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Evaluation of the Sustainability of Reforestation Initiatives in Anthropized Forest Habitats in the Lubumbashi Charcoal Production Basin (Haut-Katanga, DR Congo)

Dieu-donné N'tambwe Nghonda [1,2,*], Héritier Khoji Muteya [1,2], Gracia Kalenga Mupanda [1], François Duse Dukuku [1], Nathan Kasanda Mukendi [3,4], Bienvenu Esoma Okothomas [1], Médard Mpanda Mukenza [5,6], Sylvestre Cabala Kaleba [1], François Malaisse [2], Wilfried Masengo Kalenga [1], Jan Bogaert [2] and Yannick Useni Sikuzani [1,*]

[1] Unité Écologie, Restauration Écologique et Paysage, Faculté des Sciences Agronomiques, Université de Lubumbashi, 1825, Lubumbashi (RDC))
[2] Biodiversité, Ecosystème, Paysage, Université de Liège - Gembloux Agro-BioTech, 5030 Gembloux (Belgique)
[3] Unité de Recherche en Économie et Développement Agricole, Faculté des Sciences Agronomiques, Université de Lubumbashi, B.P. 1825, Lubumbashi (RDC)
[4] Unité de Recherche en Économie et Développement Rural, Université de Liège - Gembloux Agro-Bio Tech, 5030, Gembloux (Belgique)
[5] Département de Gestion des Ressources Naturelles Renouvelables, Faculté des Sciences Agronomiques, Université Technologique Katumba Mwanke, Lubumbashi BP 74, Kasenga (RDC)
[6] Département de Gestion des Ressources Naturelles Renouvelables, Faculté des Sciences Agronomiques, Université de Kolwezi, BP 07301, Kolwezi (RDC)
* Correspondence: nghondan@unilu.ac.cd (D.N.N.); sikuzaniu@unilu.ac.cd (Y.U.S.)

Abstract: The sustainability of reforestation initiatives depends on the involvement of local communities, whose lack of ownership compromises efforts to combat deforestation in the Lubumbashi Charcoal Production Basin. This study assesses reforestation activities in two village areas (Milando and Mwawa), based on individual interviews (50 individuals/village area) and floristic inventories carried out in two types of habitats (reforested and unexploited) for each village area. The hypotheses test whether (i) reforested habitats and tree species were inclusively selected and sustained through community-based practices, (ii) reforested habitats exhibit comparable ecological metrics to unexploited *miombo* due to protected regrowth, and (iii) ethnobotanical and floristic lists show variations reflecting differing anthropogenic impacts and limited species diversity in reforestation efforts. Thus, the interviews gathered data on habitat and woody species selection for reforestation, and management practices, while the inventories assessed the condition of these reforested habitats in terms of density per hectare, basal area, mean square diameter, and floristic diversity. The results show that in both village areas, the selection of habitats for reforestation was carried out concertedly (22.00-44.00% of citations). Woody species were chosen according to the needs of local communities (40-52%) and the availability of seeds (18.00-44.00%). Furthermore, management practices for these reforested habitats include planning/assessment meetings (26.00-38.00%) and maintenance activities, such as firebreaks (38.00-46.00%) and surveillance of reforested habitats (24.00%). Additionally, these practices are being increasingly neglected, jeopardizing reforestation efforts. However, density/ha, basal area, mean square diameter and floristic diversity did not show significant differences between reforested and unexploited habitats, particularly at Milando ($p>0.05$). Furthermore, floristic similarity is 55.56% for reforested habitats and 93.75% for unexploited habitats but remains low between reforested and unexploited habitats (40.00-47.62%). This similarity between ethnobotanical and floristic lists is also low (43.75-31.58%). The results of the present study suggest a sustainable and continuous management of these reforested habitats for an effective reconstitution of the forest cover. To reinforce the sustainable management of these reforested habitats, it is recommended that decision-makers conduct with awareness-raising campaigns and establish payment for environmental services mechanisms to motivate communities.

Keywords: restoration; deforestation; forest degradation; *miombo*; sustainable management; local community forest concession

1. Introduction

Forests are terrestrial ecosystems harboring exceptional biodiversity [1]. They are home to 80% of the Earth's biological diversity and numerous endemic plant and animal species [2]. As a result, they play an important role in the sequestration of atmospheric carbon and contribute to the survival of both rural and urban populations through the ecosystem services they provide, such as dendro-energy and various non-timber forest products [3].

These forests cover almost 4.1 billion hectares, or 31% of the planet's land surface [4]. In Africa, forests represent around 675 million hectares [5,6], of which almost 12% is covered by *miombo* [7,8], a forest dominated-by woody species of the genera *Brachystegia*, *Julbernardia* and *Isoberlinia* [9,10]. This forest covers between 2.7 and 3.6 million km² of the Zambezi ecoregion [11], providing a livelihood for over 100 million people in both rural and urban areas [12,13]. In addition, this forest harbors significant biodiversity with a high rate of endemism, making it a priority for conservation [14,15].

However, increasing anthropogenic pressure on *miombo* is leading to deforestation and forest degradation [16-18]. The main factors are shifting agriculture and dendro-energy production [19, 20], to which are added timber exploitation and repeated bushfires, contributing to forest loss [21-23]. Thus, the deforestation rate of *miombo* varies from 2% to 22% in the Zambezi region, reaching high levels in countries where populations are highly dependent on forest resources [24], such as the Democratic Republic of Congo.

Indeed, in the Democratic Republic of Congo, a country with high forestry potential, the annual deforestation rate is the highest in the Congo Basin, at almost −0.4% between 2001 and 2019 [3]. Southeastern Democratic Republic of Congo, where *miombo* is dominant, has not been spared: its cover fell from over 70% of Katanga in 2000 to 43% in 2010 [25]. In the Lubumbashi Charcoal Production Basin – the administrative areas that supply the city of Lubumbashi with dendro-energy−, the deforestation rate is 1.51%, six times the national average [20], due to the poverty of rural and urban populations [26] and a difficult socio-economic context [27]. Combined with population growth and urbanization, this overexploitation is extending the deforestation of *miombo*, threatening the survival of dependent populations [2].

To combat deforestation and forest degradation, forest cover restoration is a key solution [8,28]. This process aims to restore the structure, composition, and ecological functions of forests, essential to the survival of communities in anthropized habitats [29]. Natural regeneration, a sustainable alternative, is effective in habitats with a high restoration capacity, dependent on disturbance and the resilience of woody species [13,30,31]. In cases of low resilience, reforestation is crucial to rapidly restore forest cover and ecosystem services [32,33], as in the Lubumbashi Charcoal Production Basin.

However, successful reforestation requires the involvement of local communities in project management, particularly in the selection of habitats and tree species [27,34]. Their involvement facilitates the acceptance and appropriation of reforestation programs, thus contributing to the sustainable management of natural resources [35,36].

Furthermore, several studies emphasize the importance of involving local communities in reforestation projects in Africa [6,37], particularly for the choice of woody species and the management of reforested habitats [38-40]. However, in the Zambezi region [41-43] and the Democratic Republic of the Congo [32,44], studies demonstrate this importance without delving into other aspects of the reforestation process that can lead to its success. In the Lubumbashi region, research on reforestation is limited. Although, studies highlight the need for reforestation in response to deforestation and emphasize the importance of integrating local communities into these processes [45-47], they do not specifically address the importance of this integration. This study fills this gap by showing that the involvement of local communities is crucial to the success and sustainability of

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reforestation projects. Integrating endogenous knowledge and local perceptions into these programs fosters sustainable involvement in natural resource management [24,32].

Thus, the present study aims to assess the sustainability of reforestation activities carried out in anthropized *miombo* habitats in the Lubumbashi Charcoal Production Basin. It tests the hypotheses that (i) reforested habitats and tree species were selected concertedly by the various stakeholders, attesting to an inclusive approach. Additionally, community-based planning, maintenance, monitoring, and evaluation practices ensure the sustainability of reforested habitats; (ii) the density/ha, mean square diameter, basal area, and floristic diversity of reforested habitats are statistically equivalent to those of unexploited *miombo*, because reforested habitats have been set aside to allow the forest cover to be reconstituted, and (iii) there are significant similarities/dissimilarities between the ethnobotanical and floristic lists, due to the varying levels of anthropogenic disturbance experienced by each habitat and the limited diversity of woody species used for reforestation.

2. Materials and Methods

2.1. Study Environment

The present study was carried out in the Lubumbashi Charcoal Production Basin in Haut-Katanga province, Democratic Republic of the Congo (Figure 1). This basin is situated at an altitude between of 1,200 and 1,300 m and at 11° 40'S - 27° 29'E. According to Koppen's classification system, the climate prevailing in this Lubumbashi Charcoal Production Basin is of the Cw type [48], characterized by two seasons including a rainy season (November to March), a dry season (May to September), separated by two transition months (April and October). Average annual rainfall is 1,270 mm, and average annual temperature ranges from 17 to 26°C [9,10].

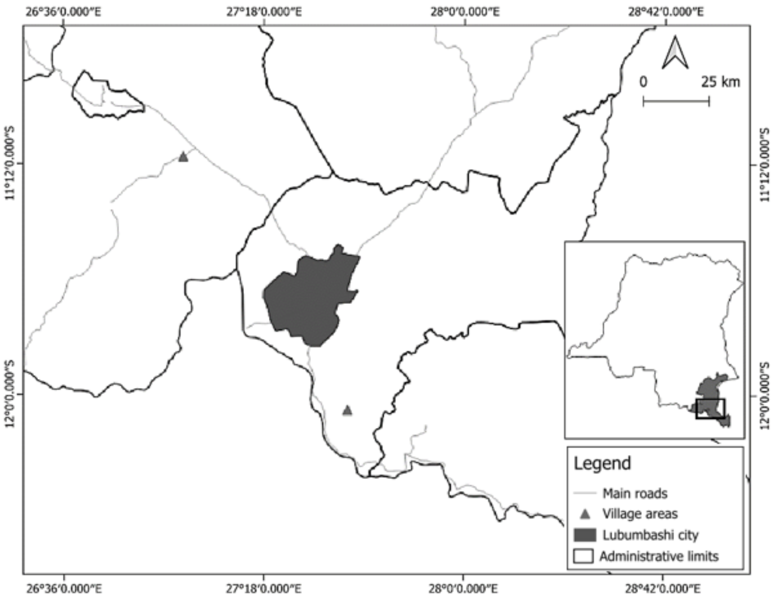

Figure 1. Location of the city of Lubumbashi (grey polygon) and its rural area (white space around the city of Lubumbashi). The triangles represent the village areas covered by the present study. The geographic coordinates used to locate these two village areas were taken from reforested habitats using GPS.

