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Exploring Floristic Diversity, Propagation Patterns, and Plant Functions in Domestic Gardens across Urban Planning Gradient in Lubumbashi, DR Congo

Yannick Useni Sikuzani [1,*], Bernard Kisangani Kalonda [2], Médard Mpanda Mukenza [3,*], Jonas Yona Mleci [1], Alex Mpibwe Kalenga [1], François Malaisse [4] and Jan Bogaert [4]

1 Ecology, Ecological Restoration and Landscape Unit, Faculty of Agronomic Sciences, University of Lubumbashi, Lubumbashi P.O. Box 1825, Democratic Republic of the Congo; jonasmleci@gmail.com (J.Y.M.); mpibwek@gmail.com (A.M.K.)
2 Laboratory of Biofortification, Defense, and Crop Valorization, Department of Crop Science, Faculty of Agronomic Sciences, University of Lubumbashi, Lubumbashi P.O. Box 1825, Democratic Republic of the Congo; bernardkis94@gmail.com
3 Department of Renewable Natural Resources Management, Faculty of Agronomic Sciences, Katumba Mwanke University of Technology, Lubumbashi P.O. Box 74, Democratic Republic of the Congo
4 Biodiversity, Ecosystem and Landscape Unit, Gembloux Agro-Bio Tech, University of Liège, 5030 Gembloux, Belgium; malaisse1234@gmail.com (F.M.); j.bogaert@uliege.be (J.B.)
* Correspondence: sikuzaniu@unilu.ac.cd (Y.U.S.); m.mpanda@eraift-rdc.org (M.M.M.)

Abstract: Urbanization degrades natural habitats and creates new urban ecosystems like domestic gardens. The plant composition of these gardens varies with socio-economic factors and urban planning levels. However, the diversity and impact of introduced species are often poorly assessed, causing potential ecological imbalances (disruptions in the natural functioning and stability of ecosystems), particularly in Lubumbashi (DR Congo). The objective was to analyze the spatial structure, plant diversity, propagation strategies, and ecological functions of domestic gardens. Three distinct neighborhoods were selected: a planned, unplanned, and residential neighborhood. Twenty avenues (with five plots per avenue) were chosen to represent the diversity within each neighborhood, and stratified random sampling of plots was conducted to analyze gardening practices. Gardens were classified into types, and their vegetation was evaluated based on species origin and ecological impact. The analysis of domestic gardens in Lubumbashi reveals significant variations across different neighborhood types. Residential neighborhoods exhibit larger average garden sizes (315.1 m^2), higher species richness (22 species), and larger plot sizes (1032 m^2) compared to unplanned and planned neighborhoods, where garden areas and species richness are notably lower. Rectangular gardens dominate in unplanned areas, while planned neighborhoods feature more intentional landscaping elements, such as flowerbeds and hedges. The use of gardens for food production is prominent in planned areas (40.7%), whereas residential neighborhoods prioritize ornamentation (51.4%). The study identified 232 taxa across 68 families, with a predominance of exotic species (80%) in all neighborhoods, particularly in unplanned areas (82.25%). The data revealed that *Mangifera indica* and *Persea americana* are abundant in all neighborhoods, illustrating their adaptability to different urban contexts. Herbaceous species are most common, followed by woody plants, with vines being sparse. Species dispersal is primarily driven by human activities (anthropochory), accounting for over 85% in all neighborhoods. These findings highlight the strong human influence on the composition and structure of domestic gardens in Lubumbashi, emphasizing the dominance of exotic species and the importance of anthropogenic factors in shaping urban green spaces. Urban policies should incorporate strategies to minimize the negative impacts of exotic species on native flora.

Keywords: urbanization; domestic gardens; plant diversity; socio-economic impact; ecological imbalance; exotic species

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1. Introduction

Urbanization refers to the process by which urban areas expand and densify in response to demographic and economic growth [1]. From 1950 to 2022, the global urbanization rate increased from approximately 29% to 57%, reflecting ongoing expansion driven by industrialization and internal migration [1,2]. However, urbanization patterns vary significantly across regions. In Europe and North America, where urbanization is more advanced, rates exceed 80% and are either stabilizing or growing slowly [3]. Conversely, Asia and Africa experience rapid urbanization due to high population growth and significant rural-to-urban migration [2,4–6]. For instance, in Asia, countries like China have seen urbanization rates rise from 20% in 1950 to around 60% by 2022 [1]. In Africa, urbanization is accelerating, though rates remain lower at about 45% in 2022, with substantial infrastructure and urban planning challenges [5,6]. India's urban population grew from 28% in 2001 to over 35% in 2021, with projections reaching 50% by 2031 [6]. Similarly, Nigeria's urbanization rose to 52% in 2021, expected to exceed 70% by 2050, driven by economic migration [6].

Urbanization significantly impacts vegetation, leading to deforestation, habitat fragmentation, and biodiversity loss. The expansion of urban infrastructure, such as roads and buildings, often replaces natural green spaces, reducing vegetation areas [7,8]. Despite this, urban vegetation remains crucial for providing various ecosystem services [9]. For illustration, trees and green spaces contribute to thermal regulation by providing shade and reducing urban heat islands [10]. Additionally, urban vegetation fosters biodiversity by providing habitats for birds and insects and playing a role in stormwater management by absorbing and filtering water, thus reducing flood risks [11]. Moreover, urban vegetation enhances human well-being by offering recreational spaces and strengthening connections with nature [12].

In urban environments, vegetation includes both natural and newly introduced ecosystems [13]. Natural urban vegetation comprises native trees and plants that persist despite urban expansion, while urbanization also leads to artificial plant ecosystems [14], and domestic gardens exemplify these newly introduced ecosystems [15]. The plant diversity in domestic gardens is influenced by several factors: residents' socio-economic context, the level of urban planning, and local environmental conditions [16,17]. In wealthier neighborhoods, diversity is often higher and oriented towards ornamental plants, whereas in less affluent areas, gardens tend to include practical food species [15].

The Democratic Republic of the Congo (DRC) stands out in Africa for its rich phytogeography, particularly in the southeast around Lubumbashi, a region where diverse ecosystems such as dense riparian forest, woodland, savannas, and copper-rich steppe savanna intersect [18]. Studying domestic gardens in Lubumbashi are crucial due to this unique diversity and the impacts of rapid urbanization on local ecosystems [19]. Since independence, Lubumbashi, driven by its mining heritage and commercial role, has experienced a demographic explosion due to migration and natural growth, with six out of ten people in Haut-Katanga living in the city in 2021 [20]. The rapid urbanization has led to uncontrolled densification and suburbanization, threatening local ecosystems such as woodlands and unique flora areas [21–23]. Industrial activities and waste pollution further exacerbate the situation, while the lack of an urban master plan leads to the destruction of green spaces in favor of new constructions [24].

Consequently, domestic gardens, mostly developed in residential plots, have become centers of both accidental and intentional botanical introduction, playing a key role in the spread of exotic plants [14]. Lubumbashi, a major economic center in Haut-Katanga, features various types of neighborhoods: planned, residential, and unplanned [25]. Residential neighborhoods, once reserved for Europeans, are relatively well preserved despite social transitions. Planned neighborhoods, originally well organized, are now degraded. Unplanned neighborhoods, often established illegally, suffer from a lack of planning and adequate public services. This unplanned urban expansion leads to the loss of local species and the dominance of exotic plants in residential plots, reflecting local preferences and socio-economic influences [26]. This dynamic underscore the need to understand the impact of urbanization policies on urban biodiversity to better manage vegetation in a context of rapid growth and phytogeographic diversification.

