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Research Article

The Effects of Land Cultivation on the Spatial Distribution of the Floristic and Structural Characteristics of Woody Plant Formations in the Central West Region

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Abstract

The diversity and structure of woody plant species will decline as the areas containing them lose the links or connections between them. This will have an impact on the structural composition and habitat diversity of woody species and does not bode well for their conservation. The objective of this research is to show the habitat types, habitat prospectivity, structural composition and species diversity of woody vegetation cover in the Centre West region (Burkina Faso). To achieve this objective, the *Land Use Land Cover* model and the Habitat assessment algorithm were used to generate habitat maps of woody species, and a floristic inventory was carried out to assess the structural characteristics and diversity of woody flora by land-use class. Importance value indices (IVI) and regeneration value indices (RVI) were calculated for each species. The inventory data shows that the region is made up of 69 species belonging to 55 genera in 28 botanical families. According to the IVI, the most important species are *Vitellaria paradoxa* (IVI=26.12), *Lannea microcarpa* (IVI=17.41), *Detarium microcarpum* (IVI=14.12) and *Piliostigma thonningii* (IVI=12.47). Analysis of the Shannon and Pielou indexes reveals that the agroforestry and field formations present species diversity with identical abundance, dominated by *Azaderata indica*, *Ecaluptus*, *Lannea microcarpa*, *Parkia biglobosa*, *Vittelaria paradoxa* and *Terminalia avicinoides*. These species are sometimes cut for charcoal production and to open up sown areas, while others are debarked and pruned for socio-economic purposes. The results of the habitat quality modelling show that the region is made up of primary and secondary habitat, and potential primary and secondary corridors. In 2020, primary habitat represented 38.47% of the study area. A prospective analysis of the habitat in 2050 shows a loss of connection between the primary habitats as a result of the increasing cultivation of sown areas. The prediction of biodiversity habitats in terms of the woody biological diversity found there highlights the need to preserve these habitats in the face of threats. Strategies and actions should be geared towards combating the destruction of interconnections between primary habitats and reclaiming secondary habitats and conservation corridors threatened with extinction.

Keywords

Biodiversity, Cultivation, Structure of Woody Formations, Habitat Modelling

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1. Introduction

The first international convention on biological diversity was adopted in Rio de Janeiro in 1992. According to [22], this is one of the most important biodiversity conventions in the world, and its aim was to extend conservation to the habitats and ecosystems in which the constituent elements of biodiversity develop. In Africa, the African Convention on the Conservation of Nature and Natural Resources [15] was adopted in Algeria in 1968 and revised in Maputo in 2003. Article VI of this African convention requires the conservation of species diversity and the genetic diversity of flora and fauna, the creation of conservation areas and the control of activities likely to have a negative impact on biodiversity [15]. Since 1968, African countries have ratified the African Convention on the Conservation of Nature and Natural Resources or the Algiers Convention [22]. However, Burkina Faso, like other sub-Saharan countries, has been facing a decline in the biodiversity of its woody plant resources for several decades [20]. This is the result of the combined effect of demographic pressure [13], unfavorable climatic conditions [2], serious land tenure crises [9] and, among other things, the security crisis that the country has been experiencing in recent decades. The consequence is the disappearance of certain woody [1], the threat to the balance of ecosystems [4] and the connection between protected areas and forestry developments [11]. The central west region is a zone of exploitation of non-timber forest products, wood production to supply major urban centers [18]. It is also a biodiversity reserve through its forest management schemes and its classified and protected forests. While exploitation seems to be under control in some managed areas and conservation zones, the effects of land conversion are generally marked by the conversion of savannahs into fields [21], threatening the balance of species and biodiversity. This pressure on woody plant resources is exacerbated by the arrival in 2023 of 70,095 according to Permanent Secretariat of the National Council for Emergency Relief and Rehabilitation (Sp/CONASUR, 2023) internally displaced persons (IDPs). Preserving woody species in their habitats is therefore a major concern. To achieve this, it is important to gain a better understanding of the structural composition and biological diversity of woody species, in order to identify threatened species and habitats that require specific conservation actions.

2. Location the Centre-West region (Burkina Faso)

The Central-West region lies between 11 ° and 13 ° north latitude and 1 °30 and 3 ° west longitude. It covers an area of 21,853 km^2 and has a population of 1,659,339 inhabitants according to the general census of the population and housing (RGPH, 2006) and a population density of 72 hbts/km^2. It is bordered to the south by the Republic of Ghana; to the north by the North region; to the east by the Central, "Plateau Central" and Central-South regions; and to the west by the "Boucle du Mouhoun" and South West regions (Figure 1). It belongs to the Sudanian phytogeographic domain [8] and has an average inter-annual rainfall of 859.57 mm. This region is made up of a network of forestry developments, classified and protected areas which constitute conservation areas.

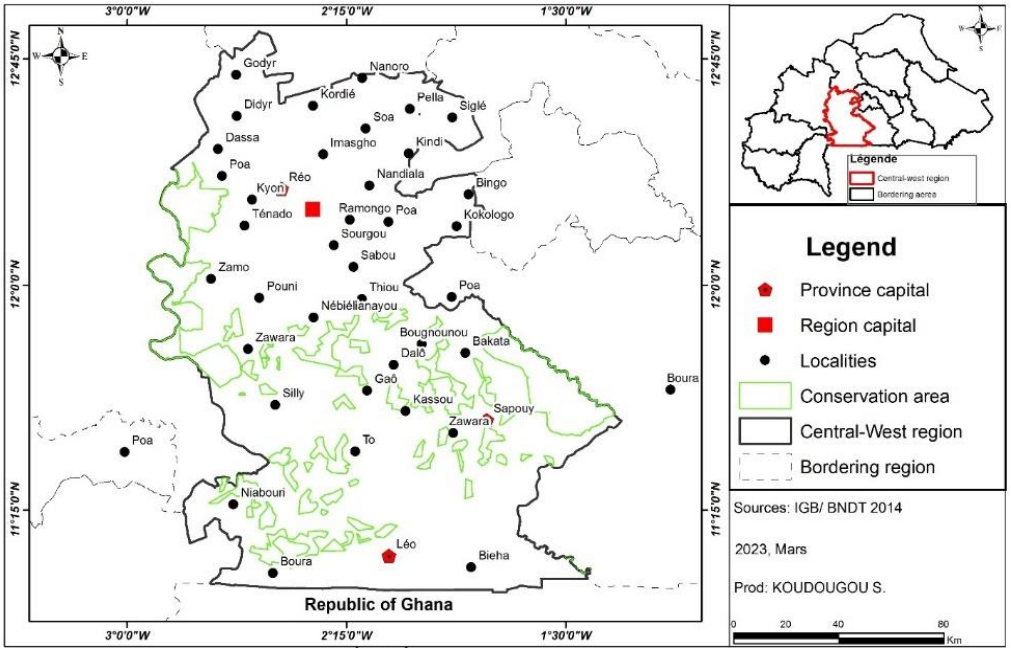


Figure 1. *Geographical location of the Central West region (Burkina Faso).*

3. Materials and Methods

3.1. Data Collected for the Study

Plot distribution data from the second national forest inventory and dendrometric statistical data from the floristic inventory carried out in 2022 were used. Landsat Oli-tir images, the National Topographic Database (NTDB 2012), and land-use data were generated and used for habitat forecasting.

