American Journal of Agricultural and Biological Sciences

Research Article

Effect of Altitude on Species Diversity and Vegetation Structure of *Kigelia africana* Parklands in Cameroon

Awé Djongmo Victor[1], Vroh Bi Tra Aimé[2], Noiha Noumi Valery[3], Ganame Moussa[4] and Zapfack Louis[5]

[1]*Department of Plant Production, Higher Institute of Agriculture, Wood, Water Resources and Environment, University of Bertoua, Belabo, Cameroon*
[2]*UFR Biosciences, Université Félix Houphouët-Boigny-Côte d'Ivoire*
[3]*Department of Life Science, Higher Teacher Training College of Bertoua, University of Bertoua-Cameroon, Cameroon*
[4]*Department of Biology and Plant Physiology, University of Joseph Ki-Zerbo, Burkina-Faso*
[5]*Department of Biology and Plant Physiology, Faculty of Sciences, University of Yaoundé I. P.O. Box-812, Yaoundé, Cameroon*

Article history
Received: 29-04-2025
Revised: 31-07-2025
Accepted: 17-10-2025

Corresponding Author:
Awé Djongmo Victor
Department of Plant Production, Higher Institute of Agriculture, Wood, Water Resources and Environment, University of Bertoua, Belabo, Cameroon
Email: awevictor920@gmail.com

Abstract: In the Faro Subdivision (North, Cameroon), there are populations of *Kigelia africana*, known by the common name “Dambale", whose variety is largely unknown. The study's goal is to demonstrate how altitude affects species diversity and vegetation structure in *Kigelia africana* parklands. To gather information for statistical analysis, a Randomized Complete Block Design (RCBD) was employed. A total of 90 quadrats of 50×50 m each (covering 22.5 ha) were sampled and inventoried under *Kigelia africana* stands in the three altitudinal classes (154-1002 m, 1002-1312 m, and 1312-2015 m). For each altitudinal slice, the diameter and height were measured. The floristic analysis was conducted using floristic richness and diversity indices, and each altitude level's demographic structure was assessed. There are 29 species in all, categorized into 24 genera and 13 families. In terms of flora, low altitudes are richer and more varied than higher altitudes. The largest density (72 individuals/ha) is found between 154 and 1002 m. The highest basal area (23.52 m²/ha) is found between 1002 and 1312 m. The height structure for each altitude level showed that the number of individuals decreases from low height classes to high height classes. This study shows that *Kigelia africana* could support rational exploitation in the Poli area so that its potential is not affected.

Keywords: Diversity, Structure, *Kigelia africana*, Altitude, Cameroon

Introduction

Only a small area of land between the Tropics of Cancer and Capricorn, between latitudes 22.5° North and South of the equator, is home to tropical woods (Soro *et al*., 2021). The recognized global importance of tropical forests is the multitude of goods and services that they guarantee to humans. Unparalleled in terms of biological diversity, tropical forests are a natural reservoir of genetic diversity that offers a rich source of medicinal plants, high-yielding foods, and a myriad of other equally useful forest products (FODER, 2021; Miabangana and Malaisse, 2021; Nyeck *et al*., 2024). In addition to providing consistent precipitation and preventing erosion, droughts, and floods, tropical forests are essential for controlling the world's climate (Awé *et al*., 2021a; Maman *et al*., 2024). They release a large amount of terrestrial oxygen while sequestering large amounts of carbon (Awé *et al.*, 2024b; 2022).

Today, biodiversity is subject to natural and anthropogenic threats. Human activity is contributing to a biodiversity catastrophe with a high rate of particular extinction; as a result, the mechanisms producing this extinction weaken the environmental services that are essential to human survival (Wanguili *et al*., 2023; Kouam *et al*., 2023; Akame, 2024; Awé *et al*., 2024a). These threats do not leave ecosystems intact, given the resulting consequences. These manifest themselves in a partial or total disappearance of species, which is called a biological crisis. The interaction between forests and abiotic factors (altitude, soil, climate, etc.) determines the type of plant formation in an environment. Thus, on a given surface area, we can find forest populations that present differences in structure, floristic composition, density, and plant diversity (Bio *et al*., 2021; Vroh *et al.*, 2022; Guissi, 2024). This most often comes from the variability of biotic and abiotic factors that affect existing populations.

DOI: 10.3844/ajabsp.2025.45.53

Kigelia africana belongs to the Bignoniaceae family and is a species of flowering plant. This type of tree, native to Senegal and known for its presence in Tanzania, Mozambique, Uganda, the wetlands of western Kenya, as well as in Zambia and Zimbabwe, is also present in Botswana and as far north as South Africa, where it is called worsboom by the Afrikaners. It is also found in the West Indies, more specifically in Marie-Galante, following its importation during the period of slavery (Arbonnier, 2004). A medium-sized tree (10 to 15 m), with large pinnate leaves comprising 8 to 10 oval leaflets (30 cm). These leaves can be evergreen or deciduous, depending on the climate in which they grow. Its large, bell-shaped flowers with 5 petals give off an unpleasant odor at night and simulate the appearance of spoiled fruit. *Kigelia africana*, also known as the "sausage tree," is an iconic species of tropical Africa, valued for its diverse meanings. It has significant socioeconomic and ecological characteristics. Socioeconomically, *Kigelia africana* is an important local resource for many African communities, providing employment and income opportunities through the collection and processing of its fruits, bark, and leaves. Its use as a traditional medicine generates income for local healers and herbalists (Gormo and Nizesete, 2013). The cosmetics industry uses *Kigelia africana* extracts to manufacture beauty products, creating jobs and markets. The fruits, although toxic in their raw form, can be processed into food after proper processing, thus contributing to food security. Ecologically, *Kigelia africana* plays a role in the biodiversity of its habitat, providing food and shelter for various animal species. The tree contributes to soil fertility through the decomposition of its leaves and fruits, thus improving environmental quality. It can adapt to harsh environments, making it an important species for the restoration of degraded land. It is used for ornamental purposes in gardens and parks, enhancing the aesthetics of landscapes (Yamontche *et al*., 2024).

