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Phytodiversity and Vulnerability of Protected Areas in Burkina Faso: Case of Péni Classified Forest

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Abstract

Protected areas contain most of Burkina Faso's plant biodiversity which confer different benefits for the communities. However, the composition of some of them remains unknown. In a context of overexploitation and climate change, it is important to have a detailed knowledge of the vegetation of forests that have not been studied, such as Péni Classified Forest (PCF) to develop better preservation protocols. The aim of this study is to contribute to the knowledge of the flora of Burkina Faso. Phytosociological surveys were carried out in 213 plots, have identified 475 species distributed in 321 genera and 87 families. We identified during this study 201 woody species representing 38% of the woody flora of Burkina Faso. 64% of this flora is confined to shrub savannahs and 61% to tree savannahs. Among the vegetation units, shrub savannahs and tree savannahs have respectively 56.21% and 44.67% of very rare species. Poaceae (11.90%), Fabaceae-Faboideae (11.27%) and Rubiaceae (6.26%) are the most dominant families. The dominant biological types of the flora are phanerophytes (42.32%) and therophytes (30.32%), and Sudanian species (20.63%) are the best represented. Logging is the most frequent disturbance factor (100%) in the PCF. The PCF is a particular ecosystem with a great di-

versity but subject to many disturbances. Actions to strengthen its protection are necessary.

Keywords

Biodiversity, Ecology, Anthropic Pressures, Classified Forests, Burkina Faso

1. Introduction

Tropical forest ecosystems play a vital role for the world (Zaouri et al., 2021). They are the most important conservation areas for plant and animal diversity on the planet (Myers et al., 2000). Aware of this vital resource, many countries have adopted laws to create protected areas (Triplet, 2009) to better conserve biodiversity. In Burkina Faso today, most of the animal and plant biodiversity is found in protected areas. This strategy makes it possible to conserve an important part of biodiversity, particularly floristic diversity (Mbayngone et al., 2008).

Burkina Faso ratified the Convention on Biological Diversity (CBD) at the Rio de Janeiro summit in 1992 for the sustainable and rational management of biological resources. However, this sustainable and rational management requires detailed scientific information on protected areas. To fill this gap, studies, including ten on sixty-six protected areas, have been undertaken by the country's researchers to know the phytodiversity within these areas. The most recent study is that of Djiguemde et al. (2022) in the Dinderesso Classified Forest. However, the biodiversity of several protected areas in the country remains imperfectly known. For Nacoulma (2012), assessing the status of biodiversity in protected areas remains a challenge for developing countries like Burkina Faso.

In addition, several studies have reported alarming situations that threaten the integrity of these areas and their resources such as anthropogenic pressures and climate change (Corlet, 2020; Edwards et al., 2019; Dimobe et al., 2017). The consequence is the disruption of ecosystems that become fragmented, inducing ecological imbalance, which creates a disappearance of important vegetation strata (Sanon, 2019).

Since its classification in 1942, the Péni classified forest (PCF) has been an island of biodiversity conservation for Burkina Faso. But no scientific information exists to date on its floristic potential. However, anthropic pressure and the effects of climate change constitute a threat to the forest, which is gradually degrading. This situation could lead to the disappearance of plant species within this formation whose diversity has not yet been studied. In addition, the FCP has historical significance since it was established with the participation of indigenous communities who voluntarily ceded their fields. In the context of biodiversity conservation and research, the Péni Classified Forest deserves in-depth investigations in all its components to increase the availability and ease of access to information on its floristic composition. This will undoubtedly lead to better planning of conservation and development policies concerning it. It is in this

context that this project is conducted with the general objective of providing knowledge on the flora of the PFC. More specifically, it aims to: 1) assess the floristic richness, composition, and ecological parameters of the PFC; 2) identify threatened species in the PFC; and 3) assess the extent of anthropogenic disturbance in the PFC.

2. Materials and Methods

2.1. Study Area

The study was conducted in Péni Classified Forest (PCF) located in southwestern Burkina Faso on the National Road 7 at 32 km of Bobo Dioulasso (**Figure 1**). The GPS coordinates are latitudes 10˚55'02.5" and 10˚56'33" North and longitudes 4˚27'26.5" and 4˚29'37.5" West.

The PCF belongs to the South Sudanese phytogeographical sector (Guinko, 1984). The climate is of the Sudano-Guinean type, over thirty years (1992-2021) in Péni commune is 1064.78 mm. The rainy season extends from May to September, with some rain throughout the year. The rainiest month is August with 281.51 mm. From 1992 to 2021 the average temperature is equal to 27.55˚C with minima of 13.17˚C in December and maxima of 41.54˚C in April. The vegetation is composed of a mosaic of savannahs (woods, grasses, shrubs, and trees)

