Characterization of the Herbaceous Vegetation of the National Park of Manda in Chad

Goy Saradoum
Institut universitaire des sciences agronomiques et de l'environnement de Sarh, Tchad
Aly Diallo
Department of Plant Biology,
University Cheikh Anta Diop, Faculty of Sciences and Technology,Dakar, Senegal

Madiara Ngom Faye
Department of Plant Biology,
University Cheikh Anta Diop, Faculty of Sciences and Technology,
Dakar, Senegal

Aliou Guisse*
Department of Plant Biology,
University Cheikh Anta Diop, Faculty of Sciences and Technology,
Dakar, Senegal

Observatory Man and Environment, Tessekéré (Ferlo)
* corresponding Author: (221) 77 638 96 69. E-mail : alguisse@orange.sn

Abstract— **Within the framework of the rehabilitation of the National park of Manda located at the South of Chad, a study was conducted in order to improve and to reactualize information on the natural resources in general, precondition to the development of management plans. One of the causes of failure in the attempts at rehabilitation of this park was the ignorance of its ecosystems. This work was therefore, primarily focused on the knowledge of diversity and on the structure of the herbaceous vegetation of the park. The study was carried out following phytosociological relevés according to the traditional Braun-blanquetiste method and the park was divided into four zones of study. It was inventoried 369 species gathered in 195 genera and 58 families starting from 128 relevés. The most species belonged to families of *Poaceae, Fabaceae, Malvaceae, Cyperaceae* and *Asteraceae*. The factorial analysis of correspondence allowed recognizing 9 herbaceous groups where the majority was also known in several tropical Africa areas. The biomass noted starting from the rate of average covering (approximately 90% in rainy season) proved that the pastures of the park could still support an important wildlife.**

Keywords-Chad, biodiversity, herbaceous groups

I. INTRODUCTION

Manda National Park (MNP), one of Chad's two parks, located in the Sudanian area was very rich in fauna and flora. The events of 1979, the incoherent conservation policy and the population explosion have caused the disappearance of wildlife and vegetation cover degradation. The MNP was poorly studied [1] and its natural resources are poorly known. This study is a part of contribution in the establishment of the biological, ecosystemic and socio-economic database on the MNP. It is question to analyze the herbaceous vegetation in terms of structure and floristic composition and phytosociological relevés using numerical analyzes in order to bring out the herbaceous groups relating to the ecological conditions of the area. This approach will lead to better understand the specific richness of herbaceous vegetation.

II. MATERIAL AND METHODS

A. Manda National Park location

MNP currently covers an area of 114,000 ha [2]. It is located, between latitude 9°20 and 9°35 North and longitude 17°45 and 18°20 East, and distant of 25 Km in Northwest of Sarh, capital of the Department of Barh Kôh; Region of Middle Chari. Its altitude varies from 344 m to 691 m. It is bordered by Barh Sara to the south, the national road Sarh-N'Djamena to the west, the Chari's river to the east and to the north by the track crossing Sarh-N'Djamena towards Waïn in the east. The park is surrounded by four cantons: Balimba to the south, Kokaga to the east, Djoli to the west and Niellim to the north (Figure 1). To study conveniently the distribution of natural resources, Manda National Park was divided into four areas: Nguéré, Djoli, Koutou and Niellim. This division allowed to better study the flora and fauna and also to understand how environmental management in these areas.

B. Water Resources

Entire eastern part of the park is limited by the Chari's river, 1,200 km long, which originates in the Central African Republic and flows into the Lake Chad. Barh Sara and Barh Salamat, two of the three main affluents of the Chari, have their tributaries in the MNP. It was identified 14 temporary pools and 23 permanent ones [3].

C. Climat

The MNP is situated in the Sudanian bioclimatic zone. The type of climate is humid tropical with two clear-cut seasons. The average annual rainfall was 1061.41 mm (Meteorological Station of Sarh). The annual averages of the temperatures were soft and ranged between 27°C and 28°C.

D. Soils

The soils of the MNP were various. Along the Chari's river were established plains with hydromorphic soil minerals, beige flooded, usually met in the alluvial basin of Logone-Chari [4]. In the extreme northern, there was soil erosion on acid rocks: granite, gneiss and rhyolite. On the lateritic slabs in the Niellim zone, were leached ferruginous tropical soils with concretions of sablo-clayey material, beige or ochre. The vertisols, materials over the fuvio-lacustrine alluvial, sandy clay to clay, generally dark in color, formed the pockets in some flooding areas between Koutou and Niellim. In the center and south of the park, ferralitic red or red ocher and the tropical ferruginous soils were exposed.

E. Methods

The study was based on classic method, floristic-ecological or braun-blanquetist methodology ([5], [6], [7], [8]). It followed two steps:
- An analytical step consisting in making statements of plant species on the ground;
- A synthetic step of data processing.

E_1. Phytosociological relevés

The relevés were executed during the rainy season when species were at the peak of their development. Each species was accompanied by quantitative and qualitative factors representing the abundance-dominance, phenology, biological characteristics and vigor. Also on the statements, non-floristic information was mentioned such as location, soil type and topography. The sampling was random by choosing areas floristically representative.

E_2. Data analysis

Given the objectives, the factorial analysis of correspondence (FAC) was chosen ([9], [10]) and data analysis was performed with XLSTAT software. The analysis was based on the first two factorial axes providing the essential of information.