3.2. Data Collection, Processing and Analysis Tools

Mapping software (ARC GIS) and habitat modelling software (Idrisi selva) were used to map the woodland habitat. The Garmin 64SX GPS is a positioning tool that was used to reach the plots and/or training sites and then to carry out the inventory activity. The 70 cm forestry caliper was used to measure dendrometric data, in particular the diameter of the trunk of woody plants during data collection activities. The metric tape has a similar role to the forestry caliper and is used to measure the circumference of trunks with a diameter greater than 70 cm. There is also the inventory sheet, a paper form, was used to record the information collected in the field. Around fifty circular plots with a radius of 25 x 25 m and an area of 0.19625 km^2 were surveyed. The sampling rate was obtained using the sampling formula of Rondeau J., (1993) cited by [12]:

$$f = \frac{n}{N} \quad (1)$$

Where f=sampling rate; n=sample size and N=sampled population size)

For the second national forest inventory (IFN2) in Burkina Faso, the sampling rate was 0.042 per thousand. IFN is the benchmark for assessing wood potential in Burkina Faso. That is why, the sampling was carried out in accordance with the methodology used during its implementation. In the central west region, the rate is 0.00082 per thousand. Finally, at the level of this sample, it is 0.000084 per thousand, i.e. 10% of the regional sampling rate and 2.02% of the national sampling rate.

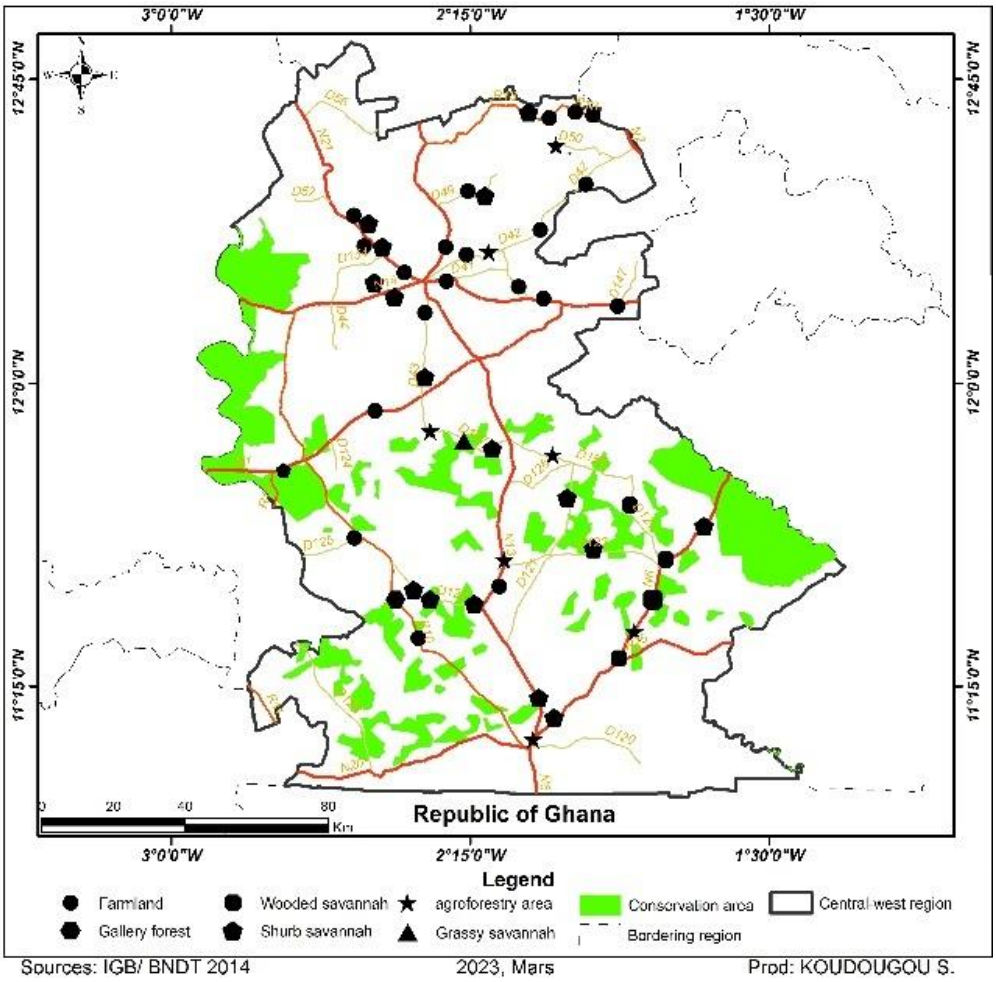


Figure 2. *Spatial distribution of plots in the Central West region.*

3.3. Data Processing and Analysis Method

3.3.1. Spatial Habitat Modelling

Habitat modelling is a tool for assessing habitat quality. In the *habitat assessment* module, parameters such as size, home range, buffer width and gap crossing-distances have been preset in the module, along with area and buffer zone requirements for each category. For the primary habitat, the minimum core area is 42.2 km^2 and the buffer distance is 250 m. The minimum habitat adequacy is 0.75. For the secondary habitat, the corresponding values are 1.55 km^2, 120 m and 0.5. For the primary potential corridor, the minimum buffer zone is 120 m and the minimum habitat suitability is 0.25, while for the secondary potential corridors, these are 60 m and 0.0 respectively. Habitat zones are mapped as primary and secondary habitat zones, primary and secondary corridors, and unsuitable land based on land cover and habitat suitability. Bare soil formations, fields and water surfaces were considered unsuitable areas for conserving woodland habitat. On the other hand, savannah and gallery forest formations were designated as potential woody habitats for conservation.