Altitude is one of the geographic and biogeographic components that explain the distribution of plant species on Earth. A variable like altitude, often relevant to describe the habitat of a species, brings together a set of conditions and resources constituting as many axes of the niche (Soro *et al*., 2021). Rising altitude can induce several changes in vegetation. Either there are sudden and occasional changes in the floristic composition or medium and long-term adaptations of species to the corresponding altitude. Variation in the structure of plant communities along an altitudinal gradient constitutes an area of study in ecology that allows exploring continuous progression within vegetation (Ouattara *et al*., 2023). Therefore, the goal of this study was to determine how environmental cues affect the richness and variety of plant species in *Kigelia africana* stands. By comparing the species and particular composition of plant communities beneath *Kigelia africana* stands in Cameroon, this work will be helpful to ecologists, conservationists, and future scholars. The purpose of this study is to confirm how altitude affects *Kigelia africana* parklands' species diversity and vegetation structure.

Supplies and Procedures

Research Site

The investigation was conducted in Cameroon's northern region, in the Faro subdivision, specifically in the Poli district. The Poli district is located at latitude 8°28'32 N and longitude 13°14'27" E (Souaibou, 2024). Figure 1. The area of the Poli district is 8045 km2 (Anonyme, 2014). The soils are feralitic and planosols with thick horizons (Victor *et al*., 20219, Awé *et al*., 2021). The climate is the Sudanese type with humid shade (Brabant and Humbel, 1974). The Poli district experiences 1200 mm of precipitation and 25 degrees on average each year (Aubréville, 1970). Vegetation is dominated by shrubby savannas to tree-degenerate facies (Letouzey, 1985).

Data Gathering

To gather information for statistical analysis, a Randomized Complete Block Design (RCBD) was employed. In forestry research, one of the most used experimental designs is the RCBD (Jayaraman, 1999). A total of 90 quadrats of 50×50 m each (covering 22.5 ha) were sampled and inventoried under *Kigelia africana* stands in the class [154-1002 m] (n = 30 quadrats), [1002-1312 m] (n = 30 quadrats), and [1312-2015 m] (n = 30 quadrats). A GPS and compass were used to trace the quadrats over a 2500 m² ground distance. All plant species with a DBH≥5 cm were counted in both zones along the quadrats. The model employed by Dossa *et al*. (2019) is compatible with this inventory system. A tape measure was used to measure the circumference of trees and shrubs to conduct inventories. The information in dendrometric research, a tape measure, and a clinometer were used to measure the diameter at breast height (dbh) on the bark. Thus, the circumferences of the species were measured using a tape measure at 1.30 m from the ground. All plants collected were determined at the National Herbarium of Cameroon. The nomenclature adopted was that of the phylogenetic classification (APG IV, 2016).

DOI: 10.3844/ajabsp.2025.45.53

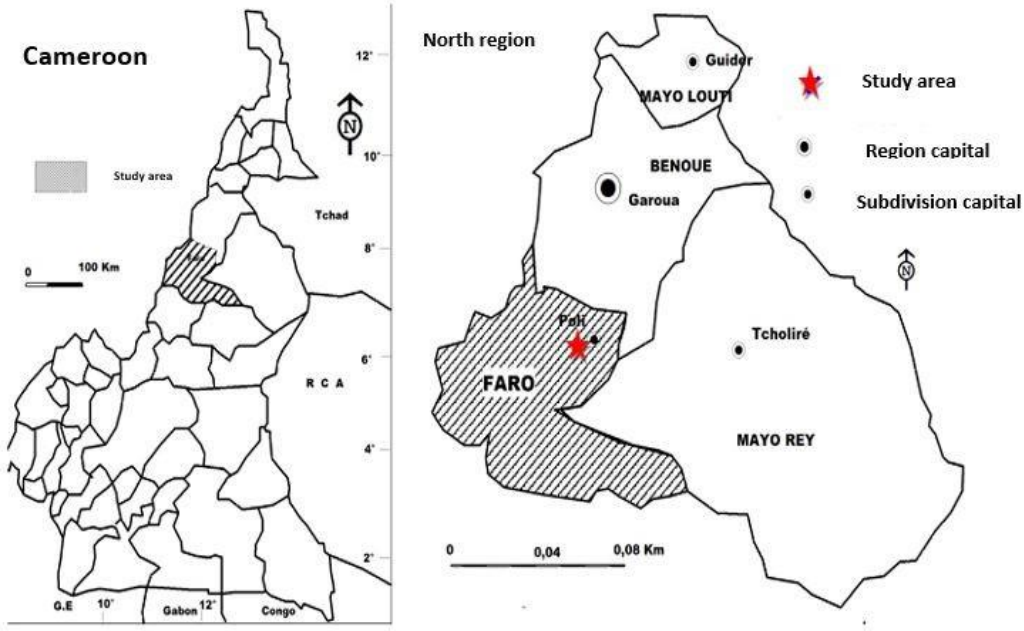

Fig. 1: The study area's location map

Floristic Diversity

The following were the main topics of the plant diversity analysis.