In the Lubumbashi Charcoal Production Basin, the primary vegetation is *miombo*, which is gradually being replaced by savannah, particularly around built-up areas, due to human activities [16,20]. The soils in this region are ferralsols with poorly differentiated horizons [49]. The population of the Lubumbashi region remains highly dependent on natural resources, particularly though slash-and-burn agriculture and dendro-energy production [27]. Moreover, most of this population lives on less than $1.25 a day, expressing a high level of poverty, food insecurity, and deprivation [26].

2.1. Methods

2.2.1. Village Areas Selection and Sampling

To assess the effectiveness and sustainability of forest cover restoration activities, two village areas (Milando and Mwawa) in the Lubumbashi Charcoal Production Basin were selected. These village areas were identified as having intense anthropogenic activities, notably agriculture and charcoal production [27]. In addition, Milando and Mwawa benefited from reforestation activities initiated in 2018 as part of the implementation of forest concessions for local communities (FCLC). These activities involved the participation of several categories of stakeholders, including local communities, NGOs (APRONAPAKAT: Action pour la Protection de la Nature et des Peuples Autochtones du Katanga; BUCODED: Bureau Conseil en Développement Durable), the provincial environment coordination and the FAO (Food and Agriculture Organization of the United Nations). In these village areas, 100 individuals, 50 per village area, were selected for ethnobotanical surveys using the snowball method [50,51], between August 3 and September 15, 2024. This number was determined due to the lack of official statistics concerning individuals familiar with reforestation issues in both village areas.

2.2.2. Data collection

Ethnobotanical surveys were carried out using a semi-directive method [52], enabling the participants' discourse to be guided by pre-defined themes [53]. These surveys made it possible to gather qualitative data on the involvement of local communities in reforestation activities, particularly concerning the choice of habitats and woody species for reforestation, as well as the management activities of these habitats (Supplementary material). Forest management refers to all technical and practical actions aimed at preserving, restoring, and sustainably exploiting forests, including planning, reforestation, biodiversity monitoring, fire control, and conservation [54]. The identification of woody species cited under their vernacular names during these ethnobotanical surveys was carried out using existing floras (Flora of Zambia, Flora of Zimbabwe, World Flora) and identification manuals [9,55-57]. Field trips with some of the respondents also enabled to identify species cited and described in the local language, particularly those whose identification was difficult through the manuals.

Additionally, floristic inventories were carried out in reforested habitats and unexploited forests in each village area. Unexploited forest refers to *miombo* never exploited on a human scale for agriculture and charcoal production [20]. To this end, 40 floristic inventory plots were randomly installed, 20 in Milando village area (10 in reforested habitat and 10 in patches of unexploited forest) and 20 others in Mwawa. Plot dimensions were determined based on previous studies [58,59] which had shown that 50 m x 20 m (1000 m^2) are adequate dimensions for floristic studies in *miombo* [13,59]. In these plots, all woody individuals with a diameter at breast height (*DBH*) ≥ 10 cm were counted and measured using forest tape [60]. These data on individual diameters allowed the establishment of the diameter structure of each inventoried habitat, while the counting enabled the calculation of individual density per unit area (hectare; [61]).

2.2.3. Data analysis

To determine the criteria used when selecting habitats and woody species for reforestation, the citation frequency (C_f; Equation (1); [62]) was calculated with the *ethnobotanyR* package under R software version 4.3.2, based on individual interviews. This frequency is based on the principle that the most frequently cited criteria directly influence the choice of habitats and species for reforestation. It is calculated by the equation:

$$C_f = \frac{S}{N} \times 100 \quad (1)$$

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where s represents the number of respondents citing the criterion and N, the total number of respondents. If C_f approaches 0, the criterion had little influence on the choice, while an C_f close to 100 indicates a strongly favored criterion.

Furthermore, to characterize and compare reforested and unexploited habitats in both village areas, several indicators were calculated: the diametric structure of inventoried individuals, density per hectare (N; Equation (2)), and the importance value index (IVI; [13,58]). The diametric structure reveals forest composition and dynamics, possibly indicating tree growth and the effects of environmental disturbances [61]. Density measures the number of individuals per hectare, while relative density reflects the proportion of a woody species within the habitat [62].

$$N = \frac{n_i}{a} \tag{2}$$

where n_i is the number of individuals of a wood species on a plot and a is the area of the plot expressed in a hectare.

Additionally, the IVI assesses the ecological dominance of woody species, with a higher value indicating greater ecological significance of the species within the forest ecosystem [59,63]. This index is calculated by the following equation (Equation (3)):

$$IVI = \mathrm{RDo} + \mathrm{RD} + \mathrm{RF} \tag{3}$$

where RDo represents relative dominance (Equation (4)), while RD and RF correspond to relative density and frequency (Equations (6) and (7), respectively).

Relative dominance measures the basal area occupied by all individuals of a species over a hectare. However, relative density expresses the proportion of individuals of a species about all individuals in the habitat, while relative frequency indicates the proportion of a species out of wood species [58,59].

$$RDo = \frac{g_i sp}{g_i Tsp} \times 100 \tag{4}$$

where $g_i sp$ is the basal area of a species and $g_i Tsp$, the sum of all basal areas of all woody species inventoried. However, g_i, the basal area of each individual measured (expressed in m^2/plot area), is calculated using the equation below (Equation (5)):

$$g_i = \frac{\pi D^2}{4} \tag{5}$$

with D, the diameter at breast height (DBH) of an individual, measured at 1.30 m from the ground.

$$RD = \frac{n_i}{N} \times 100 \tag{6}$$

where n_i is the number of individuals of a species and N is the total number of individuals surveyed.

$$RF = \frac{f}{F} \times 100 \tag{7}$$

with f the frequency of a woody species (Equation (8)), expressing the probability that a woody species occurs in each of the installed floristic inventory plots (surveys), and F the sum of all frequencies.

$$f = \frac{n}{Np} \tag{8}$$

where n is the total number of plots where the species was surveyed, and Np is the total number of plots.

However, mean square diameter (DBH_m, Equation (9)) and basal area (GBA, Equation (10)) were calculated. The mean square diameter, expressed in cm, is used for trees with several trunks at 1.3 m height. In this study, DBH_m was used to determine the mean diameter of trees in both reforested and unexploited habitats. The basal area, a common metric in forest management (expressed in m^2/ha), represents the cross-sectional area of tree trunks measured at breast height (1.3 m) [61,64]. In addition, the averages of species, genera, and families of individual trees inventoried in each habitat were calculated [64].

$$DBH_m = \sqrt{\frac{1}{n}\sum_{i=1}^{n} d_i^2} \quad (9)$$

where di is the diameter at breast height (*DBH*) of each tree trunk or branch, measured at 1.3 m above the ground, and n is the total number of such trunks or branches measured.

$$GBA = FE\sum_{i=1}^{m} g_i \quad (10)$$

with m being the number of woody individuals inventoried in the plot, and FE the extension factor related to plot area (m^2), used to extrapolate g_i values to the hectare [61].

To highlight statistical differences at the 5% significance level among the parameters characterizing these two habitat types, the non-parametric Kruskal-Wallis's test [65] was applied to density/ha, means square diameter, basal area, and floristic richness. This test was used given the non-normality of the data confirmed by Shapiro's test [66]. In the case of significant differences, the Dunn-Bonferroni post-hoc test enabled pairwise comparison of means [67,68].

To compare floristic diversity between the reforested and unexploited habitats, the Shannon, Simpson, and Piélou indices were calculated from floristic inventory data [2]. The Shannon index assesses specific heterogeneity and the distribution of individuals between species, while Simpson measures the probability of encountering two individuals of the same species consecutively. Piélou's equitability index estimates the ratio between observed diversity and maximum possible diversity [2,59].

Finally, to compare the plant species lists from individual interviews and floristic inventories in each village area, Jaccard's similarity index (J; Equation (11)) was calculated [69]. All these analyses were carried out using R (dendrometry package) and Past (version 4.05) software.

$$J = \frac{a}{a+b+c} \quad (11)$$

where a is the total number of woody species inventoried in the two habitats being compared; b and c respectively the number of woody species inventoried in one of the two habitats but absent in the other.

3. Results

3.1. Habitats and Species Selection Criteria for Reforestation and Management of Reforested Habitats

3.1.1. Choice of Habitats for Reforestation in Village Areas

Over 70% of respondents reported that reforestation habitats were chosen either through concertation among stakeholders or by village chiefs. Specifically, in Milando village area, the choice of habitats was strongly influenced by the village chief, whereas in Mwawa, it resulted from consultation involving the community, the NGO, the public environmental service, and the village chief (Table 1).

Table 1. Factors influencing the choice of habitats used for reforestation in both village areas. n= number of people surveyed. The sum of frequencies does not add up to 100%, as the proportions of those with no answer to this question have been removed from the table.

Selection criteria	Reforested habitats (%)	
	Milando (*n=50*)	Mwawa (*n=50*)
Choice of the village chief	48.00	24.00
Choice of the village chief and NGO	6.00	4.00
Choice of the village chief and notables	14.00	12.00
Consultation	22.00	44.00

3.1.2. Choice of Woody Species for Reforestation in Village Areas

More than 70% of respondents reported that woody species used for reforestation were selected based on their usefulness and the availability of seeds. In Milando, the availability of seeds was the main factor, while in Mwawa, the choice of woody species was primarily based on the needs of the local community. Other criteria, such as the use of timber and adaptation to soil types, influenced the selection of certain woody species, particularly in Mwawa (14% of respondents; Table 2).

Table 2. Criteria for choosing woody species for reforestation in the rural area of Lubumbashi. n= number of people surveyed; -: the choice criterion was not cited in the concerned village area.