The habitat change analysis panel was used to assess the impacts of habitat change between 2020 and 2050. It enabled the assessment of the net rates of habitat change between the two dates and the analysis of protection gaps for a particular species based on a map of the species' habitat condition.

3.3.2. Ecological and Biodiversity Indicators for Woody Plants

(i). Ecological Indicators

Ecological indices were calculated for each woody species. This involved calculating basal area (G), relative dominance, frequency (F), relative frequency (F_r), and the Importance Value Index (IVI). Authors such as [3, 5-7, 10, 12, 14] used these parameters to characterize the forest structure and biodiversity in Burkina Faso, Ivory Coast, Senegal, Benin and Niger.

1) Basal area (G):

$$g = \left(\frac{10000\pi}{4s}\right) * \sum_{i=1}^{n} di2 \quad (2)$$

2) Relative dominance (D_{omr}):

$$Domr = \left(\frac{G\_species}{G\_all\ species}\right) * 100 \quad (3)$$

3) Frequency (F) of a species:

$$Fr = (Fr_{species} / \sum Fr) * 100 \quad (4)$$

4) Frequency (Fi) of a species and relative frequency (Fr)

It is obtained from the following formula:

$$Fi(\%) = \left(\frac{ni}{N}\right) * 100 \quad (5)$$

With n_i: number of individuals per species; N: total number of individuals encountered

Relative frequency is the product of the frequency of a species and the cumulative frequency of the species encountered.

5) Relative density (Dr):

$$Dr = \left(\frac{Nber\ ind\ especes}{Nber\ total\ ind}\right) * 100 \quad (6)$$

6) Species Importance Value Index (IVI)

It is the sum of relative dominance, relative frequency and relative density.

$$IVI = Domr + Dr + Fr \quad (7)$$

With IVI: Importance Value Index; Fr: Relative Frequency; Domr: Relative Dominance; Dr: Relative Density.

(ii). Biodiversity indicator

Biological diversity in the study area is measured by indices. These include the Shannon diversity index (H), the Pielou evenness index (EQ) and the regeneration importance value index (ISR). The calculation formulae for each indicator are given below.

1) Shannon index (H)

$$H = -\sum_{i=1}^{s} PilogPi \quad (8)$$

With $Pi = n_i / \sum n_i$ where; $_{ni}$: number of individuals per species; *n*: total number of individuals encountered.

It quantifies the species diversity within a community. If the community is homogeneous, H=0. The more different species there are, the more the value increases logarithmically. Typically, H ranges from 1 to 5.

2) Pielou fairness index (EQ):

$$EQ = \left(\frac{H}{log2S}\right) \quad (9)$$

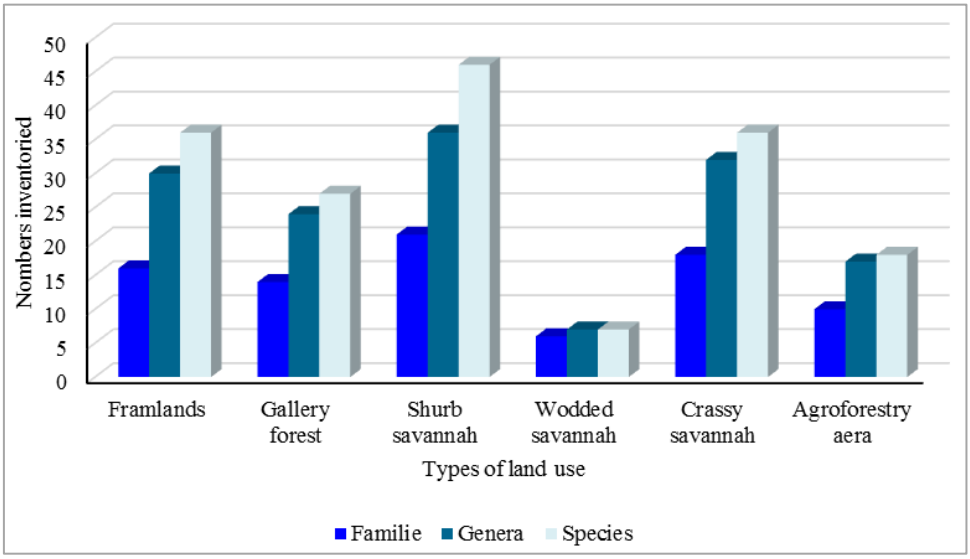
With H: Shannon index; Log_2S: maximum diversity

Pielou's evenness index ranges from 0 to 1. A value approaching 1 indicates that the species present in the community have similar abundances. Conversely, a value approaching 0 suggests an imbalance, or a single species dominating the entire community.

4. Results

4.1. The Composition of Families, Genera and Species in the Study Area

Analysis of the graph below shows that shrub savannah formations are the most representative in terms of abundance of families, genera and species. The shrub savannahs contain 21 families, 36 genera and 46 species. In the farmland's units, there are 16 families, 30 genera and 36 plant species. In the gallery forest plots, there are 14 families, 24 genera and 27 species. The tree savannah formations are less representative in terms of families (06), genera (07) and species (07).



Sources. 2022 forest inventory

Figure 3. *Distribution of families, genera and species by land use.*

4.2. Effect of Land Cultivation on Woody Plant Formations

Farmlands observations show that 99% of the woody species used for firewood production are also species that are debarked and pruned. Of the debarked and peeled species, 90% are burnt, 85% exhibit trunk cavities and 99% of the pruned species have been debarked. Photo 1 shows a charcoal production site in the managed forest of TÔ in the Sissili province. Photos 2 and 3 on Figure 4 illustrate, respectively, a clearing of farmland within the forest in the background and a cultivated area following charcoal production. Photo 1 on Figure 4 shows charcoal production phase after the woody plants have been felled. These images are the result of agricultural and socio-economic pressures that are putting a strain on landscape structure and the overall conservation of species.