The total number of Species (S) present in an agroforestry parkland is known as specific richness. As for specific diversity, it refers to the distribution of the total number (Ni) between the different species.

Shannon-Wiener index (H) (Barmo *et al*., 2019; Singh and Pusalkar, 2021; Kouam *et al*., 2023): H is represented in bits and is equal to -Σ (ni/Ni) *log2 (ni/Ni), where Ni is the total number of individuals and ni is the number of individuals of the species.

Index of Pielou Equitability (E) (Barmo *et al*., 2019; Singh and Pusalkar, 2021): E = H/ H/Log2Ni, where Ni is the total number of people, while H is represented in bits.

The Simpson's index (D') is expressed by the following formula: D'= Σ (ni/Ni)2 (Awé *et al*., 2021; Kouam *et al*., 2023).

Structural Characterization

The number of people per hectare is known as density (D). The density (D) in the quadrats is determined using the following formula: D = n/S, where D is the density (individuals/ha), n is the total number of individuals in a sample plot, and S is the sample plot's area (ha).

Basal area (Ba): This enables the presentation of area per hectare (m2/ha) the surface of each species at 1.30 m (Dbh); the formula is: Ba = (D^2 x π / 4), where D = Dbh (cm), π = 3.142 (constant), and Ba = (Basal area is computed in cm^2/ha then converted to m^2/ha).

Height and Diametric structures: The distribution of individuals in height and diameter classes was carried out. For the height structure, 03 classes ([0-4 m], [4-8 m], [8-12 m]) of an amplitude equal to 4 m have been established. Four classes ([0-20 cm], [20-40 cm], [40-60 cm], [60-80 cm]) with an amplitude of 20 cm were created for the diameter structure.

Analysis of Data

STATGRAPHICS plus version 5.0 for Windows was used for all statistical analyses. The species diversity within the three elevation classes was compared using Duncan's test and One-Way Analysis Of Variance (ANOVA). Statistical significance was assessed using a p-value of 0.05.

Results

Altitude's Impact on Floristic Composition

In total, 810 individuals were recorded in eight Kigelia africana agroforestry parklands. These individuals are members of 24 genera, 13 families, and 29 species Table 1. There are 26 species, 22 genera, and 13 families in the lower altitudinal range (154-1002 m), 24 species, 22 genera, and 12 families in the middle altitudinal range (1002-1312 m), and 12 species, 11 genera, and 8 families in the top altitudinal range (1312-2015 m). The lower altitudinal range (154-1002 m) is the richest in terms of phytodiversity. Fabaceae (9 species), Combretaceae (6 species), and Rubiaceae (3 species) were the most represented families in Kigelia populations, followed by Malvaceae (2 species). Afzelia africana, Combretum collinum, Combretum molle, Kigelia africana, Lannea acida, Parkia biglobosa, Sterculia setigera, Terminalia laxiflora, Vitellaria paradoxa, and Vitex doniana are present at all altitude levels Table 1. Species such as Bombax costatum, Terminalia macroptera, and Ximenia americana are only found at lower altitudes (154-1002 m), Table 1.

Effect of Altitude on Diversity and Structure Indices

The lowest of these indices (1.80 bits; 0.45; 0.01) is found at higher elevations (1312 and 2015 m), while the strongest Shannon index, Pielou equitability, and Simpson index are found between 154 and 1002 m (2.48 bits; 0.58; 0.07) Table 2. Higher elevations (1312 and 2015 m) exhibit the lowest density (28 individuals/ha), whereas the highest density (72 individuals/ha) is found between 154 and 1002 m. The lowest basal area (8.32 m²/ha) is found at lower elevations (154 and 1002 m), whereas the largest is found between 1002 and 1312 m (23.52 m²/ha) Table 2.

The analysis of variance shows that there is no significant difference in the Shannon ($F = 0.14$; $p = 0.078>0.05$), Pielou ($F = 0.874$; $p = 0.06>0.05$), and Simpson ($F = 0.804$; $p = 0.0>0.05$) indices between the three altitudinal ranges Table 2. The three altitudinal ranges differ significantly in density ($F = 5.84$; $p = 0.04<0.05$) and basal area ($F = 5.99$; $p = 0.038<0.05$), according to the analysis of variance Table 2.

Effect of Altitude on Diameter Class Distribution

There are 210 individuals in the smallest diameter class (0 to 20 cm) at the altitudinal range of 154–1002 m. 51.85% of the stems in this level are represented by this. Of the total number of individuals, 34.56% belong to the diameter class of 20 to 40 cm. Therefore, only 13.58% of the stems are found in the final two diameter classes ([40 to 60 cm] and [60 to 80 cm]) Fig. 2.