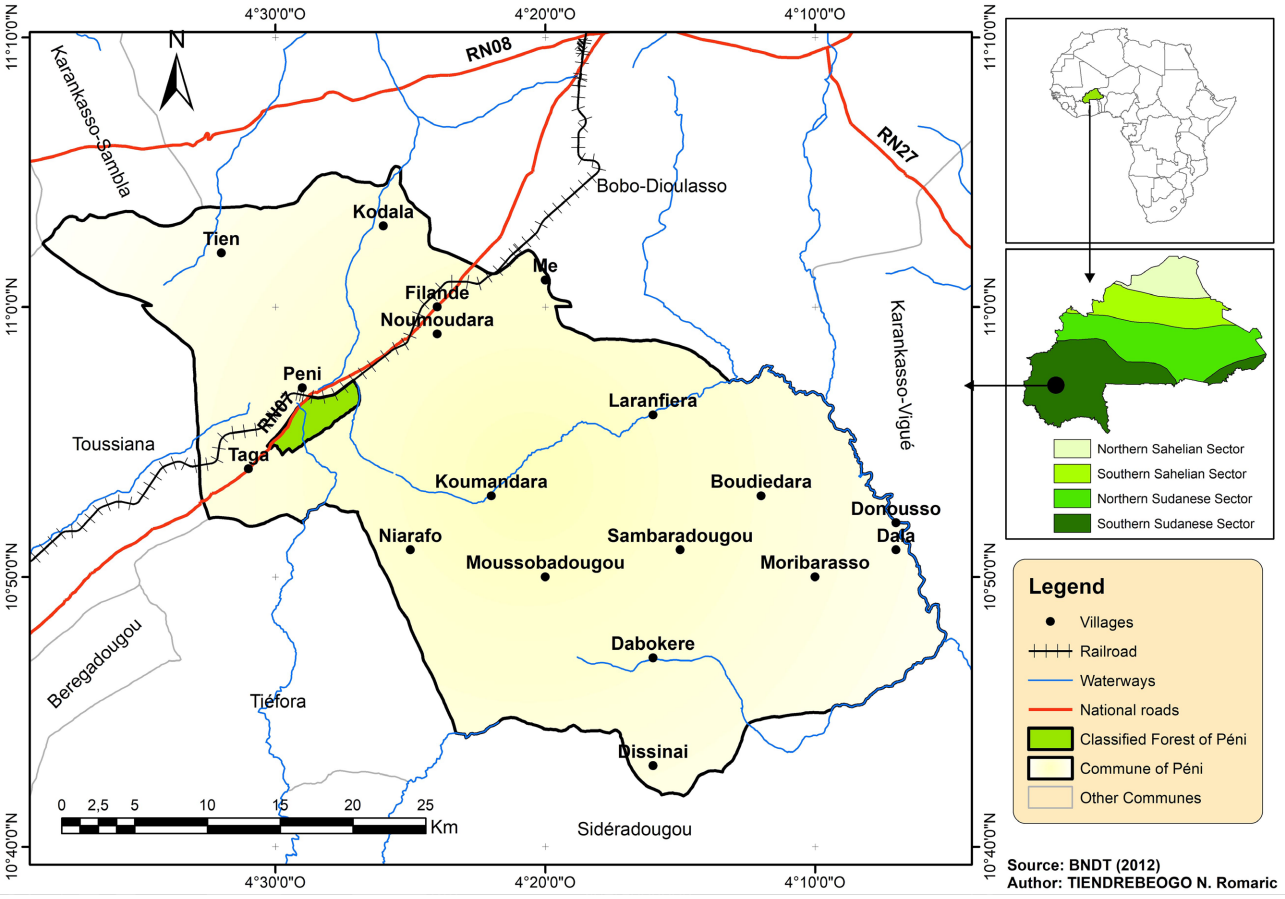

Figure 1. Location of Péni Classified Forest in Burkina Faso, West Africa.

and gallery forests (Fontès & Guinko, 1995). The main soil types at the study site are ferrallitic soils, poorly evolved soils, and soils with sesquioxide and rapidly mineralizable organic matter (BNDT, 2012).

2.2. Sampling and Data Collection

The sampling method was stratified according to the vegetation units of the PCF. 213 phytosociological plots of 900 m^2 (30 m × 30 m) and 500 m^2 (50 m × 10 m) were used respectively in the savannahs and in the gallery forests for the woody stratum, then in each woody stratum, a subplot of 100 m^2 (10 m × 10 m) was used to inventory the herbaceous stratum (Thiombiano et al., 2016). Ribbons, strings, and stakes allowed the demarcation of the plots. In each plot, the following data were recorded: Site identification characteristics, station conditions, overall recovery rate, list of all species present with an abundance-dominance coefficient according to the Braun-Blanquet (1932) scale. The geographic coordinates of the center of each survey plot were noted using a Garmin 62S GPS. In addition, Observations on the human disturbances were made within each phytosociological survey. These include bush fires, grazing, wood cutting and carbonization (charcoal production site). Their presence in the survey is noted 1 and their absence is noted 0 (Ouoba, 2006).

3. Data Processing and Analysis

3.1. Taxonomic Determination and Characterization

Floristic richness, species frequency, were calculated and biological and phytogeographical types were determined. The species were determined based on the flora of Lebrun and Stork (1991, 1992, 1995, 1997), Aubréville (1950), Hutchinson and Dalziel (1954, 1958, 1963, 1968, 1972) and the Arbonnier (2019) botanical guide. The nomenclature of species has been adapted to that of the Catalogue of Vascular Plants of Burkina Faso (Thiombiano et al., 2012).

Equation (1) was used to determine species frequencies:

$$Fr = \frac{Ni}{N} \quad (1)$$

where Ni is the number of surveys in which a species i is encountered and N is the total number of records. Species were then grouped according to their frequency frequency classes. Sambaré's (2013) frequency classes were used to distinguish between rare species ($Fr \leq 5\%$), occasional species (Fr between 5 and 25%), infrequent species (Fr between 25% and 50%), and frequent species ($Fr \geq 50$).

For the determination of biological spectra, those defined by Raunkiaer (1934) and adapted for the study of tropical plant formations by various authors (Godron et al., 1968; Aké Assi, 2001, 2002; Ouoba, 2006) were used. As for the phytogeographical spectra, we used those of White (1986). The Excel spreadsheet and the RAWGraphs 2.0 beta (Mauri et al., 2017) software were used to realize the graphs.

3.2. Diversity Analysis

These analyses focused on the calculation of diversity indices.

- The Shannon-Weaver Index (H') was used to assess species diversity (Legendre & Legendre, 1998). This index varies according to the number of species present. It is expressed in bits and varies from the lowest diversity (0 bit) to the highest (5 bits). It was evaluated by equation (2) of Kent and Cooker (2003) where:

$$H = -\sum_{i=1} pi \ln(pi) \tag{2}$$

with pi the ratio of the average overlap of species i in the vegetation unit to the sum of all overlaps of all species of the vegetation unit.

- The mode of distribution of species within plant formations (or equitability) is assessed using Piélou's equitability index (J) (Kent & Cooker, 2003) according to the following equation:

$$J = \frac{H}{\ln(N)} \tag{3}$$

where H is the Shannon diversity index, and N is the total number of species in one vegetation unit. This index makes it possible to assess the nature of the distribution of species in plant formations and varies between 0 and 1 (Boubacar et al., 2022). It tends to 0 when there is a phenomenon of dominance and tends to 1 when the distribution of species is regular.

- The probability that two randomly selected individuals belong to the same species was measured using the Simpson index (Magurran, 2004): Equation (4) was used:

$$D = \sum_{i=1}^{s} \frac{ni(ni-1)}{N(N-1)} \tag{4}$$

given species i and N, the total abundance of individuals. This index has a value of 0 to indicate the maximum diversity, and a value of 1 to indicate the minimum diversity. To obtain "more intuitive" values, the reciprocal of the Simpson index represented by 1 − D was calculated, the maximum diversity being represented by value 1, and the minimum diversity by value 0 (Traoré, 2013). This diversity index gives more weight to abundant species than to rare species.

- The similarity between two types of vegetation was verified by the Jaccard index (Cj) (Jaccard, 1908), calculated based on the presence/absence of species, by the following equation:

$$Cj = \frac{J}{a+b+j} \tag{5}$$

where j is the number of species common to two units s of vegetation A and B; a, the number of species on site A and b, the number of species on site B. It tends to 0 when there is no floristic similarity and to 1 otherwise.