E_3. Data identification

For taxa determination (family, genus and species), the flora published documents of Chad ([11], [12], [13]), of tropical Africa ([14], [15]), of Senegal ([16], [17]) were used and updated by using ([18], [19], [20], [21]).

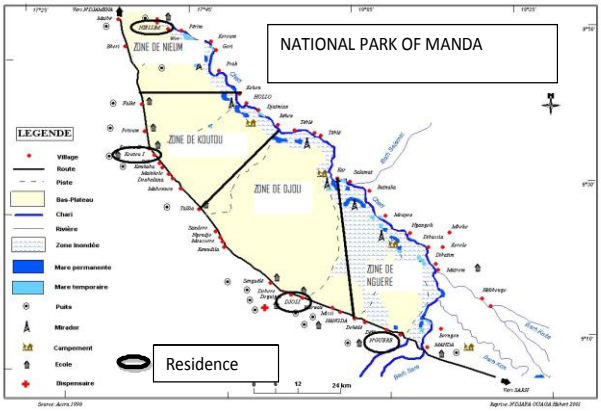

Figure 1. Location of the study area

III. RESULTS AND DISCUSSION

The number of statements made in this study was 128.

A. Analysis per zone of vegetation

- *FAC analysis of the herbaceous vegetation in the area Nguéré*

It was carried out 26 relevés and 188 herbaceous species identified in this area. The average recovery was 91.5%, the average height of 117cm and average exposure to solar radiation of 85%. The cumulative variance of the first four factorial axes was 64.75% (F1 = 17.10%, F2 = 17.78%, F3 = 14.56%, F4 = 14.29%). The average contribution of species was 1.82% and 9.09% for the relevés. After analyzes, there were species and revelés with the highest records which were relevant (Figure 2).

The F1 axis discriminates the group G1 constituted of relevés R110, R111 and R112 of the other groups of the relevés G1. This group was mainly constituted of species of anthropic environments such as *Indigofera hirsuta* (ihi), *Eragrostis tremula* (etr), *Pandiaka involucrata* (pine), *Cassia obtusifolia* (cob), *Digitaria argilacea* (dar) etc. Discrimination made by the axis F1 was induced by a gradient of anthropisation.

The F2 axis opposed the relevés 102, 103 and 106 of group G2 to the relevés R114, R124, R125 and R128 of group G3 following the moisture gradient. Indeed, the group G2 was mainly composed by land species including Andropogoneae of Sudanian areas (*Andropogon gayanus* var squamulatus (ags), *Loudetia simplex* (LSI), *Hyperthelia dissoluta* (hdi), *Beckeropsis uniseta* (bun) and *Hyparrhenia*) while the group G3 was characterized by *Nymphaea lotus* (nlo) in the center showing a wetland. In

G3 were individualized three subgroups: The axis F3 opposed the relevé R115 to the revelés R114, R124 and R125. The relevé R115 was constituted of semi-aquatic species such as *Oryza barthii* (oba), *Oryza longistaminata* (olo), *Thalia geniculata* (tge) and *Thaumatococcus danielli* (tda) constituting the subgroup G3a. The F4 axis separated the subgroup G3b represented by the relevé 114 gathering the species of temporarily wet environments like *Jardinea congoensis*, *Vetiveria nigritana*, *Cyperus pustulatus* (cpu) and *Mariscus sublimis* (MSU) of the subgroup G3a composed of floating-stemmed species such as *Nymphaea lotus* (nlo), *Vossia cuspidata* (VCU), *Ipomoea aquatica* (IAQ) and *Echinochloa stagnina* (is) more aquatic.

In Nguéré area, according to abundance-dominance indices given to each species in the field, naming proposals were assigned to groups from the FAC:

- The group G1a ruderals or fallow was considered as a anthropogenic group;
- The group G2 of Andropogoneae was called group of *Andropogon* and *Hyparrhenia*;
- The group G3 presented successively, when going from the stream bed toward the periphery of the wetland, the following groups:
    - • Group *Echinochloa stagnina* and *Vossia cuspidata*;
      • Grouping *Oryza barthii* and *Thalia geniculata*;
      • Grouping *Jardinea congoensis* and *Vetiveria nigritana*.

➢ *FAC results of the herbaceous vegetation of Djoli*

In Djoli area, 43 relevés were conducted and 178 species were identified. The overall recovery was 91% and the average height of grass was 1.20 m. The shrub exposition to solar radiation was 80.8%.
The matrix was 43 relevés x 178 species. The variance of the first four factorial axes asw 65.68% (F1 = 21.22%, F2 = 18.69%, F3 = 15.62% and F4 = 10.13%). The average contribution of species was 1.85% and 6.66% for the relevés (Figure 3).

- The axis F1 separated the group (G1) combining the relevés R67, R68, R70 and R80 with associated species such as *Oxytenanthera abyssinica* (oab), *Dioscorea dumetorum* (ddu), *Dioscorea sagittifolia* (dsa), *Ctenium newtonii* (cne) etc. from other groups of relevés. The major species of this group G1 was *Oxytenanthera abyssinica* having a significant abundance-dominance in the relevés related to the group. This species prefered some types of soils and it was probable that the axis F1 separated the groups along a gradient of soil conditions.

