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Dynamics of sacred forests under the action of human pressures and climate variability in the South-East of the Far North Region of Cameroon

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ABSTRACT: This study focused on the sacred forests of anthropized areas in the southeast of Far North Cameroon. These are forests from a few square meters to a few hectares. The floristic data collected from the surveys showed that the average richness is 17 species. A total of 67 plant species grouped into 27 families have been identified. Formerly preserved for ritual practices, these forests are experiencing regressive changes both in terms of specific richness and diversity of species under the combination of anthropogenic actions and climatic variability. 2/3 of these sacred forests are experiencing a deterioration. The density and specific richness of the species have decreased by 60 to 80% compared to the well-preserved sacred forests. The diversity indices are only 1.36 bit for very degraded forests against 3.85 bits for those in good condition. Species such as *Mytragina inermis*, *Daniellia oliveri* and *Celtis integrifolia* have almost completely disappeared with a rarity index above 80%. Faced with the current socio-economic and environmental changes, actions to raise awareness and collective appropriation through land titles in favor of local populations should be undertaken by the State.

KEYWORDS: Evolution, Sacred forests, Human pressures, Climatic variability, Far North Cameroon Region.

1 INTRODUCTION

The 1992 United Nations Conference on Environment and Development in Rio de Janeiro marked a turning point in policies for the conservation and enhancement of natural spaces and resources around the world. It is from this perspective that the tropical forests, which are characterised by a great diversity of flora and fauna, have caused global anxiety due to their massive destruction. Indeed, they are considered in the collective imagination as the last resort against pollution and the greenhouse effect (Froment & Bahuchet, 2003). Since the beginning of the 20th century, sacred forests have been reported in sub-Saharan Africa by many authors including Chevalier (1933), Kokou, Afiademanyo & Akpagana (1999), Kokou &Sokpon (2006) and among others. Sacred forests are considered to be the traditional method of conserving biodiversity and maintaining relics of ancient natural forest vegetation and are of increasing interest to scientists and conservationists around the world (Gadgil and Vartak, 1976; Salpeteur, 2010). In Africa south of the Sahara, and mainly in the western part, the dynamics, diversity but also the various pressures on these forests have interested some authors who insist on their conservation (Guinko, 1985; Kokou and Kokutse, 2006). Because of their importance in the conservation of plant and animal biodiversity, sacred forests have consequently been classified in the private forest domain of the State in Burkina-Faso, Benin, Mali etc. In Cameroon, the northern regions and particularly the highly vulnerable Sahelian region, especially the Far North, where agricultural and pastoral holdings have increased from 200,000 ha in the years 1980-1985 to more than 500,000 ha in the years 2000-2015 (MINADER, 2018). Similarly, climate variability is increasingly important, with irregularity coefficients rising from 1.54 in 1979 to over 2.38 in 2009, with sacred forests undergoing rapid and massive changes (MEM, 2010).This has led to a reduction in their surface area and diversity, or even their complete disappearance. It is in this sense that in 2002 Gautier and Ntoupka were already pointing out the effective degradation of tree resources in the northern part of Cameroon.

In Africa, the sacred forests, which are wooded areas reserved for initiation rites, are an integral part of these spaces with natural plant resources. According to the spaces considered, and just like tropical forests, sacred forests are currently characterised by dynamics linked to the effects of human activities and climate variability. Based on floristic analyses and interviews with the local populations of the surveyed sites, this study characterises and analyses the dynamics of sacred forests. It is based on the hypotheses that climatic variability and anthropic pressures negatively impact the dynamics of these sacred spaces in this ecologically fragile area. The aim is to conserve and sustainably use these sacred forests, which are among the areas where biodiversity is still conserved. But given the effects of climate variability and current anthropogenic pressures, what is the current state of these last refuges of biodiversity? How do anthropogenic activities and climate variability impact their dynamics? What actions need to be taken to safeguard them?

The study area is the Far North Region of Cameroon which is located in the Sahelian strip south of the Sahara. Apart from parks and reserves, the only forests that exist there are limited to forest galleries and sacred forests preserved for ritual and initiation practices. While the former are currently highly disturbed, the latter are subject to the effects of rainfall variability and anthropogenic pressures. The area studied in the South-East Region of Far North Cameroon covers a territory of approximately 10514 km². Administratively, it essentially occupies two Division: Mayo-Kani and Mayo Danay (Figure 1), which are mainly made up of the Moundang, Guiziga, Toupuri and Massa ethnic groups. Nearly 80% of them are occupied by farmland and pastures. The sacred forests that are the subject of this study are dry forests in the sense of Hall and Swaine (1981), very often located in valleys, lowlands or on rocky soils. The climate is tropical dry and the average annual rainfall is 600-700 mm (Suchel, 1972) and the average annual temperature is well above 30°C.