3.3. Anthropogenic Disturbance Factors

The processing of data on the presence or absence of cutting, grazing, bushfires and carbonization outbreaks consisted in relating the number of surveys in which these factors were observed to the total number of surveys. These results, for each factor, were reported as a percentage. The disturbance index was calculated to identify the vegetation units most sensitive to anthropogenic disturbance. Indeed, an ecosystem influenced by human action, the more therophytes and chamephytes become more important (Floret & Pontanier, 1982). This index is formulated and used in several studies (Loisel & Gomila, 1993; Gnahoré et al., 2020).

$$\mathrm{IP} = \frac{\text{Number of Chamephytes} + \text{Number of Therophytes}}{\text{Total species number}} \times 100 \qquad (6)$$

4. Results

4.1. Floristic and Ecological Analysis

The floristic inventory identified 475 species in 321 genera and 87 families (Table 1). This richness is composed of 201 woody and 274 herbaceous. The most represented families are Poaceae (12 %), Fabaceae-Faboideae (11.37%), Rubiaceae (5.89%), Asteraceae (4.21%), Malvaceae (4%), Fabaceae-Caesalpinioideae (3.79%), Lamiaceae (3.58%), Apocynaceae (3.37%), Cyperaceae (3.16%), Combretaceae (2.95%), Vitaceae (2.74%), Acanthaceae (2.53%) and Fabaceae-Mimosoideae (2.32%) with more than 10 species each. 64.93% of this flora is found in shrub savannahs, 61.26% in wooded savannahs, 44% in gallery forests and 23.58% in plantations (Figure 2).

The distribution of this rich floristic within the vegetation units of the PCF is shown in Figure 3. Shrub savannahs are the richest in species with 306 species

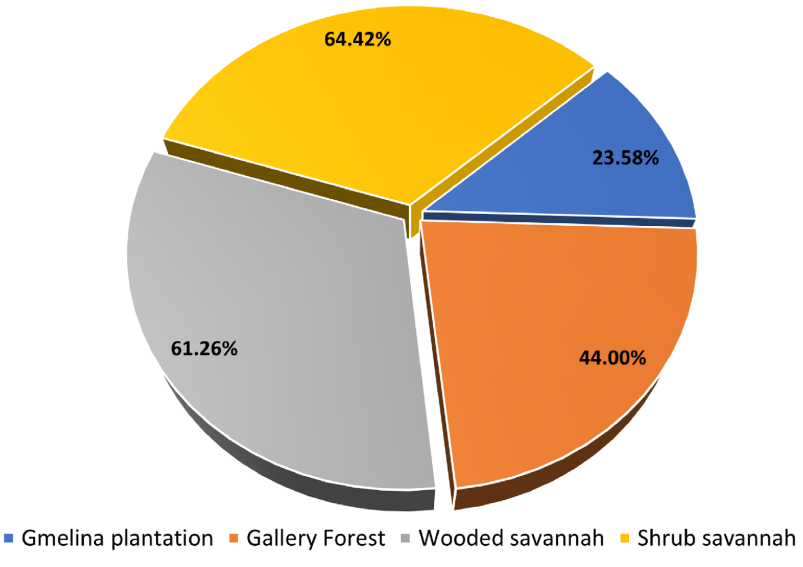

Figure 2. Species proportion of each vegetation unit as a function of the total flora of the PCF.

Table 1. Taxonomic distribution of PCF flora into families, genus, and species.

Family	Genus		Species		Family	Genus		Species	
	Number	%	Number	%		Number	%	Number	%
Poaceae	36	11.21	57	12.00	Zingiberaceae	2	0.62	2	0.42
Fabaceae-Faboideae	25	7.79	54	11.37	Aloaceae	1	0.31	1	0.21
Rubiaceae	18	5.61	28	5.89	Amaryllidaceae	1	0.31	1	0.21
Asteraceae	16	4.98	20	4.21	Anthericaceae	1	0.31	1	0.21
Lamiaceae	14	4.36	17	3.58	Apiaceae	1	0.31	1	0.21
Apocynaceae	13	4.05	16	3.37	Araliaceae	1	0.31	1	0.21
Malvaceae	13	4.05	19	4	Bignoniaceae	1	0.31	1	0.21
Fabaceae-Caesalpinioideae	11	3.43	18	3.79	Bixaceae	1	0.31	2	0.42
Acanthaceae	8	2.49	12	2.53	Boraginaceae	1	0.31	1	0.21
Euphorbiaceae	8	2.49	9	1.89	Burseraceae	1	0.31	1	0.21
Cyperaceae	7	2.18	15	3.16	Cannabaceae	1	0.31	1	0.21
Fabaceae-Mimosoideae	7	2.18	11	2.32	Capparaceae	1	0.31	1	0.21
Anacardiaceae	6	1.87	9	1.89	Caryophyllaceae	1	0.31	1	0.21
Meliaceae	6	1.87	6	1.26	Celastraceae	1	0.31	1	0.21
Phyllanthaceae	6	1.87	8	1.68	Connaraceae	1	0.31	1	0.21
Asparagaceae	5	1.56	5	1.05	Costaceae	1	0.31	1	0.21
Combretaceae	5	1.56	14	2.95	Dilleniaceae	1	0.31	1	0.21
Vitaceae	5	1.56	13	2.74	Dioscoreaceae	1	0.31	6	1.26
Amaranthaceae	4	1.25	5	1.05	Dipterocarpaceae	1	0.31	1	0.21
Araceae	4	1.25	5	1.05	Hypericaceae	1	0.31	1	0.21
Commelinaceae	4	1.25	6	1.26	Iridaceae	1	0.31	1	0.21
Orchidaceae	4	1.25	6	1.26	Leguminosae-Mimosoideae	1	0.31	1	0.21
Sapindaceae	4	1.25	4	0.84	Limeaceae	1	0.31	1	0.21
Sapotaceae	4	1.25	4	0.84	Lycopodiaceae	1	0.31	1	0.21
Annonaceae	3	0.93	3	0.63	Ochidaceae	1	0.31	1	0.21
Convolvulaceae	3	0.93	7	1.47	Olacaceae	1	0.31	1	0.21
Loganiaceae	3	0.93	4	0.84	Oleandraceae	1	0.31	1	0.21
Ochnaceae	3	0.93	4	0.84	Onagraceae	1	0.31	1	0.21
Adiantaceae	2	0.62	3	0.63	Ophioglossaceae	1	0.31	1	0.21
Arecaceae	2	0.62	2	0.42	Opiliaceae	1	0.31	1	0.21
Chrysobalanaceae	2	0.62	2	0.42	Oxalidaceae	1	0.31	1	0.21
Clusiaceae	2	0.62	2	0.42	Passifloraceae	1	0.31	1	0.21
Cucurbitaceae	2	0.62	2	0.42	Pedaliaceae	1	0.31	1	0.21
Droseraceae	2	0.62	2	0.42	Pontederiaceae	1	0.31	1	0.21
Gentianaceae	2	0.62	3	0.63	Proteaceae	1	0.31	1	0.21