- The axis F2 allowed distinguishing the groups G2 and G3. The group G2 included mainly the fallow or ruderal species such as *Digitaria gayana* (dga), *Pennisetum pedicellatum* (EPP), *Indigofera hirsuta*, *Sida rhombifolia*, *Urena lobata* etc. while the group (G3) was constituted of the relevés including *Andropogon gayanus* var squamulatus (ags), *Hyparrhenia rufa* (hru), *Schizachyrium sanguineum* (ssa) etc.

In Djoli area, following groups were proposed:
- The G1 was a group of *Oxytenanthera abyssinica*;
- The group G2 of fallow or ruderal species is an anthropogenic group;
- The group G3 of Andropogoneae was the group gathering *Andropogon* and *Hyparrhenia*.

➢ *FAC results of the herbaceous vegetation of Koutou*

In Koutou area, 31 relevés and 180 species were stated. The overall recovery average was 89% and the average height of grass was 1m. The exposure to solar radiation was 92%. The matrix was 31 relevés x 180 species. The average contribution of species was 1.2% and that of relevés was 5.88%. The percentages of the variances were for F1 = 11.26%, F2 = 10.95%, F3 = 10.42% and F4 = 9.83% while the cumulative percentage for the first four axes was 42.47% (Figure 4).

- The F1 axis separated clearly the group G1 gathering the relevés R33, R39, R40, R41, R46 and R127 to the groups G2 and G3. The group G1 gathering almost the same species belonging to groups of wetlands observed in Nguéré. But, *Nymphoides indica* (nin) and *Nymphaea lotus* (nlo) clearly dominated this vegetation by their indices of abundance-dominance. The distinction made by the F1 axis was based on a moisture gradient.

- The F2 axis separated the groups G2 to the groups G3 and G4.

The group G2 gathered the Andropogoneae but also in equal importance *Oxytenanthera abyssinica* (oab). These species were belonging to the group of *Andropogon* and *Hyparrhenia* and to the group of *Oxytenanthera abyssinica* already recognized.

- The F3 axis divided the groups G3 and G4. In group G3, emerged the creeping or lianescentes species or even the species of sub-shaded wood species such as *Cissus flavescens* (cfl), *Commelina nigritana* (cni), *Dioscorea sagittifolia* (dsa), *Aneilema lanceolatum* (ala), *Gladiolus psittacinus* (GPS), *Desmodium velutinum* (DVE) with low contributions but highlighted by relevés R30 and R55.
The group G4 was mainly represented in the relevés R36 and R38 containing mostly the ruderal or fallow species associated with anthropogenic groups.

Apart from the groups already identified, FAC analysis set out another group of the medium called the group of *Nymphoides indica* and *Nymphaea lotus*.

- *FAC results of the herbaceous vegetation of Niellim*

In the Niellim area, 28 relevés were conducted and 170 species identified. The overall recovery was 87% and the average height of grass was 54cm. The herbaceous vegetation was exposed to 96% of solar radiation.

The matrix was 28 relevés x 170 species. The first four factorial axes had a cumulative variance of 55.63% (F1 = 15.36%, F2 = 14.82%, F3 = 13.58 % and F4 = 11.86%). The average of specific contributions was 2.17% and 5.88% for the relevés (Figure 5).

- The F1 axis opposed mainly the group G1 of *Indigofera hirsuta* (ihi), *Tephrosia linearis* (tli) which were species related to human activities than other groups. The discrimination was made here following an anthropogenic gradient. The group G1 belonged to anthropogenic group
- The F2 axis divided the group G2 and G3. The group G3 showed a set of relevés including wetland species. The separation of groups G2 and G3 by F2 axis was influenced by a moisture gradient. The group (G2) constituted of a set of relevés largely including Andropogoneae and species of temporarily flooded area represented by *Vetiveria nigritana* and *Jardinea*. This group was a mixing of the groups of *Jardinea congoensis* and *Vetiveria nigritana* and group of *Andropogon* and *Hyparrhenia* proposed above.

- The F3 axis opposed within the group G3, two subgroups: the subgroup (G2a) composed by relevés R28, R27 and R26 largely made of the Cyperaceae: *Pycreus macrostachyos* (pmc), *Cyperus pustulatus* (cpu), *Fimbristylis littoralis* (blt) etc. of temporarily flooded area and the subgroup (G2b) which most representative relevés were especially R12 and R5, containing aquatic species such as *Pistia stratiotes* (pst), *Neptunia oleracea* (nol), *Ceratophyllum demersum* (cde). Then the axis F3 allowed separating the semi-aquatic species to aquatic ones. In addition to the identified groups, FAC analysis of Niellim area allowed identifying two other groups: group of *Nymphaea lotus* and *Pistia stratiotes* and groups of *Fimbristylis littoralis* and *Cyperus pustulatus*.

B. Floristic richness of the herbaceous vegetation of the MNP

It was inventoried 368 species grouped in 194 genera and 57 families (Table 1). The most common species were Fabaceae of genera *Tephrosia*, *Indigofera* and *Cassia*; Poaceae of genera *Andropogon*, *Hyparrhenia* and *Loudetia*, and *Rubiaceae* of genera *Spermacoce* and *Alysicarpus*.

