	0,9	25,45	58,68
Celastraceae	1	1	2	0,94	0,03	0,25	1,22	Ochnaceae	1	1	4	0,47	0	0,25	0,72
Cesalpiniaceae	7	7	399	19,4	27,8	1,72	5,94	Olacaceae	1	1	10	2,82	1,5	1,32	5,59
Chrysobanalaceae	1	1	2	0,94	0,58	0,25	1,77	Polygalaceae	1	1	4	0,94	0,1	0,25	1,31
Clusiaceae	1	1	6	1,88	0,13	0,54	2,54	Rhamnaceae	1	2	6	0,47	0	0,13	0,6
Combretaceae	3	5	349	5,54	1,26	2,63	9,43	Rubiaceae	6	6	55	2,84	14	13,14	30,19
Dipterocarpaceae	1	1	36	3,76	10,29	4,85	18,9	Sapotaceae	1	1	96	9,87	12	10,76	32,2
Ebenaceae	1	1	1	0,47	0,05	0,13	0,65	Sterculiaceae	1	1	26	2,35	0,6	1,32	4,23
Euphorbiaceae	5	7	123	4,97	2,48	2,7	10,2	Tiliaceae	1	1	39	6,58	0,5	1,83	8,87
Fabaceae	3	3	207	1,3	9,23	7,95	18,5	Verbenaceae	1	2	20	4,46	0,5	1,57	6,55
Hernandiaceae	1	1	1	0,47	0	0	0,47	Total	31	73	1557	100	100	100	300

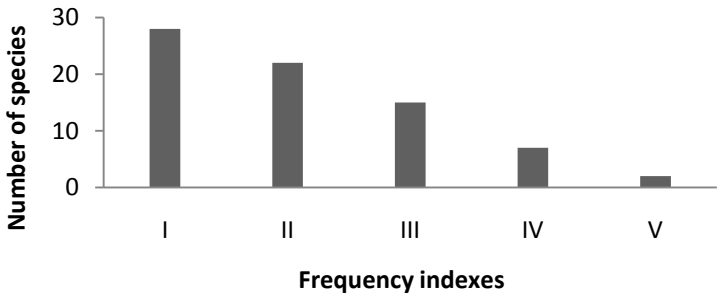
m) Distribution of ecological preference of plant species at the Ngaoundere cliff

The gauged frequencies help to understand the horizontal repartition of the species listed. Picture 9 illustrates the frequency histogram of woody species listed in the Ngaoundere cliff.

Out of the 73 species listed, 28 species that is 38.35% of the flora have a frequency indication equal to 1. Some among them are scare. As an example we have the *Breonodia salicina, Ceiba pendandra, Combretum glutinosum, Croton zambesicus , Cussonia barteri, Diospyros mespiliformis* To 2 frequency index. These are the one whose relative frequency varies from 20 to 40%. The species whose frequency index is equal to 3 represent 20.55% of the listed flora. Only 9.60% of the flora indicates frequency index equal to 4. It is represented by *Afzelia africana, Annona senegalensis, Parkia biglobosa, Bridelia scleroneura, Pterocarpus lucens, Sarcocephalus latifolius, Terminalia glaucescens.* The most frequent with a frequency index is equal to 5 are two of them with 2.77% the most of the listed flora. Those two species *Isoberlinia doka* and *Vitellaria paradoxa* have 87.5% frequency index and appear in the 21 of the 24 listed. This structure of the vegetation shows a high heterogenous frequency of the area and would be the consequence of a high anthropic pressure on the vegetation.

n) Shannon, Equitability of Pielou, Simpson diversities indexes of the Ngaoundere cliff

Table 10 shows the values of the different indexes calculated. The Shannon wearer calculated diversity indexes considerably vary from one group to the other. They are low in fallow plants (3.26) and the fields (2.81) as a result of the impact of anthropisation on the vegetation. In addition this index is higher in fallow lands than those of the fields and this is simply due to the fact that after the cutting down of trees there is a good reconstruction of the vegetation. The calculation of Pielou equitability theory associated with the Shannon confirms the fluctuation between index values of the diversity. In facts the value equitabilities are negligible in the fallow (0.54) and as in the shrub savannahs (0.74) and arborescent savannahs (0.85). Globally, there are 59% opportunities to equilibrium in the repartition of species in the area. Moreover, the Simpson index proves that the probability for subjects chosen and randon that is from different species is very high. The low values of the indexes of the fallow lands (0.13) and of the fields (0.18) show that they are negligible in biodiversity. This negligible diversity would be the consequence of human activities developed in the cliff by the resident population.