Selection criteria	Reforested habitats (%)	
	Milando (n=50)	Mwawa (n=50)
Timber	-	4.00
Village chief and notables	-	6.00
Choice of NGO	16.00	16.00
Seed availability	44.00	18.00
NTFP sources	40.00	52.00
Soil type	-	4.00

3.1.3. Management Practices on Reforested Habitats Within Village Areas

Around 75% of respondents report that the management of reforested habitats relies mainly on planning and assessment meetings, the installation of firebreaks, and surveillance by forestry brigades. Specifically, the holding of such meetings and the installation of firebreaks are frequently mentioned in both village areas. In addition, plant nursery maintenance was particularly highlighted as a key activity in Mwawa, in contrast to Milando where this maintenance is less reported (Table 3).

Table 3. Management practices for reforested habitats in the rural area of Lubumbashi. n= number of people surveyed; -: management practice was not cited in the concerned village area.

Management practices	Reforested habitats (%)	
	Milando (n=50)	Mwawa (n=50)
Firebreaks	38.00	46.00
Plant nursery	-	4.00
Planning/assessment meetings	38.00	26.00
Surveillance (Brigade)	24.00	24.00

3.2. Forest Recovery in Reforested Habitats Compared to Unexploited Miombo in Both Village Areas

3.2.1. Diameter Structure of Individuals Inventoried in Reforested and Unexploited Habitats Within Village Areas

Most individuals inventoried in reforested and unexploited habitats have a diameter at breast height (*DBH*) of between 10 and 40 cm. In the reforested habitat of Mwawa, many individuals are in

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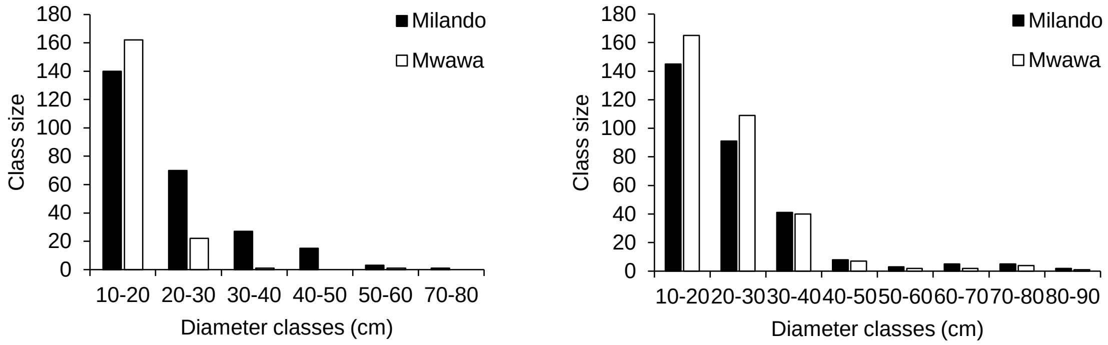
the 10-20 cm *DBH* class, while in Milando, these individuals are distributed across all diametric classes. However, the unexploited habitats in both village areas show a similar diametric distribution, presenting increasingly larger trees compared to the reforested habitats. Furthermore, the "inverted J" diametric structure observed in both habitat types (reforested, unexploited) reflects the predominance of juveniles, indicating active regeneration and the gradual reconstitution of the forest cover, especially in reforested habitats (Figure 2).



(**a**) (**b**)

Figure 2. Diametric structure of habitats in both village areas: (a): reforested habitats; (b): unexploited habitats.

3.2.2. Density per Hectare and Ecological Importance of Woody Species Inventoried within Reforested and Unexploited Habitats in Both Village Areas

A total of 442 woody individuals were inventoried in reforested habitats, including 256 in Milando and 186 in Mwawa, belonging to 26 genera (Milando: 17; Mwawa: 21) and 13 families (Milando: 7; Mwawa: 11). In unexploited habitats, 630 individuals were counted: 300 in Milando and 330 in Mwawa, belonging to 37 species (35 per habitat), 27 genera (Milando: 25; Mwawa: 21) and 17 families (Milando: 15; Mwawa: 12). The Fabaceae family dominates in both habitat types, accounting for 60.94% and 74.73% respectively in the reforested habitats of Milando and Mwawa, and 70.67% and 76.97% in the unexploited habitats.

Some wood species cited by respondents as chosen for reforestation, such as *Acacia polyacantha*, *Afzelia quanzensis*, and *Anisophyllea boehmii*, were not recorded in either reforested or unexploited habitats. Nevertheless, of these woody species, *Brachystegia spiciformis*, *Diplorhynchus condylocarpon*, and *Isoberlinia angolensis* are the most represented in reforested habitats, while *B. spiciformis* remains dominant in unexploited habitats (Table 4).

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Table 4. Floristic list of woody species cited during interviews and those recorded in reforested and unexploited habitats across both village areas. Woody species are listed in alphabetical order. Density per hectare; IVI: Index of importance values; Re: Reforested habitat; Un: Unexploited habitat; -: the woody species was not inventoried in the concerned village area; *: the species was cited during the interviews and recorded during the floristic inventories; +: the species was cited during the individual interviews but not recorded during the floristic inventories.

Species	Families	Density/ha				IVI			
		Milando		Mwawa		Milando		Mwawa	
		Re	Un	Re	Un	Re	Un	Re	Un
Acacia polyacantha Willd.	Fabaceae	-+	-	-	-	-	-	-	-
Afzelia quanzensis Welw.	Fabaceae	-+	-	-+	-	-	-	-	-
Albizia adianthifolia (Schumach.) W. F. Wight	Fabaceae	-*	6	37	14	-	8.36	55.73	15.24
Albizia antunesiana Harms	Fabaceae	20*	8	6*	9	24.37	10.77	10.82	8.78
Albizia versicolor Welw. ex Oliv.	Fabaceae	-	1	7	1	-	1.39	12.50	1.29
Anisophyllea boehmii Engl.	Anisophylleaceae	-*	4	-*	1	-	4.81	-	1.40
Baphia bequaertii De Wild.	Fabaceae	-	11	7	12	-	11.67	10.13	10.80
Bobgunnia madagascariensis (Desv.) J.H.Kirkbr. & Wiersema	Fabaceae	8*	2	5*	4	9.88	2.85	11.91	3.51
Brachystegia boehmii Taub.	Fabaceae	5*	-	10*	-	13.70	-	13.36	-
Brachystegia floribunda Benth.	Fabaceae	-	-	-+	-	-	-	-	-
Brachystegia spiciformis Benth.	Fabaceae	23*	59	10*	70	24.59	42.38	15.94	49.86
Brachystegia wangermeeana De Wild.	Fabaceae	24	98	15	108	31.99	69.52	20.54	68.83
Combretum collinum Fresen.	Combretaceae	-	1	-	1	-	1.94	-	1.88
Combretum molle R.Br ex G. Don	Combretaceae	-	1	-	2	-	1.96	-	3.41
Combretum zeyheri Sond.	Combretaceae	-	-	1	-	-	-	2.03	-
Dalbergia boehmii Taub.	Fabaceae	2	-	-	-	3.51	-	-	-
Diplorhynchus condylocarpon (Müll. Arg.) Pichon	Apocynaceae	15*	8	21	8	16.72	9.26	29.01	8.77
Ekebergia benguelensis Welw. ex C.DC.	Meliaceae	-	1	-	-	-	1.43	-	-
Erythrina abyssinica (Hochst.) A. Rich.	Fabaceae	4	-	12	-	5.80	-	27.58	-
Erythrophleum africanum (Welw. ex Benth.) Harms	Fabaceae	-	4	-	3	-	5.20	-	4.01
Faurea rochetiana (A.Rich.) Chiov. ex Pic. Serm.	Proteaceae	-	-	1	-	-	-	1.89	-
Ficus sp	Moraceae	-	-	1	-	-	-	1.97	-
Isoberlinia angolensis (Benth.) Hoyle & Brenan	Fabaceae	20*	7	19*	12	22.81	8.89	24.26	13.34
Julbernardia globiflora (Benth.) Troupin	Fabaceae	4	-	1	-	6.88	-	1.97	-

Julbernardia paniculata (Benth.) Troupin	Fabaceae	12*	5	4*	2	12.94	6.33	7.04	1.93
Lannea discolor (Sond.) Engl.	Anacardiaceae	2	4	-	4	3.04	3.70	-	3.46
Maranthes floribunda (Baker) F.White	Chrysobalanaceae	-	-	1	-	-	-	1.87	-
Markhamia obtusifolia (Boulanger) Sprague	Bignoniaceae	-	3	-	3	-	10.34	-	10.72
Marquesia macroura Gilg	Dipterocaerpaceae	-*	18	1*	8	-	32.40	1.88	17.00
Monotes africanus Gilg	Dipterocaerpaceae	3	1	2	1	4.90	2.10	2.67	2.06
Monotes katangensis De Wild.	Dipterocaerpaceae	7	12	3	6	8.34	8.41	4.69	4.64
Mystroxylon aethiopicum (Thunb.) Lœs.	Celastraceae	-	1	-	1	-	2.04	-	1.99
Ochna schweinfurthiana F.Hoffm.	Ochnaceae	-	2	4	6	-	2.73	7.98	6.69
Olax obtusifolia De Wild.	Olacaceae	-	-	-	1	-	-	-	1.49
Parinari curatellifolia Planch. ex Benth.	Chrysobalanaceae	2*	3	5*	6	2.96	3.38	10.02	6.84
Pericopsis angolensis (Harms) Van Meeuw.	Fabaceae	29*	7	2*	5	32.44	8.12	2.83	6.87
Philenoptera katangensis (De Wild.) Schrire	Fabaceae	1	-	-	-	1.47	-	-	-
Phyllocosmus lemaireanus (De Wild. & T. Durand) T. Durand & H. Durand	Ixonanthaceae	-	1	-	4	-	1.60	-	3.63
Pseudolachnostylis maprouneifolia Pax	Phyllanthaceae	5	2	-	1	4.69	2.79	-	1.26
Psorospermum febrifugum Spach	Hypericaceae	-	1	-	-	-	1.39	-	-
Pterocarpus angolensis DC.	Fabaceae	1*	4	4*	14	1.45	5.30	7.97	13.89
Pterocarpus tinctorius Welw.	Fabaceae	3*	-	-*	-	6.42	-	-	-
Salacia rhodesiaca Blakelock	Celastraceae	-	-	1	-	-	-	2.00	-
Strychnos cocculoides Boulanger	Loganiaceae	-	3	-	1	-	3.69	-	1.67
Strychnos innocua Del. subsp. innocua	Loganiaceae	1	-	-	-	1.42	-	-	-
Strychnos pungens Soler.	Loganiaceae	-	1	-	1	-	1.64	-	1.56
Strychnos sp	Loganiaceae	-	2	-	2	-	3.17	-	2.95
Strychnos spinosa Lam.	Loganiaceae	-	1	-	1	-	1.50	-	1.41
Syzygium guineense (Willd.) DC. subsp. Macrocarpum	Myrtaceae	-*	-	2*	-	-	-	4.27	-
Uapaca kirkiana Müll. Arg.	Phyllanthaceae	43*	10	2*	7	36.46	11.64	2.64	8.14
Uapaca nitida Müll.Arg.	Phyllanthaceae	15	7	1	7	15.05	5.91	2.43	5.38
Uapaca pilosa Hutch. var. pilosa	Phyllanthaceae	7	-	1	-	8.15	-	2.07	-
Uapaca robynsii De Wild.	Phyllanthaceae	-	1	-	3	-	1.39	-	3.90
Vitex doniana Sweet	Lamiaceae	-	-	-	1	-	-	-	1.39