Source: photo taken by KOUDOUGOU S. 2022

Figure 4. *Effect of cultivation on ligneous plants.*

4.3. Effect of Land Cultivation on the Biological Diversity of Species

The effect of the dynamics on the diversity community of species was analyzed using the Analyze of variance (ANOVA) method. The significance threshold is $P_{value} < 0.005$. The number of analysis samples corresponds to the distribution of species illustrated in the tables. The Shannon biological diversity index for the Central West region is 1.36 bits and the Pi đou index is 0.76 bits. This shows that the study area exhibits a frequent community diversity and that the species within in the community have similar abundances. A comparative analysis of Shannon index values in savannah formations and farmlands formations shows that the biodiversity of fields is higher than that of wooded savannahs, grassy savannahs and agroforestry areas. It is only in shrub savannahs and gallery forests that the Shannon index is higher than in fields. This could be explained by the fact that the species in the savannahs and gallery forests are in classified and protected areas. These factors slow the impact of the agricultural expansion on these areas. Pi đou's evenness index values in all formations are greater than 0.50, except in the grassy savannah formations. This means that the woody species in the farmlands and agroforestry areas have as much equilibrium in their distribution as in the tree and shrub savannahs. The equal distribution of biodiversity in farmlands and agroforestry areas could also be explained by agricultural pressure and the colonization and opening up of savannah fields by local people for agricultural purposes (photo 3). Additionally, the fact that certain species are spared during deforestation due to their cultural, medicinal and nutritional values and. This practice favors a balanced species distribution and homogeneity among species in farmlands, agroforestry areas and savannahs in general.

Table 1. *Index of biological diversity by land use type.*

Farmlands

Groups	Number of samples	Sum	Average	Variance	pvalue
Shannon index	36.00	2.48	0.07	0.01	0.00
index	36.00	0.69	0.02	0.00	0.00
Average density	36.00	110.06	3.06	40.04	0.00

Forest gallery

Groups	Number of samples	Sum	Average	Variance	pvalue
Shannon index	27.00	2.82	0.10	0.01	0.00
Pi đou index	27.00	0.86	0.03	0.00	0.00
Average density	27.00	616.56	22.84	649.85	0.00

Shrub savannah

Groups	Number of samples	Sum	Average	Variance	pvalue
Shannon index	46.00	3.02	0.07	0.00	0.00
Pi đou index	46.00	0.79	0.02	0.00	0.00
Average density	46.00	264.01	5.74	82.94	0.00

Wooded savannah

Groups	Number of samples	Sum	Average	Variance	pvalue
Shannon index	7.00	1.53	0.22	0.01	0.02
Pi đou index	7.00	0.79	0.11	0.00	0.02
Average density	7.00	91.72	13.10	223.79	0.02

Agroforestry area

Groups	Number of samples	Sum	Average	Variance	pvalue
Shannon index	18.00	1.99	0.11	0.01	0.00
Pi đou index	18.00	0.69	0.04	0.00	0.00
Average density	18.00	65.51	3.64	28.49	0.00

Grassland savannahs

Groups	Number of samples	Sum	Average	Variance	pvalue
Shannon index	36.00	1.74	0.05	0.00	0.00
Pi đou index	36.00	0.47	0.01	0.00	0.00
Average density	36.00	100.00	2.78	13.99	0.00

Source: ANOVA analysis

4.4. Effect of Land Cultivation on the Importance of Species

4.4.1. Endangered Species

The plant species listed in Table 2 are threatened in the Central West region. *In fine*, species such as *Balanites aegyptiaca, Bombax costatum Pellegr, Combretum adegonuim, Daniellia oliveri, Feretia apodanthera, Gardenia ternifolia, Lannea acida, Maytenus senegalensis, Parkia biglobosa, Vitex doniana* threatened in the study area have importance values greater than 10 in the savannahs and gallery forests. In agroforestry areas, only *Parkia biglobosa* has a high importance value. Species such as *Anacardium occidental, Bombax costatum, Burkea africana and Magnifera indica* are considered to be of minor concern in agroforestry areas. They provide agroforesters with substantial socio-economic income, which encourages their preservation and conservation. In the farmlands, all the plant species listed are endangered due land cultivation, and their extinction seems imminent.

Table 2. *Endangered species.*

Species name	Importance value indices (IVI)						
	(IVI)	SS	GS	WS	AFA	FLS	GF
Acacia nilotica	0.87	-	-	-	-	0.57	-
Adansonia digitata	0.34	-	-	-	-	0.57	-
Afzelia africana	0.34	-	-	-	-	0.57	-
Anacardium occidental	0.69	-	0.93	-	5.79	-	-
Annona senegalensis	4.02	2.67	2.93	-	2.22	1.14	-
Anogeissus leiocarpus	4.92	5.97	8.80	-	-	0.57	8.57
Balanites aegyptiaca	4.88	11.86	14.15	-	-	1.71	-
Bombax costatum Pellegr.	2.93	0.63	0.93	11.12	5.06	0.57	6.77
Bridelia ferruginea	1.49	0.65	3.21	-	-	0.57	-
Burkea africana	2.29	1.56	5.02	-	5.01	-	1.65
Combretum adegonuim	1.68	1.17	-	-	-	-	18.34
Combretum glutinosum	3.90	3.39	5.89	-	1.12	0.57	-

Species name	Importance value indices (IVI)						
	(IVI)	SS	GS	WS	AFA	FLS	GF
Combretum micranthum	2.76	1.25	-	-	-	0.57	1.65
Combretum microcapum	0.99	0.29	-	-	-	-	-
Combretum molle	3.05	2.78	5.26	-	-	-	3.34
Cordia myxa	1.46	6.72	-	-	-	-	-
Crossopteryx febrifuga	1.38	2.23	2.10	-	-	-	-
Daniellia oliveri	1.65	-	-	22.24	-	0.57	18.05
Dichrostachys cinerea	2.17	0.29	-	-	2.24	1.14	4.97
Entada africana	0.86	-	4.78	-	-	-	1.67
Faidherbia albida	0.34	-	-	-	-	0.57	-
Feretia apodanthera	2.63	0.29	7.28	11.11	1.12	-	3.31
Ficus sycamore	0.41	-	-	-	-	1.14	-
Flueggea virosa	0.75	2.34	-	-	-	-	-
Gardenia erubescens	1.43	0.90	0.93	-	-	-	1.65
Gardenia ternifolia	0.69	0.29	-	11.11	-	-	-
Grewia bicolor	0.34	-	0.93	-	-	-	-
Grewia venusta	0.34	-	-	-	-	-	1.65
Holarrhena floribunda	1.10	0.29	-	-	-	-	-
Isoberlinia doka	0.34	0.84	-	-	-	-	-
Khaya senegalensis	0.34	-	-	-	-	-	1.92
Lannea acida	2.16	3.81	17.42	-	-	0.57	-
Lannea velutina	1.44	2.90	0.93	-	-	-	-
Magnifera indica	1.10	-	-	-	7.10	1.14	-
Maytenus senegalensis	0.82	-	-	-	-	-	15.60
Mitragyna inermis	1.92	-	-	-	1.12	-	36.44
Nocleya longifolia	0.34	-	-	-	-	0.57	-
Ozoroa insignis	1.03	0.29	0.93	-	-	-	-
Parkia biglobosa	2.49	2.51	10.70	-	15.70	-	1.65
Pericopsis laxiflor	0.86	0.56	6.91	-	-	-	-
Piliostigma pillengus	0.75	-	-	-	-	0.57	-
Piliostigma reticulatum	6.09	1.17	-	-	-	1.71	1.65
Prosopis africana	1.20	1.31	1.10	-	-	0.57	-
Pterocarpus erinaceus	1.71	1.89	3.56	-	-	-	19.09
Sarcocephalus latifolius	0.58	-	-	-	-	-	8.65
Sclerocarya birrea	2.31	2.70	4.36	-	-	1.71	-
Securidaga longepedunculata	0.74	-	-	-	-	0.57	3.31
Sterculia setigera	1.03	2.10	-	-	-	-	-
Strychnos spinosa	1.09	0.60	1.98	-	-	-	-