Poaceae were the most numerous with 90 species and 44 genera. Other important families in order were: Fabaceae (56 species and 19 genera), Malvaceae (25 species and 11 genera), Cyperaceae (21 species and 6 genera), Asteraceae (17 genera and 9 species), Rubiaceae (10 species and 5 genera), Acanthaceae (9 species and 7 genera) and Commelinaceaes (9 species and 3 genera).

The herbaceous plant communities were divided into three categories:

B_1. Groups of wetlands

Depending on the level of the water and the duration of the flooding we distinguished aquatic groups and semi-aquatic ones.

- *Aquatic Groups*

It was a flora consisted of fixed or floating species that grew in ponds or permanent subpermanentes and some funds backwaters Chari. This vegetation, often located around *Nymphaea lotus*, was the equivalent of a set of aquatic herbaceous tropical africa groups ranged in the same phytosociological class, *Nymphaeetalia loti*, with several associations with variable floristic composition [12]. The floristic composition of the aquatic vegetation of the MNP was comparable with some exceptions (without *Azolla africana* and *Typha domingensis*), to that found in the National Park of Bird of Djoudj [22]. With regard to the MNP, aquatic vegetation could be summarized in two main groups:

- Group of *Nymphoides indica* and *Nymphaea lotus*.

This group was found in several ponds where these species may live in communities with *Nymphaea micrantha* and *Nymphaea decidula*. Some species were specific to certain ponds, so *Heteranthera callifolia*, *Cyrtosperma senegalensis* were related to pools that were in the area of Koutou while *Thaumatococcus danielli* and *Echhornia crassipes* were more present in the area Nguéré.

- Group of *Nymphaea lotus* and *Pistia stratiotes*.

It was present in the muddy backwaters low current of the Chari River which met non-rooted floating vegetation in *Pistia stratiotes* and rooted vegetation in *Nymphaea micrantha*, *Nymphaea decidula*, *Ceratophyllum demersum* and *Neptunia oleracea*. Some semi-aquatic species forming floating meadows and fixed on the bank might floating extensions that entered the aquatic groups, they were: *Echinochloa stagnina* , *Echinochloa colona*, *Polygonum pulchrum*, *Vossia cuspidata* and *Ipomoea aquatica*.

- *Semi-aquatic groups*

They settled around the ponds, shorelines, backwaters of rivers and submerged plains, at least for a long period in the year, by shallow water. The groups identified the following ecological zones were:

- Group of *Thalia geniculata* and *Oryza barthii*.

It occured usually around temporary ponds and medium flood plains widespread in the zone of Koutou to the zone of Nguéré. Depending on the pool some Poaceae such as *Oryza longistaminata*, *Leptochloa malabarica* and *Echinochloa colona* could become dominant. Other elective species such as *Ludwigia abyssinica*, *Ludwigia octovalvis*, *Hygrophila auriculata*, *Centrostachys aquatica*, *Acroceras amplectens* and *Sebastiania chamaelea* were also present.

- Group of *Echinochloa stagnina* and *Vossia cuspidata*.

This group was also featured in the lower valley of Senegal [23]. These two species which sometimes form monospecific aquatic were divided into two associations in the former Belgian Congo: *Echinochletum stagninae* and *Vossietum cuspidatae* [24]. In places, the Polygonaceae (*Polygonum salicifolium*, *Polygonum pulchrum* and *Polygonum sp*) with very similar biological characteristics replaced the other two. All these species formed aquatic stands or floating islands on the shores and backwaters of the Chari River.

- Group of *Jardinea congoensis* and *Vetiveria nigritana*.

It colonized the periphery shorter flooded. Around the "hippo pool" occured a few shreds of *Phragmites australis*. This group was accompanied along the banks of the Chari River by a swampy meadow dominant by Andropogoneae (*Andropogon gayanus* var *squamulatus*, *Andropogon schirensis* and *Hyparrhenia rufa*) associated with other species including *Echinochloa pyramidalis* and *Sporobolus pyramidalis*. When the waters receded the soil gradually covered with hygrophilous species belonging to the lawns of *Glinus lotoides*, *Glinus oppositifolius* and *Coldenia procumbens* [25]. These three groups formed swampy meadows characteristics of hydromorphic vertisols largely structured to collapse and calcareous nodules or hydromorphic mineral gley or pseudo-gley [26].

- Group of *Fimbristylis littoralis* and *Cyperus pustulatus*

It occupied dug basins between the slabs of rock and shallow temporarily flooded. It was largely dominated by Cyperaceae (*Fimbristylis littoralis*, *Cyperus pustulatus*, *Mariscus sublimis* and *Pycreus macrostachyos*) and some Poaceae (*Brachiaria jubata* and *Schizachyrium brevifolium*). Other species may be cited: *Rhamphicarpa fistulosa* and *Portulaca foliosa*.

B_2. Groups of dryland

- Group of *Andropogon* and *Hyparrhenia*

These two genera characterizing the group represented the high grassy herbaceous species widely distributed in the MNP. The combinations of species associated with this group were quite varied depending on the characteristics and ecological environment; one could observe the dominance of one or more species of these genera.

In the clay areas often little wet, tall grass were dominated by *Andropogon gayanus* var *squamulatus*, *Andropogon schirensis*, *Loudetia simplex*, *Beckeropsis uniseta*, *Diheteropogon hageryi* and *Hyparrhenia rufa*.