Picture 9 : Frequency of the species listed at the Ngaoundere cliff

Table 10 : values of the different indexes of calculated diversity

H= Shannon index, E= pielou equitability D = Simpson index

Indices / formations of vegetation	allows	fields	shrub savannahs	Arborescent savannahs	Mean
H'	3,26	2,81	4,05	4,77	3,72±0,87
E	0,54	0,23	0,74	0,85	0,59±0,27
D	0,13	0,18	0,26	0,35	0,23±0,19
1-D	0,87	0,82	0,74	0,65	0,77±0,09

o) The floristic similarity coefficients of Jaccard and the Hamming distances between the different

By applying the Jaccard test for the vegetation homogeneity or heterogeneity evaluation, the Table 11 values show that the floristic difference stronger between the fallow lands and the arborescent savannahs (67.82%), medium between the fallow lands and shrub savannahs (58.45%). This explains a relative heterogenerty between those environments. However, it is very poor between the follow lands and the fields (32.2%) the arborescent savannahs and the fields (30.3%), the fields and shrub savannahs (31.75%). The floristic difference is very poor between the shrub savannahs and arborescent savannahs (12.3%). The

poor floristic difference between the shrub savannahs and the arborescent savannahs conveys a great number of similar species they contain. This difference could due to the anthropisation degree on the survey zones and above all to the bioclimatic estate.

Table 11 : Floristic similitude coefficients of Jaccord and the Hamming distances between the different formations of vegetation

JP = Jaccard index H = Hamming distance

Lands	Fallow		Fields		Shrub savannahs		Arborescent savannahs	
	PJ	H	PJ	H	PJ	H	PJ	H
Fallow	100	0	67,8	32,2	41,55	58,45	32,18	67,82
Fields	67,8	32,2	100	0	30,3	87,7	69,7	30,3
Shrub savannahs	41,55	58,45	68,25	31,75	100	0	87,7	12,3
Arborescent savannahs	32,18	67,82	69,7	30,3	87,7	12,3	100	0

p) The influence of the natural resources on the biological types of distribution on the Ngaoundere cliff species

Table 12 shows the biological types of woody plants in various formations of vegetation. The mesophanero- phytes (Ms Ph) are far more important in the formations of vegetation; that is 38.59%. They represent 65.68% of woody plants of arborescent savannahs while in the shrub savannahs, the fields and fallow lands they respectively occupy 29.03%, 43.55% and 16.11%. The second biological type is represented by the nanophanerophytes (Nn ph) with 29.52% with dominant fallow lands of (58.22%) and very poor at the level of arborescent savannahs (3.28%). The megaphanerophytes (Mgph), with only (1.47%), are less abundant at the vegetation. Globally, the study of the variance at 5% threshold take into consideration the non negligeable difference between the types of the formations of vegetation and the biological forms found (p 0.01).

Table 12 : Distribution of biological types of plants at the Ngaoundere cliff

Mgph: Megaphaneropytes; Msph: Mesophanerophytes; Mcph: Microphanerophytes; Nnph: Nanophanerophytes.

Biological types	MgPh	MsPh	McPh	MnPh	Mean
Fallow	0	16,11	25,65	58,22	25,00±24,55[a]
Fields	0	43,55	17,31	29,05	22,48±18,43[a]
Shrub savannahs	0,64	29,03	42,79	27,52	25,00±17,63[a]
Arborescent savannahs	5,25	65,68	25,77	3,28	25,00±20,97[a]
Mean	1,47±2,54[a]	38,59±21,25[b]	27,88±10,70[c]	29,52±22,48[d]	24,37±1,26[a]

The figures assigned the same letters are not significanthy different from the threshold of 5%

q) The influence of anthropisation on the phytogeographic distribution of species at the Ngaoundere cliff

African multiregional species (PRA) represent 67.07% of the whole flora (Table 13). They are species whose distribution area covers many African floristic areas where only two are not physically in contact. The zoudano Zambian species (CZ), the cosmopolitans (Cos) and the pantropical species (Pan), representing respectively 0.42%, 2.10% and 1,53% are not found in their phytogeographic distribution areas. A high proportion of species with a substancial distribution may be a degradation index. Statistic analysis projects however the inexistancce of significant difference between the phytogeographic types and the formations of vegetation (p 5%).

Table 13 : phytogeagraphic distribution of vegetation species at the cliff (%)

AS = Afrotropical species; cos = cosmopolitan species; pal = paleotropical species, pan = pantropical species, PRA = African multiregional species; s1 = soudano Zambian species

Formations types/ phytogeagraphic	Fallow	Fields	Shrub savannahs	Arborescent savannahs	Mean
AS	8,33	11,11	15,09	16,66	12,80±3,79a
Cos	2,08	2,77	1,88	1,66	2,10±0,48b
Pal	16,66	19,44	13,20	15,00	16,08±2,65c
Pan	0,00	2,77	0,00	3,33	1,53±1,78b
PRA	72,91	63,88	69,81	61,66	67,07±5,20d
Sz	0,00	0,00	0,00	1,66	0,42±0,83a
Mean	16,66±28,29a	16,66±24,21a	16,66±26,88a	16,66±26,88a	16,66±25,54c

r) The influence of anthropisation on the dissemination of the diasporas species at the Ngaoundere cliff.

The dissemination of diaspore types varies according to the vegetation (Table 14). This comes out that the ballochores (Ballo) show a signifificant dissemination rate in the vegetation 26.63% of species insure themselves the dissemination of their own Diasporas in different formations of vegetation. The second element that contributes to the dissemination of the Diasporas is the wind. 21.85% of species are anemochores. The sclerochores (9.22%), the sarcochores (11.83%) and the barochores (12.67%) are less represented at the cliff vegetation.