The scientific literature on the flora of domestic gardens highlights their significant plant diversity, including ornamental, medicinal, and food plants, influenced by climate, cultural preferences, and management practices [27]. These gardens play a crucial role in urban biodiversity by providing refuge for wildlife, contributing to microclimatic regulation, and participating in nutrient cycling [17]. Socio-economically, they offer food and medicinal products and help maintain local knowledge [28]. However, gaps remain, notably the lack of longitudinal studies on the evolution of flora in response to climate and urban changes [29]. Additionally, the ecosystem services provided by these gardens, such as carbon sequestration and air purification, are not sufficiently quantified [30]. The relationship between urban policies and the conservation of these green spaces is also under-explored [15,31,32]. In the DRC, research on urban domestic gardens is limited [33]. While some studies have focused on plant diversity in rural areas or fruit trees in urbanized areas, urban gardens, particularly in Lubumbashi, are under-researched [9,14,26,34–36]. There is a lack of systematic floristic inventories, analyses of the socio-economic interactions influencing gardening practices, and studies on the impact of urban dynamics, such as plot fragmentation and densification, on the preservation of these gardens. Thus, Lubumbashi represents a promising field for further research in this area.

Studies on the flora of domestic gardens in urban settings can rely on reports from specialized state agencies, such as environmental management agencies and urban agriculture departments [37]. These reports provide information on plant species, gardening practices, and green space planning policies. While useful for identifying general trends and types of vegetation, these reports may have limitations [38]. They can lack detail or be outdated and may omit specific local variations, non-compliant practices, or illegally introduced species [39]. For a more comprehensive assessment, combining socio-economic surveys with floristic inventories is relevant. Socio-economic surveys provide insights into residents' motivations, resources, and biodiversity knowledge, revealing the impact of economic and social factors on garden composition [15]. Floristic inventories offer precise data on species, their abundance, and distribution [28]. Together, these approaches enable a thorough understanding of domestic gardens, integrating botanical and socio-economic aspects to enhance urban biodiversity and quality of life [15].

The objective of this study is to comprehensively characterize domestic gardens in selected neighborhoods of Lubumbashi by analyzing their spatial structure, plant diversity, propagation strategies, and the ecological and social functions they fulfill. The following is expected: (i) The spatial structure of domestic gardens will exhibit significant variation across different types of neighborhoods. Specifically, gardens in planned areas are expected to display more organized and systematic layouts, whereas gardens in unplanned areas are anticipated to have more heterogeneous and irregular configurations. (ii) In unplanned neighborhoods, it is expected that there will be higher plant diversity. This is likely driven by informal urban expansion and the introduction of exotic species by residents. Plant dispersal in these areas is hypothesized to occur largely through human activities such as trade and informal gardening practices. (iii) Domestic gardens in unplanned neighborhoods are hypothesized to serve a wider range of functions compared to those in planned areas. These functions may include food production, medicinal uses, and cultural practices, reflecting the lack of formal urban planning and the more challenging socio-economic conditions present in these neighborhoods.

2. Materials and Methods

2.1. Study Area

Lubumbashi (Figure 1), the capital of Haut-Katanga in the southeastern part of DRC, spans seven municipalities (Kampemba, Kenya, Kamalondo, Lubumbashi, Katuba, Ruashi, and Annexe), covering approximately 747 km^2 [25]. Situated at an altitude of around 1200 m on a plateau, Lubumbashi is in the upper basin of the Kafubu River, between 11°20′ and

12°00′ South latitude and 27°10′ and 27°43′ East longitude. The dominant soils in the region are ferrallitic, predominantly yellow and red in color [18]. The climate is classified as Cw according to Köppen's classification, with a dry season from May to September, a rainy season from November to March, and transitional months in April and October [18]. Recent studies indicate a delay in the onset of rains and a reduction in annual precipitation, which is estimated to be around 1047 mm between 1970 and 2005 [40,41]. The average annual temperature was 20.1 °C in the latter half of the 20th century, with a trend toward warming [40,41]. At the beginning of the 20th century, miombo woodland covered 90% of the region, but it has significantly receded, requiring a 35 km journey outside the city to find remnants patches [42]. Deforestation caused by agriculture, wood collection, and mining activities has transformed the miombo woodland into savannah and, subsequently, into barren land in mining areas [21]. Termite mounds, once common, are now less abundant, and their soil is used for brick production [43]. Previously well-maintained green spaces are now neglected or abandoned, especially in unplanned neighborhoods [19]. Urban expansion also promotes the proliferation of invasive exotic plants, such as Mexican sunflower [44]. The city still includes a few large recreational spaces, such as a zoological garden and a golf course, but green spaces are increasingly scarce in newly developed areas [19]. Lubumbashi is a major economic center due to its mining activities, particularly copper and cobalt extraction, which drive the regional economy [25]. However, this mining prosperity contrasts with challenges in urban governance [25]. Managing a city with over 2.5 million inhabitants is often characterized by a lack of coherent planning and institutional instability, exacerbating infrastructure and urban organization issues [45]. Environmentally, rapid urban growth and industrial expansion have led to significant degradation of local ecosystems and increased pollution, threatening vital ecosystem services and exacerbating negative environmental impacts [25].

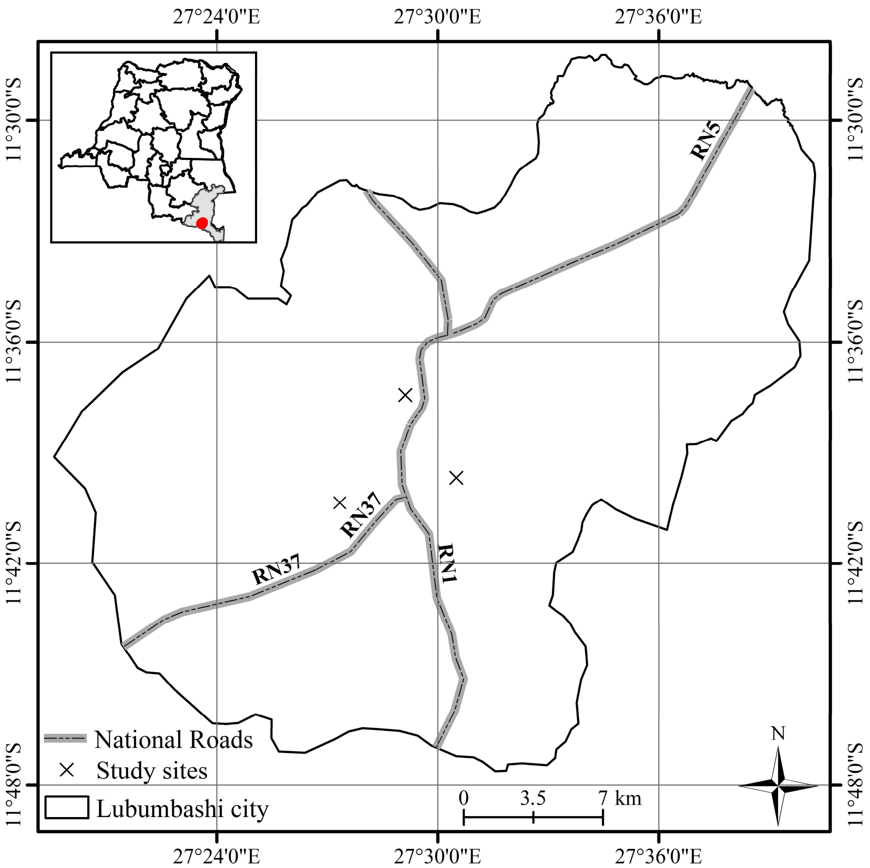

Figure 1. Geographical map of the Lubumbashi city in southeastern DRC. The map also shows the study sites: Gambela III, Bel-AirI, and Mampala neighborhoods. The red dot on the map locates the study area in the province of Haut-Katanga in the DRC.