In drier sandy clay areas, were met *Andropogon gayanus* var *tridentatus*, *Hyparrhenia bagirmica*, *Hyparrhenia rufa*, *Schizachyrium sanguineum*, *Cymbopogon giganteus* and *Hyperthelia dissoluta*. On ferruginous crust, were found *Loudetia simplex*, *Ctenium elegans*, *Schizachyrium sanguineum*, *Andropogon* schirensis and *Eragrostis atrovirens*.

- Group of *Oxytenanthera abyssinica*

It was an important stand of bamboo (*Oxytenanthera abyssinica*) in the area of Koutou. This gregarious species colonized the not floodplain but long to dry [23]. It was associated with low red lateritic deep soils and well drained [27]. These bamboos were exploited by local populations located between the villages of Sanguélé and Manbonon and were highly threatened.

This vegetation was accompanied by some tall grasses such as *Ctenium newtonii*, *Andropogon* and *Hyparrhenia* especially many shade species as *Dioscorea dumetorum*, *Dioscorea sagittifolia*, *Dioscorea quartiniana*, *Costus spectabilis*, *Siphonochilus aethiopicus*, *Gladiolus psittacinus* and *Stylochaeton hypogaeus*.

B_3. Groups ruderal and anthropogenic

They were described as associations of weeds accompanying harvest or row crops [28] also called ruderal groups [12] . You should also add that ruderals were also common in areas of high pressure area and rest places for domestic animals. The most common species in ruderal groups belonged to the families Poaceae (*Digitaria*, *Pennisetum* and *Brachiaria*), Fabaceae (*Cassia*, *Tephrosia* and *Indigofera*), Malvaceae (*Sida*, *Triumfetta*, *Corchorus* and *Urena*) and Rubiaceae (Spermacoce). They formed very heterogeneous communities but some species could be grouped into small dense colonies. In the area Nguéré eg *Pandiaka involucrata* tended to become invasive in certain places. The analysis of the flora showed that families Poaceae (24.46%) and Fabaceae (15.22%) were the most diverse. The importance of these two families also observed in special environments such as Niayes [29]. Other important families were the Malvaceae (6.79%), Cyperaceae (5.71%), Asteraceae (4.61%), Rubiaceae (2.71%), Acanthaceae (2.44%) and Commelinaceae (2.44%). There were 22 families (38.6%) represented by a single species.

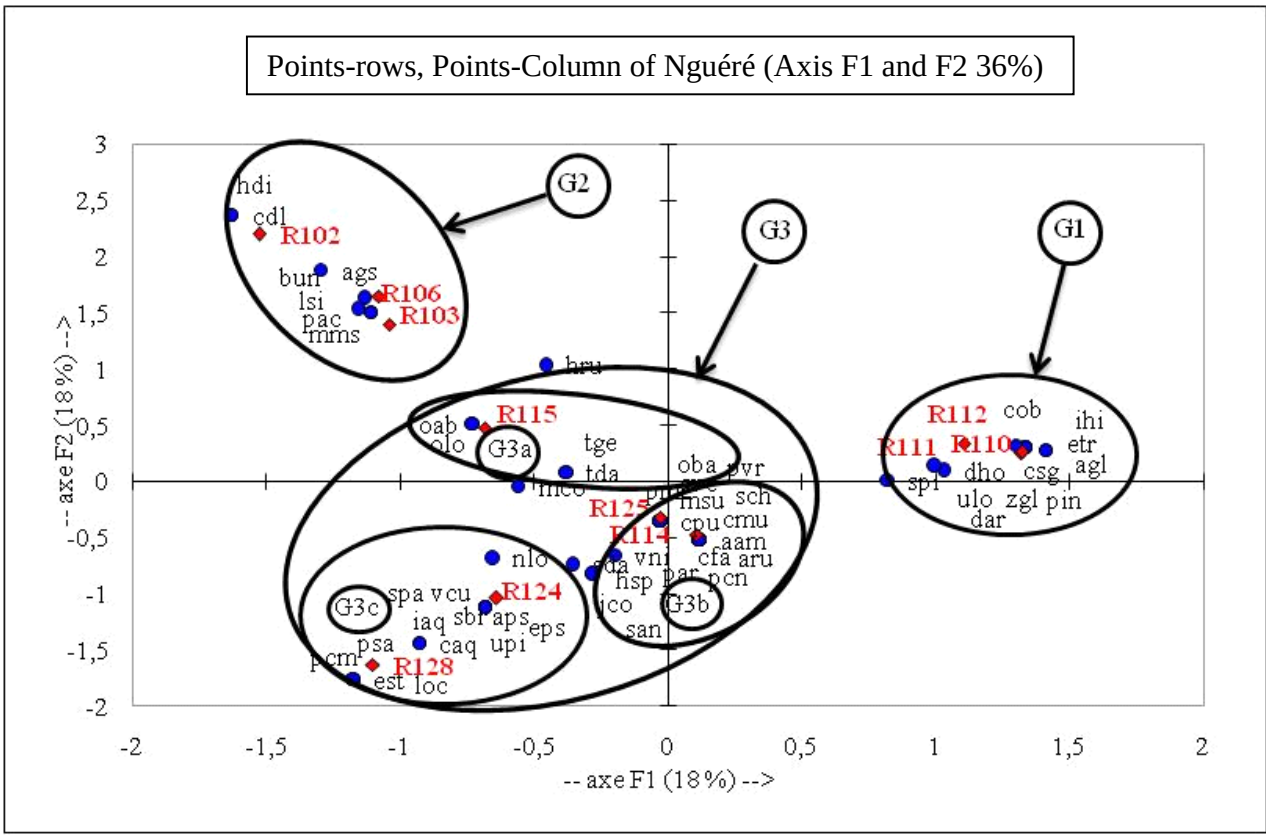

Figure 2. Diagramm of relevés / herbaceous species in the factorial plan axis F1 (horizontal) and F2 (vertical) of Nguéré.