Continued

Lauraceae	2	0.62	2	0.42	Ranunculaceae	1	0.31	1	0.21
Melastomataceae	2	0.62	2	0.42	Rutaceae	1	0.31	1	0.21
Moraceae	2	0.62	12	2.53	Santalaceae	1	0.31	1	0.21
Myrtaceae	2	0.62	3	0.63	Smilacaceae	1	0.31	1	0.21
Orobanchaceae	2	0.62	3	0.63	Taccaceae	1	0.31	1	0.21
Plantaginaceae	2	0.62	2	0.42	Thelypteridaceae	1	0.31	1	0.21
Polygalaceae	2	0.62	2	0.42	Ximeniaceae	1	0.31	1	0.21
Solanaceae	2	0.62	2	0.42	Xyridaceae	1	0.31	1	0.21
Verbenaceae	2	0.62	2	0.42	Total	321	100	475	100

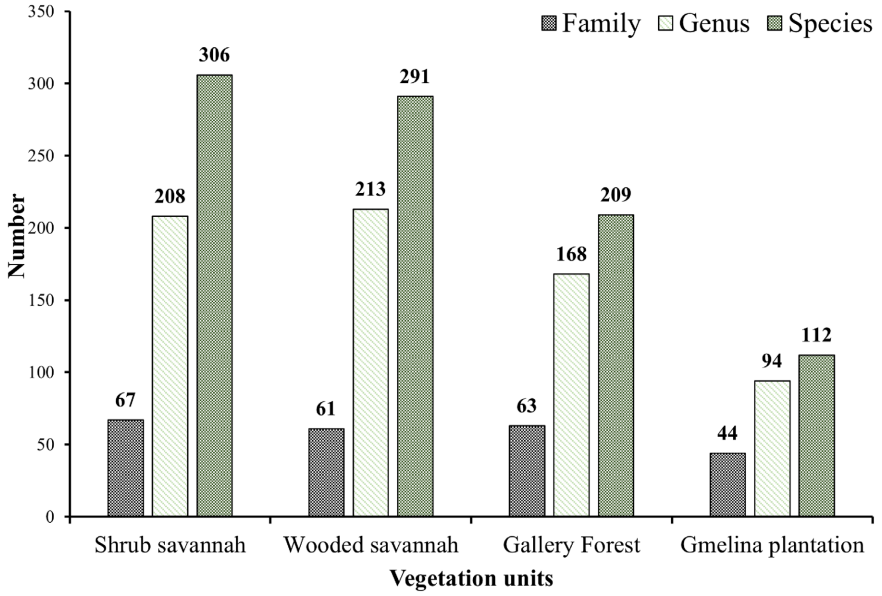

Figure 3. Taxonomic distribution by type of training.

grouped into 208 genera and 67 families. They are followed by wooded savannahs with 291 species grouped into 213 genera and 61 families, then gallery forests with 209 species grouped into 168 genera and 63 families. The plantations are the least rich in species and total 112 species grouped into 94 genera and 43 families.

Figure 4 shows that most of the species recorded are very rare in Péni Classified Forest but also in each vegetation unit. Globally, 59.58% of the species int 283 species are very rare with an occurrence of less than 5%. These include *Milicia excelsa* (Welw.) C.C.Berg, *Pentadesma butyracea* Sabine, *Paullinia pinnata* L., *Ximenia americana* L., *Protea madiensis* Oliv., *Anogeissus leiocarpa* (DC.) Guill. & Perr., *Canarium schweinfurthii* Engl. for woody stratum. *Chlorophytum pusillum* Schweinf. ex Baker, *Elionurus elegans* Kunth, *Clematis hirsuta* Guill. & Perr., *Macledium sessiliflorum* (Harv.) S.Ortiz, *Hyperthelia dissoluta* (Nees ex Steud.) Clayton for herbaceous stratum. Among the vegetation units, shrub and wooded savannahs comprise respectively 56.21% and 44.67% of very rare species.

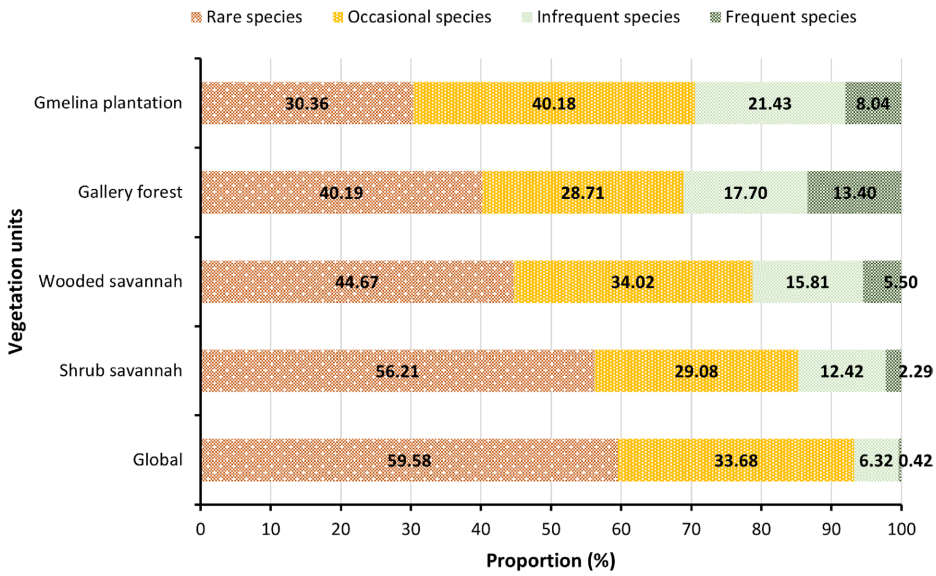

Figure 4. Frequency/rarity of species by plant formation type.