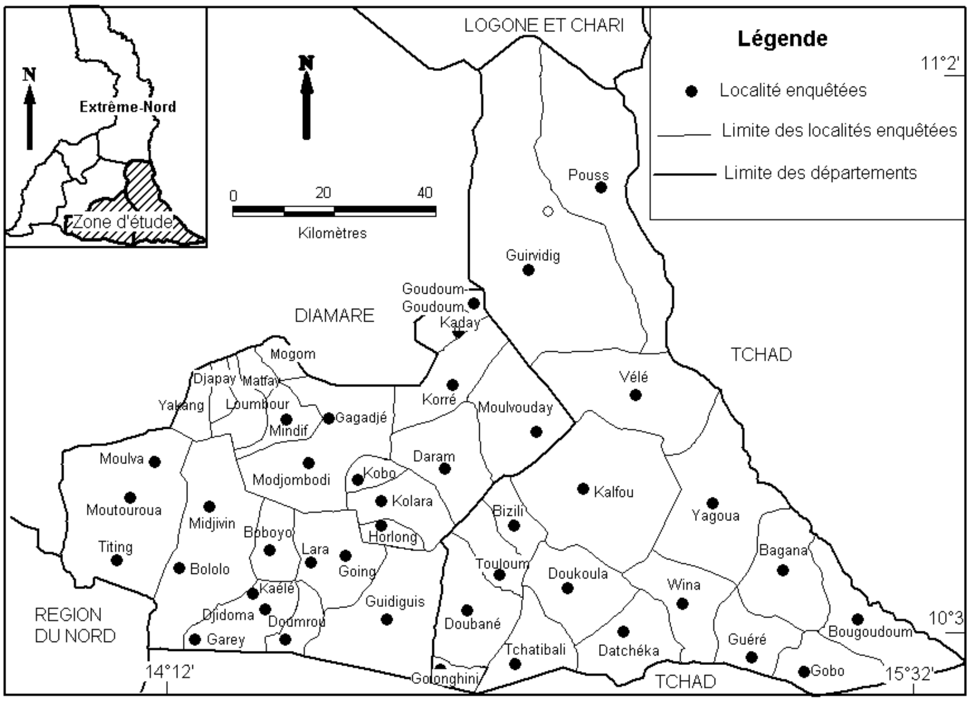

Fig. 1. Study area

***Source:** Seignobos Ch. and O. Iyébi Mandjeck, 2000, Altas de l'Extrême-Nord Cameroon and field surveys, June 2019.*

2 Instruments And Methods

Sacred forests have been identified and delimited by GPS in the studied area. A total of 40 forests were the subject of phytosociological studies. After discussions with the village chiefs on their importance in the life of the populations, their current state and their evolution, the floristic surveys were carried out along small transects made up of continuous 30 m x 30 m square plots, installed in each identified sacred forest. Given the variable size of forests, the number of samples is proportional to the size of the forest. Thus some forests (5ha and more) have 10 and others that are too small (less than 1ha) have only one survey. A total of 85 plots were sampled, i.e. an area of 7.5 ha covered, representing a sampling rate of more than 10%.

In each plot, all plant species were systematically surveyed. The species were identified in the field using the Arbonnier (2004) determination key. A floristic list was drawn up for each forest and for all the surveys as a whole. The diameter of individuals with a height greater than 3 m was measured at 1.30 m above ground level (dbh), the number of individuals and vitality were recorded and the coverage rate of the different strata was assessed by visual scoring using the vade mecum for systematic vegetation surveys (Godron et al., 1969).