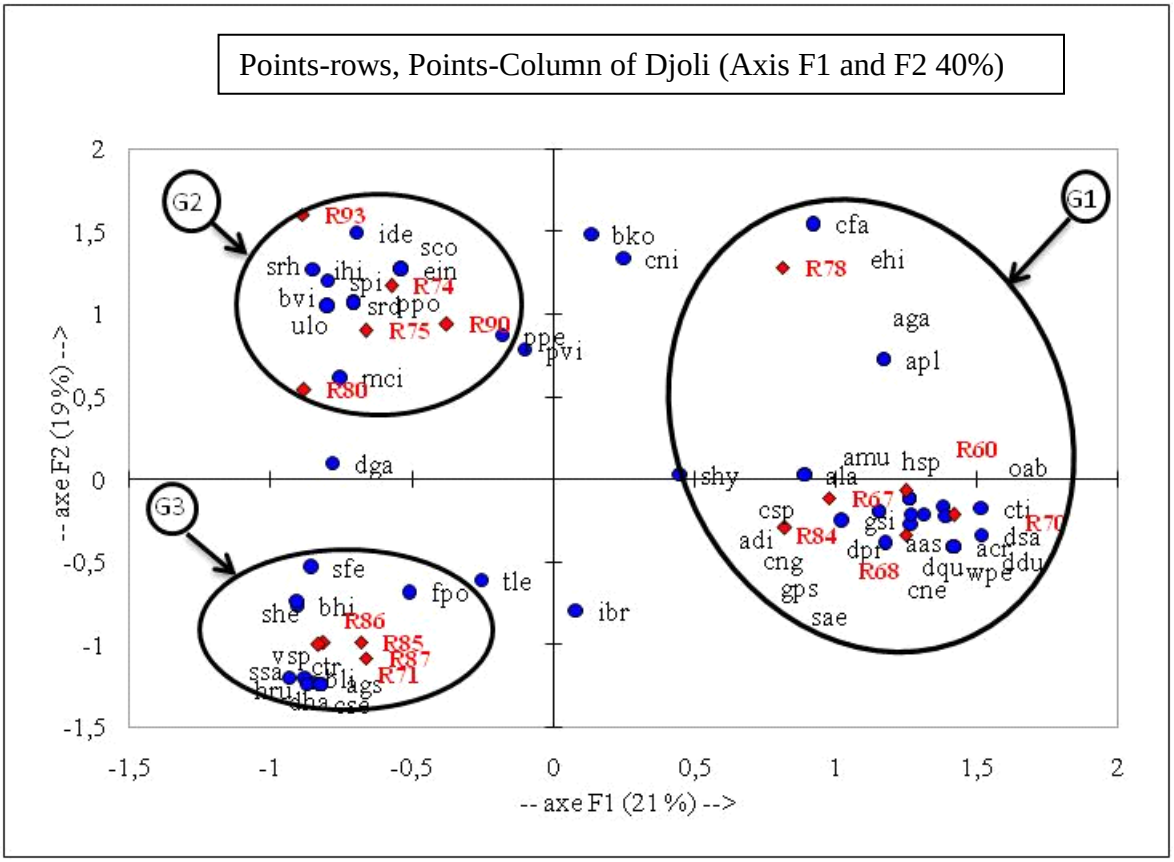

Figure 3. Diagramm of relevés / herbaceous species in the factorial plan axis F1 (horizontal) and F2 (vertical) of Djoli zone.