Figure 5 shows the ten most represented families in each vegetation unit. In the shrub savannahs, Poaceae (14.47%), Fabaceae-Faboideae (12.22%), Rubiaceae (5.79%), Asteraceae (4.50%), Combretaceae (4.50%), Malvaceae (4.50%), Fabaceae-Caesalpinioideae (4.18%), Cyperaceae (3.22%), Lamiaceae (3.22%) and Apocynaceae (2.89%) dominate. For wooded savannahs, these are Fabaceae-Faboideae (12.20%), Poaceae (10.80%), Rubiaceae (6.27%), Asteraceae (5.23%), Fabaceae-Caesalpinioideae (5.23%), Malvaceae (4.53%), Combretaceae (4.18%), Apocynaceae (3.83%), Lamiaceae (3.83%) and Cyperaceae (3.48%). In gallery forests, Rubiaceae (7.55%), Fabaceae-Faboideae (6.60%), Moraceae (5.19%), Poaceae (5.19%), Apocynaceae (4.72%), Fabaceae-Caesalpinioideae (4.72%), Malvaceae (4.72%), Acanthaceae (3.77%), Asteraceae (3.77%) and Lamiaceae (3.30%) dominate. In *Gmelina* plantations, Fabaceae-Faboideae (15.18%), Combretaceae (7.14%), Fabaceae-Caesalpinioideae (7.14%), Fabaceae-Mimosoideae (6.25%), Rubiaceae (6.25%), Dioscoreaceae (4.46%), Apocynaceae (3.57%), Lamiaceae (3.57%), Poaceae (3.57%) and Malvaceae (2.26%) dominate.

The overall Shannon index of the PCF is 4.96 bits, the Pielou equitability index 0.80 and the Simpson reciprocal index 0.99 (Table 2). The wooded savannahs are the most diverse with a Shannon index of 4.57 bits. The lowest diversity is observed in *Gmelina* plantations (2.94 bits). The pielou equitability index is roughly equal between gallery forests and wooded savannahs with 0.79 and 0.80 respectively, reflecting an equitable distribution of species in these vegetation units. Simpson's reciprocal index is roughly equal between gallery forests, wooded savannahs and shrubby savannahs with values close to 1 reflecting a maximum diversity within these vegetation units.

The calculation of the Jaccard index shows that there is no similarity between the vegetation units of the PCF except for shrub savannahs and wooded savannahs which share more than 50% of the species (Table 3).

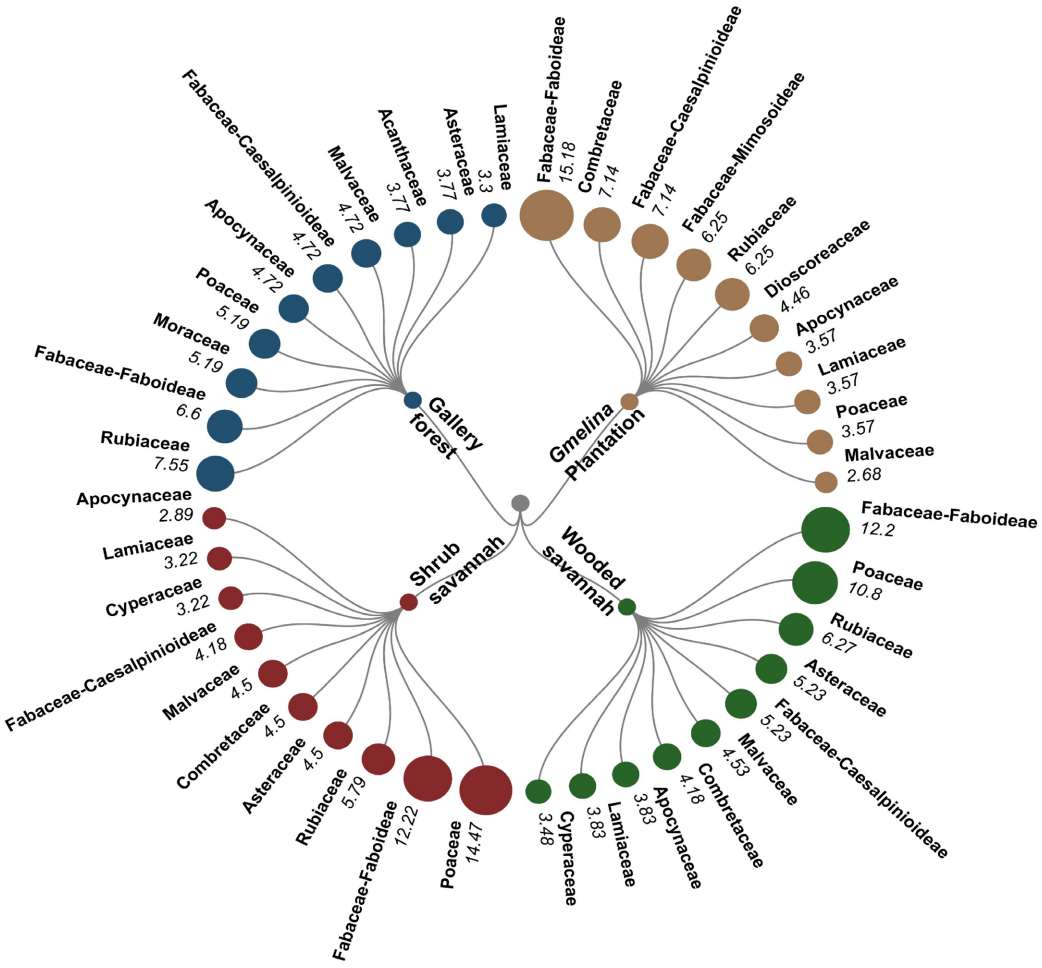

Figure 5. Spectrum of the ten most represented families of the flora of the PCF by vegetation unit. Legend: Ph = Phanerophytes; Th = Therophytes; Ch = Chamephytes; Ge = Geophytes; He = Hemicryptophytes; Ep = Epiphytes; Hl = Helophytes.

Table 2. Parameters of overall diversity and vegetation units of the PCF.

Index	Gallery forest	*Gmelina* plantation	Wooded savannah	Shrub savannah	Global
Shannon Diversity Index	4.20	2.94	4.57	4.36	4.96
Pielou Equitability Index	0.79	0.62	0.80	0.76	0.80
Reciprocal of the Simpson index	0.97	0.83	0.98	0.98	0.99

Table 3. Jaccard index between CPF vegetation units.

	Gallery forest	Wooded savannah	Shrub savannah	*Gmelina* plantation
Gallery Forest	1.00			
Wooded savannah	0.32	1.00		
Shrub savannah	0.22	0.52	1.00	
Forest plantation	0.21	0.33	0.29	1.00

Analysis of the overall biological spectrum of the PCF shows variability in the representativeness of the biological types of the PCF (Figure 6). Phanerophytes and therophytes are dominant in the flora with crude spectra of 42.32% and 30.32% respectively, and weighted spectra of 65.69% and 22.63% reflecting the forest character of the PCF. A significant proportion of geophytes (8%) are also observed.