2.2. Selection of Neighborhoods, Avenues, and Residential Plots

Three neighborhoods were chosen for the study based on their distinct typologies. Mampala, located within the Lubumbashi municipality (~5 km^2 and 55,000 inhabitants), was selected to represent a planned neighborhood. Despite its structured layout, it faces challenges of degradation and has only one green space [26]. Bel-Air, situated in the Kampemba municipality (~5 km^2 and 65,000 inhabitants), exemplifies a residential area formerly reserved for Europeans. It retains relatively good conditions, reflecting characteristics of older urban development. The neighborhood features some paved roads, moderately sized plots, moderate sanitation conditions, reliable electricity, minimal informal economic activities, easy accessibility, and several public green spaces, with an average-to-high standard of living among residents [45]. Lastly, Gambela III (~4 km^2 and 50,000 inhabitants), located in Lubumbashi municipality, was chosen to represent an unplanned neighborhood. It illustrates the challenges associated with informal urban expansion and lack of planning, characterized by low-income residents, significant informal economic activities, chaotic and unplanned constructions, inadequate public infrastructure, difficult accessibility, dusty conditions in dry seasons, and a lack of public green spaces. The living conditions in this area are often precarious due to anarchic urbanization [26].

For the selection of avenues within each neighborhood, a systematic approach was adopted to ensure a representative coverage of the city's varied characteristics. Avenues were chosen based on their representativeness and accessibility [26]. The selected avenues were intended to reflect typical variations within residential, planned, and unplanned neighborhoods. Once the avenues were selected, specific plots within each avenue were chosen using stratified random sampling [16]. Selection criteria for the plots included the diversity of garden types and accessibility for observations [15].

Data collection on each plot primarily involved interactions with the plot owner. If the owner was unavailable, the longest-residing tenant was consulted. This process ensured that the collected information was as accurate and representative as possible, providing a comprehensive view of gardening practices and floral characteristics in each studied area [15]. Field data collection was conducted over a period of three and a half months, from 10 May 2022 to 28 August 2022, using a pre-established field data sheet. Data were collected directly from the plots and households, preferably on Sunday afternoons to ensure the availability of household heads. This approach aimed to obtain precise information on the structure and function of domestic gardens.

For each neighborhood, a total of 20 avenues were randomly selected to ensure diverse coverage. Within each avenue, five plots were strategically chosen to represent different points along the avenue. Two plots were selected at the ends of the avenue, one at each end, while one plot was chosen at the center of the avenue, alternating between the left and right sides. This method captured variability in gardening practices and floral characteristics along the avenues [26]. Thus, for each neighborhood, 100 plots were explored, offering a comprehensive and detailed view of domestic gardens in various geographic and urban contexts. This approach ensured a balanced representation of different configurations and types of gardens within each neighborhood, allowing for an in-depth analysis of the collected data [15].

2.3. Data Collection

Domestic gardens were classified into five distinct types [16,46,47]: (i) flowerbeds (areas planted on the ground, often decorative), (ii) lawns (grass areas primarily used for leisure), (iii) pergolas (structures covered with climbing plants providing shade), (iv) hedges (vegetative barriers often used to delineate properties), and (v) shrubbery (clusters of shrubs and flowering plants, generally for ornamentation). This typology of domestic gardens provides insights into the functional and aesthetic roles these elements play within urban environments. Understanding these different types helps to assess how gardens contribute to biodiversity, microclimate regulation, and social well-being in urban areas [47]. The geometric shape of the gardens was assessed based on their configuration, such as rectangular, circular, or irregular, to better understand their spatial arrangement. Understanding the configuration helps in assessing how space is utilized within gardens, which can affect factors like the accessibility of green spaces for residents. Additionally, the shape and layout of gardens can reflect broader urban planning patterns and the socio-economic conditions of neighborhoods, as these factors often dictate how much space is available for gardening and how it is organized.

Regarding the floristic study, two types of data were collected: (1) the plant species present in the domestic gardens, determined through careful observations and identification of collected specimens, and (2) residents' practices and perceptions regarding these flora. For plant species nomenclature, the available flora and specialized literature were used [48–50]. The origin status of species was determined by classifying them as exotic if they are not native to a specific geographic region and as indigenous if they originate from the region (here, Africa). The Afro-Asian species were considered as indigenous [49]. This approach distinguished species based on their origin and ecological impact, providing an overview of the floristic diversity of domestic gardens and their influence on the urban environment [51].

Species were also categorized into biological types based on Raunkiaer's classification (1934), which has been adapted for tropical zones with a pronounced dry season [52]. This classification separates species into Phanerophytes (tall, woody plants, such as trees and large shrubs, with buds located high above the ground to survive unfavorable seasons), Chamaephytes (small, woody plants or dwarf shrubs, with buds situated close to the ground, allowing them to endure dry conditions), Hemicryptophytes (plants that have their perennating buds at the soil surface, often protected by soil or leaf litter, which is common in herbaceous species), Geophytes (species that survive adverse seasons with underground storage organs like bulbs, tubers, or rhizomes), Therophytes (annual plants that complete their life cycle quickly and survive unfavorable periods as seeds), and Hydrophytes (aquatic plants that grow in or near water, having adapted to survive submerged or floating environments). This classification helps in understanding the ecological strategies of different plant species within the studied area [14]. Morphological types were distinguished according to Grime's strategy (1975) into three main forms: herbaceous (non-woody stemmed plants), liana (climbing plants), and woody (including trees, shrubs, and bushes). The morphological types of plants, classified by Grime's strategy, reflect how urban planning, socio-economic conditions, and the presence or absence of green spaces influences garden composition and biodiversity across different urban settings [53]. Species dispersal strategies—such as anthropochory (human-mediated), zoochory (animal-mediated), autochory (self-dispersal), hydrochory (water-mediated), and anemochory (wind-mediated)—was evaluated for understanding how plants spread and establish in domestic gardens [54]. This understanding helps identify the influence of human activity and environmental factors on plant diversity, aiding in conservation, sustainable garden management, and the resilience of urban green spaces [55,56].

Finally, the uses and functions of domestic gardens were analyzed by collecting information from residents about the goods and ecosystem services provided by the vegetation and the observed floristic composition. Domestic gardens are distinguished by four main uses: ornamental gardens, where plants are grown for aesthetic beauty, contributing to the enhancement of outdoor spaces and creating pleasant environments; food gardens, which provide edible products such as fruits, vegetables, and herbs, essential for the residents' daily diet; cultural gardens, where certain species have specific cultural importance and are used in rituals, celebrations, or local traditions; and medicinal gardens, where plants are cultivated for their medicinal properties and are used in the preparation of traditional remedies for various ailments [49]. This approach highlighted the diversity of functions of domestic gardens and their multifunctional role in urban environments [57].