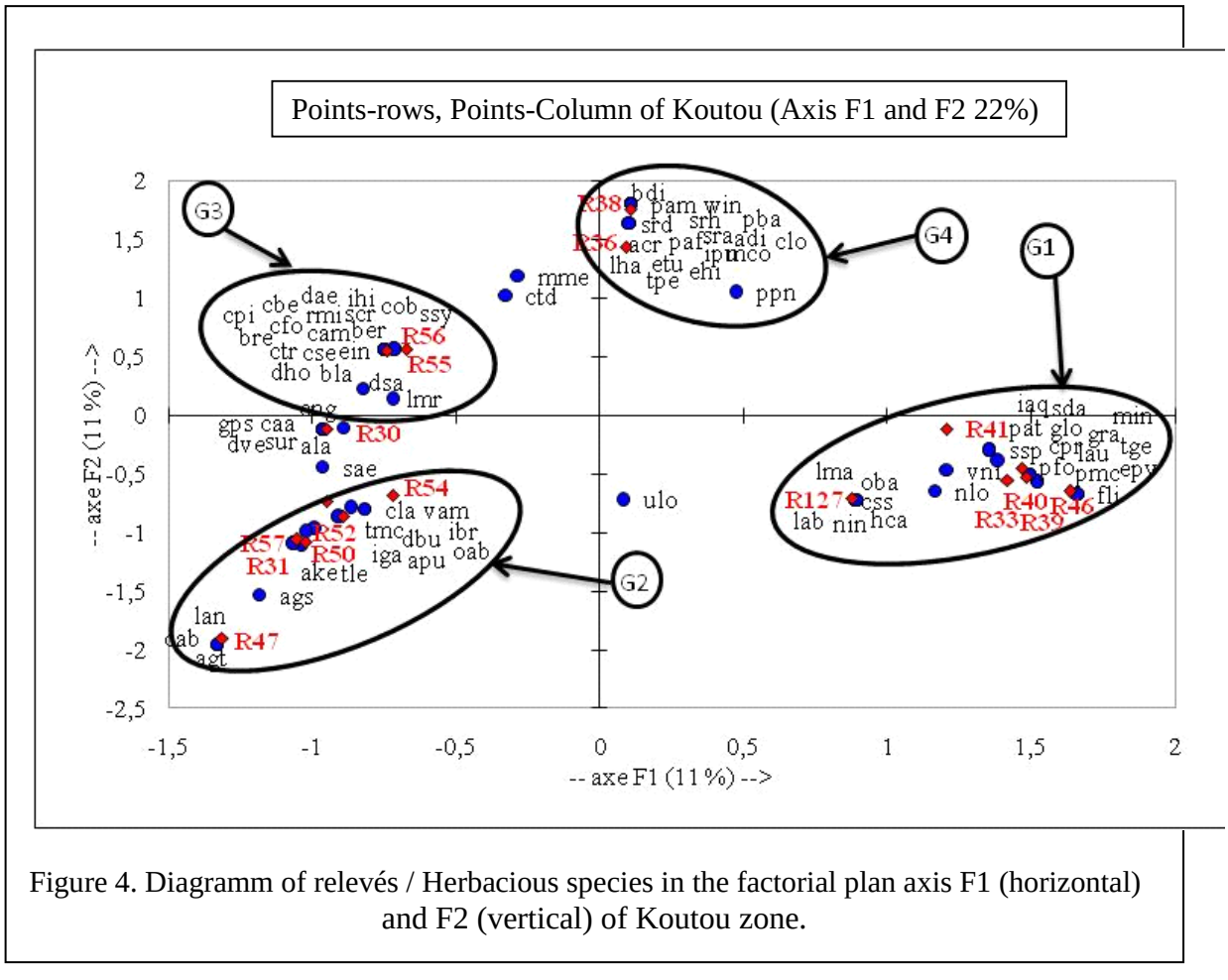

Figure 4. Diagramm of relevés / Herbacious species in the factorial plan axis F1 (horizontal) and F2 (vertical) of Koutou zone.