There are 122 individuals in the smallest diameter class (0 to 20 cm) at the level of the altitudinal range 1002-1312 m, representing 49.39% of the stems. The diameter class of 20 to 40 cm comprises 36.44% of the total number of individuals. Therefore, almost 86.23% of the stems are in the first two diameter classes Fig. 2.

At the elevation of the 1312–2015 m altitudinal range, 43.67% of the trees and 31.64% of the individuals had diameters between 0 and 20 cm and 20–40 cm, respectively. The remaining individuals, or 24.68%, are in the 40 to 80 cm diameter class. For the three altitude levels, the distributions of people in the diameter classes are shown as a graph in the shape of a "inverted J" Fig. 2.

Table 1: Floristic composition of *Kigelia africana* populations according to altitudinal ranges

Scientific names	Families	154-1002 m	1002-1312 m	1312-2015 m
Afzelia africana	Fabaceae	11	6	2
Anogeissus leiocarpus	Combretaceae	0	3	1
Bombax costatum	Malvaceae	1	0	0
Burkea africana	Fabaceae	8	2	0
Combretum collinum	Combretaceae	21	16	9
Combretum molle	Combretaceae	18	6	11
Crossopteryx febrifuga	Rubiaceae	0	2	8
Cussonia arborea	Araliaceae	4	2	0
Daniellia oliveri	Fabaceae	3	6	0
Detarium macrocarpum	Fabaceae	9	6	0
Detarium microcarpum	Fabaceae	2	0	0
Diospyros mespiliformis	Ebenaceae	4	1	0
Entada africana	Fabaceae	8	3	0
Ficus glumosa	Moraceae	5	2	0
Gardenia ternifolia	Rubiaceae	13	7	0
Gardenia aqualla	Rubiaceae	11	0	0
Isoberlinia doka	Fabaceae	14	9	0
Khaya senegalensis	Meliaceae	20	1	0
Kigelia africana	Bignoniaceae	158	98	55
Lannea acida	Anacrdiaceae	2	6	1
Parkia biglobosa	Fabaceae	16	3	9
Pterocarpus erinaceus	Fabaceae	1	20	0
Sterculia setigera	Malvaceae	32	13	28
Terminalia laxiflora	Combretaceae	36	5	18
Terminalia macroptera	Combretaceae	1	0	0
Terminalia schimperiana	Combretaceae	0	6	0
Vitellaria paradoxa	Sapotaceae	5	10	8
Vitex doniana	Lamiaceae	1	14	8
Ximenia americana	Ximeniaceae	1	0	0
Total		405	247	158

DOI: 10.3844/ajabsp.2025.45.53

Table 2: Floristic diversity and structure index according to the altitudinal gradient

Index names	Items	154-1002 m	1002-1312 m	1312-2015 m
Floristic diversity index	Number of species	26	24	12
	Shannon index (H)	2.48 0.03a	2.42±0.02a	1.80±0.01a
	Pielou index (E)	0.58±0.01a	0.57±0.01a	0.45±0.01a
	Simpson index (D)	0.07±0.01a	0.06±0.01a	0.0±0.01a
Structure index	Density (individuals/ha)	72±0.15c	44±0.10b	28±0.09a
	Basal area (m²/ha)	8.32±0.05a	23.52±0.08c	19.87±0.04b

The same letter in the same row indicates the lack of a significant difference (Duncan's multiple range test, p>0.05)

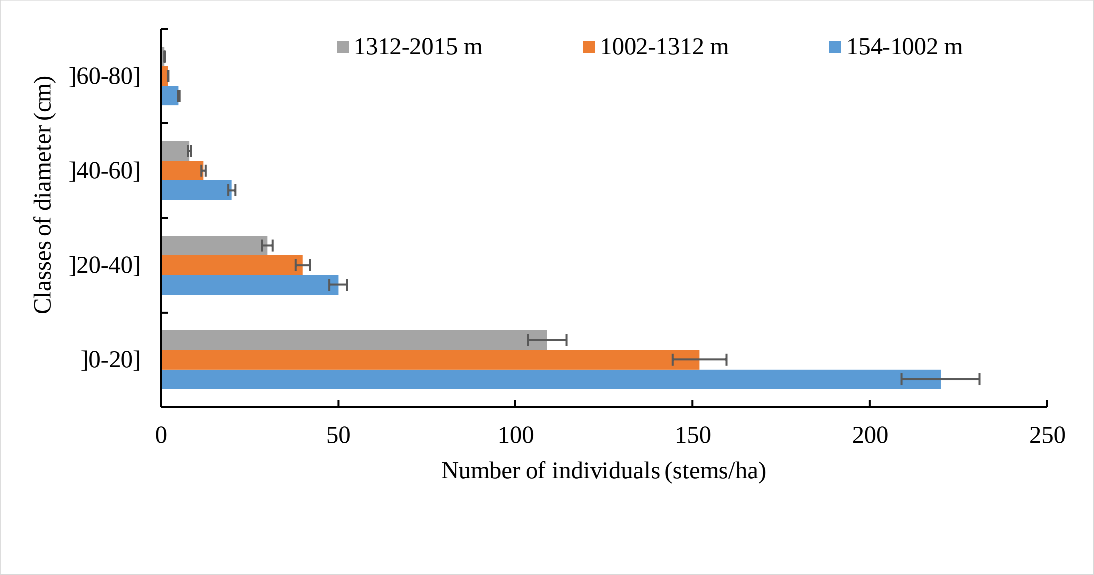

Fig. 2: Distribution by diameter class according to the number of individuals on the altitudinal gradient. The same letter in the same row indicates the lack of a significant difference (Duncan's multiple range test, p>0.05)