Within Phanerophytes, microphanerophytes (35%) and mesophanerophytes (23.76%) are the dominant subtypes followed by nanophanerophytes. The phanerophyte vines all combined occupy a proportion of nearly 15% (Figure 7).

The overall phytogeographical spectrum (Figure 8) shows a dominance of Sudanian species followed by Afro-tropical and Sudano-Zambezian species.

4.2. Characterization of Anthropogenic Disturbances

Wood cutting is the most observed anthropogenic disturbance factor with a frequency of 100%, followed by pastoral pressure (98.59%), bushfires (80.28%) and finally carbonization (coal making) with a frequency of 37.56% (Figure 9). Figure 10 shows the frequency of disturbances in each vegetation unit. In wooded

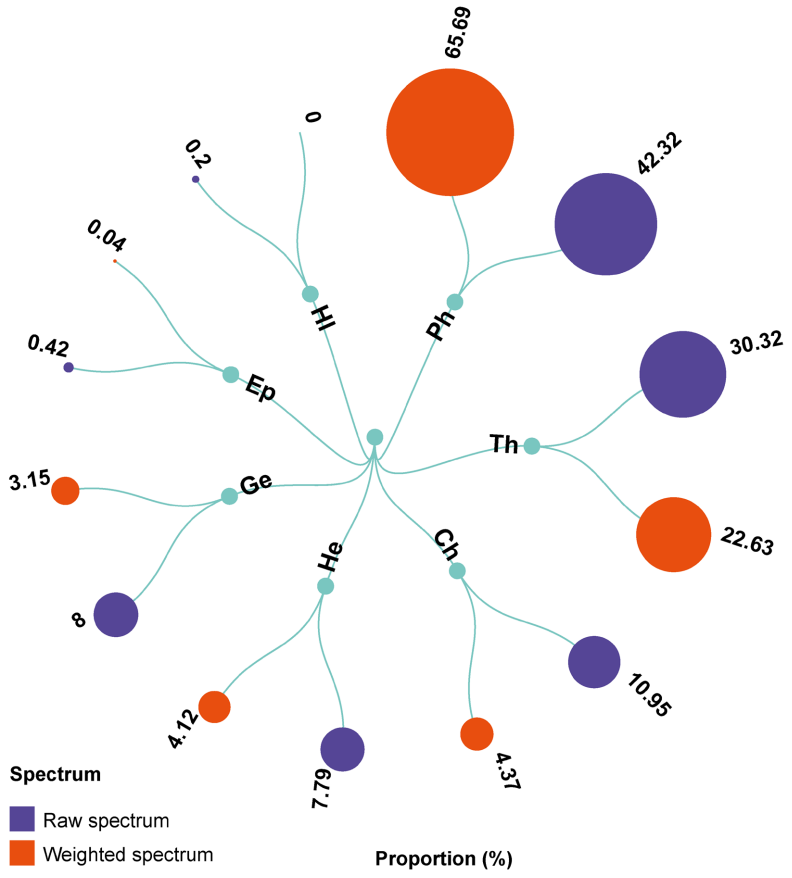

Figure 6. Overall spectrum of biological types of flora in the PCF. Legend: mph = Microphanerophytes; mPh = Mesopohanerophytes; nph = Nanophanerophytes; Lmph = Lianes microphanerophytes; Lnph = Lianes Nanophanerophytes; LmPh = Liane Mesopohanerophytes.

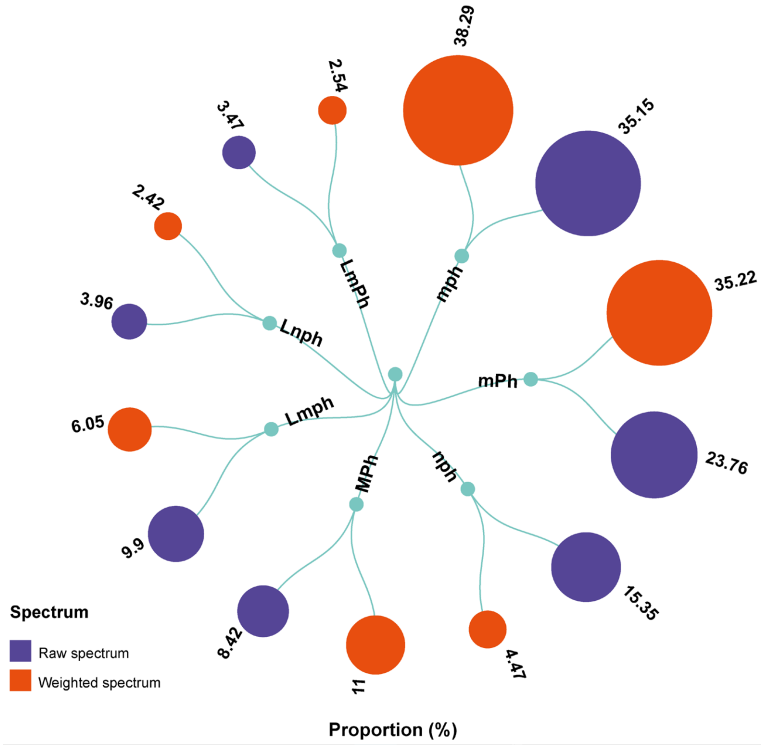

Figure 7. Global spectrum of phanerophyte subtypes. Legend: S = Sudanians; At = Afro-tropical; SZ = Sudano-Zambians; Pan = Pantropical; PRA = African Pluriregional; Pal = Paleotropical; GC = Guineo-Congolese; GC-SZ = Guineo-Congolese and Suda-no-Zambezians; AM = Afro-Malagasy; AA = African American, Cosm: Cosmopolitan.