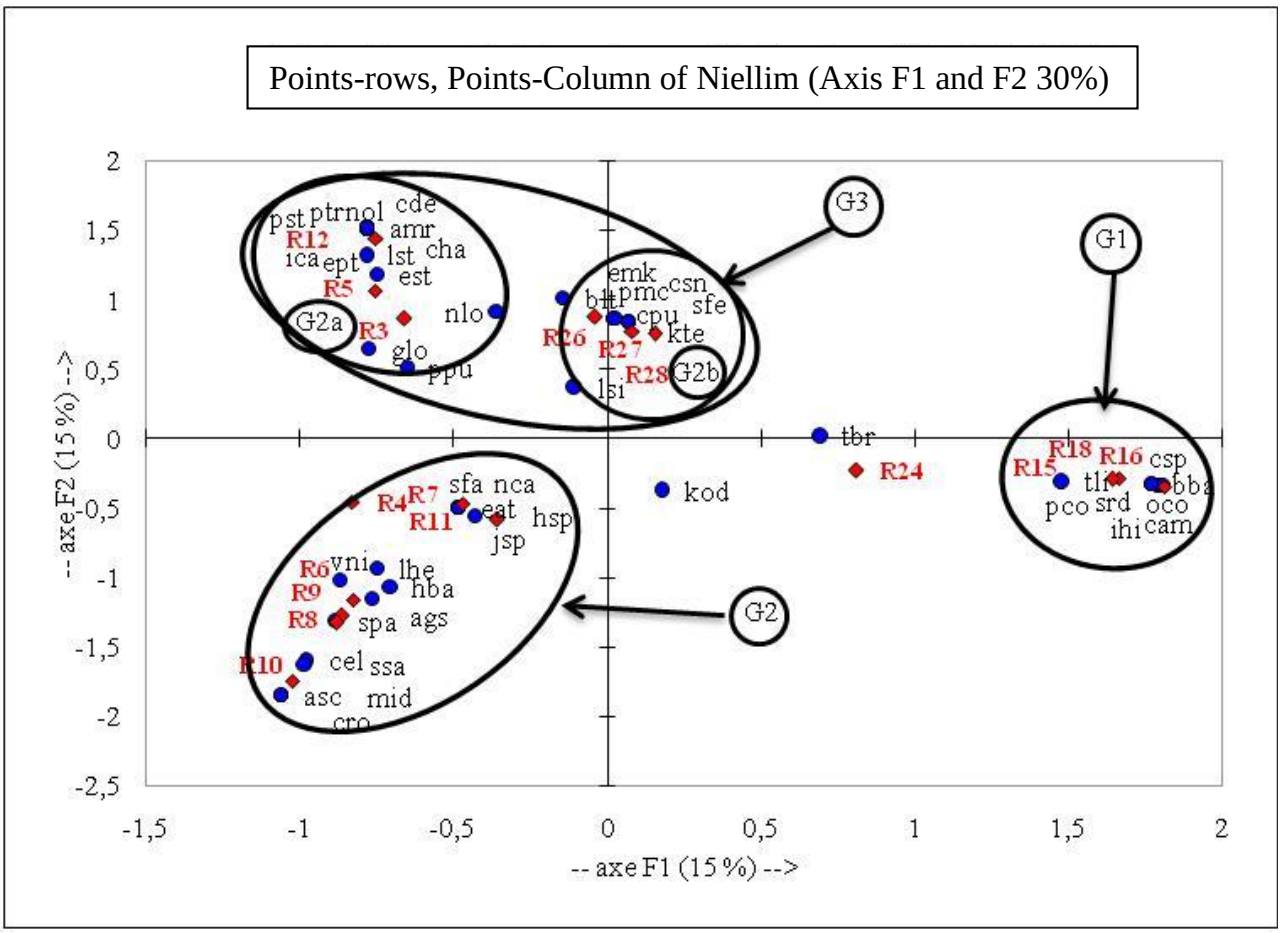

Figure 5. Diagramm of relevés / Herbacious species in the factorial plan axis F1 (horizontal) and F2 (vertical) of Niellim zone.

Table 1. Importance of species and genera according to herbaceous families.

Families	**Genera**	**Species**	**Families**	**Genres**	**Species**	**Families**	**Genera**	**Species**
Poaceae	*44*	*90*	*Amaryllidaceae*	*4*	*4*	*Dilleniaceae*	*1*	*1*
Fabaceae	*19*	*56*	*Apocynaceae*	*2*	*3*	*Costaceae*	*1*	*1*
Malvaceae	*11*	*25*	*Nyctaginaceae*	*1*	*3*	*Dracaenaceae*	*1*	*1*
Cyperaceae	*6*	*21*	*Nymphaeacea*	*1*	*3*	*Eriocaulaceae*	*1*	*1*
Asteraceae	*9*	*17*	*Polygalaceae*	*2*	*3*	*Hyacinthaceae*	*1*	*1*
Rubiaceae	*5*	*10*	*Phyllanthaceae*	*1*	*3*	*Hypoxidaceae*	*1*	*1*
Acanthaceae	*7*	*9*	*Orobanchaceae*	*4*	*2*	*Iridaceae*	*1*	*1*
Commelinaceae	*3*	*9*	*Boraginaceae*	*2*	*2*	*Limnocharitaceae*	*1*	*1*
Euphorbiaceae	*5*	*8*	*Pontederiaceae*	*2*	*2*	*Lythraceae*	*1*	*1*
Amaranthaceae	*6*	*8*	*Alismataceae*	*2*	*2*	*Maranthaceae*	*1*	*1*
Cucurbitaceae	*6*	*8*	*Solanaceae*	*2*	*2*	*Menispermaceae*	*1*	*1*
Convolvulaceae	*4*	*8*	*Asparagaceae*	*1*	*2*	*Menyanthaceae*	*1*	*1*
Vitaceae	*3*	*8*	*Colchicaceae*	*1*	*2*	*Moraceae*	*1*	*1*
Araceae	*5*	*7*	*Pedaliaceae*	*1*	*2*	*Orchidaceae*	*1*	*1*
Lamiaceae	*5*	*5*	*Polygonaceae*	*1*	*2*	*Oxalidaceae*	*1*	*1*
Dioscoreceae	*1*	*5*	*Portulacaceae*	*1*	*2*	*Sapindaceae*	*1*	*1*
Molluginaceae	*2*	*5*	*Plantaginaceae*	*1*	*1*	*Thymeleaceae*	*1*	*1*
Caryophyllaceae	*1*	*4*	*Ceratophyllaceae*	*1*	*1*	*Taccaceae*	*1*	*1*
Onagraceae	*2*	*4*	*Bixaceae*	*1*	*1*	*Zingiberaceae*	*1*	*1*
Total						**57**	**194**	**368**

IV. CONCLUSION

This work provided evidence on which to base the development of management plans and the effective management of the MNP. The herbaceous flora was very diverse as the number of 368 species recorded was much higher than 250 species advanced as areal richness in the zone in whole stratum. This rich flora was characterized by a diversity of habitats including Sahelian environments, Sahel-Sudanian and Sudanian zones interspersed with aquatic, semi-aquatic and cuirasses. The different herbaceous recognized groups were very influenced by water and human activities intensity. The diverse herbaceous flora and its high recovery rates showed that this park was still able to withstand the loads of a relatively abundant wildlife in the event of natural return or reintroduction. The disappearance of certain species on the periphery of the park and the high number of families represented by a single species in the park plead for protection and preservation of the stronger species.

ACKNOWLEDGMENT

We would like to thank Ir. Emile C. Agbangba for his comments on earlier draft of the paper and for proofreading.

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