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3.2.3. Dendrometric and floristic parameters of woody individuals inventoried within reforested and unexploited habitats in both village areas

Overall, floristic parameters (number of species, genera, and families per hectare) show no statistically significant differences between reforested and unexploited habitats. However, reforested habitats, particularly in the Mwawa village area, show significantly lower values for density ($p < 0.05$), mean square diameter, and basal area ($p < 0.001$; Table 5). These results indicate that *miombo* is recovering in reforested habitats, although this process remains less advanced than in unexploited habitats.

Table 5. Dendrometric and floristic parameters of individuals inventoried in the reforested and unexploited habitats. Mean ± standard deviation. Letters indicate significant differences at the $p<0.05$ significance level.

Parameters	Reforested habitats		Unexploited habitats	
	Milando	Mwawa	Milando	Mwawa
Dendrometric parameters				
Density (individuals/ha)	256.00 ± 111.77ab	186.00 ± 64.15b	300.00 ± 97.18a	330.00 ± 123.47a
Mean square diameter (cm)	21.94 ± 3.11a	14.97 ± 2.54b	24.64 ± 4.71a	22.73 ± 3.11a
Basal area (m^2 /ha)	11.52 ± 5.52a	3.40 ± 1.17b	17.23 ± 7.70a	15.89 ± 6.72a
Floristic parameters				
Taxa/plot	10.40 ± 3.10a	9.10 ± 2.92a	10.30 ± 3.43a	11.20 ± 2.86a
Type/ plot	8.30 ± 2.71a	7.70 ± 2.71a	8.30 ± 2.58a	9.00 ± 2.11a
Families/ plot	3.60 ± 1.43a	3.90 ± 2.03a	5.00 ± 2.21a	5.10 ± 2.23a

3.2.4. Floristic Diversity Indices of Reforested and Unexploited Habitats in Both Village Areas

The Simpson and Shannon diversity indices range from 0.0834 to 0.1633 and from 2.503 to 2.809 respectively, with higher values in unexploited habitats. This indicates greater biodiversity in these habitats, where the probability of two randomly selected individuals belonging to the same species is lower. Piélou's equitability, which ranged from 0.7039 to 0.8593, remained almost similar between reforested and unexploited habitats, suggesting a relatively uniform distribution of species in both habitat types (Table 6).

Table 6. Diversity index between reforested and unexploited habitats in the Lubumbashi charcoal production basin.

Indices	Milando reforested	Milando unexploited	Mwawa reforested	Mwawa unexploited
Simpson	0.0834	0.1581	0.08689	0.1633
Shannon	2.731	2.531	2.809	2.503
Piélou's equitability	0.8593	0.712	0.8342	0.7039

3.3. Similarities Between Ethnobotanical and Floristic Lists of Habitats in Both Village Areas

Jaccard's similarity index varies between 31.58% (between the ethnobotanical list and that of the floristic inventory in the reforested habitat at Mwawa) and 93.75% (between the unexploited habitats). This similarity remains low (below 50%), particularly between the ethnobotanical lists and those of the floristic inventories of reforested habitats in the two village areas. However, the ethnobotanical lists of these two village areas show a similarity of up to 66.67% (Table 7). These observations indicate a high dissimilarity between the ethnobotanical lists and the woody species present in the reforested habitats, while highlighting a high similarity between the floristic lists within unexploited habitats.

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Table 7. Jaccard's similarity index of ethnobotanical and floristic lists in both village areas. Values are presented in percentages. - Less informative comparison.

	Milando reforested	Milando unexploited	Mwawa reforested	Milando ethnobotany
Milando unexploited	40.00			
Mwawa reforested	55.56	-		
Mwawa unexploited	-	93.75	47.62	
Milando ethnobotany	43.75	-	-	
Mwawa ethnobotany	-	-	31.58	66.67

4. Discussion

4.1. Involvement of Local Communities in Decision-Making on Reforestation in Both Village Areas

Habitats and woody species for reforestation were selected through concertation, involving local communities, public services, NGOs, and international organizations (Tables 1, 2). These results underline a participatory approach to reforestation, valuing the environmental perception and endogenous knowledge of local communities. This approach to selecting habitats and woody species can be explained by the fact that the NGDOs driving this reforestation process advocate the promotion of a participatory approach, to meet the requirements of funding agencies [34]. This has led to consideration of the environmental perception of local community members when choosing habitats for reforestation. Indeed, in Milando, reforestation targeted habitat degraded by dendro-energy production, while in Mwawa, it was concentrated in post-cultivation fallows, as indicated by the perception maps of Ref. [70]. These habitats were selected because they had been abandoned by local communities after being exploited, respectively for agriculture and charcoal production. In addition, *miombo* species were chosen for reforestation, to meet the specific needs of local communities (Table 2). Indeed, these species will help maintain the floristic composition, structure, and functions of the forests, thus ensuring the continuity of ecosystem services for the local communities [71]. This contributes to the involvement of local communities in the reforestation process, thereby reinforcing its success [72]. For illustration, other reforestation activities previously conducted in the Lubumbashi region using primarily exotic species, such as *Acacia auriculiformis* A.Cunn. ex Benth. and *Leucaena leucocephala* (Lam.) de Wit [73], have not yielded satisfactory results. Indeed, these exotic species have proven to be invasive, threatening local biodiversity [74] and providing ecosystem services that are less comparable to those of *miombo* woody species [75]. This have led to low community participation and limited sustainability of the reforestation processes. This situation highlights the importance of a participatory approach, which greatly enhances the success of reforestation and its adoption by local communities [36]. Indeed, the active and equitable involvement of the various stakeholders, in particular local communities, ensures that their needs and interests are considered, guaranteeing greater inclusiveness and relevance of the actions carried out. Furthermore, incorporating traditional knowledge enriches restoration strategies, offering adapted and culturally relevant solutions [76]. The results of this study corroborate findings from research conducted in Africa [39,77] and in the miombo ecoregion, particularly in Tanzania [78] and Mozambique [43], highlighting the importance of integrating endogenous cultures and knowledge in the choice of habitats and woody species for reforestation.

However, reforested habitat management practices primarily include planning and assessment meetings, as well as maintenance actions, and surveillance carried out by forestry brigades (Table 3). This can be explained by the fact that, following the implementation of the project to reforest anthropized habitats, local communities are striving to sustain these initiatives despite the interruption in funding. These practices are essential to ensure the sustainability of reforestation and promote the restoration of forest cover. Nevertheless, the implementation of certain activities, such as plant nursery maintenance and the creation of firebreaks, has dwindled, particularly in Mwawa. This is due to a lack of motivation on the part of local communities, attempts to expropriate reforested

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land, and insufficient post-project monitoring. Sustainable management of reforested habitats requires ongoing action to strengthen ecosystem resilience [76]. Thus, the gradual reduction of these practices exposes reforested habitats to anthropogenic pressures, notably late and repetitive bushfires, which characterize the *miombo* ecoregion [79-82], and especially the Lubumbashi region [23]. This threat is compounded by intensive tree-cutting for dendro-energy and agriculture, practices that are increasingly observed around reforested habitats. These activities are among the main drivers of deforestation and degradation of *miombo* [83,84], particularly in the Lubumbashi region [20,22,85]. Weak management and maintenance practices for green spaces, resulting in the exponential degradation of these habitats, have already been reported in Burundi [86]. The results of the present study confirm the findings of previous research conducted in the *miombo* ecoregion [33,87,88], highlighting the importance of continuity of management practices, such as bushfire control, in the reforestation process. These practices are essential for mitigating anthropogenic pressures and promoting the rapid regeneration of forest cover in reforested habitats.

4.2. Reconstitution of Forest Cover Within Reforested Habitats in Both Village Areas

The results show statistically similar values between reforested and unexploited habitats, for dendrometric parameters, and more particularly for floristic parameters (figure 2; tables 4, 5, and 6). This shows that the *miombo* forest cover is recovering in reforested habitats, compared with unexploited habitats in the Lubumbashi region. Indeed, the values for diameter structure, density of individuals/ha, root mean square diameter, basal area, and floristic diversity are increasingly like those for unexploited *miombo* and to the results for unexploited forest found by Ref. [33]. This situation is justified by the reforestation carried out, the protection of these reforested habitats, and the management activities mentioned above, such as the establishment of firebreaks and the monitoring of these habitats, which contribute to the growth and establishment of woody species while being spared from anthropic pressure. These results corroborate those of studies carried out in Mozambique [59,79,89], showing that in the absence of anthropogenic activities, anthropized *miombo* habitats reconstitute their forest cover over the years up to the pyroclimax stage [11,90]. Nevertheless, this reconstitution is a function of the level of anthropogenic degradation experienced by the habitats and the resilience of woody species to these disturbances [13,59]. This also explains the low values represented by the reforested Mwawa habitat in terms of dendrometric parameters, compared with other habitats. Indeed, the reforested habitat at Mwawa would have undergone a high degree of anthropization, compared with that at Milando, thus explaining this difference in dendrometric parameter values particularly. In addition, the increasingly rare application of management practices works against the biodiversity conservation and reforestation efforts devoted to *miombo*. The results of the present study corroborate those of other research conducted in the *miombo* ecoregion [2,13,21,59,91-93], showing that habitat composition and floristic diversity are negatively correlated with anthropogenic disturbance.