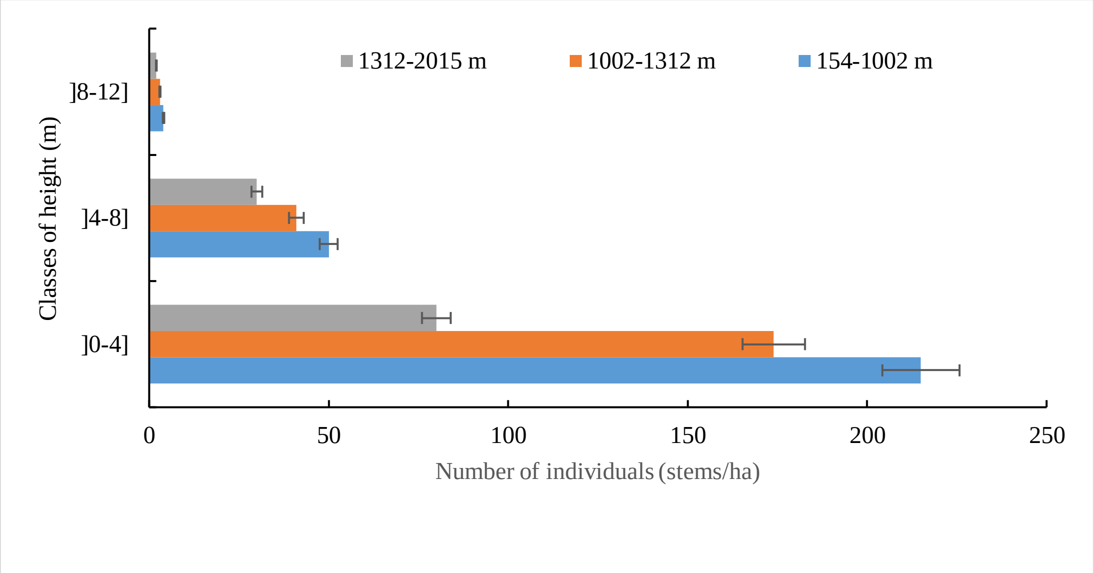

Fig. 3: Distribution by total height class according to the number of individuals on the altitudinal gradient. The same letter in the same row indicates the lack of a significant difference (Duncan's multiple range test, p>0.05)

Effect of Altitude on the Distribution in Height Classes

There are 315 individuals in the smallest height class ([0 to 4 m]) at the level of the altitudinal range 154-1002 m. 77.77% of the stems in this level are represented by this. Therefore, only 33.33% of the stems are found in the final two height classes ([4 to 8 m] and [8 to 16 m]). There are 174 individuals in the shortest height class ([0 to 4 m]) at the level of the altitudinal range 1002-1312 m, representing 70.44% of the stems.

Therefore, just 29.56% of the stems are in the last two height classes. 50.63% of the trees at the level of the altitudinal range 1312-2015 m have heights ranging from 0 to 4 m, and 25.31% of the individuals have heights between 4 and 8 m. The remaining individuals, or 25.06%, are in the height class 8 to 12 m. For the three altitude levels, the distributions of people in the height classes are shown as a graph in the shape of a "inverted J" Fig. 3.

Discussion

Highlighting the relationship between altitude, floristic richness, and vegetation structure was the aim of this study. The inventory of the woody flora of Kigelia africana agroforestry parklands made it possible to identify a total of 29 species over three altitudinal ranges. This flora, which testifies to the richness of the environment, is representative of the flora of Kigelia africana populations. These findings closely resemble those of (Ouattara *et al*., 2023), who identified 66 species at three height levels ([300-400 m], [400-500 m], and [500-600 m] in the highlands of Bowé de Kiendi in the Gontougou region (Ivory Coast). Phytodiversity is highest in the lower altitudinal range (154-1002 m). The explanation for this richness is that lower altitudes generally benefit from milder and more constant temperatures, which allows a greater number of species to establish and thrive, and also, lower elevations are often richer in resources such as water, nutrients, and sunlight, which promotes species diversity. This is reasonable because lower altitudes provide more favorable conditions for life, such as a more constant temperature and greater availability of resources, which allows a greater number of species to thrive (Silva *et al*., 2014). Also, lower elevations generally have warmer and more stable temperatures, which is conducive to the growth and reproduction of many species. Tree species such as Afzelia africana, Combretum collinum, Combretum molle, Lannea acida, Parkia biglobosa, Sterculia setigera, Terminalia laxiflora, Vitellaria paradoxa, and Vitex doniana are found at various altitudes due to their ability to develop ecological adaptations and resilience characteristics in the face of environmental fluctuations. These processes give them the ability to survive and thrive in diverse environments, from lowlands to plateaus, despite variations in temperature, access to water, and soil types. According to Sadia *et al*. (2025), these species have developed resistance systems to deal with elements such as drought, intense heat, poor soil fertility, and competition from other plants. For instance, certain species may access groundwater because of their deep root systems, while others have developed modified leaves to minimize water loss through transpiration. Species such as Bombax costatum, Terminalia macroptera, and Ximenia americana are found at lower elevations because they have adapted to the specific environmental and climatic conditions of these regions. These conditions include high temperatures, fluctuating precipitation, and generally dry or well-drained soils (Sharma *et al*., 2025).