Within each inventory plot, a small plot of 10 x 10 metres has been delimited to count regeneration (woody <1.5 m). The parameters relating to human activities were also recorded (stump, cutting, pruning, fields, grazing etc.). The data were supplemented by rainfall records covering a 40-year period (1970-2009) and surveys of local populations on a random sample of 450 households chosen at random and spread over all the localities studied. Finally, interviews were also conducted with the Water, Forestry and Environment Departments. The treatments carried out with XLSTAT and Excel consisted in realisation a floristic assessment made up of a matrix of 67 species x 85 records and allowed to make statistical tables, curves and a typology of the forests through an ascending hierarchical classification (Bouroche and Saporta, 1987) based on their floristic composition. The floristic diversity of forests has been studied on the basis of index calculations (Daget, 1980; Le Floc'h, 2007) carried out on the frequencies of the species recorded during floristic surveys. These are:

- The floristic richness (specific: N0), the total number of species);
- The Shannon index (Shannon and Weaver, 1949)
- $\mathrm{ISH} = -\sum_{i=1}^{n} pi \log_2 \ (pi)$, where n=number of species encountered and pi=probability of species i;
- Equitability $E = \frac{\mathrm{Ihs}}{\log_2 N0}$ corresponds to the ratio between the observed diversity and the maximum possible diversity given the number of species No.
- Jaccard's coefficient of floristic similarity$\mathrm{Pj} = \frac{\mathrm{c}}{a+b-c} x100$ used to compare the types of sacred forests identified. In addition, the land areas of the tree stratum were calculated according to the formula G=ΣπD2/4 where G is the area in m²/ha, D is the diameter of the trees. Similarly, the status of species was specified by calculating a species scarcity index (Géhu & Géhu, 1980) according to the equation RI= [1- (ni/N)] x100 where RI is the scarcity index, ni the number of surveys in which species i is present and N is the total number of surveys. Species with IR>80% are qualified as rare species. To do this, the rank-frequency curve, indicating infrequent and therefore rare species, was carried out over all the surveys. Regeneration in sacred forests was also assessed using the ratio of the number of young to old trees. The analysis of data from population surveys provided insight into their current perceptions of the sacred forests and the effects of climate variability were analysed by calculating the coefficient of interannual irregularity of rainfall in the area.

3 Results

3.1 Current State Of Sacred Forests

The analysis of the data collected in the field has made it possible to establish an inventory of the state of degradation of sacred forests. It is based on the typology of forests and the calculation of various indices used for the characterisation of woody vegetation.

3.1.1 Typology Of Forests Based On Their Floristic Composition

The classification carried out on all the surveys individualises the 85 sampled plots corresponding to the 40 sacred forests according to their floristic similarity. This grouping made it possible to highlight three types of sacred forests, named forests 1, 2 and 3 (Figure 2). Considering this hierarchical classification:

- Type 1 forests are made up of 36 plots, 33 of which are established in highly degraded forests and 3 in less degraded ones (Pfd1 to Pfd34 and Fmd4, 7 and 25);
- Forest type 2 consists of 29 plots established in both moderately degraded and well-preserved forests (Ftd 12, Fmd2, 3, 5, 8, 9, 11, 12, 14, 16, 17, 18, 19, 23, 24, 26, 27 and Fbe 2, 3, 5, 8, 9, 11, 12, 16, 17, 19, 23, 24);
- Type 3 forests consist of 20 plots distributed between plots with less forest and plots in good condition. The distribution between the two forest types indicates the varying degree of degradation and that even sacred forests that are in good condition from a physiognomical point of view are still in good condition. Overall, it appears that 70% of the plots representing 2/3 of all sacred forests are in degraded or moderately degraded condition.