Species name	Importance value indices (IVI)						
	(IVI)	SS	GS	WS	AFA	FLS	GF
Tamarindus indica	0.69	3.82	-	-	-	-	1.65
Terminalia glaucescens	0.40	0.78	-	-	-	-	-
Terminalia laxiflora	0.81	-	-	-	-	0.57	-
Terminalia macroptera	2.35	0.88	2.97	-	1.12	2.86	-
Vitex doniana Sweet	1.09	-	1.09	11.11	-	-	3.33
Xeroderrma stuhlmannnii	0.34	-	1.14	-	-	-	-
Ximenia americana	1.20	0.88	3.11	-	-	-	-
Zatropha gossypiifolia	0.52	-	-	-	-	2.29	-
Zizuphus mauritiana	0.69	-	-	-	-	1.14	-

Source: processing of 2022 floristic inventory data
FLS. Farmlands; *GF*. Gallery forest; *SS*. Shrub savannah; *WS*. wooded savannah; *GS*. grassy savannahs; *AFA*. agroforestry area; *IVI*. Importance Value Index; *value in bold*. vulnerable species; *value in bold red*. species of minor concern

4.4.2. Species of Minor Concern

Table 3 shows the plant species of minor concern in the Central West region. *Acacia macrostachya, Cassia sieberiana, Diospyros mespiliformis, Guiera senegalensis and Piliostigma reticulatum* have IVIs ranging from 5 to 10 (Table 3). These are more important in shrub savannahs, wooded savannahs and gallery forests. However, *Terminalia avicennioides* species is dominant among agroforestry formations. This situation is the result of deforestation to expand agroforestry activities. The presence of exotic plants such as Eucalhptus *globulus* in the farmlands is significant, while *Diospyros mespiliformis* also shows a minor concern status. Although *Diospyros mespiliformis* is a savannah species, its conservation in the farmlands is mainly linked to the production of non-wood forest products (NTFPs) and the economic potential that the species provides for local populations. *Acacia macrostachya, Cassia sieberiana, Guiera senegalensis and Piliostigma reticulatum*, which are typical savannah species, are also becoming extinct in the farmlands as the area under cultivation expands.

Table 3. *Species of minor concern.*

Species name	Importance value index (IVI)						
	(IVI)	SS	GS	WS	AFA	FLS	GF
Acacia macrostachya	6.82	10.70	17.18	-	1.12	4.57	3.31
Cassia sieberiana	5.49	4.55	*14.50*	-	-	1.14	-
Diospyros mespiliformis	8.55	*16.65*	9.86	-	-	7.43	*20.28*
Eucalhptus globulus	8.51	4.72	-	-	-	*62.29*	-
Guiera senegalensis	7.00	1.75	1.85	-	-	1.14	-
Piliostigma reticulatum	6.09	1.17	-	-	-	1.71	1.65
Terminalia avicennioides	6.40	7.73	10.53	-	14.59	-	14.32

Source: processing of 2022 floristic inventory data
FLS. Farmlands; *GF*. Gallery forest; *SS*. Shrub savannah; *WS*. wooded savannah; *GS*. grassy savannahs; *AFA*. agroforestry area; *IVI*. Importance Value Index; *value in bold*. vulnerable species; *value in bold red*. species of minor concern

4.4.3. Vulnerable Species

Table 4 shows the ecological characteristics of the most dominant species according to the Importance Value Index (IVI) in the study area. *Vitellaria paradoxa* (IVI=26.12), *Lannea microcarpa* (IVI=17.41), *Detarium microcarpum* (IVI=14.12), *Piliostigma thonningii* (IVI=12.47) and *Azadirachta indica* (IVI=11.91) are the most important species. These are species that generally dominate savannahs, agroforestry areas and farmlands. *Detarium microcarpum and Piliostigma thonningii* are very important in the savannahs, but are disappearing in the farmlands and agroforestry areas. On the other hand, *Azadirachta indica and Vitellaria paradoxa* species are more important in farmlands and agroforestry areas than in wooded savannahs, shrub savannahs and grassy savannahs. The arboriculture of the exotic *Azaderata indica* indicates the substitution of local savannah species for exotic species in farmlands and agroforestry areas.