Between 154 and 1002 meters, the highest Simpson, Pielou, and Shannon indices were recorded. This shows that the conditions are ideal for the establishment of several species in nearly equal amounts at this altitude level of 154 and 1002 m. The higher density (72 individuals/ha) seen between 154 and 1002 m can be attributed to more conducive environmental conditions for their growth. Better forest biomass is produced at these lower elevations because of the longer growth season, better fertiliser and water availability, and more temperate temperatures (Awé *et al*., 2020; Vroh *et al*., 2022; Awé *et al*., 2024a).

A high basal area indicates a denser and more productive forest stand. Basal area is a useful indication of a forest stand's richness (Zishan and Shreekar, 2025). The presence of huge tree specimens is confirmed by the maximum basal area found between 1002 and 1312 m (23.52 m²/ha). The large percentage of species that can give shade throughout the year can also be explained by the high rate of shading seen in the altitudinal range 1002-1312 m (Miabangana, 2020).

At all altitudes, the distribution of individuals in diameter and height classes provides the same appearance (inverted J). Individual traits like height and diameter, which are directly related to a plant's growth and development, are heavily impacted by both the individual's genetics and environmental elements including temperature, precipitation, soil, and disturbances (Ouattara *et al*., 2023). Accordingly, the demographic events of recruitment, death, and individual growth rates over time are synthesized in the distribution of people in diameter and height classes (Awé *et al*., 2021; Vroh *et al*., 2022). Thus, the inverted J shape observed at our study site is indicative of good regeneration with numerous juvenile individuals at all altitude levels. As a result, there is a high probability that the death of an adult individual will be replaced by the growth of an individual belonging to a small diameter class. Such results were also obtained in the Ivory Coast by Ouattara *et al*. (2023) and in Cameroon by Souaibou (2024) in plant formations that have a flora more or less similar to that of this site.

DOI: 10.3844/ajabsp.2025.45.53

Conclusion

The impact of altitude on the phytodiversity of Kigelia africana populations in Cameroon's northern area was the main focus of this study. The findings revealed that a total of 29 species were found in the three altitudinal ranges, spread throughout 24 genera and 13 families. Low altitudes have more diverse and richer vegetation than higher altitudes. The highest density is observed between 154 and 1002 m (72 individuals/ha). The highest basal area is observed between 1002 and 1312 m (23.52 m²/ha). The diameter and height structures across altitudinal ranges indicate that the flora of the *Kigelia africana* agroforestry parklands has a good capacity for regeneration. This study shows that the protection of *Kigelia africana* populations makes it possible to conserve significant biodiversity due to the specificities linked to each altitude level. It is therefore necessary to develop conservation policies for this plant biodiversity for the reconstitution of the flora of *Kigelia africana* populations in the North region of Cameroon. This structure also suggests a high exploitation of large-diameter people. In view of these facts, these parks demand special attention from decision-makers in order to propose adequate solutions to guarantee their sustainability and the diversity of their function. In view of its social, ecological, and environmental relevance, such an agroforestry system is regarded a component in local development and the battle against climate change. In order to encourage local communities to create conservation plans so that future generations can benefit from them, agricultural development services should be interested in the creation of these agroforestry parks.

Acknowledgment

The authors thank all reviewers whose contributions greatly contributed to the improvement of this study.

Funding Information

This research had no external funding for this study.

Author’s Contributions

Awé Djongmo Victor: Execution of the experimental protocols, data analysis, and preparation of the original manuscript draft.

Vroh Bi Tra Aimé: Management of sample collection, initial processing, and stabilization procedures.

Noiha Noumi Valery: Provided academic oversight and scientific guidance throughout the research and manuscript development.

Ganame Moussa: Critical review, editing, and final refinement of the manuscript text.

Zapfack Louis: Conceptualization of the research study and development of the formal methodology.

Ethics

The data presented in this study are available on request from the corresponding authors.

References

Akame, L. (2024). Diversité Floristique et Caractérisation Structurale des Formations Ligneuses des Collines Dans le Canton d’Ataloté au Nord-Togo. *Physio-Géo, Volume 20*, 1–20. https://doi.org/10.4000/physio-geo.16141

Anonyme. (2014). Plan Communal de Développement de Poli. Ministère de L’Administration Territorial et de la Décentralisation, République du Cameroun, Région du Nord. 21-42p.

APG IV. (2016). An Update of the Angiosperm Phylogeny Group Classification for the Orders and Families of Flowering Plants. *Botanical Journal of the Linnean Society*, *181*(1), 1–20. https://doi.org/10.1111/boj.12385

Arbonnier, M. (2004). *Trees, Shrubs and Lianas of West African Dry Zones*. *9*. https://doi.org/10.1515/9782763728636-007

Aubréville, A. (1970). *Flora of Cameroon: legumes caesalpinoids*. *8*.