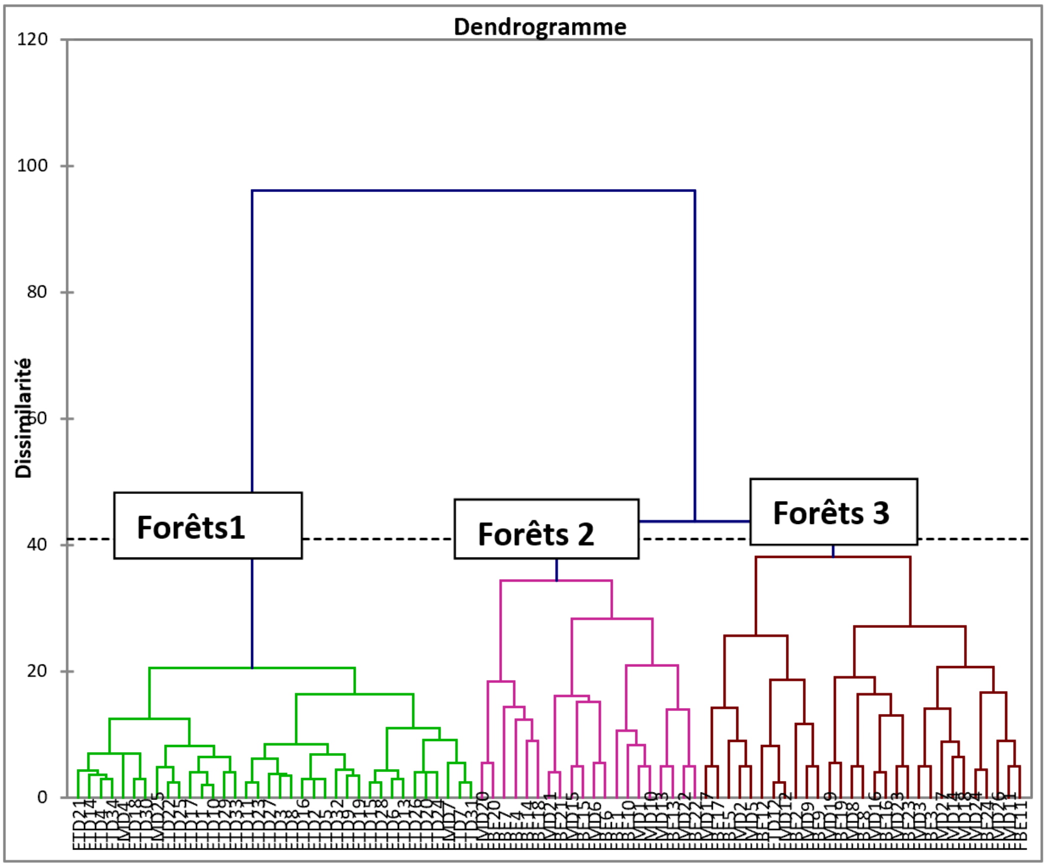

Fig. 2. Typology of sacred forests

3.2 Species Richness And Density

By considering all the sacred forests, the analysis of the floristic richness allowed the identification of 67 species and 27 families in all the plots, for an average density of 2162.6 individuals/ha. Considering the forests according to their degree of disturbance, specific richness and density, the values are distinct (Table 1).

Table 1. Flora richness according to forest types

Physiognomic state	Some localities concerned	Medium specific richness/plot	Specific richness total	Average density/ha
Heavily degraded	Tchaodé, Garey, Moulva	8.64	21	1421
Less degraded	Mindjil, Goubara, Fouli	16.15	42	2033
Forests in good condition	Kalfou, Moulvoudaye, Pété, Gagadjé	24.62	67	3034

Source: *Field surveys, June 2018*

Thus, the species richness and density of individuals in highly degraded forests only represents half the value of forests in good condition. The comparison of values between sacred forests according to the density of individuals shows that the value of degraded forests is half that of forests in good condition. This reflects the high degree of disturbance of the first type of forest as well as the weight of the factors that caused the disturbances, which explains the variation in abundance-dominance observed between species.

3.3 Abundance-Dominance Of Species And Families

The species fairly representative of sacred forest vegetation are in order of importance: *Anogeissus leiocarpus* (21.3%), *Acacia ataxacantha* (14.6%), *Balanites aegyp*tiaca (8.5%), *Acacia seyal* (6.4%), *Dichrotachys cinerea* (5.4%), *Combretum* *glutinosum* (4.5%), *Diospyros mespilitiformis* (3.5%), *Piliogstima reticulatum* (3.2%), *Annona senegalensis* (3.1%), *Khaya senegalensis* (2.1). On the other hand, the under-represented or rare species are: *Mitragyna inermis* (1.2), *Celtis integrifolia* 1.1%, *Grewia flavescens* (0.81%, *Daniellia oliveri* (0.80%), *Lophira lanceola* (0.72%), *Andira inermis* (0.54%) *Pterocarpus erinaceus* (0.43%), *Commiphora africana* (0.4%), *Maytenus senegalensis* (0.37%), *Detarium microcarpum* (0.2%). Sacred forests have a wide range of families within them. In fact, of the 27 families inventoried, the most represented are the Combretaceae with a rate of 16.66%, followed by the Mimosaceae (15%), the Caesapiniaceae (8.33%), the Anacardiaceae (6.66%), the Moraceae (6.66%), the Meliaceae and the Fabaceae (5%) each.