Table 4. *Vulnerable species.*

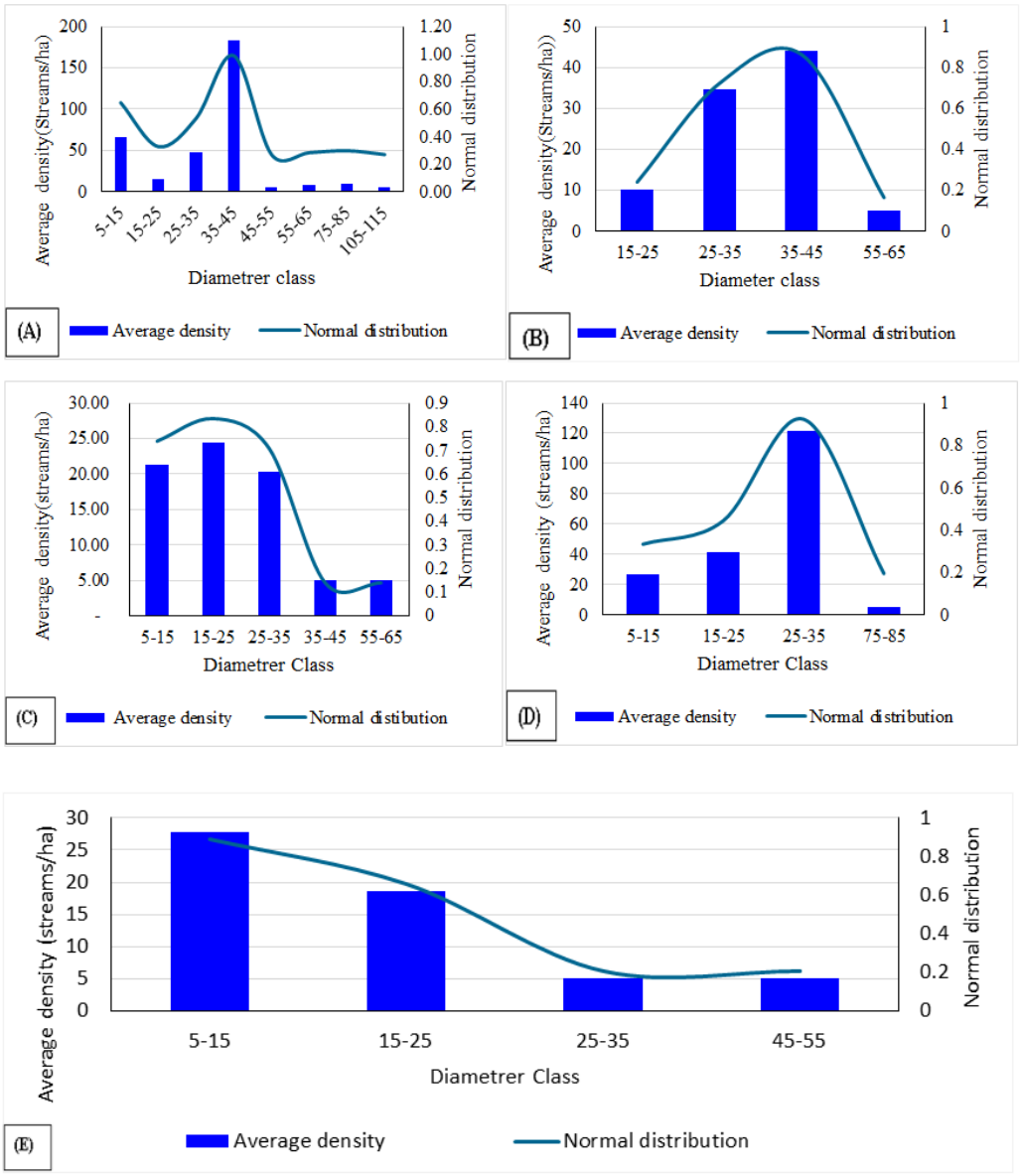
Species name	Importance value index (IVI)						
	(IVI)	**SS**	**GS**	**WS**	**AFA**	**FLS**	**GF**
Azadirachta indica	11.91	3.17	-	-	111.77	60.04	-
Detarium microcarpum	14.12	44.50	22.12	33.36	2.24	0.57	1.65
Lannea microcarpa	17.41	49.44	13.03	-	15.93	15.46	5.28
Piliostigma thonningii	12.47	29.06	29.28	-	3.37	1.14	-
Vitellaria paradoxa	26.12	54.31	62.32	100.38	346.11	21.26	-

Source: processing of 2022 floristic inventory data

FLS. Farmlands; *GF*. Gallery forest; SS. Shrub savannah; *WS*. wooded savannah; *GS*. grassy savannahs; *AFA*. agroforestry area; *IVI*. Importance Value Index; *value in bold*. vulnerable species; *value in bold red*. species of minor concern

4.5. Effect of Land Cultivation on Species Diameter

The overall structure of the five land-use types reveals a poor distribution of individuals by diameter class. Large trees (diameter > 35 cm) are rare. The most common species in savannah formations include *Vitellaria paradoxa, Detarium microcarpum, Azadirachta indica, Piliostigma thonningii, Eucalhptus globulus, Lannea microcarpa, Diospyros mespiliformis, Guiera senegalensis, piliostigma reticulatum, Acacia macrostachya, Terminalia avicennioides, Cassia sieberiana, Anogeissus leiocarpus, Balanites aegyptiaca, Annona senegalensis, Mitragyna inermis, Cordia myxa, Combretum glutinosum, Combretum micranthum, Combretum molle, Lannea acida, Combretum adegonuim, holarrhena floribunda, Pterocarpus erinaceus, Daniellia oliveri, Combretum microcapum, Bombax costatum, Feretia apodanthera, Terminalia macroptera, Acacia nilotica, Burkea Africana, Lannea velutina, Sclerocarya birrea.* These species are regenerating in these formations. In the farmlands and agroforestry formations, the major diameter classes are observed. Preservation of the species in these formations is very important because of their contribution to maintaining and balancing human life, protecting soils against erosion, facilitating the water cycle (infiltration, run-off) and fixing the soil. Agroforestry areas and farmlands are dominated by species of *Vitellaria paradoxa, Lannea microcarpa, Azadirachta indica, Parkia biglobosa, magnifera indica, Anacardium occidental, Eucalhptus globulus* and *Balanites aegyptiaca*. The conservation of these species in cultivated areas and agroforestry zones is linked to non-timber forest products, the collection of timber for sheds and granaries after harvests, as well as for the storing agricultural products and residues for livestock. Species typical of savannah formations can also be found, as a result of the deforestation of natural areas for agricultural purposes. The normal distribution curve shows a symmetrical pattern for graph 1A, indicating a normal structure centered around the mean diameter. However, it characterizes a farmland stand made up of trees of the same age. In Graph 1B, the distribution shows left-skewed asymmetry. However, this graph illustrates a predominance of species of the same age and large diameters in agroforestry areas (diameter > 35) with a predominance of mature-aged species. Graph 1D, which represents wooded savannah, also shows the same group of trees as illustrated in graph 1B. Graphs 1C and 1E, for shrub and grassy savannahs respectively, are characteristic of monospecific stands with a predominance of young or small-diameter individuals (diameter <35 cm). In all the graphs, densities are higher for species in the 15 to 45 cm diameter group.