Awé, D. V., Noiha, N. V., Vroh, B. T. A., & Zapfack, L. (2024a). Ecological diversity, structure and aboveground biomass of Guiera senegalensis J.F.Gmel. agroforestry parklands in Central Africa: A case study from Cameroon. *Annals of Silvicultural Research, 49(1), 57-65*. https://doi.org/10.1093/ijlct/ctae005

Awé, D. V., Noiha, N. V., Vroh, B. T. A., & Zapfack, L. (2024b). Biological carbon storage potential of Guiera senegalensis J. F. Gmel. Agroforestry parklands in Central Africa: a case study from Cameroon. *International Journal of Low-Carbon Technologies*, *19*, 236–244. https://doi.org/10.1093/ijlct/ctae005

Awé, D.V., Noiha, N.V., & Zapfack, L. (2021). Structure and Diversity of Agroforestry Parklands in the Sudano-Sahelian Zone of Cameroon. *American Journal of Agricultural and Biological Sciences*, *16*(1), 8–18. https://doi.org/10.3844/ajabssp.2021.8.18

Awé, D.V., Noiha, N.V., Madou, C., & Zapfack, L. (2020) Floristic composition, diversity and structure of Khaya senegalensis agroforestry parklands in Benue Subdivision, Cameroon. *Journal of Tropical Resources and Sustainable Science (JTRSS)*, *8*(1), 60–68. https://doi.org/10.47253/jtrss.v8i1.165

Awé, D.V., Noiha, N.V., Madou, C., Alium, H., Vroh, B.T.A., Stéphanie, C., & Zapfack, L. (2022). Carbon Stock Assessment of Psiduim guajava L. (Myrtaceae) Agroforestry Systems in Septentrion Zone of Cameroon. *Archives of Current Research International*, 16–26. https://doi.org/10.9734/acri/2022/v22i8542

Awé, D.V., Noiha, N.V., Vroh, B.T.A., & Zapfack, L. (2021). Biodiversity Biodiversity Management under Cashew Agro-ecosystems in Central Africa: A Case Study from Cameroon. *Open Journal of Agricultural Research*, *1*(2), 45–61. https://doi.org/10.31586/ojar.2021.130

Barmo, S., Amani, A., Soumana, I., Ichaou, A., Karim, S., & Mahamane, A. (2019). Structure et diversité des parcs agroforestiers adjacents à la forêt protégée de Baban Rafi, Niger-Afrique de l'Ouest. Afrique Science, 15(2), 166-185.

Bio, I., Issoufou, A. A., Mamoudou, B. M., Soumana, I., & Mahamane, A. (2021). Specific diversity of Vachellia tortilis subsp. raddiana formations in Kilakam and N'Guel kolo in the Diffa region, Niger. *Journal of Applied Biosciences*, *183*, 19123–19139. https://doi.org/10.35759/jabs.183.2

Brabant, P., & Humbel, F.-X. (1974). *Explanatory Note No. 51, Polished Cameroon Pedological Map.*

Danjouma, R. M. M., Inoussa, M. M., Morou, B., Noma, A. L. H., Souley, M. H. I., & Bakasso, Y. (2024). Diversité Floristique de la Végétation de la Zone Centrale de l'Habitat des Girafes du Niger, Afrique de l'Ouest. Eur. Sci. Journal, ESJ, 20(12), 96.

Dossa, B. A. K., Sourou, B., & Ouinsavi, C. (2019). Germination des Graines et Croissance en Pépinière et en Champ des Plantules de Detarium Senegalense au Bénin. *European Scientific Journal ESJ*, *16*(12), 38. https://doi.org/10.19044/esj.2020.v16n12p38

FODER. (2021). Evaluation de la diversité floristique dans et autour du massif forestier de Tchabal-Mbabo, Adamaoua Cameroun. Rapport Projet COGESPA-CEPF. 53p.

Gormo, J., & Nizesete, B. D. (2013). Des Végétaux et Leurs Usages Chez Les Peuples du Nord-Cameroun: Sélection et Mode d'emploi du XIXeau XXesiècle. In *História, Ciências, Saúde-Manguinhos* (Vol. 20, Issue 2, pp. 587–607). https://doi.org/10.1590/s0104-59702013000200013

Guissi, M.J. (2024). Phytodiversité et stock de carbone des parcs agroforestiers à Ficus glumosa (Moraceae) et à Sterculia setigera (Malvaceae) de la Région du Nord: Cas de l'arrondissement de Garoua IIIème. Mémoire de Master II, Université de Ngaoundéré, Cameroun. 68p.

Jayaraman, K. (1999). A statistical manual for forestry research. *Forestry research support programme for Asia and the Pacific*.

Kouam, K. P., Noiha, N. V., Betti, J. L., Tchobsala, A., D.V., & Zapfack, L. (2023). Diversity and Structure of Prunus Africana (Hook.f.) Kalkman Agroforestry Parklands in the Tchabal Forest Massif: A Case Study from Adamawa Cameroon. *Annals of Silvicultural Research*, *48*(1), 22–31.