4.3. Similarity Between Ethnobotanical and Floristic Lists of Reforested and Unexploited Habitats in Both village Areas

The similarity between the ethnobotanical and floristic lists of reforested habitats remains low (Table 7). Some woody species present on the ethnobotanical lists are absent from the floristic inventory lists, and vice versa. This situation can be explained on the one hand by the fact that, during the floristic inventory, the individuals of certain species chosen for reforestation were still juveniles, with a diameter (*DBH*) below the pre-counting level set at ≥10 cm for the present study. This lower diameter of these individuals would be justified by the slow growth exhibited by most *miombo* woody species, as attested by previous studies [2,94], leading to this situation during floristic inventories [95]. Furthermore, the availability of woody species in a reforested habitat depends on these ecological requirements and the technical problems that may arise during the reforestation operation. Indeed, the requirements of a woody species in terms of ecological factors, particularly the physico-chemical properties of the soil, influence its ability to recover, survive, and establish in a habitat [96]. On the other hand, this situation can be explained by the fact that reforested habitats were already

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teeming with individuals of other woody species, leading to this difference between ethnobotanical and floristic lists.

However, the similarity of floristic inventory lists within reforested and unexploited habitats is low. This situation can be explained by the anthropogenic disturbances experienced by these reforested habitats in the past. Indeed, the composition and floristic diversity of habitat is inversely correlated with anthropogenic disturbance [13,21,92]. These results corroborate previous studies conducted in the Zambezi region [59,92] and particularly in Lubumbashi region [33], showing that the floristic diversity of habitats that have experienced anthropogenic disturbance, remains low, compared to unexploited habitats.

4.4. Implications of Results for Optimized Management of Reforested Habitats in the Lubumbashi Charcoal Production Basin

The *miombo* forest cover is in full recovery within the reforested habitats of the Lubumbashi charcoal production basin. However, the mechanisms (firebreaks and surveillance) that can regulate human activities are increasingly neglected in these village areas. This leads to a proliferation of human activities around these habitats, affecting efforts to combat deforestation and forest degradation in Lubumbashi Charcoal Production Basin. In response to this issue, environmental education is one of the potential solutions. Indeed, through awareness campaigns, environmental education would increasingly promote the involvement of local communities in the management of these reforested habitats [97]. It would also encourage compliance with regulations governing the protection of these reforested habitats and the continuation of practices regulating anthropogenic activities [98], such as bushfires, charcoal production, and agriculture, the main drivers of deforestation and forest degradation [20,85]. Environmental education has already been used after reforestation projects in Malawi, Lesotho, and Tanzania, to raise local communities' awareness of the need for further action to ensure the sustainable management of these habitats [99]. However, this awareness-raising may not produce the expected results, due to the mistrust and lack of confidence that plague relations between governance players in the Lubumbashi region [27]. The solution to this problem would be to organize dialogue frameworks between the different stakeholders, to renew mutual trust.

Improving land tenure laws and forestry policy is also a key alternative. Strengthened land legislation would secure habitats under local community forest concession (LCFC), which are often coveted by concessionaires, farmers, and dendro-energy producers. Indeed, cases of habitat invasion under biodiversity conservation/preservation status have already been reported in the Charcoal Production Basin of Lubumbashi, resulting in the degradation of the vegetative cover of these habitats [47]. Additionally, reform of forestry policy would help address anthropogenic invasions of these habitats through appropriate sanctions [36,100]. This will only be possible with the support of accredited public services and the advocacy of NGOs and international agencies [101]. However, the strengthening of the existing monitoring framework will have to be considered to ensure continuous monitoring and assess the results of the reforestation activities after the implementation of the related projects.

Finally, mechanisms to encourage local communities to become involved in the sustainable management and expansion of reforested habitats, such as payment for environmental services (PES), is a solution that decision-makers need to implement. Indeed, PES is an incentive mechanism designed to encourage the protection, restoration, or enhancement of natural ecosystems [102]. This concept is based on the idea that beneficiaries of environmental services (governments, and companies) pay local communities for the adoption of practices that maintain or improve forest ecosystems [103]. This type of PES has already been initiated in the *miombo* ecoregion in Zimbabwe, with convincing results in terms of sustainable management of forest resources [104]. However, this will need to be accompanied by equitable distribution and reasoned use of PES dividends, to prevent conflicts between stakeholders [105].

The present study does not address social risks, such as land conflicts or inequalities in the distribution of benefits between local communities, which could compromise the sustainability of reforested habitats. Such information would enrich the current results and help develop strategies to ensure the long-term sustainability of these habitats.

5. Conclusions

The present study assessed the sustainability of reforestation activities carried out in two anthropized *miombo* habitats in the village areas of Milando and Mwawa, through individual interviews combined with floristic inventories in two habitat types (reforested and unexploited) for each village area. The results confirm that habitats and woody species for reforestation were selected concertedly, aligning with the environmental perceptions and needs of local communities. Indeed, these habitats were selected in consultation with local communities, public services, NGOs, and international organizations, while the woody species were chosen according to the local communities' needs. This participatory approach ensures the sustainability of reforested habitats, through activities such as planning, maintenance, monitoring, and assessment, involving local communities in the ongoing management of these habitats. The results also confirm that the *miombo* forest cover is recovering in reforested habitats, with dendrometric and floristic parameter values approaching those of unexploited *miombo*. Indeed, the averages of dendrometric (diameter structure; density/ha; root mean square diameter; basal area) and floristic (taxa, genera, and families) parameters did not generally show significant differences between reforested and unexploited habitats. Finally, these results confirm that there are similarities and dissimilarities between the ethnobotanical and floristic lists of reforested and unexploited habitats. Certainly, high similarities were found between the floristic lists of these different habitats, while dissimilarities were observed between the ethnobotanic lists and these floristic lists. Although this study does not address social risks, such as land conflicts or inequalities in the distribution of benefits, it nevertheless highlights the importance of including local communities to ensure the sustainable success of reforestation projects. To promote the restoration of forest cover in reforested habitats, decision-makers need to revive environmental education and raise awareness among local communities about the need to adopt practices that support reforestation. Additionally, establishing a payment for environmental services mechanism is necessary to encourage local communities to manage their forests sustainably.

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References

1. Tchekoté, H.; Meva'a Nleme, Z.L.; Moudingo J.H.; Djofang, N.P. Diagnostic de la conservation pour une gestion durable de la biodiversité dans le Bakossi, Banyang-Mbo, Régions du Sud-Ouest et du Littoral au Cameroun. *Rev. Sci. Tech. For. Environ. Bassin Congo* **2020**, 5, 49–59. https://doi.org/10.5281/ZENODO.4044111
2. Kalaba, F.K.; Quinn, C.H.; Dougill, A.J.; Vinya, R. Floristic composition, species diversity and carbon storage in charcoal and agriculture fallows and management implications in *Miombo* woodlands of Zambia. *For. Ecol. Manag.* **2013**, 304, 99–109. https://doi.org/10.1016/j.foreco.2013.04.024