Source: 2022 forest inventory

Figure 5. *Normal distribution of densities as a function of diameter classes.*

4.6. Effect of Land Cultivation on Regeneration

Table 5 shows that 25.56% of regenerating plant species are found in farmlands and 58.11% in shrub savannahs. The specific index of regeneration in grass savannahs and gallery forests are 8.11% and 4.84% respectively. The Lowest regenerating rates among species are found in agroforestry areas and wooded savannahs respectively.

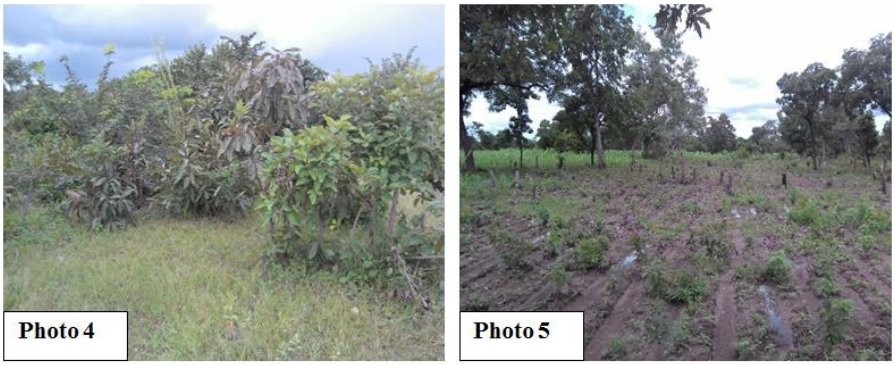
Table 5. *Regeneration rate per Land Use Unit.*

Land Use Unit	Regeneration rates (%)
Fields	25.56
Gallery forest	4.84
Shrub savannah	58.11
Wooded savannah	0.34
Grass savannah	8.11
Agroforestry area	3.04
Grand total	100.00

Source: 2022 forest inventory

The regenerating species in the farmlands consist of Terminalia laxiflora, acacia nilotica, Annona senegalensis, Cassia

sieberiana, Guiera senegalensi and piliostigma reticulatum, which are savannah species, and azadirachta indica and Eucalhptus globulus, which are exotic regenerating species. In the shrub savannahs, the stands of species with high regeneration values are Combretum microcapum, Terminalia avicennioides, Eucalhptus globulus, holarrhena floribunda, Anogeissus leiocarpus, Combretum micranthum, Cordia myxa, Vitellaria paradoxa, Diospyros mespiliformis, piliostigma reticulatum, Guiera senegalensis, Piliostigma thonningii, Detarium microcarpum. These species were cut down when the land was cultivated, as shown in photo 5, and from regenerating savannahs, as shown in photo 4.



Source: photo taken by KOUDOUGOU S. 2022

Figure 6. *Effect of cultivation on species regeneration.*

4.7. Modelling and Forecasting Biodiversity Habitats in the Study Area

Mapping biodiversity habitats will help monitor and conserve sites that are important for the preservation of the species taking refuge there. The Central West region is home to (04) potential natural reserves of woody plants. These include potential secondary corridors, potential primary corridors, secondary biodiversity natural habitats and primary biodiversity habitats. They represent potential reserves for both fauna and floral diversity in this region. Primary and secondary habitats represent 38.47% and 1.93% of the area of the region respectively. Potential secondary and primary corridors account for 4.57% and 3.39% of the region's surface area respectively. Although 38.47% of the surface area appears to be composed of a woody habitat reserve, it should be noted that the area classified "*unsuitable*" woody species represents more than half (51.64%) of the study area. In the 2050 projections, primary habitats will undergo a net loss of -7.75% of their surface area, of which 6.75 will be overtaken by unsuitable or low-quality habitat areas. They will also lose 1.29% of their surface area to secondary habitats and 0.21% to the primary corridor.

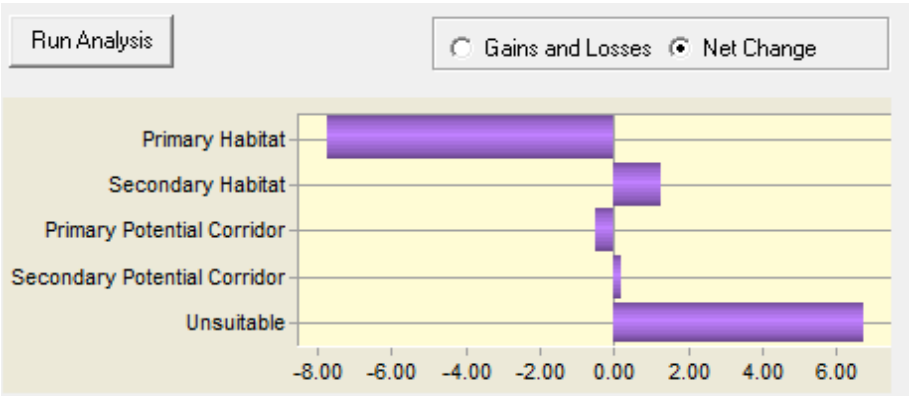
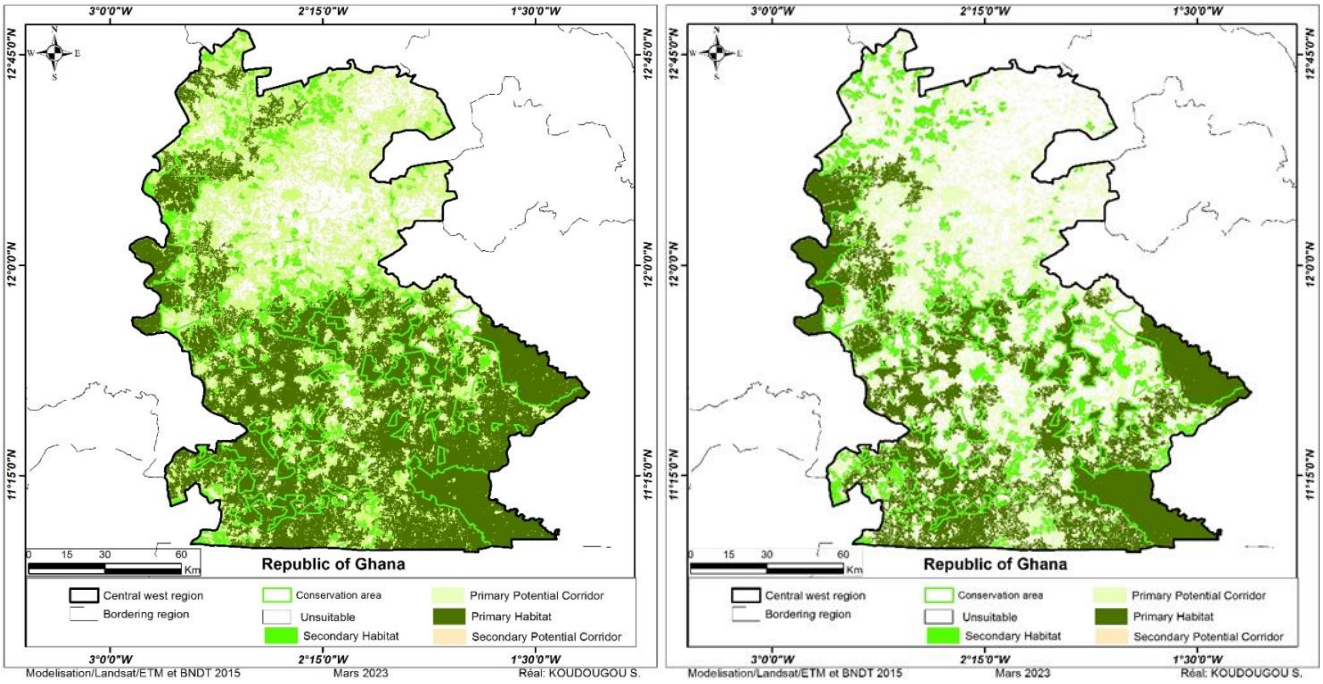