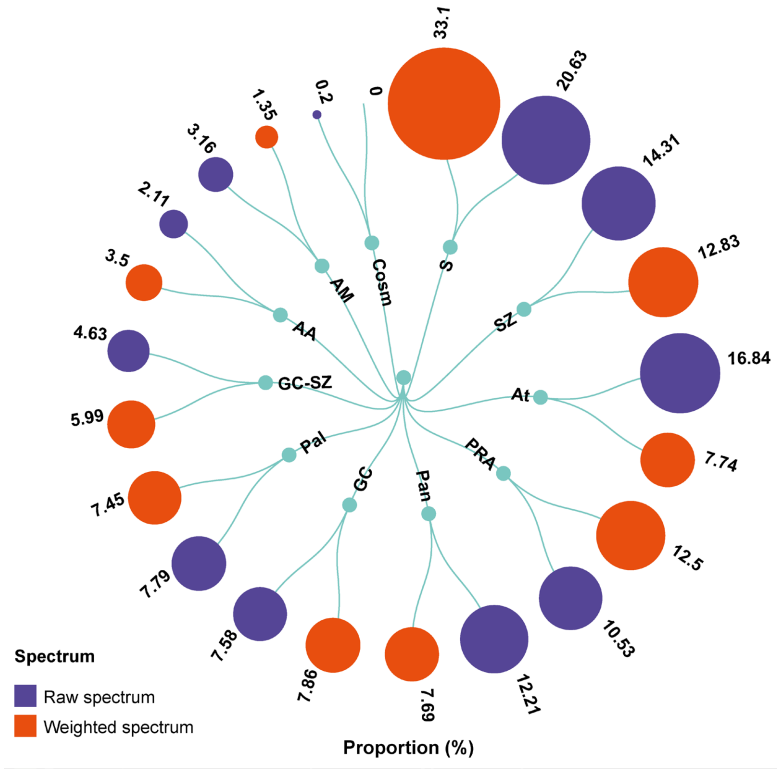

Figure 8. Spectrum of phytogeographical types of flora.

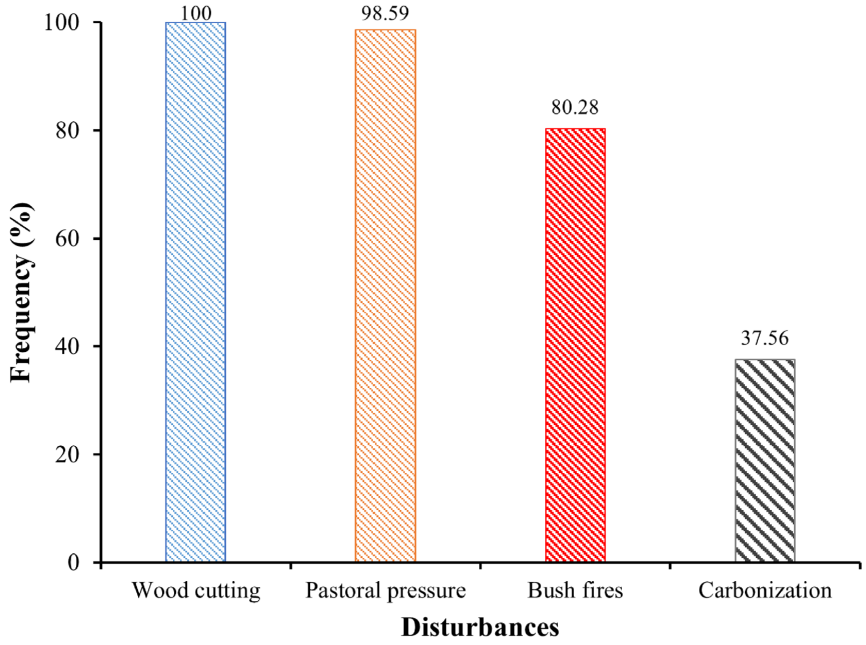

Figure 9. Frequency of forest-level disturbance factors.

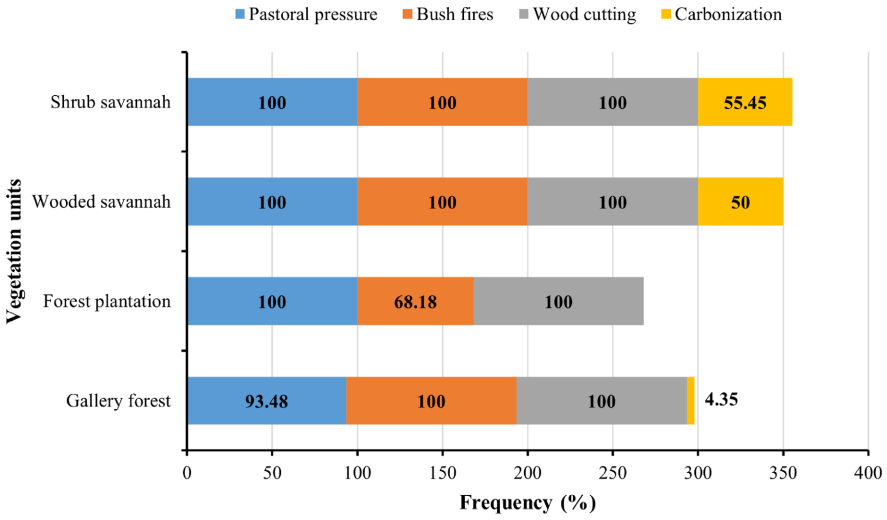

Figure 10. Frequency of disturbance factors per unit of vegetation.

and shrub savannahs, the most observed disturbance factors are pastoral pressure, bush fires and wood cutting with frequencies of 100% each. Lakes and gallery forests are less affected by carbonization.

The calculation of disturbance indices shows that shrub savannahs and wooded savannahs are the most disturbed vegetation units in the PCF with indices of 49.01% and 40.20% respectively (Table 4). At the forest level, this index is 41.12%. Some disturbances are illustrated by Figure 11.

5. Discussion

The floristic richness of Péni Classified Forest is estimated at 475 species including

Table 4. Disturbance index in PCF vegetation units.

	Global	Gallery forest	Wooded savannah	Shrub savannah	Forest plantation
Disturbance indices (%)	41.12	27.75	40.20	49.10	25.00