3. Eba'a Atyi, R.; Hiol Hiol, F.; Lescuyer, G.; Mayaux, P.; Defourny, P.; Bayol, N.; Saracco, F.; Pokem, D.; Sufo Kankeu, R.; Nasi, R. *Les forêts du bassin du Congo : état des forêts 2021*. CIFOR, Bogor, Indonésie, 2022; 474p. https://doi.org/10.17528/cifor/008565
4. FAO. *La Situation des forêts du monde 2024 – Innovations dans le secteur forestier pour un avenir plus durable*. FAO, Rome, Italie, 2024; 132p. https://doi.org/10.4060/cd1211fr
5. Gonçalves, F.M.P.; Chisingui, A.V.; Luís, J.C.; Rafael, M.F.F.; Tchamba, J.J.; Cachissapa, M.J.; Caluvino, I.M.C.; Bambi, B.R.; Alexandre, J.L.M.; Chissingui, M.D.G.; Manuel, S.K.A.; Jacinto, H.D.; Finckh, M.; Meller, P.; Jürgens, N.; Revermann, R. First vegetation-plot database of woody species from Huíla province, SW Angola. *Veg. Classif. Surv*. **2021**, 2, 109–116. https://doi.org/10.3897/VCS/2021/68916
6. Bostancı, S.H. The Role of Local Governments in Encouraging Participation in Reforestation Activities. In: Singh, P.; Milshina, Y.; Batalhão, A.; Sharma, S.; Mohd, M.H. (eds.), *The Route Towards Global Sustainability*. Springer nature, Cham, Switzerland, 2023; 25–44. https://doi.org/10.1007/978-3-031-10437-4_2
7. Campbell, B. M.; Frost, P.; Byron, N. *Miombo* Woodlands and their use: overview and key issues. In: Campbell, B. (eds.), *The Miombo in Transition: Woodlands and Welfare in Africa*. Centre for International Forestry Research, Bogor, Indonesia, 2006; 1–10
8. Berrahmouni, N.; Regato, P.; Parfondry, M. *Global guidelines for the restoration of degraded forests and landscapes in drylands: building resilience and benefiting livelihoods*. FAO, Rome, Italie, 2015; 173 p.
9. Malaisse, F. *How to live and survive in Zambezian open forest (Miombo ecoregion)*. Les Presses Agronomiques de Gembloux, Gembloux, Belgique, 2010; 424 p.
10. Malaisse, F.; Bogaert, J.; Boisson, S.; Useni, S.Y. La végétation naturelle d'Élisabethville (actuellement Lubumbashi) au début et au milieu du XXième siècle. *Géo-Eco-Trop*. **2021**, 45(1), 41–51
11. Sawe, T.; Munishi, P.; Maliondo, S. Woodlands degradation in the Southern Highlands, *Miombo* of Tanzania: Implications on conservation and carbon stocks. *Int. J. Biodivers. Conserv*. **2014**, 6, 230–237
12. Mwitwa, J.; German, L.; Muimba-Kankolongo, A.; Puntondewo, A. Governance and sustainability challenges in landscape shaped by mining: mining forestry linkages and impacts in the copper belt of Zambia and the DR Congo. *For. Policy Econ*. **2012**, 25, 19–30. https://doi.org/10.1016/j.forpol.2012.08.001.
13. Gonçalves, F.M.P.; Revermann, R.; Cachissapa, M.J.; Gomes, A.L.; Aidar, M.P.M. Species diversity, population structure and regeneration of woody species in fallows and mature stands of tropical woodlands of southeast Angola. *J. For. Res*. **2018**, 29, 1569–1579. https://doi.org/10.1007/s11676-018-0593-x
14. Mittermeier, R.A.; Mittermeier, C.G.; Brooks, T.M.; Pilgrim, J.D.; Konstant, W.R.; Da Fonseca, G.A.B.; Kormos, C. Wilderness and biodiversity conservation. *Proc. Natl. Acad. Sci. U.S.A*, **2003**, 100, 10309–10313. https://doi.org/10.1073/pnas.1732458100
15. Godlee, J.L.; Gonçalves, F.M.; Tchamba, J.J.; Chisingui, A.V.; Ilunga, M.J.; Ngoy, S.M.; Ryan, C.M.; Brade, T.K.; Dexter, K.G. Diversity and Structure of an Arid Woodland in Southwest Angola, with Comparison to the Wider *Miombo* Ecoregion. *Diversity* **2020**, 12, 140. https://doi.org/10.3390/d12040140
16. Munyemba, K. F.; Bogaert, J. Anthropisation et dynamique spatiotemporelle de l'occupation du sol dans la région de Lubumbashi entre 1956 et 2009. *E-revue Unilu* **2014**, 1, 3–23.
17. Mojeremane, W.; Lumbile, A. A review of Pterocarpus angolensis DC. (Mukwa) an important and threatened timber species of the *Miombo* woodlands. *Res. J. For*. **2016**, 10, 8–14
18. Khoji, M.H.; N'tambwe, N.D.; Malaisse, F.; Waselin, S.; Sambiéni, K.R.; Cabala, K.S..; Munyemba, K.F.; Bastin, J.-F.; Bogaert, J.; Useni, S.Y. Quantification and Simulation of Landscape Anthropization around the Mining Agglomerations of Southeastern Katanga (DR Congo) between 1979 and 2090. *Land* **2022**, *11*, 850. https://doi.org/10.3390/land11060850
19. Cabala, K.S.; Useni, S.Y.; Munyemba, K.F.; Bogaert, J. Activités anthropiques et dynamique spatiotemporelle de la forêt claire dans la Plaine de Lubumbashi. In: Bogaert, J., Colinet, G. & Mahy, G. (Eds), *Anthropisation des paysages katangais*. Les Presses Universitaires de Liège, Liège, Belgique, 2018; 253-266.
20. Khoji, M.H.; N'tambwe, N.D.; Mwamba, K.F.; Harold, S.; Munyemba, K.F.; Malaisse, F.; Bastin, J.-F.; Useni, S.Y.; Bogaert, J. Mapping and Quantification of *Miombo* Deforestation in the Lubumbashi Charcoal Production Basin (DR Congo): Spatial Extent and Changes between 1990 and 2022. *Land* **2023**, 12, 1852. https://doi.org/10.3390/land12101852
21. Syampungani, S.; Geldenhuys, C.J.; Chirwa, P.W. Regeneration dynamics of *miombo* woodland in response to different anthropogenic disturbances: forest characterisation for sustainable management. *Agrofor. Syst*. **2016**, 90, 563–576. https://doi.org/10.1007/s10457-015-9841-7
22. Mpanda, M.M.; Khoji, M.H.; N'Tambwe, N.D.; Sambieni, R.K.; Malaisse, F.; Cabala, K.S.; Bogaert, J.; Useni, S.Y. Uncontrolled Exploitation of Pterocarpus tinctorius Welw. and Associated Landscape Dynamics in the Kasenga Territory: Case of the Rural Area of Kasomeno (DR Congo). *Land* **2022**, 11, 1541. https://doi.org/10.3390/land11091541
23. Useni, S.Y.; Mpanda Mukenza, M.; Khoji Muteya, H.; Cirezi Cizungu, N.; Malaisse, F.; Bogaert, J. Vegetation Fires in the Lubumbashi Charcoal Production Basin (The Democratic Republic of the Congo): Drivers, Extent and Spatiotemporal Dynamics. *Land* **2023**, 12, 2171. https://doi.org/10.3390/land12122171

24. Chirwa, P.W.; Larwanou, M.; Syampungani, S.; Babalola, F.D. Management and restoration practices in degraded landscapes of Southern Africa and requirements for up-scaling. *Int. For. Rev.* **2015**, 17, 31–42. https://doi.org/10.1505/146554815816006965
25. Potapov, P.V.; Turubanova, S.A.; Hansen, M.C.; Adusei, B.; Broich, M.; Altstatt, A.; Mane, L.; Justice, C.O. Quantifying forest cover loss in Democratic Republic of the Congo, 2000–2010, with Landsat ETM+ data. *Remote Sens. Environ.* **2012**, 122, 106–116. https://doi.org/10.1016/j.rse.2011.08.027
26. Cadre Intégré de Classification de la sécurité Alimentaire. *Analyse de l'IPC de l'insécurité alimentaire chronique*. IPC-Kinshasa, Kinshasa, République démocratique du Congo, 2024 ; 120p.
27. N'tambwe, D.N.; Khoji, M.H.; Kasongo, K.B.; Kouagou, S.R.; Malaisse, F.; Useni, S.Y.; Masengo, K.W.; Bogaert, J. Towards an Inclusive Approach to Forest Management: Highlight of the Perception and Participation of Local Communities in the Management of *miombo* Woodlands around Lubumbashi (Haut-Katanga, D.R. Congo). *Forests* **2023**, 14, 687. https://doi.org/10.3390/f14040687
28. Rinaudo, T.; Muller, A.; Morris, M. *Manuel La Régénération Naturelle Assistée (RNA). Une ressource pour les gestionnaires de projets, les utilisateurs et tous ceux qui ont un intérêt à mieux comprendre et soutenir le mouvement pour la RNA*. FMNR Hub, World Vision, Melbourne, Australia, 2020; 241p.
29. Awono, A.; Assembe-Mvondo, S.; Tsanga, R.; Guizol, P.; Peroches, A. *Restauration des paysages forestiers et régimes fonciers au Cameroun : Acquis et handicaps*. Document Occasionnel 10. CIFOR-ICRAF, Bogor, Indonésie, 2023; 43p. https://doi.org/10.17528/cifor-icraf/009035
30. Holl, K.D.; Aide, T.M. When and where to actively restore ecosystems? *For. Ecol. Manag.* **2011**, 261, 1558–1563. https://doi.org/10.1016/j.foreco.2010.07.004
31. Chazdon, R.L.; Guariguata, M.R. Natural regeneration as a tool for large-scale forest restoration in the tropics: prospects and challenges, *Biotropica* **2016**, 48(6), 716–730. https://doi.org/10.1111/btp.12381
32. Reyniers, C. Agroforesterie et déforestation en République démocratique du Congo. Miracle ou mirage environnemental ? *Monde dev.* **2019**, 187, 113–132. https://doi.org/10.3917/med.187.0113
33. N'tambwe, N.D.; Khoji, M.H.; Salomon, W.; Cuma, M.F.; Malaisse, F.; Ponette, Q.; Useni, S.Y.; Masengo, K.W.; Bogaert, J. Floristic Diversity and Natural Regeneration of *Miombo* Woodlands in the Rural Area of Lubumbashi, D.R. Congo. *Diversity* **2024**, 16, 405. https://doi.org/10.3390/d16070405
34. Buttoud, G.; Nguinguiri J.C., 2016. *La gestion inclusive des forêts d'Afrique centrale : passer de la participation au partage des pouvoirs*. FAO-CIFOR, Bogor, Indonésie, 2016; 250p.
35. Hervé, D.; Randriambanona, H.; Ravonjimalala, H. R.; Ramanankierana, H.; Rasoanaivo, N. S.; Baohanta, R.; Carrière, S. M. Perceptions des fragments forestiers par les habitants des forêts tropicales humides malgaches. *Bois For. Trop.* **2020**, 345, 43–62. https://doi.org/10.19182/bft2020.345.a31929
36. Nansikombi, H.; Fischer, R.; Kabwe, G.; Günter, S. Exploring patterns of forest governance quality: Insights from forest frontier communities in Zambia's *Miombo* ecoregion. *Land Use Policy* **2020**, 99, 1-16. https://doi.org/10.1016/j.landusepol.2020.104866
37. Asaah, E.K.; Tchoundjeu, Z.; Leakey, R.R.B.; Takousting, B.; Njong, J.; Edang, I. Trees, agroforestry and multifunctional agriculture in Cameroon. *Int. J. Agric. Sustain.* **2011**, 9:110–119. https://doi.org/10.3763/ijas.2010.0553
38. Ouattara, B.; Sanou, L.; Koala, J.; Hien M. Perceptions locales de la dégradation des ressources naturelles du corridor forestier de la Boucle du Mouhoun au Burkina Faso. *Bois For. Trop.* **2022**, 352, 43–60. https://doi.org/10.19182/bft2022.352.a36935
39. Baïyabe, I.-M.; Dongock, N.D.; Amougoua, A.C.; Tchobsala; Mapongmetsem, P.M. Perceptions paysannes des sites reboisés de la région de l'extrême-nord, cameroun. *Rev. ivoir. sci. technol.* **2023**, 42, 114–131
40. Diawara, S.; Dao, A.; Ouattara, M.; Savadogo, P. Evaluation des connaissances locales dans la restauration écologique des paysages forestiers dégradés au Burkina Faso. *Sci. Nat. Appl.* **2024**, 43(1), 180–205
41. Landry, J.; Chirwa, PW. Analysis of the potential socioeconomic impact of establishing plantation forestry on rural communities in Sanga district, Niassa province, Mozambique. *Land Use Policy* **2011**, 28, 542–551. https://doi.org/10.1016/j.landusepol.2010.11.001
42. Axelsson, E.P.; Grady, K.C. Symphony for the native wood(s): Global reforestation as an opportunity to develop a culture of conservation. *People Nat.* **2022**, 4, 576–587. https://doi.org/10.1002/pan3.10299
43. Montfort, F. Dynamiques des paysages forestiers au Mozambique : étude de l'écologie du *Miombo* pour contribuer aux stratégies de restauration des terres dégradées. *Bois For. Trop.* **2023**, 357, 105–106. https://doi.org/10.19182/bft2023.357.a37281
44. Bisiaux, F.; Peltier, R.; Muliele, J.-C. Plantations industrielles et agroforesterie au service des populations des plateaux Batéké, Mampu, en République Démocratique du Congo. *Bois For. Trop.* **2009**, 301(3), 21–32. https://doi.org/10.19182/bft2009.301.a20404
45. Muchiza, B.I.; Monga, I.D.R.; Mumba, T.U.; Ndabereye, S. M.D.A.; Kalombo, W.K.C.; Nono, M.N. Perceptions des populations locales sur la forêt, la déforestation et leur participation à la gestion forestière du *Miombo* dans l'hinterland de Lubumbashi (Haut-Katanga/RDC). *Rev. Afr. Environ. Agric.* **2022**, 5(4), 108–115.