3.4 Varied Indices Reflecting The Heterogeneity Of The Forests

3.4.1 Diversity And Fairness Index

The calculated Jaccard similarity coefficient indicates a significant difference between the three types of sacred forests. It is 54.38% between well conserved forests and highly degraded forests and 38.23% between good and moderately disturbed forests. Similarly, considering the Shannon-Weaver diversity indices, it appears that it is also variable. It does not exceed 1.4 bits in highly degraded forests, whereas it is 3.85 bits in forests in good condition (Table 2). **Table 2.** Comparison of floristic diversity between sacred forest types

	Shannon Index	Fairness Index
Highly degraded sacred forest	1.36	0. 36
Moderately degraded forest	2.8	0.61
Forest in good condition	3.85	0.72

Source: *Field data analysis, June 2018*

The equitability index confirms these observed differences; it goes from 0.36 for highly degraded forests to 0.72 for those in good condition.

3.4.2 Rarity Index

The rank-frequency curve over the data set shows a logarithmic pattern, indicating that some species are significantly more frequent, followed by moderately frequent species and a significant number of rare species (Figure 3). Rare species in sacred forests include taxa such as *Mitragyna inermis, Celtis integrifolia, Grewia flavescens, Daniellia oliveri, Lophira lanceola, Andira inermis.* Of these, only *Grewia flavescens* is present in heavily degraded forests, in the rest it is non-existent.

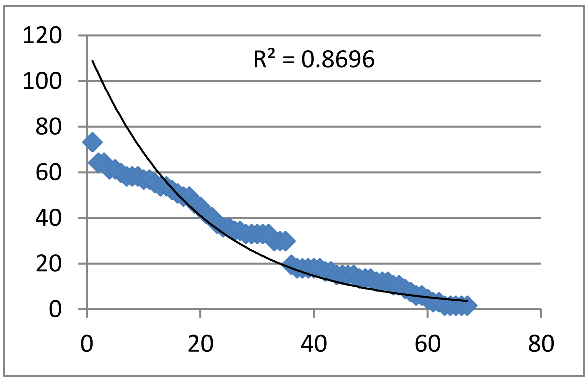

Fig. 3. Row-species curve for all readings

Calculation of rarity indices indicates that species with IR>80% higher in less degraded forests in good condition are distributed as follows: Andira inermis (97%); Daniellia oliveri (88.3%); Mytragina Inernis (87.2%); Lophira lanceolata (83.3%); Celtis integrifolia (81.2%) These species, which are almost non-existent in highly degraded forests, reflect the degree of degradation in sacred forests.

3.4.3 Regeneration Index

The regeneration index calculated for the three forest types is a function of the forest types (Table 3) and shows strong and varied values. The values obtained are respectively 0.17 for highly degraded forests, 0.45 for the least degraded and 0.5 for those in good condition (Table 3).

Table 2. Forest-based scarcity indices

Types of forests	Average number of young plants/ha	Rarity index
Heavily degraded	326	0.17
Less degraded	923	0.45
Forests in good condition	1422	0,50

Source: *Field survey, June 2018*

The results show that regeneration, which is essentially the result of germination and the rejection of stumps, has an average rate in forests in good condition and in moderately degraded forests, whereas it is very low in the first type of highly degraded forests.

3.5 A Variation In Land Surfaces Indicating Heterogeneity

The analysis of the basal area by sampled forest type shows that the largest areas correspond respectively to the less degraded and good areas with 44.25 m2/ha and 52.76 m2/ha respectively (Table 4). On the other hand, it is low in highly degraded sacred forests with a value of 24.35 m2/ha. Thus, the less degraded areas are those with large trees. These low values justify a low rate of mature individuals and a small size for a few stems of woody species present in degraded forests.

Table 3. Land surfaces by sampled areas

Zones	Land surfaces
Highly degraded	$24.35m^2/ha$
Less degraded	$44.25m^2/ha$
Forests in good condition	$52.76m^2/ha$

Source: *Analysis of floristic field surveys, May-June 2018.*

In sum, considering the total density of individuals, the specific richness and the various indices, the values are low in highly degraded forests compared to those still in good condition. These values reflect a regressive forest dynamics due to the effects of the various factors that cause the observed disturbances.