2.4. Data Analysis

Analysis of variance (ANOVA) were performed using R software (4.2), to compare the neighborhood types [26]. When significant differences between means were identified, a post hoc Tukey test was applied to compare the means of each pair and determine significantly distinct groups. It should be noted that avenues were treated as repetitions in this analysis. The relative frequency of species was calculated to assess their prevalence within the gardens [16]. Additionally, species classification according to their frequency index was conducted using Caratini's method (1985) [58], as detailed in Table 1. The Caratini method provides a systematic approach to classify species abundance and distribution in domestic gardens, enabling detailed analysis of plant diversity and ecological interactions, which are crucial for understanding urban biodiversity dynamics and ecosystem health. In this study, this method characterizes species based on their relative occurrence in the collected samples, providing a precise measure of their abundance and distribution across the different studied neighborhoods [59]. These statistical analyses offer insights into the variations in the floristic composition of domestic gardens and identify significant trends in the data.

Table 1. Caratini's frequency index classification for species abundance and distribution. Accessory species, though not dominant, enhance biodiversity by providing habitat and resources, supporting ecological functions like nutrient cycling and pest regulation. They contribute to ecosystem resilience and overall health, enriching domestic gardens and benefiting wildlife and humans.

Frequency	Indices	Qualification
0.8 to 1.0	V	Constant
0.6 to 0.8	IV	Abundant
0.4 to 0.6	III	Frequent
0.2 to 0.4	II	Accessory
0.0 to 0.2	I	Rare or accidental

3. Results

3.1. Plot Characteristics

The analysis of Lubumbashi's domestic garden characteristics revealed significant differences between neighborhoods (Table 2). The residential neighborhood showed a higher average number of gardens (2.84 ± 0.6) and a larger average garden area (315.1 ± 336.2 m^2) compared to the unplanned (2.4 ± 0.7 and 154.3 ± 106.6 m^2) and planned neighborhoods (2.04 ± 1.31 and 42.8 ± 57.3 m^2). This trend is also reflected in species richness, which was highest in the residential neighborhood (22 ± 8.272 species) compared to the unplanned (15.96 ± 5.852) and planned neighborhoods (13.355 ± 12.811). The average plot size was also larger in the residential neighborhood (1032.0 ± 205.5 m^2), with a higher proportion of vegetation (31.10 ± 11.6%), contrasting with the unplanned (17.80 ± 10.8%) and planned neighborhoods (14.87 ± 19.0%). These results highlight that domestic gardens in the residential neighborhood exhibit larger sizes, greater floral richness, and higher vegetation proportions compared to those in the unplanned and planned neighborhoods, indicating a more extensive and diverse management of green spaces in this area.

3.2. Distribution of Domestic Garden Shapes, Typologies, and Utilizations across Different Neighborhood Types

Square-shaped gardens are relatively rare across all neighborhood types, with the highest occurrence in planned neighborhoods (2.2%) and the lowest in residential neighborhoods (0.7%). This scarcity indicates that square gardens are uncommon, especially in unplanned and residential areas (Table 3). In contrast, rectangular plots are more prevalent, particularly in unplanned neighborhoods (22.0%), followed by residential areas (19.0%). This suggests that rectangular shapes are better suited to the often irregular layouts of unplanned environments. Irregularly shaped plots dominate across all neighborhood types, with the highest percentage found in residential neighborhoods (80.3%). This predominance reflects the preference or necessity for irregular shapes, indicating flexibility in land use.

Table 2. Characteristics of domestic gardens (DG) and plots across a planned neighborhood (PN), unplanned neighborhood (UN), and residential neighborhood (RN) in the city of Lubumbashi. Mean ± standard deviation; letters indicate significant differences between neighborhood means. *** $p < 0.001$.

Neighborhood Types	Presence of DG (%)	Number of DG	DG Area (m^2)	Species Richness	Plot Area (m^2)
PN	89.0	2.0 ± 1.3 c	42.8 ± 57.3 c	13.355 ± 12.811 c	526.8 ± 192.8 c
UN	90.0	2.4 ± 0.7 b	154.3 ± 106.6 b	15.96 ± 5.852 b	963.0 ± 226.0 b
RN	94.0	2.8 ± 0.6 a	315.1 ± 336.2 a	22 ± 8.272 a	1032.0 ± 205.5 a
p-value	-	***	***	***	***

Table 3. Distribution of domestic garden shapes, typologies, and utilizations across different neighborhood types. Data are expressed in percentage. *n* refers to the number of domestic gardens.

		Neighborhood Type		
		Planned (n = 89)	Unplanned (n = 90)	Residential (n = 94)
Shape	Square	2.2	0.8	0.7
	Rectangular	18.6	22.0	19.0
	Irregular	79.2	77.2	80.3
Typology	Pergolas	2.9	1.6	2.1
	Hedge	9.8	16.5	13.4
	Flowerbed	43.1	38.6	31.7
	Lawn	6.1	11.0	19.0
	Shrubbery	38.0	32.3	33.8
Utilization	Alimentation (Food)	40.7	37.0	32.4
	Ornamentation	35.3	37.0	51.4
	Cultural	4.4	2.4	4.9
	Medicinal	19.6	23.6	11.3

Pergolas are sparse across all neighborhoods, with planned neighborhoods showing the highest occurrence (2.9%). This rarity suggests that pergolas, likely due to their decorative and space-consuming nature, are not a common feature. Hedges are more frequently found in unplanned neighborhoods (16.5%), indicating their role as natural boundaries or privacy screens in less structured environments. Flowerbeds are a prominent feature in planned neighborhoods (43.1%), reflecting more intentional landscaping efforts, whereas their presence decreases in residential neighborhoods (31.7%), where other vegetation or landscaping types may be prioritized. Lawns are most common in residential neighborhoods (19.0%), likely due to cultural preferences for open green spaces around homes. Conversely, they are less common in planned (6.1%) and unplanned neighborhoods (11.0%). Shrubberies are fairly consistent across all neighborhood types, with a slight dominance in planned neighborhoods (38.0%), suggesting their popularity as a versatile landscaping option (Table 3).

The use of domestic gardens for food production (alimentation) is significant, particularly in planned neighborhoods (40.7%), highlighting a strong emphasis on food security or self-sufficiency. Ornamentation is most prevalent in residential neighborhoods (51.4%), suggesting that aesthetic considerations are more emphasized in these areas. Cultural uses of gardens are relatively low across all neighborhood types, with a slight increase in residential neighborhoods (4.9%), reflecting the incorporation of cultural elements in private spaces. Medicinal plants are most common in unplanned neighborhoods (23.6%), possibly due to limited access to formal healthcare, leading to a reliance on traditional remedies (Table 3).

Overall, the data revealed that planned neighborhoods exhibit a more structured approach, with a focus on food production and ornamentation, while unplanned neighborhoods tend to prioritize practical features like hedges and medicinal plants. Residential areas, on the other hand, place greater emphasis on lawns and ornamentation, reflecting a focus on aesthetics and recreational spaces.