46. Numbi, M.D.; Mbinga, L.B.; Mpange, K.F.; Mukendi, E.; Kazaba, K.P.; Nzuzi, M.G.; Kapend, K.D.L.V.; Kaya, B.H.H.; Lwamba, B.J.; Monga, I.D.R.; Ngoy, S.M. Influence de traitements sur la germination et la croissance en pépinière d'Afzelia quanzensis Welw. (Fabaceae) à Lubumbashi en République Démocratique du Congo. *Rev. Afr. Environ. Agric.* **2024**, 7(1), 11–17. https://doi.org/10.4314/rafea.v7i1.2
47. Khoji, M.H.; Mpanda, M.M.; Kipili, M.I.; Malaisse, F.; N'tambwe, N.D.; Kasanda, M.N.; Bastin, J.-F.; Bogaert, J.; Useni, S.Y. Protected area creation and its limited effect on deforestation: Insights from the Kiziba-Baluba hunting domain (DR Congo). *Trees, Forests and People* **2024**, 18, 100654. https://doi.org/10.1016/j.tfp.2024.100654
48. Kalombo, K. D. *Evolution des éléments du climat en RDC : Stratégies d'adaptation des communautés de base, face aux événements climatiques de plus en plus fréquents*. Éditions universitaires européennes, Sarrebruck, Allemagne, 2016; 220p.
49. Kasongo, L.M.E.; Banza, M.J. Evaluation de la réponse du soja aux doses croissantes d'un compost à base de Tithonia diversifolia sur un sol fortement altéré. *Int. J. Innov. Appl. Stud.* **2015**, 11(2), 273–281
50. Johnston, L.G.; Sabin, K. Échantillonnage déterminé selon les répondants pour les populations difficiles à joindre. *Methodol. Innovations* **2010**, 5(2), 38–48. https://doi.org/10.4256/mio.2010.0017a
51. Marpsat, M.; Razafindratsima, N. Les méthodes d'enquêtes auprès des populations difficiles à joindre : Introduction au numéro spécial. *Methodol. Innovations* **2010**, 5(2), 3–16. https://doi.org/10.4256/mio.2010.0014a
52. Traoré, L.; Hien, M.; Ouédraogo, I. Usages, disponibilité et stratégies endogènes de préservation de Canarium schweinfurthii (Engl.) (Burseraceae) dans la région des Cascades (Burkina Faso). *Ethnobot. Res. Appl.* **2021**, 21(1), 1–17. https://doi.org/10.32859/era.21.01.1-17
53. Dubois, É.; Michaux, E. Étalonnages à l'aide d'enquêtes de conjoncture : de nouveaux résultats. *Econ. Prévis.* **2006**, 172 : 11-28. https://doi.org/10.3917/ecop.172.0011
54. Bettinger, P.; Boston, K.; Siry, P.J.; Grebner, L.D. *Forest Management and Planning*. Academic press, 2nd ed, Cambridge, Massachusetts, USA, 2016; 362p.
55. Smith, P.; Allen, Q. *Field guide to the trees and shrubs of the miombo woodlands*. Royal Botanic Gardens, Brussels, Belgium, 2004; 176p.
56. Meerts, P.J.; Hasson, M. *Arbres et Arbustes du Haut-Katanga*. Editions Jardin Botanique de Meise, Brussels, Belgium, 2016; 386p.
57. Vollesen, K.; Merrett, L. *A photo rich field guide to the (wetter) Zambian Miombo woodland: Based on Plants from the Mutinondo Wilderness Area, Northern Zambia*. Lari Merret, Lusaka, Zambia, 2020; 1200p.
58. Thiombiano, A.; Glele kakaï, R.; Bayen, P.; Boussim, J.I.; Mahamane, A. Méthodes et dispositifs d'inventaires forestiers en Afrique de l'Ouest : état des lieux et propositions pour une harmonisation. *Ann. Sci. Agron.* **2016**, 20, 15–31.
59. Ameja, L.G.; Ribeiro, N.S.; Sitoe, A.; Guillot, B. Regeneration and Restoration Status of *Miombo* Woodland Following Land Use Land Cover Changes at the Buffer Zone of Gile National Park's Central Mozambique. *Trees, Forests and People* **2022**, 9, 100290. https://doi.org/10.2139/ssrn.4046799
60. Ding, Y.; Zang, R.; Lu, X.; Huang, J. The impacts of selective logging and clear-cutting on woody plant diversity after 40 years of natural recovery in a tropical montane rain forest, south China. *Sci. Total Environ.* **2017**, 579, 1683–1691. https://doi.org/10.1016/j.scitotenv.2016.11.185
61. Rondeux, J. *La mesure des arbres et des peuplements forestiers*. 3ème édition. Les Presses Universitaires de Liège – Agronomie – Gembloux, Gembloux, Belgique, 2021; 738p. http://hdl.handle.net/2268/262622
62. Badjaré, B.; Kokou, K.; Bigou-lare, N.; Koumantiga, D.; Akpakouma, A.; Adjayi, M.B.; Abbey, G.A. Etude ethnobotanique d'espèces ligneuses des savanes sèches au Nord-Togo, diversité, usages, importance et vulnérabilité. *Biotechnol. Agron. Soc. Environ.* **2018**, 22(3), 152–171
63. Amba, G.J.A.; Gnahoré, É.; Diomandé, S. Diversité floristique et structurale de la forêt classée de la Mabi au Sud-Est de la Côte d'Ivoire. *Afr. Sci.* **2021**, 18(1), 159–171.
64. Zébazé, D.; Gorel, A.; Gillet, J.-F.; Houngbégnon, F.; Barbier, N.; Ligot, G.; Lhoest, S.; Kamdem, G.; Libalah, M.; Droissart, V.; Sonké, B.; Doucet, J.-L. Natural regeneration in tropical forests along a disturbance gradient in South-East Cameroon. *For. Ecol. Manag.* **2023**, 547, 121402. https://doi.org/10.1016/j.foreco.2023.121402
65. Ostertagová, E.; Ostertag, O.; Kováč, J. Methodology and Application of the Kruskal-Wallis Test. *Appl. Mech. Mater.* **2014**, 611, 115–120. https://doi.org/10.4028/www.scientific.net/amm.611.115
66. Razali, N.M.; Wah, Y.B. Power comparisons of Shapiro-Wilk, Kolmogorov-Smirnov, Lilliefors and Anderson-Darling tests. *J. Stat. Model. Anal.* **2011**, 2(1), 21-33
67. Gupta, B.; Mishra, T.K. Analysis of tree diversity and factors affecting natural regeneration in fragmented dry deciduous forests of lateritic West Bengal. *Trop. Ecol.* **2019**, 60, 405–414. https://doi.org/10.1007/s42965-019-00039-8
68. Heinken, T.; Diekmann, M.; Liira, J.; Orczewska, A.; Schmidt, M.; Brunet, J.; Chytrý, M.; Chabrerie, O.; Decocq, G.; De Frenne, P.; Dřevojan, P.; Dzwonko, Z.; Ewald, J.; Feilberg, J.; Graae, B.J.; Grytnes, J.; Hermy, M.; Kriebitzsch, W.; Laiviņš, M.; Lenoir, J.; Lindmo, S.; Marage, D.; Marozas, V.; Niemeyer, T.; Paal, J.;

Pyšek, P.; Roosaluste, E.; Sádlo, J.; Schaminée, J.H.J.; Tyler, T.; Verheyen, K.; Wulf, M.; Vanneste, T. The European Forest Plant Species List (EuForPlant): Concept and applications. *J. Veg. Sci.* **2022**, 33, e13132. https://doi.org/10.1111/jvs.13132