Table 14 : dissemination of the Diasporas in the different formations of vegetation

diaspores types	Fallow	Fields	Shrub savannahs	Arborescent savannahs	Average
Anemo	20,83	23,91	22,64	20	21,85±1,76[a]
Ballo	27,08	28,26	24,52	26,66	26,63±1,56[b]
Barro	12,5	15,21	11,32	11,66	12,67±1,76[c]
Sarco	10,41	8,69	13,2	15	11,83±2,82[c]
Sléro	10,41	8,69	9,43	8,33	9,22±0,92[d]
Zoo	18,75	15,21	18,88	18,33	17,79±1,74[e]
Mean	16,66±6,72[a]	16,66±7,98[a]	16,67±6,25[a]	16,66±6,50[a]	16,66±0,00[a]

The figures assigned the same letters are significantly different from the threshold 5%

IV. Discussion

The exploitation of discussions of vegetative resources has immediate consequences on the biodiversity existence that is why the density and specific richness of vegetative species are more important at the level of wood savannahs which are less disrupted than other sectors like the fields. GIEC (2007) demonstrated that reduce the vegetative biodiversity of 20%. This demonstrations is similar to the one found at the level of the Ngaoundere cliff where the number of arborescent savannah subjects are the double of the fields. The vegetative resource exploitations are equally remarquable through the increase of scarce species and unpredictable with higher frequence index 1. One can observe the presence of scarce species such as. The intensification and the antropisation may be the cause of the scarcity of the four formations of vegetation of the cliff. The moose common species with an equal frequency "V" are at 2.74% of the listed flora. *Iberlinia doka* and *Vitellaria paradoxa* have a high frequency. In the same vein, Tchobsala (2011) in the periuban savannahs of Ngaoundere pointed out that the vegetation is made us of 37.67% species with frequent index1, 28% of species with frequent index equal to II, 23.18% of species with frequent index equal to III, 6.63% of species with frequent index equal to IV and 3.52% of species whose frequent index is equal to V. this vegetative structure explains a significant heterogeneity of the area and have appears to be as direct consequence of a significant anthropic pressure on the vegetation. This anthropisations is characterized by a high floristic difference between the fallow lands and planed tree savannahs with 67.82% rate. However, it not considerable between the fallow lands and the fields with (32.2%), the planted tree savannahs and the fields (30.3%) and the fields vs. the shrub savannahs (31.75%). The mesophanerphytes (Msph) are more considerable implanted tree savannahs and this shows that with this formation most of the species have trees whose height are superior to 30 m high compared with the shrub savannahs fields and fallow lands. Similar research works were carried out in carbon and showed that the mesophanerophytes are the more biological commontresss (Auberville, 1962). In addition, the megaphaneropytes are poorly depicted at the Ngaoundere cliff. Tchobsala and Mbolo (2013) research works at the Ngaoundere periubar savannhs also showed that the megaphanerophytes (2.75%) are poorly represented at the level of the Ngaoundere vegetation. At the phytogeographic level, the African multiregional species (PRA) represent 67.07% of the whole flora. They are species whose distribution area covers many African floristic regions where two floristique regions are not in constant contact. The soudano Zambian species (SZ), cosmopolitans cos and the pantropical species (pan) respectively representing (0.42%, 2.10% and 1.53%) are not found in their phytogeographic distribution area. A high species promotion with large distribution can be degradation index facto. The formations which were subjected to higher anthropisation. Like the fields and fallow land have high regeneration ability. The subjects' density is highly considered when the height is less than 5m. If the woody species whose height is superior to 15cm are less considered in fallow lands, fields and shrub savannah unlikely to planted tree savannahs. This testifies that the important species were destroyed by the population unaware of tree production in the fields. These results go in line with those of Tchobsala (2011) who proved that the vegetation in the Ngaoundere

periurban savannahs are dominated by shrubs; (result with high anthropisation rate). The fallow lands and the fields which underwent deforestation take up a negligible earth surface. This is due to the fact that it is mostly made up wastes in comparison with the planted tree savannahs. Some close similar research work were carried out by GIEC (2007) and revealed that some formations under some anthropisation pressures (wastes, fields, pastures) considerably reduce the tassel diameters and consequently reduced the earth surfaces of the formation of vegetation.

V. Conclusion and Perspectives

The survey on the anthropisation impact on floristic composition, ecological structure and characterization of the Ngaoundere cliff vegetation showed that global density and the floristic resources of woody species considerably reduce up to the threshold of 5% the fields, fallow lands, shrub savannahs and arborescent savannahs. The fields show negligible more floristic resources than the other formation of vegetation. The diversity index estimated to 3.25 shows that the anthropic disruptions are high influenced on the diversity of woody species. Besides, the conversion of the forestry arena of the cliff into a cultivation field by the deforestation phenomenon leads to a drastic reduction of specific resource. The cliff vegetation anthropisation deserve the putting in place of a sustainable development plan, a joint management and a certification of this measure forestry.

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