3.6 Degradation Caused By Various Factors

Among the many factors that can lead to the degradation of sacred forests in the south-east of the Far North of Cameroon, the main ones are the growth of agricultural areas, the appearance of revealed religions and climate variability. The growth in agricultural land is evident in the study area. Continued population growth in this part of the country has brought with it an increase in agricultural land. Thus, between 1985 and 2015, the area used for agriculture increased from some 120 000 hectares to more than 550 000 hectares (Figure 4).

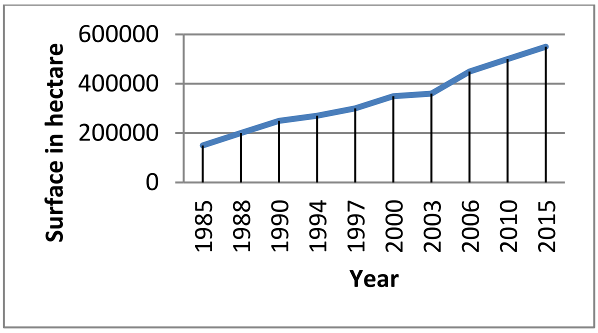

Fig. 4. Evolution of cultivation areas between 1985 and 2015

Source: *Regional Delegation of the Minader, 2018.*

Among the areas exploited are the sacred forest areas. In fact, 64.7% of the surveyed households claim to have had a plot of land cleared in the last ten years, and 73.5% of household members look for timber and firewood or forest products that are included in the pharmacopoeia. In addition to the increase in agricultural land, the role played by revealed religions must be emphasised. The introduction of Christianity and Islam led to the loss of ancient cultural values, the desacralization of sacred places and thus opened the door to the exploitation of forests that were once sacred to the people. Indeed, if 82% of the animists/peasants still consider sacred forests as sacred places, it is different for Christians and Muslims who do not feel concerned at all. In fact, between 34 and 55% of Christian and Muslim households today consider sacred forests as reserves of agricultural land, and between 52 and 73% consider them as reserves of pasture, timber and fuelwood (Table 5). Moreover, a small proportion of animists/peasants also see them as reserves of agricultural land, timber and firewood.

Table 4. Current perception of sacred forests according to the status of populations

Household status /Perception of sacred forests	Distribution of households	Sacred Places	Agricultural land reserves	Pasture, timber and firewood reserves
Animists /païens	150	82.3%	5.2%	12.5%
Christians	150	0	54.3%	73.1%
Muslims	150	0	34.6%	52.8%

Source: *Field surveys, April-June 2018*

As a result, sacred forests are exploited and continue to be exploited (Plate 1) by local populations in general throughout the study area.

Board 1. Photo A and B, Timber harvesting in the sacred forest

As far as climate variability is concerned, it should be pointed out that the Far North Region of Cameroon, which is the study area of the present endeavour, is subject to increasing climate variability. Calculation of the K3 coefficient of interannual irregularity of rainfall in the study zone shows that it has been increasing continuously over the last four decades (Table 6). These increasingly high values reflect the irregularity of rainfall in the area. These variations have harmful effects on the woody vegetation and result in significant wood mortality. With regard to sacred forests, an overall mortality rate of 8.26% has been recorded (Photo 1), with the Combretaceae family being the most affected.

Table 5. Coefficient K3 of interannual rainfall irregularity

Decade	1970-1979	1980-1989	1990-1999	2000-2009
Coefficient K3 of interannual rainfall irregularity	1.54	1.95	2.16	2.38

Source: *Departmental Delegation of the Minader of Kaélé and Yagoua, 2018*

Photo 1: Desiccation of large trees in a sacred wood in Kalfou. In the centre of the photo stand dried out Anogeissus leiocarpus and Combretum glutinosum.