3.3. Flora Analysis

The inventory of domestic gardens in Lubumbashi revealed significant floral diversity varying by neighborhood type. The study identified 232 taxa across 68 families, with Araceae, Euphorbiaceae, Asteraceae, and Solanaceae being the most prominent. Notable differences among neighborhoods included 169 species in the unplanned area, 181 in the residential area, and 209 in the planned area. Frequency indices showed that rare or incidental species dominate all neighborhoods: 94.47% in the planned area, 89.35% in the unplanned area, and 80.66% in the residential area. Accessory species are also significant, representing 10.06% in the unplanned area, 4.31% in the planned area, and 16.57% in the residential area. Frequent and constant species are less represented, with no constant species found in the unplanned area. The data revealed that *Mangifera indica* and *Persea americana* are abundant in all neighborhoods, illustrating their adaptability to different urban contexts. The distribution of other species varies by neighborhood: The planned area has a high presence of woody and rare species, while the unplanned area is characterized by a high proportion of rare or incidental species. The residential area stands out for its richness in herbaceous plants and greater diversity of frequent species. These results illustrate how garden management practices and environmental conditions influence floral diversity. The prevalence of species such as *Mangifera indica* and *Persea americana*, along with the diversity of morphological types, provides valuable insights into plant preferences and ecological dynamics within Lubumbashi (See Appendix A).

The analysis of domestic gardens in the studied neighborhoods reveals a marked predominance of exotic species over native ones, with at least 80% of the species being exotic. This dominance is paradoxical given the potential ecological benefits of native species for local biodiversity. The distribution of exotic species is remarkably consistent across neighborhoods, with minor variations. The unplanned neighborhood has the highest proportion of exotic species at 82.25%, which may be attributed to gardening practices that favor the introduction of non-native species. In contrast, the residential area has a slightly higher proportion of native species (~20%), which may be related to the larger plot sizes that facilitate the spontaneous establishment and survival of native species (Figure 2). The dominance of exotic species in Lubumbashi's domestic gardens, despite their homogeneous distribution, raises questions about the long-term impact of these species on local biodiversity, especially in areas where native species have a better chance of establishing themselves.

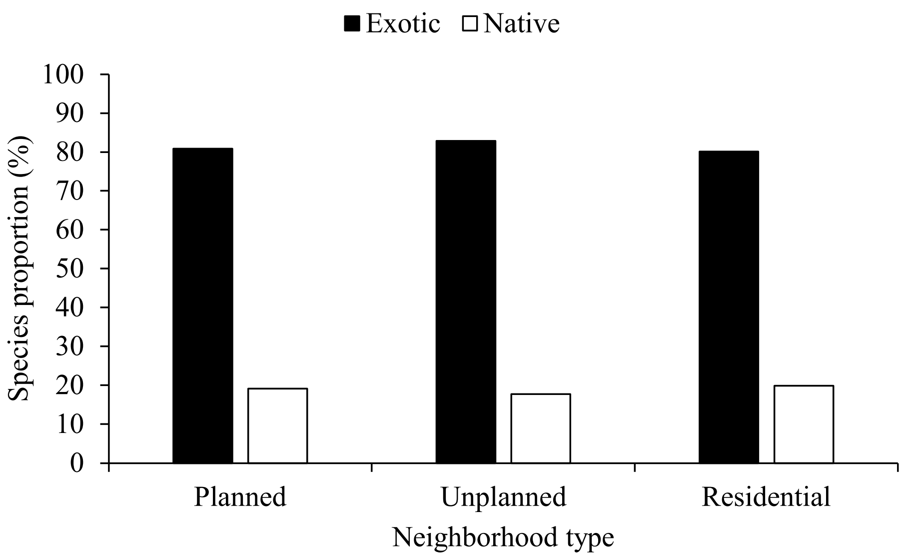

Figure 2. Origin status of plant species inventoried in domestic gardens across neighborhood types.

3.4. Morphological, Biological, and Propagation Characteristics of Domestic Gardens Species across Different Neighborhood Types

The analysis of the morphological types of flora in domestic gardens in the study area showed a clear predominance of herbaceous species across all neighborhoods. These species make up more than half of the floral composition: 57.40% in the unplanned neighborhood, 61.72% in the planned neighborhood, and 60.22% in the residential neighborhood. Woody species are the second most common, with proportions of 38.87% in the unplanned area, 33.97% in the planned area, and 35.36% in the residential area. In contrast, vines are sparsely represented in these gardens, not exceeding 4% in any neighborhood (Table 4). These results highlight the dominance of herbaceous species, likely due to their adaptability and their role in the aesthetics and functionality of gardens. The modest presence of vines may be explained by garden management practices that favor other types of vegetation.

Table 4. Morphological, biological, and propagation characteristics of domestic gardens species across different neighborhood types. Data are expressed in percentage. *n* refers to the number of domestic gardens.

		Neighborhood Type		
		Planned (n = 89)	**Unplanned (n = 90)**	**Residential (n = 94)**
Morphological type	Liana	2.2	0.8	0.7
	Woody	18.6	22.0	19.0
	Herbaceous	79.2	77.2	80.3
Biological type	Phanerophytes	29.7	33.7	30.9
	Chamaephytes	5.7	7.1	6.1
	Hemicryptophytes	3.4	4.1	4.4
	Therophytes	36.8	33.7	32.6
	Epiphytes	1.0	0.6	1.1
	Hydrophytes	0.5	0.6	0.0
	Geophytes	23.0	20.1	24.9
Propagation mode	Hydrochory	0.0	0.0	0.6
	Anemochory	12.0	11.0	11.0
	Anthropochory	86.0	87.0	85.1
	Autochory	1.0	1.0	1.1
	Zoochory	1.0	1.0	1.1

The floral composition of domestic gardens in the three studied neighborhoods is predominantly characterized by therophytes and phanerophytes, reflecting the presence of annual plants and woody species adapted to varying conditions. Geophytes, while secondary, also play a significant role in contributing to the diversity of species. In contrast, hydrophytes and epiphytes are nearly absent, their rarity suggesting environmental conditions or gardening practices that are not conducive to their development (Table 4). These observations highlight a planting strategy focused on more robust species suited to urban environments, leaving little space for species that require more specific conditions.

The analysis results indicated a clear predominance of diaspore dispersal by humans (anthropochory) in the three studied neighborhoods. This phenomenon is particularly pronounced in the planned neighborhood, where 87% of species are dispersed this way, followed closely by the unplanned neighborhood with 86% and the residential neighborhood with 85.05% (Table 4). Anemochory, or wind dispersal, ranks second but at significantly lower levels. Other dispersal modes, such as zoochory or hydrochory, are virtually absent, reflecting a strong human influence on the composition and floral dynamics of domestic gardens in these neighborhoods. This finding underscores the considerable impact of human activities on urban flora, favoring species that can adapt to gardening practices and urban conditions.

4. Discussion

4.1. Methodological Limitations

Selecting only one neighborhood per neighborhood type among more than 40 neighborhoods in the city presents several potential limitations. Specifically, these limitations relate to representativeness, intra-typological variability, and result generalization. However, the chosen neighborhoods were selected based on rigorous criteria to maximize their representativeness for each type [60]. This included preliminary analyses to ensure that the selected neighborhoods are close to the average characteristics of the type. Subsequently, secondary data were used to verify whether the trends observed in the selected neighborhood correspond to those in other neighborhoods of the same type [45]. By following these precautions, selecting a single neighborhood per type does not compromise the validity of the results, provided that the neighborhood is truly representative [61]. Comparative analysis with other studies and cross-validation help reinforce the reliability of the conclusions. Moreover, this approach allows for a more detailed and in-depth analysis of domestic garden characteristics, providing specific insights while limiting biases [31,62].