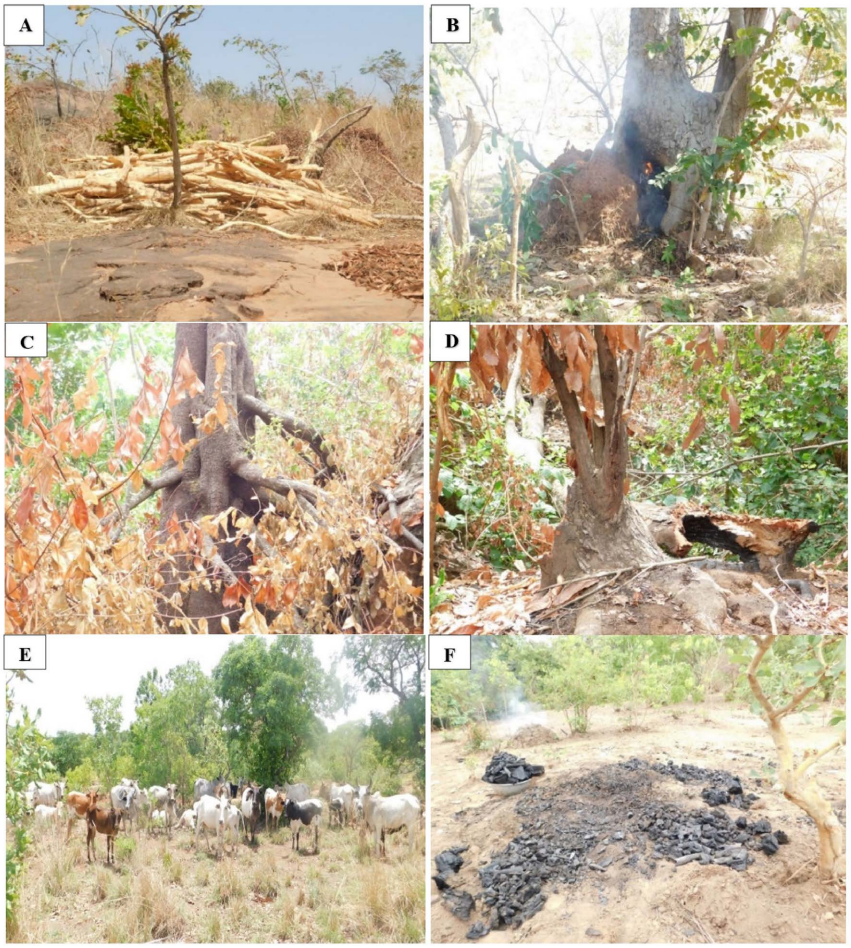

Figure 11. Anthropogenic disturbances encountered in Péni Classified Forest. Legend: (A) cut stems of *Ximenia americana* whose bark is taken and dried for sale; (B, C, D) Effect of fires in gallery forests; (E) cattle yard in the PCF; (F) Carbonization site in shrub savannahs.

201 woody and 274 herbaceous representing 13% of the vascular plants of Burkina Faso (Thiombiano et al., 2012). Woody trees represent 38% of the woody flora of Burkina Faso (Nacoulma et al., 2018). However, the diversity varies according to the vegetation units. This diversity is higher compared to other classified forests that have been inventoried in the same phytogeographical zone. Indeed, the floristic inventory carried out in the protected areas of Bala (Taïta, 1997), Bansié (Ouédraogo, 2004), Niangoloko (Ouoba, 2006), Pama (Mbayngone, 2008), Kou (Yaovi et al., 2021) and the two Balé (Tankoano, 2017) recorded respectively 282 species, 303 species, 353 species, 336 species, 206 species and 109 species. This difference reflects the importance of Péni Classified Forest

(PCF) in the conservation of diversity despite its small size (1200 hectares). Indeed, according to the conclusions of several studies (Mbayngone et al., 2008; Ouédraogo, 2009; Nacoulma, 2012), the floristic potential is not related to area but would rather be related to heterogeneity of environmental conditions. Rare and very rare species occupy a high proportion in the PCF reflecting the predominance of a small number of more frequent species and many less frequent species. According to Ouédraogo (2006), these results reflect the presence of species that are endangered and/or confined to reduced plant habitats or communities. In addition, poaceae, Fabaceae-Faboideae and Rubiaceae are the dominant families at the forest scale. According to Ouédraogo (2009), this indicates that the flora still retains its originality. The dominance of poaceae reflects the strong presence of open formations. Indeed, among the vegetation units of the PCF, the shrub savannahs occupy a vast area (782 hectares) characterized by a continuous herbaceous carpet that accentuates the action of fires. However, according to Ballouche & Dolidon (2005) and Ouattara (2016), fire promotes the development of herbaceous plants, especially grasses at the expense of trees by opening plant formations and creating a space offering enough light for their development. Moreover, the dominance of these 3 families recalls the common floristic composition on the inselbergs of West Tropical Africa (Folega et al., 2018). Indeed, a good part of Péni Classified Forest is located on a cliff comparable to an inselberg.

Phanerophytes and therophytes are the dominant biological types in the flora with crude spectra of 42.32% and 30.32% respectively. The predominance of these biological types is a characteristic of the flora of the Sudanese areas of Burkina Faso (Thiombiano et al., 2010). The dominance of phanerophytes reflects the forest character of Péni Classified Forest. However, this proportion of phanerophyte remains low compared to the proportions of Niangoloko Classified Forest (65.44%) (Ouoba, 2006) and Comoé-Léraba Classified Forest and Partial Wildlife Reserve (45.52%) (Gnoumou et al., 2015). This could be explained by the anthropogenic pressure exerted on the woody forest leading to the decline of phanerophytes to the detriment of the herbaceous stratum, including Therophytes which have a high proportion in our study site. Regarding chorology, the importance of Sudanian base element species (20.63%), afro-tropical species (16.84%) and sudano-zambezian species (14.32%) compared to other phytogeographical types shows that Sudanian species and Sudano-Zambezi species are well represented on the study site. These results could be explained by the mountainous regime of Péni Classified Forest creating a microclimate favorable to the installation of Sudano-Guinean species, which confirms the assertions of Nguinambaye et al. (2015). In addition, the predominance of Sudanian element-base species over other phytogeographical types is a characteristic of Sudanian savannahs (Pallo & Sawadogo, 2010).

Anthropogenic pressures are strong in Péni Classified Forest. These disturbances modify the evolution process of plant formations and weaken their relative dynamic balance. These results could be explained by the proximity of this

forest to the locality of Péni, the high need for firewood of its population and the massive displacement of herders from the insecure areas of the Sahel to the south-west of Burkina Faso. In addition, the CPF does not benefit from administrative oversight that could reduce these consequent anthropogenic pressures. Sawadogo (2006), Yoni and Sedogo (2015) and Kagambega et al. (2019) also explained these pressures by non-compliance with development requirements and insufficient monitoring.

6. Conclusion

This study allowed us to know the floristic richness of Péni Classified Forest (PCF). It is home to 475 species divided into 321 genera and 87 families. This important diversity represents 13% of the floristic wealth of Burkina Faso. Woody trees represent 38% of the woody flora of Burkina Faso. The shrubby savannahs and woody savannahs are the vegetation units with the highest number of species with 306 species and 291 species respectively, but with the highest rates of very rare species. The dominant families are Poaceae, Fabaceae-Faboideae, Rubiaceae, Asteraceae and Combretaceae. All diversity indices show that the PCF is very diverse with equitability in species distribution. Logging, pastoral pressure, bush fires and charring are very frequent in the PCF with a disturbance index that is very high. This study, which is the first ever in the PCF, shows that the PCF is an ecosystem that still maintains its forest character and contributes to the well-being of the population through its ecosystem services. In perspective, a detailed analysis and classification of the plant associations of these habitats would allow us to perceive the major ecological determinants that govern this diversity to orient and reinforce the management actions within it.

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Conflicts of Interest

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

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