4 DISCUSSION

4.1 SACRED FORESTS DYNAMICS

The characterisation of sacred forests in the south-east of the Far North Region of Cameroon indicates varying degrees of degradation of sacred forests in the localities studied. Heavily degraded forests, which represent 2/3 of the sacred forests, are characterised by regressive dynamics, resulting in low floristic richness (8.34 species on average), low density (1421 individuals/ha) and low diversity and equitability indices of 1.36 and 0.21 respectively. In contrast to these, the sacred forests, which are still in good condition although representing only 1/3 of all the sacred forests surveyed, are characterised by a high floristic richness (25 species on average), a high density of 2832 individuals/ha and high diversity and equitability indices of 3.85 bits and 0.72. These values confirm those of Sani et al. (2013), who put forward diversity and equitability index values of 3.75 bits and 0.63 respectively for the Mozogo-Gokoro National Park in the extreme north of Cameroon. Among the key factors noted was the agricultural boom that continues to nibble away at the sacred forests. Indeed, looking back over the last three decades, agricultural areas have doubled and in this evolution, which is far from abating, farmers are no longer sparing the sacred forests, which are increasingly seen not only as reserves of agricultural land. These degradations are aggravated by the actions of Christianised and Islamicised populations who no longer consider these forests as sacred places, as noted by Koukou and Sokpon (2006). Although marginal, and as pointed out by Adjossou et al. (2009), climate variability characterised by a continuously increasing coefficient of interannual rainfall irregularity favours the mortality of ligneous trees, estimated at 8.26% for the sacred forests studied. In view of the ecosystem services rendered to local populations and the galloping population growth in the study area, combined with this trend towards increased climate deterioration (Agrhimet, 2009), the question that arises is that of the conditions for the sustainability of these forests.

4.2 WHAT ACTIONS TO TAKE FOR SUSTAINABLE MANAGEMENT

The expansion of food crops as a result of dizzying population growth; the introduction of revealed religions, which have greatly favoured the desacralization of sacred forests, and increasing climate variability, have contributed, and still contribute today, to the dynamics of sacred forests. They have made their exploitation possible. Given that sacred forests are being degraded despite the environmental services they provide to the local populations living along their shores and the recognition of their role in the conservation of biodiversity in several regions of the world (Unnikkrishnan 1995), it is imperative that they be managed sustainably. As a custodian, the State should encourage their management and conservation by raising awareness of the need to protect sacred forests among the populations concerned. To this end, awareness-raising campaigns in the local mass media should be carried out to achieve this objective. Similarly, protection could also be achieved through the adoption of management approaches such as those proposed by Bellefontaine et al. (1997) in order to promote their sustainable management and the development of common species. Finally, the promotion of collective appropriation by favouring the establishment of land titles for the benefit of local riparian populations should be envisaged.

5 CONCLUSION

This first analysis of sacred forests confirms the advanced state of degradation of the majority of sacred forests in the Far North Region of Cameroon. In a nutshell, whether in the localities of Tchéodé, Moulva, Garey, Gagadjé or Moulvoudaye and Kalfou, the sacred forests are characterised by a tendency towards a strong degradation of their sacred forests with a few rare exceptions. These are justified by the persistence of ritual and initiation practices. The factors of degradation noted are above all the continuous increase in agricultural areas, the appearance of revealed religions and the climatic variability that has been raging in the Sahelian zone in recent decades. Given their importance for local communities and biodiversity conservation, the state should encourage awareness for conservation and also foster ownership by facilitating land titling of these forests.

REFERENCES

[1] Adjossou K., Bellefontaine R., Kokou K., 2009. Les forêts claires à *Anogeissus leiocarpus* du Parc national Oti-ke'ran au Nord-Togo: structure, dynamique et impacts des modifications climatiques, *Sécheresse*, 20 (4): 394-396.

[2] AGRHYMET, 2009. Le Sahel face aux changements climatiques. Enjeux pour un développement durable. Niamey, CILSS/AGRHYMET, *Bulletin mensuel, numéro spécial*, 42 p.

[3] Arbonnier M., Girard P. et Bonnet P., 2008. *Ligneux du Sahel* V.1.0, CIRAD.

[4] Bellefontaine R, Gaston A, Petrucci Y. 1997. Aménagement des forêts tropicales sèches. FAO, pp. 59-220.

[5] Bouroche, J.M., Saporta, G., 1987. *L'analyse des données*. PUF, 127 p.

[6] Chevalier, A., 1933. Les bois sacrés des noirs, sanctuaire de la nature. *C.R. de la Société de Biogéographie*, 37 p.

[7] Daget, P., 1980. Le nombre de diversité de Hill, un concept unificateur dans la théorie de la diversité écologique. *Acta Oecologica/Oecol. Gener., vol. 1, n°1*: 51-70.

[8] Gadgil, M. &Vartak, V.D., 1976. Sacred groves of Western Ghats of India. *Econom. Bot*. 30, 152-160.