The seasonal limitation in data collection could affect the reliability of the findings, particularly in relation to plant diversity and ecosystem dynamics. Many species, especially annuals and ephemerals, have seasonal growth patterns, flowering, or fruiting periods that may not coincide with the data collection timeframe. As a result, certain species may be underrepresented or completely absent in the dataset, potentially leading to an incomplete assessment of biodiversity. This can skew the estimates of species richness and composition, particularly for those plants that exhibit strong seasonal variability.

Collecting data only during the dry season in this study presents certain limitations for a complete understanding of the ecological dynamics of domestic gardens. Floristic diversity and garden structure can vary significantly between seasons. Some species may be less visible or dormant during the dry season, which could lead to an underestimation of species diversity and plant cover. By collecting data only during the dry season, there is a risk of missing important observations regarding plant reproduction and dispersal. However, in domestic gardens, plants are often regularly watered, which mitigates the effects of the dry season [63]. Irrigation supports the growth and blooming of many species, making the data representative of plant composition and garden management practices. Plants in domestic gardens are often selected for their drought resistance or ability to thrive in low-humidity conditions. Also, many domestic garden plants, particularly trees and shrubs, are perennial species whose presence and dominance do not vary considerably between seasons [32]. Therefore, the collected data remain reliable for assessing garden structure and composition.

4.2. Shape and Types of Domestic Garden in Relation to Land-Use Planning

The analysis of the data regarding the presence or absence of domestic gardens on plots in the studied neighborhoods revealed a marked trend: The vast majority of plots, approximately 90%, feature domestic gardens. However, this proportion is particularly high in residential neighborhoods compared to non-planned and planned neighborhoods. This observation can be attributed to the larger plot sizes in residential areas, which offer more space for garden establishment. This hypothesis is supported by the Groupe Huit [45] report on the urban planning reference for Lubumbashi, which noted that, in such neighborhoods, the building coverage rarely exceeds half of the total plot area.

The observation that domestic gardens in residential neighborhoods exhibit larger sizes, greater floral richness, and higher vegetation proportions compared to those in unplanned and planned neighborhoods can be attributed also to socio-economic status [15]. Higher socio-economic status in residential areas often correlates with larger land areas and increased disposable income, enabling residents to invest more in their gardens [64]. For instance, affluent neighborhoods in Limpopo Province, South Africa, benefit from extensive properties that allow for diverse and extensive domestic gardens [32]. Cultural and aesthetic preferences also play a significant role [65,66]. In cities like Akure, Nigeria, residents in higher socio-economic neighborhoods place a strong emphasis on aesthetic and recreational spaces, leading to more elaborate and varied garden designs [67]. Similar trends were observed in Kinshasa, DR Congo [34]. Urban planning and development constraints further explain these trends [45]. Planned neighborhoods often face stricter zoning regulations that limit garden size and diversity [68]. Conversely, unplanned areas may have bigger plots, resulting in more extensive green spaces. Economic investment in green spaces is another critical factor. In the Limpopo and North West Provinces in South Africa, residential areas with significant economic resources see enhanced investment in landscaping and garden maintenance, contributing to larger and more diverse gardens [69]. Lastly, community engagement and social practices influence garden management [70]. In Kinshasa, Lubumbashi and Kolwezi, DR Congo, active community involvement often leads to better vegetation care and investment, promoting larger and more diverse green spaces [26,34].

Plot owners often utilize the vacant space to create domestic gardens for various purposes. This correlation between plot size and the presence of domestic gardens is also observed in other studies. For instance, Lubbe et al. [31] demonstrated that plot size directly influences plant diversity and the number of gardens a plot can accommodate. Larger plots are better able to support a variety of plants and multiple types of gardens. This relationship aligns with the findings of Muratet [71] on the vegetation of abandoned lands in the Hauts-de-Seine department, which showed that species richness is largely determined by the area of the land. Thus, plot size affects not only the presence of gardens but also their typology and configuration.

Regarding domestic garden typology, our results indicate a specific trend: in smaller plots, typical of planned neighborhoods, owners tend to create more compact gardens, such as flowerbeds, hedges, and pergolas. This tendency can be explained by the need to optimize the limited available space [72]. In contrast, in residential neighborhoods, where plots are larger, lawns are more common [73]. This is because larger areas allow for the installation of extensive lawns, which require more space [74]. Flowerbeds, on the other hand, are evenly distributed across all sampled neighborhoods, regardless of plot size. Flowerbeds primarily consist of trees, which, due to their height, can coexist with other activities on the plot without disrupting the overall layout. This observation is supported by Ngur-Ikone [75], who noted that flowerbeds are often preferred for their ability to provide shade, serve as windbreaks, and produce fruit, making them particularly attractive to homeowners.

Most domestic gardens have irregular forms, which can be attributed to their placement in non-conventional interstitial spaces. This observation aligns with the findings of Ngur-Ikone [75] and Cameron et al. [76], who also noted a predominance of irregular shapes in urban gardens, often due to the need to adapt gardens to residual spaces or constraints imposed by urban planning. The results show that larger spaces in residential neighborhoods not only support a higher density of gardens but also a greater diversity of garden types, whereas smaller spaces in planned neighborhoods lead to more compact and optimized configurations [77]. Despite the predominance of irregular shapes, reflecting spatial constraints, domestic gardens play a central role in plot design, demonstrating an effective adaptation to urban realities and residents' needs [78].

4.3. Flora and Uses of Domestic Gardens

The analysis of the flora in domestic gardens within the studied neighborhoods highlighted a complex relationship between the level of urban planning and plant species richness. The results indicated significant variation in floral diversity among the gardens, suggesting that socio-economic and historical factors strongly influence the observed plant composition [14]. Firstly, the species richness of domestic gardens appears to be correlated with the degree of neighborhood planning. This observation is supported by the work of Lubbe et al. [31], who indicated that the socio-economic characteristics of residents, as well as their standard of living, play a crucial role in garden plant diversity. For instance, older or historically established neighborhoods, such as those dating back to the colonial era, exhibit greater species diversity compared to more recently developed areas. This trend is corroborated by Makumbelo et al. [79], who observed similar variations in gardens in Kinshasa.

Another factor influencing plant richness is the historical impact on vegetation. The planned neighborhood, although also affected by initial deforestation, recorded a greater species diversity. This can be attributed to the active efforts of residents to reintroduce diverse species into their gardens after deforestation and the toxic atmospheric fallout from mining activities. Research by Shutcha et al. [80] emphasized that harsh environmental conditions have driven residents of planned neighborhood to seek a diverse vegetation that can survive in altered conditions. The abundance of the herbaceous layer in domestic gardens is also significant. This predominance is related to the major use of annual species, as shown by Bernholt et al. [28]. The high proportion of therophytes observed in all studied neighborhoods can be explained by the high density of buildings and the limited space available for gardens. This observation is reinforced by Marco et al. [81] in high-density built-up areas, such as Lauris, where a similar trend was identified.