69. Albatineh, A.N.; Niewiadomska-Bugaj, M. Correcting Jaccard and other similarity indices for chance agreement in cluster analysis. *Adv. Data Anal. Classif.* **2011**, 5, 179–200. https://doi.org/10.1007/s11634-011-0090-y
70. N'tambwe, N.D.; Khoji, M.H.; Cabala, K.S.; Malaisse, F.; Amisi, M.Y.; Useni, S.Y.; Masengo, K.W.; Bogaert, J. Spatial Footprint of anthropogenic activities in the Charcoal Production Basin of Lubumbashi (D.R. Congo): Applicability of Kevin Lynch's (1960) approach. *J. nat. conserv.* (**In press**). http://dx.doi.org/10.2139/ssrn.4743650
71. Aerts, R.; Honnay, O. Forest restoration, biodiversity and ecosystem functioning. *BMC Ecol.* **2011**, 11, 29. https://doi.org/10.1186/1472-6785-11-29
72. Evans, M.D.; Zipper, E.C.; Burger, A.J.; Strahm, D.B.; Villamagna, M.A. Reforestation practice for enhancement of ecosystem services on a compacted surface mine: Path toward ecosystem recovery. *Ecol. Eng.* **2013**, 51, 16–23. https://doi.org/10.1016/j.ecoleng.2012.12.065
73. Useni Sikuzani, Y.; Khoji Muteya, H.; Yona Mleci, J.; Mpanda Mukenza, M.; Malaisse, F.; Bogaert, J. The Restoration of Degraded Landscapes along the Urban–Rural Gradient of Lubumbashi City (Democratic Republic of the Congo) by Acacia auriculiformis Plantations: Their Spatial Dynamics and Impact on Plant Diversity. *Ecologies* **2024**, 5, 25–41. https://doi.org/10.3390/ecologies5010002
74. Doren, R.F. ; Volin, J.C.; Richards, J.H. Invasive Exotic Plant Indicators for Ecosystem Restoration: An Example from the Everglades Restoration Program. *Ecol. Indic.* **2009**, 9, 29–36.
75. Useni, S.Y.; Mpibwe, K.A.; Yona, M.J.; N'Tambwe, N.D.; Malaisse, F.; Bogaert, J. Assessment of Street Tree Diversity, Structure and Protection in Planned and Unplanned Neighborhoods of Lubumbashi City (DR Congo). *Sustainability* **2022**, *14*, 3830. https://doi.org/10.3390/su14073830
76. FAO. *Restauration du paysage forestier*. Unasylva, Rome, Italie, 2015; 116p. https://openknowledge.fao.org/handle/20.500.14283/i5212f
77. Tiki, L.; Abdallah, J.M.; Marquardt, K.; Tolera, M. Does Participatory Forest Management Reduce Deforestation and Enhance Forest Cover? A Comparative Study of Selected Forest Sites in Adaba-Dodola, Ethiopia. *Ecologies* **2024**, *5*, 647–663. https://doi.org/10.3390/ecologies5040038
78. Kimambo, N.E.; L'Roe, J.; Naughton-Treves, L.; Radeloff, V.C. The role of smallholder woodlots in global restoration pledges – Lessons from Tanzania. *Forest Policy Econ.* **2020**, 115, 102144. https://doi.org/10.1016/j.forpol.2020.102144
79. Giliba, R.A.; Mafuru, C.S.; Paul, M.; Kayombo, C.J.; Kashindye, A.M.; Chirenje, L.I.; Musamba, E.B. Human Activities Influencing Deforestation on Meru Catchment Forest Reserve, Tanzania. *J. Hum. Ecol.* **2011a**, 33(1): 17–20. https://doi.org/10.1080/09709274.2011.11906344
80. Van Wilgen, B.W.; De Klerk, H.M.; Stellmes, M.; Archibald, S. An analysis of the recent fire regimes in the Angolan catchment of the Okavango Delta, Central Africa. *Fire Ecol.* **2022**, 18, 13. https://doi.org/10.1186/s42408-022-00138-3
81. Buramuge, V.A.; Ribeiro, N.S.; Olsson, L.; Bandeira, R.R. Exploring Spatial Distributions of Land Use and Land Cover Change in Fire-Affected Areas of *Miombo* Woodlands of the Beira Corridor, Central Mozambique. *Fire* **2023a**, 6, 77. https://doi.org/10.3390/fire6020077
82. Buramuge, V.A.; Ribeiro, N.S.; Olsson, L.; Bandeira, R.R.; Lisboa, S.N. Tree Species Composition and Diversity in Fire-Affected Areas of *Miombo* Woodlands, Central Mozambique. *Fire* **2023b**, 6, 26. https://doi.org/10.3390/fire6010026
83. Cabral, A.I.R.; Vasconcelos, M.J.; Oom, D.; Sardinha, R. Spatial dynamics and quantification of deforestation in the central-plateau woodlands of Angola (1990–2009). *Appl. Geogr.* **2011**, 31, 1185–1193. https://doi.org/10.1016/j.apgeog.2010.09.003
84. Barbara, N.; Linda, N.; Ngonga, C. Drivers of Deforestation in the *Miombo* Woodlands and Their Impacts on the Environment. *Adv. Res.* **2016**, 6(5), 1–7. https://doi.org/10.9734/AIR/2016/23831
85. Cabala, K.S.; Useni, S.Y.; Amisi, M.Y.A.; Munyemba, K.F.; Bogaert, J. Activités anthropiques et dynamique des écosystèmes forestiers dans les zones territoriales de l'Arc Cuprifère Katangais (RD Congo). *Tropicultura* **2022**, 40(3/4), 2100 https://doi.org/10.25518/2295-8010.2100
86. Kabanyegeye, H.; Useni, S.Y.; Sambieni, K.R.; Masharabu, T.; Havyarimana, F.; Bogaert, J. Trente-trois ans de dynamique spatiale de l'occupation du sol de la ville de Bujumbura, République du Burundi. *Afrique Sci.* **2021**, 18, 203–2015. https://hdl.handle.net/2268/256070
87. Giliba, R. A.; Boon, E. K.; Kayombo, C. J.; Musamba, E. B.; Kashindye, A. M.; Shayo, P. F. Species composition, richness and diversity in *Miombo* woodland of Bereku Forest Reserve, Tanzania. *J. Biodivers.* **2011b**, 2(1), 1–7.
88. Chirwa, W.P.; Mahamane, L. Overview of restoration and management practices in the degraded landscapes of the Sahelian and dryland forests and woodlands of East and southern Africa, Southern Forests. *J. For. Sci.* **2017**, 17(3), 20-30. http://dx.doi.org/10.2989/20702620.2016.1255419

89. Vinya, R.; Syampungani, S.; Kasumu, E.C.; Monde, C.; Kasubika, R. *Preliminary study on the drivers of deforestation and potential for REDD+ in Zambia.* A consultancy report prepared for Forestry Department and FAO under the national UN-REDD+ Programme Ministry of Lands & Natural Resources. Lusaka, Zambia, 2011; 65p.
90. Masharabu, T.; Noret, N.; Lejoly, J.; Bigendako, M-J.; Bogaert, J. Etude comparative des paramètres floristiques du Parc National de la Ruvubu, Burundi. *Géo-Eco-Trop*. **2010**, 34, 29 – 44
91. Gonçalves, F.M.P.; Revermann, R.; Gomes, A.L.; Aidar, M.P.M.; Finckh, M.; Juergens, N. Tree Species Diversity and Composition of *Miombo* Woodlands in South-Central Angola: A Chronosequence of Forest Recovery after Shifting Cultivation. *Int. J. For. Res*. **2017**, 2017, 1–13. https://doi.org/10.1155/2017/6202093
92. Montfort, F.; Nourtier, M.; Grinand, C.; Maneau, S.; Mercier, C.; Roelens, J.-B.; Blanc, L. Regeneration capacities of woody species biodiversity and soil properties in *Miombo* woodland after slash-and-burn agriculture in Mozambique. *For. Ecol. Manag*. **2021**, 488, 119039. https://doi.org/10.1016/j.foreco.2021.119039
93. Kissanga, R.; Catarino, L.; Máguas, C.; Cabral, A.I.R.; Chozas, S. Assessing the Impact of Charcoal Production on Southern Angolan *Miombo* and Mopane Woodlands. *Forests* **2023**, 15, 78. https://doi.org/10.3390/f15010078
94. Kaumbu, J.M.K.; Mpundu, M.M.M.; Kasongo, E.L.M.; Ngoy Shutcha, M.; Tekeu, H.; Kalambulwa A.N.; Khasa, D. Early Selection of Tree Species for Regeneration in Degraded Woodland of Southeastern Congo Basin. *Forests* **2021**, 12, 117. https://doi.org/10.3390/f12020117
95. Tonga, K.P.; Zapfack, L.; Kabelong B.L.P.R.; Endamana, D. Disponibilité des produits forestiers non ligneux fondamentaux à la périphérie du Parc national de Lobeke. *Vertigo* **2017**, 17(3), consulté le 20 octobre 2024. https://doi.org/10.4000/vertigo.18770
96. Caro, TM.; Sungula, M.; Schwartz, M.W.; Bella, EM. Recruitment of Pterocarpus angolensis in the wild. *For. Ecol. Manag*. **2005**, 219, 169–175.
97. Alemagi, D. ; Hajjar, R. ; Tchoundjeu, Z.; Kozak, R.A. Cameroon's environmental impact assessment decree and public participation in concession-based forestry: An exploratory assessment of eight forest-dependent communities. *J. Sustain. Dev*. **2013**, 6(10), 8–24.
98. Fobissie, K.; Chia, E.; Enongene, K., 2017. Mise en œuvre de la REDD+, du MDP et de la CDN du secteur AFAT en Afrique francophone. *Forum For. Afr*. **2017**, 3(7), 61p.
99. Wily, L.A. *Vers une gestion démocratique des forêts en Afrique orientale et australe*. International Institute for Environment and Development, Programme zones arides. International Institute for Environment and Development (IIED), Londres, au Royaume-Uni, 2000; 27p.
100. Kiyulu, J.; Mpoyi, M.A. *Mécanismes d'amélioration de la gouvernance forestière en République Démocratique du Congo : Rapport national d'études juridiques et socio-économiques*. UE, IUCN, Kinshasa, RDC, 2007; 88p.
101. Ibanda, K.P. *La réforme forestière de 2002 en République démocratique du Congo. Essai d'évaluation de ses conséquences juridiques, fiscales, écologiques et socio-économiques*. L'Harmattan, Paris, France, 2019; 22p.
102. Etrillard, C. Paiements pour services environnementaux : nouveaux instruments de politique publique environnementale. *Dev. Durab. Territ*. **2016**, 7(1), 1–8. Consulté le 15 février 2023. https://doi.org/10.4000/developpementdurable.11274
103. Lescuyer, G.; Karsenty, A.; Eba'a Atyi, R. Un nouvel outil de gestion durable des forêts d'Afrique Centrale : les paiements pour services environnementaux. In : De Wasseige, C.; Devers, D.; De Marcken, P.; Eba'a Atyi, R.; Nasi, R.; Mayaux, P. (Eds.), *Les forêts du bassin du Congo : état des forêts 2008*. Publications Office of the European Union, Luxembourg, Luxembourg, 2009; 143-155.
104. Dewees, P.A.; Campbell, B.M.; Katerere, Y.; Sitoe, A.; Cunningham, A.B.; Angelsen, A.; Wunder, S. Managing the *miombo* woodlands of southern Africa: policies, incentives and options for the rural poor. *J. nat. resour. policy res*. **2010**, 2(1), 57–73.
105. Martin, A.; Akol, A.; Phillips, J. Just conservation? On the fairness of sharing benefits. In: Sikor, T.; Fisher, J.; Few, R.; Martin, A.; Zeitoun, M. (Eds), *The justices and injustices of ecosystem services*. 1st éd, Routledge, London, UK, 2013; 69-91. https://doi.org/10.4324/9780203395288