Letouzey, R. (1985). Phytogeographic map of Cameroon at 1/500000è. Sahelian and Sudanian. IRA (National Herbarium), Yaoundé. *Institute of the International Map of Vegetation, Toulouse*. 1-26p.

Miabangana, E. S. (2020). Structure, Composition Et Diversité Floristiques De La Forêt De La Djoumouna (République du Congo). *European Scientific Journal ESJ*, *16*(12), 179. https://doi.org/10.19044/esj.2020.v16n12p179

Miabangana, E. S., & Malaisse, F. (2021). Structural Characteristics of a Forestry Facies at Cynometra Pedicellata De Wild. and Pterocarpus soyauxii Taub. on the Loufézou island in the Plateau of Cataracts (Congo Republic. *Geography Ecology Tropical*, *45*(1), 53–65.

Nyeck, B., Noumi, V. N., Maffo, N. M., Djongmo, V. A., Chimi, C. D., & Zapfack, L. (2024). Floristic Diversity and Conservation Status of Guineo-Congolese Species in Southeastern Cameroon: The Case of the Gari-Gombo Communal Forest. *Open Journal of Forestry*, *14*(01), 87–97. https://doi.org/10.4236/ojf.2024.141006

Ouattara, D. N., Tro, H. H., Soro, D., & Bakayoko, A. (2023). Gradient altitudinal de la diversité et de la structure de la flore ligneuse sur les hauts plateaux du Bowé de Kiendi dans la Région du Gontougo (Nord-Est Côte d'Ivoire). *International Journal of Biological and Chemical Sciences*, *17*(2), 417–429. https://doi.org/10.4314/ijbcs.v17i2.11

Sadia, S., Waheed, M., Arshad, F., Al-Andal, A., Munir, M., Jabeen, A., & Aslam, S. (2025). Adaptive Floristic Diversity and Ecological Responses to Environmental Gradients in the Saline Soil Ecosystem. *Journal for Nature Conservation, 84*, 126862. https://doi.org/10.1016/j.jnc.2025.126862

Sharma, A., Bhardwaj, D. R., Thakur, C. L., Katoch, N., & Sharma, J. P. (2025). Floristic Diversity and Dominance Patterns of Sal (Shorea robusta Gaertn. f.) Forests in North Western Himalayas: Implications for Conservation and Sustainable Management. *Frontiers in Forests and Global Change*, *8*, 1524808 https://doi.org/10.3389/ffgc.2025.1524808

Silva, F. K. G. da, Lopes, S. de F., Lopez, L. C. S., Melo, J. I. M. de, & Trovão, D. M. de B. M. (2014). Patterns of Species Richness and Conservation in the Caatinga along Elevational Gradients in a Semiarid Ecosystem. *Journal of Arid Environments*, *110*, 47–52. https://doi.org/10.1016/j.jaridenv.2014.05.011

DOI: 10.3844/ajabsp.2025.45.53

Singh, D. K., & Pusalkar, P. K. (2021). Floristic Diversity of the Indian Himalaya. *Jammu and Kashmir State*, *18*, 93–126. https://doi.org/10.1007/978-981-32-9174-4_5

Soro, D., Ouattara, N.D., Djézou, K., Koné, M.W., & Bakayoko, A. (2021). Etude des Valeurs Ecologiques de la Chaîne de Montagnes du Bowé dans la Région du Gontougo au Nord-Est de la Côte d'Ivoire. *Journal Applied Biosciences*, 164, 16955-16969.

Souaibou, I. (2024). Phytodiversité et stock de carbone des agrosystèmes à Citrus limon (Rutaceae): Cas de la Commune de Poli, Région du Nord - *Cameroun. Mémoire de Master II, Université de Ngaoundéré, Cameroun*. 68p.

Victor, A. D., Valery, N. N., Louis, Z., Aimé, V. B. T., & Aliou, S. (2019). Carbon Sequestration Potential and Economic Value in Agroforestry Parkland to Tectona grandis L. f. (Verbenaceae) in Central Africa: A Case Study to Department of Poli (Northern Region in Cameroon). *Advances in Research*, 1–16. https://doi.org/10.9734/air/2019/v18i530100

Vroh, B. T. A., Kone, Y., & Awé, V. D. (2022). Plant species diversity and structure in tree plantations at Téné Protected Forest (Côte d'Ivoire. *Annals of Silvicultural Research*, *47*(1), 39–47. https://doi.org/10.12899/asr-2342

Wanguili, D.Y., Tchobsala, & Noiha, N.V. (2023). Ecological and structural study of the Moringa oleifera population in the Sudano-sahelian zone: case of the Far North of Cameroon. *International Journal of Ecosystems and Ecology Science*, 12 (2), 473-482.

Yamontche, C., Sourou, B., Wedjangnon, A., Houetchegnon, T., & Ouinsavi, C. (2024). État des connaissances sur Kigelia africana (Lam.) Benth. en vue de la promotion et de la conservation de l'espèce. Bulletin de la Recherche Agronomique du Bénin, 34(03), 71–81.

Zishan, A.W., & Shreekar, P. (2025). Assessment of floristic diversity and community characteristics of Gulmarg Wildlife sanctuary, Kashmir Himalaya. *Geology, Ecology, and Landscapes*, *9*(1), 296–316. https://doi.org/10.1080/24749508.2023.2196767