Figure 7. *Net change in biodiversity habitat in the study area.*

The expansion of areas under cultivation for agricultural purposes will threaten the connection between primary biodiversity habitats. This break in the connection between biodiversity habitats could lead to a geographical restriction of species individuals and a geographical assemblage restricted to protected areas and classified ecosystems. Conservation

means maintaining viable individuals of species in their natural and semi-natural habitats. Over and above the importance of the sites already fully protected in the study area for species conservation, it would therefore be imperative for habitat conservation strategies to focus on securing habitats and land tenure, given their role in the preservation of woody species. In addition, investment by donors and the private sector must support local and indigenous opportunities to preserve species. From this point of view, the development of secondary habitats and corridors will improve connections between habitats and should allow species to migrate from one area to another.



a. habitat 2020 *b*. habitat 2050

Figure 8. *Biodiversity habitat outlook between 2020 and 2050.*

5. Discussion

The study area has a total of 69 species belonging to 55 genera in 28 families, including *Fabaceaes, Combretaceaes, Caesalpiniaceaes, Sapotaceaes, Anacardiaceaes, Meliaceaes and Mytraceaes.* The *Rhamanaceaes, Tiliceaes and Leguminosaes* families are very poorly represented. These results corroborate those of [3] who found a dominance of the *Fabaceace-cesa, Caesalpiniaceaes, Minaosoideaces and combretaceaes* families in Niger. They are also similar to the research result of [6]. Indeed, the latter showed that the *Caesalpiniaceaes, Minaosoideaces and Anacardiaceaes* families dominate their study area. In Casamance [5] showed that the *Meliaceaes and Verbenaceaes* families are poorly represented, which corroborates the results of this study. New or exotic species are increasingly colonizing fields and agroforestry plantations. These are species of azarderata indica, Eucalhptus globulus. Indeed, the work of [14] indicates that populations are observing an introduction of new species including Azarderata indica, Eucalhptus globulus, Maguifera indica in eastern Burkina Faso. In the extreme south-west of Burkina Faso, [22] inventoried 92 species, 77 genera and 37 families in assisted natural regeneration plots. According to [3], conservation measures are needed to prevent the local extinction of species with low RVI and IVI. Species with high IVI and RVI must not be left out of these conservation measures. The different ways of collecting NTFPs and exploiting wood, and the recognition of rights (scientific, cultural, ritual, medicinal) should be taken into account to preserve them from anthropogenic and/or climatic pressure. Habitat, diversity and the structure of woody plants are closely correlated. The structure of formations depends on the type of habitat and land use. The most robust, largest and best-preserved species are found in farmlands and agroforestry areas. In savannahs, the structure by diameter class shows that they are made up of shrubs**.** These results align with those of [17], who observed a decline in species richness, and an increased loss of large vegetation trees despite re-greening trends and a shift from savannah species towards Sahelian species better adapted to aridity. According to [16-19], this is due to fraudulent felling and management by farmers, who only save and conserve the desired woody species in their farmlands. Very few studies have been carried out to model the habitats of plant species. At least, those that do

exist are based on empirical habitat assessment methods. This study has therefore shed light on the habitat typology of woody species in the Central West region. It reveals that the region is made up of two habitats (primary and secondary), two potential corridors (primary and secondary) and land unsuitable for the expansion of woody species. However, by 2050, these habitats will lose the connections that existed among them in 2020 as a result of the cultivation of land for agricultural purposes.

6. Conclusion

The structure by diameter reveals that the formations of the farmlands and agroforestry areas abound in large-diameter trees compared with those of the savannahs in general and the riparian formations. Land cultivation affects structure, diameter, species distribution balance and species biodiversity in the study area. Dangerous species, species of minor concern and vulnerable species were defined and compared on the basis of savannahs and other formations. The study mapped five (5) types of woody habitat in the central west region (Burkina Faso). These involve primary and secondary habitat zones, primary and secondary corridors, and unsuitable land, aiming to understand what will happen to the habitat by 2050. Two conservation approaches emerged from the analyses. The first focuses on the conservation of species with high or low IVI and RVI in savannahs and human-impacted areas, and the second emphasizes the conservation of land uses or habitats containing the species.

Abbreviations

AFA	Agroforestry Area
ANOVA	Analyze of Variance
Domr	Relative Dominance
Dr	Relative Density
EQ	Piélou Evenness Index
F	Frequency
FLS	Farmlands
F_r	Relative Frequency
G	Basal Area
GF	Gallery Forest
GPHC	General Population and Housing Census
GS	Grassy Savannahs
H	Shannon Index
IDP	Internally Displaced Persons
IVI	Importance Value Indices
NTDB	National Topographic Database
NTFP	Non-wood Forest Products
RVI	Regeneration Value Indices
Sp/CON ASUR	Permanent Secretariat of the National Council for Emergency Relief and Rehabilitation
SS	Shrub Savannah
WS	Wooded Savannah

Author Contributions

Stéphane Koudougou is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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