Finally, specific species such as *Mangifera indica* (mango) and *Persea americana* (avocado) are particularly common in domestic gardens in the study area. These trees provide various urban services, including shading, fruit production, and economic benefits for households. The results are consistent with studies by Makumbelo et al. [79] in Kinshasa, which observed similar trends in the use of plant species in urban environments. The floral diversity of domestic gardens in the studied neighborhoods is the result of a complex interplay between urban planning, historical landscaping practices, and residents' socio-economic needs.

However, it is noteworthy that the planned neighborhood, a newly developed neighborhood, showed lower floral diversity compared to the residential and unplanned neighborhoods, despite the latter being established earlier. The presence of 169 species in the unplanned neighborhood reflects higher biodiversity compared to studies in similar urban environments, where species counts typically range from 65 to 127 species, such as within neighborhoods of Bogota, highlighting the rich flora facilitated by informal gardening practices [64]. In addition, this difference might be attributed to urban planning practices that often involve the removal of existing vegetation to be replaced by exotic species. This practice aligns with findings on species origin status, where exotic species dominate all studied gardens, with proportions ranging from 80.11% to 82.25% depending on the neighborhood. This dominance of exotic species is also observed in other African cities, as highlighted by Bernholt et al. [28], Marco et al. [81], and Bigirimana et al. [49]. The reasons for this dominance include the intentional introduction of plants for ornamental, cultural, and economic purposes [50].

The dominance of exotic plants can lead to a reduction in local biodiversity, as these species often outcompete native plants that are crucial for supporting local wildlife and maintaining ecosystem functions [13]. For example, in Boston, USA, the widespread planting of exotic species has resulted in a decline in native flora, negatively impacting local fauna that rely on native plants [82]. Additionally, exotic species may disrupt essential ecosystem services provided by native plants, such as soil stabilization, water filtration, and pollination [83]. In Paris, France, the introduction of exotic plants in urban green spaces has disrupted local pollinator networks, as native pollinators depend on native plants for food and habitat [84]. Moreover, exotic plants can alter soil chemistry and habitat conditions, making them less suitable for native species [85]. Lastly, the dominance of exotic species can erode the cultural and ecological heritage associated with native plants [86]. In central Europe, the replacement of native plants with exotic species in home gardens has led to the loss of traditional knowledge and cultural practices associated to native flora [87]. In an urban context, the dominance of exotic species in domestic gardens can significantly alter local ecological dynamics. As non-native species become more prevalent, they may outcompete native plants, leading to a decline in urban biodiversity [88,89]. This reduction in indigenous flora can disrupt urban ecosystems, as native plants often support local wildlife, including pollinators, birds, and small mammals. The displacement of these species may reduce habitat quality and food availability for urban fauna, further fragmenting already vulnerable urban ecological networks. Long-term ecological consequences include the degradation of urban ecosystem services such as air quality improvement, stormwater management, and temperature regulation provided by native vegetation. Native plants are often better adapted to local climates and soil conditions, and their replacement by exotic species may impair these essential functions. Additionally [90], the reduction in biodiversity can make urban ecosystems more susceptible to disturbances like pest outbreaks, invasive species, and climate change, undermining the resilience of urban green spaces and their ability to support human and environmental well-being [91].

Cameron et al. [76] emphasized that domestic gardens play a crucial role in urban vegetation, often designed to meet specific needs of their owners. This perspective is reinforced by Loram et al. [92], which asserted that the presence of plant species in a domestic garden is significantly influenced by socio-economic aspects and personal habits, including nutritional, aesthetic, medicinal, and cultural needs. Our results align with these observations. In the studied neighborhoods, the functions of domestic gardens varied according to the socio-economic context. Planned neighborhoods are often designed with a comprehensive master plan that includes designated areas for various purposes. In 2022, the Human Development Index (HDI) of the DRC was 0.479, placing the country in the "low human development" category and ranking it 180th out of 189 countries and territories. Additionally, a large portion of the population lives on less than USD 1.25 per day and typically holds jobs that are less stable [93]. To meet health needs and support human and livestock nutrition, various socio-economically important plants are cultivated in domestic gardens. In the city of Lubumbashi, the species richness in neighborhoods is high, including many native species crucial for local biodiversity conservation. These native species also provide several ecosystem services to residents and surrounding populations. The high frequency of fruit tree species such as *Mangifera indica* (confirmed by previous study, i.e., Useni et al. [26]) and *Carica papaya* may result from human preference due to the ecosystem services these species offer, including shade, edible fruits, and ornamental flowers. *Mangifera indica* (mango) and *Carica papaya* (Papaya) thrive in urban settings due to their adaptability to diverse soil types and climates, coupled with their high economic value and cultural significance, which encourages cultivation. Their fruit-bearing characteristics and aesthetic appeal make them desirable in domestic gardens, contributing to their success and prevalence across various urban environments. Additionally, their leaves and bark are used in traditional medicine, which enhances their popularity despite being an introduced species [94]. Although alien weeds like *Tithonia diversifolia* can negatively impact native biodiversity and agricultural productivity, they also offer significant socio-economic benefits [95]. These gardens also serve for cultivating vegetable species and even cereals such as maize for human consumption. Herbaceous plants like *Nicotiana tabacum* are grown not only for human consumption but also as pesticides for other crops and for use in livestock management [96]. The cultivation of such diverse species underscores the multifunctional value of these gardens for contributing to food security and sustainable agricultural practices within the community. For example, in Bujumbura, Burundi, urban planning promotes the structured use of garden space for both food production and ornamentation [15]. This approach reflects the intentional design of these areas to balance aesthetic and practical functions.

Unfortunately, the consumption of vegetables from urban gardens poses a serious health risk due to high concentrations of trace metals found in these products, specifically in the mining context of Lubumbashi. Studies have shown that vegetables grown in contaminated soils can contain dangerous levels of copper, cobalt, and cadmium, adversely affecting consumer health [97,98]. These metals can cause various health issues, including neurological disorders and kidney diseases [99]. To mitigate this risk, bioponics, a soilless cultivation method, is currently being tested as an alternative [100]. By using nutrient substrates and hydroponic solutions, bioponics allows for better control of growing conditions and reduces the risk of contamination. In contrast, unplanned neighborhoods typically lack formal urban planning, leading to a focus on immediate practical needs [101]. For instance, in informal settlements in Niamey, Niger, gardens often feature practical elements such as hedges for privacy and medicinal plants [28]. Residents prioritize these features due to the absence of structured planning and the necessity to address everyday needs with available resources [102]. In residential areas, especially in more affluent neighborhoods, there is a greater emphasis on aesthetics and recreational spaces. For example, in upscale neighborhoods like those in Niamey (Niger) and Cape Town (South Africa), residents invest in well-maintained lawns and ornamental gardens [103,104]. This trend is driven by higher socio-economic status and a lifestyle that values visual appeal and functional recreational spaces [105].

The vegetation in Lubumbashi's domestic gardens includes some native species; however, these species face a high risk of local extinction due to various factors. Phanerophytes are notably scarce and less frequent in the city's vegetation. Their long-term survival is jeopardized by the combined effects of isolation and insufficient population size [106]. Most therophytes, chamaephytes, and ruderal species are found in gardens that are frequently repurposed for new construction. As vegetated lands are progressively destroyed, even short-lived or ruderal species, whether native or alien weeds, face a significant risk of local extinction. Ornamental species also pose a potential threat to biodiversity. Despite comprising a small proportion of naturalized flora, escaped ornamental plants are among the most invasive in the city, with many others posing high invasion risks [44]. The increasing density of properties, driven by population growth and reduced availability of new land for development, further exacerbates the decline in plant species diversity. Additionally, the allocation of new properties often results in the destruction of public green spaces that previously supported diverse cultivated plants.