[9] Gautier D., Ntoupka M., 2002. Une inflexion dans la dégradation des ressources arborées au Nord-Cameroun, Editeurs scientifiques, Jamin J.Y., SeinyBoukar L., Floret C. (éditeurs scientifiques), 2003. *Savanes africaines: des espaces en mutation, des acteurs face à de nouveaux défis. Actes du colloque, mai 2002, Garoua, Cameroun*. Prasac, N'Djamena, Tchad -Cirad, Montpellier, France, 9 p.

[10] Guinko, S., 1985. Contribution à l'étude de la végétation et de la flore du Burkina Faso. Les reliques boisées ou bois sacrés. *Bois et forêts des Tropiques*, n° 208, pp. 29-36.

[11] Géhu, J.M. & Géhu, J., 1980. Essai d'objection de l'évaluation biologique des milieux naturels. Exemples littoraux. *In*: Géhu J.M. (ed), *Séminaire de Phytosociologie Appliquée. Amicale Francophone de Phytosociologie*, Metz, pp. 75-94.

[12] Godron M., Daget P., Emberger L., Long G., Le Flo'ch E., Poissonnet J., Sauvage C., &Wacquant, J. P., 1969.*Vade-mecum pour le relevé méthodique du milieu et de la végétation*. CNRS, p.169.

[13] Hall, J. B. and Swaine, M. D., 1981. *Distribution and ecology of vascular plants in a tropical rain forest vegetation in Ghana.*Springer-Sciences+Business Media, Netherlands, pp. 1-14.

[14] Froment A., Bahuchet S., 2003. L'homme suit-il les forêts ? *In*: Cormier Salem Marie-Christine (éd.). *La terre. La Recherche. Hors Série*, n°11, pp. 20-25.

[15] Kokou, K, Afiademanyo, K. &Akpagana, K., 1999a. Les forêts sacrées littorales du Togo: rôle culturel et de conservation de la biodiversité. *J. Rech. Sci. Univ. Bénin (TOGO), 3 (2):* 91-104.

[16] Kokou, K. &Sokpon, N., 2006. Les forêts sacrées du couloir du Dahomey. *Bois et Forêts des Tropiques n° 288 (2),* pp 15-23.

[17] Kokou, K. & Kokutse, A.D., 2006. Rôle de la régénération naturelle dans la dynamique actuelle des forêts sacrées littorales du Togo. *Phytocoenologia 36 (2).*

[18] Kokou Kouami, Adjossou Kossi et Hamberger Klaus, 2005. « Les forêts sacrées de l'aire Ouatchi au sud-est du Togo et les contraintes actuelles des modes de gestion locale des ressources forestières", *VertigO - la revue électronique en sciences de l'environnement* [En ligne], Volume 6 Numéro 3, Décembre 2005, mis en ligne le 01 décembre 2005, consulté le 24 février 2017. URL: http://vertigo.revues.org/2456; DOI: 10.4000/vertigo.2456, 13 p.

[19] Le Floc'h E. 2007. *Guide ROSELT/OSS pour l'étude et le suivi de la flore et la végétation.* Collection ROSELT/OSS, CT n°1: Tunis; 175 p.

[20] MINADER, 2018. Rapport d'activités de la délégation régionale de l'agriculture et du développement rural de l'Extrême-Nord, 43 p.

[21] Salpeteur M., 2010. « Espaces politiques, espaces rituels: les bois sacrés de l'Ouest Cameroun", *Autrepart*, *Revue de sciences sociales au Sud*, IRD, n°55, pp 19-38.

[22] Sandjong Sani R.C., Ntoupka M., Ibrahima A et Vroumsia Toua., 2013. *Etude écologique du Parc National de Mozogo-Gokoro (Cameroun): Prospections préliminaires de la flore ligneuse et du sol pour sa conservation et son aménagement,* in: *International Journal of Biological and Chemical Sciences* 7 (6), December 2013, pp 2434-2449.

[23] Shannon C.E. & Weaver W. 1949. The mathematical theory of communication. *Urbana,* Chicago Ill., Univ. Illinois Press, 125 p.

[24] Suchel, J. B., 1972. *La répartition et les régimes pluviométriques au Cameroun. Travaux et Documents de Géographie Tropicale*, n° 5, CEGET-CNRS Bordeaux, 283 p.

[25] Unnikrishnan, E., 1995. *Sacred groves of north Kerela: An ecofolklore study.* Jeevarekha, Thrissur, Kerela, India, 229 p.