4.4. Socio-Ecological Implications

Gardens are dominated by herbaceous plants in high proportions (57.40% in unplanned neighborhood, 61.72% in planned neighborhood, and 60.22% in residential neighborhood). These fast-growing, short-lived plants can influence soil structure and nutrient cycling differently from woody species, which play crucial roles in carbon sequestration and soil stabilization [107]. Their low presence in gardens may limit long-term ecological benefits such as erosion reduction and carbon storage. The predominant anthropogenic dissemination (87% in planned neighborhood) indicates that human practices strongly influence the floristic composition of gardens, potentially reducing ecological resilience and altering local ecosystem functions [50]. To reverse this trend, promoting native plant species, enhancing public awareness of ecological gardening practices, and encouraging natural dispersal methods (zoochory and anemochory) are essential [108]. Implementing community-led garden projects and providing incentives for sustainable landscaping can also help restore biodiversity and strengthen the ecological resilience of urban gardens [109].

Domestic gardens, particularly in the unplanned neighborhood, play a critical role in food security for residents. The food and medicinal gardens in this neighborhood provide essential sources of food and medicine, especially in the context of limited incomes. For example, urban vegetable gardens like those observed in the residential neighborhood allow low-income families to supplement their diets and diversify their nutritional sources. In the residential neighborhood, gardens are more oriented towards environmental and aesthetic functions. The presence of lawns and flowerbeds contributes to improving residents' quality of life by providing attractive and functional green spaces. These green areas support recreational and social activities, enhance community cohesion, and can increase the real estate value of neighboring properties. To improve this situation, integrating food production with environmental and aesthetic functions in all neighborhoods is key [110]. Encouraging the cultivation of both edible and ornamental plants, supporting community garden initiatives, and providing resources for sustainable gardening can enhance food security, improve quality of life, and strengthen community bonds across urban areas [111].

The challenges faced by both (un)planned and residential neighborhoods in Lubumbashi have significant implications for the persistence and functionality of domestic gardens. In unplanned neighborhoods, where plots are often fragmented and sold to different owners, there is a notable risk of reducing the surface area available for gardens or even the complete disappearance of these spaces. This fragmentation can lead to a lack of continuity and coherence in the urban green space, affecting the ecological and aesthetic value of the area. On the other hand, in planned neighborhoods, the increasing density of construction poses a long-term threat to the sustainability of gardens. As the demand for more housing and commercial spaces grows, the pressure to convert green spaces into built environments intensifies, potentially leading to the loss of existing gardens. Additionally, the sale of plots to external investors who frequently demolish existing structures and vegetation for new developments—such as apartment buildings, commercial centers, or service stations—further exacerbates this issue. Such practices undermine the role of gardens in urban sustainability and highlight the need for integrated urban planning strategies that balance development with the preservation of green spaces. To reverse this trend, implementing urban planning policies that protect and promote domestic gardens is essential [112]. Encouraging green space preservation, limiting plot fragmentation, and integrating gardens into new developments can help maintain urban biodiversity, enhance ecological resilience, and ensure the long-term sustainability of green spaces in Lubumbashi [113].

The study revealed that *Mangifera indica* and *Persea americana* are abundant in all neighborhoods. The inclusion of commonly grown species such as *Aloe vera*, *Psidium guajava*, *Ipomoea batatas*, *Cymbopogon citratus*, and *Vitex trifolia* is essential, as these plants also play significant roles in domestic gardens. *Aloe vera* is valued for its medicinal properties and drought tolerance, making it a popular choice in arid urban environments. *Psidium guajava* (guava) is appreciated for its nutritional benefits and adaptability, while *Ipomoea batatas* (sweet potato) serves both as a food source and a ground cover. *Cymbopogon citratus* (lemongrass) contributes to culinary uses and pest deterrence, and *Vitex trifolia* provides ecological benefits such as habitat for pollinators. Discussing these species enriches the understanding of biodiversity in urban gardens and highlights their contributions to ecological and cultural dynamics.

5. Conclusions

The objective of this study was to assess the spatial structure, plant diversity, propagation strategies, and functions of domestic gardens in three Lubumbashi neighborhoods chosen based on their land-use planning levels. The findings revealed significant differences in garden structure across neighborhoods, with planned areas having more organized layouts, while unplanned neighborhoods exhibited varied configurations. Residential neighborhoods, however, stood out with larger average garden sizes (315.1 m^2), higher species richness (22 species), and bigger plot sizes (1032 m^2) compared to both unplanned and planned areas, where gardens are smaller and less diverse. In unplanned neighborhoods, rectangular gardens dominate, whereas planned neighborhoods feature more deliberate landscaping elements such as flowerbeds and hedges. Notably, plant diversity peaks in unplanned areas, where 232 taxa across 68 families were identified, with exotic species comprising 80% of the flora, which is particularly high in these areas (82.25%). Common species like *Mangifera indica* and *Persea americana* were found across all neighborhoods, demonstrating adaptability to urban environments. Unplanned neighborhoods have gardens with more diverse functions, including food, medicinal, and cultural uses, reflecting the lack of urban planning and more challenging socio-economic conditions. Planned areas primarily use gardens for food production (40.7%), while residential neighborhoods emphasize ornamentation (51.4%). Herbaceous species are most prevalent, followed by woody plants, with vines being rare. Human activities (anthropochory) heavily influence species dispersal, accounting for over 85% in all neighborhoods. Despite the study being limited to the dry season and focusing on one neighborhood per type, the results highlight the importance of domestic gardens for urban biodiversity and food security. The findings underscore the predominance of exotic species and anthropogenic influence on plant dispersal. The data suggest that urban management policies should promote local plant diversity and sustainable gardening practices. Additionally, the predominance of gardens for food and ornamentation calls for supporting gardeners to enhance ecological resilience and sustain urban green spaces.

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Appendix A

Table A1. List of species recorded in domestic gardens of three neighborhoods in Lubumbashi with indications of their morphological type (MT: Herb = herbaceous; Lign = woody), propagation strategy (PS: Anthr = anthropochory; Anem = anemochory; Zooc = zoochory; Hydr = hydrochory; Auto = autochory), origin status (OS: N = native; E = exotic),absolute frequency (dash (-) indicates absence of the species in the neighborhood), and uses (F = food; O = ornamentation; C = cultural; M = medicinal). UN = unplanned neighborhood; RN = residential neighborhood; PN = planned Neighborhood.

Family	*Taxa*	MT	*PS*	OS	Absolute Frequency			*Uses*
					UN	RN	PN	
Acanthaceae	*Justicia brandegeeana* Wassh. & L.B.Sm.	Herb	Anthr	E	-	-	0.01	O
	Justicia secunda Vahl	Herb	Anthr	E	0.10	0.06	0.10	O, M
	Megaskepasma erythrochlamys Lindau	Herb	Anthr	E	-	-	0.01	O
	Odontonema strictum (Nees) Kuntze	Herb	Anthr	E	0.14	0.16	0.11	O, M
	Pseuderanthemum atropurpureum (W.Bull) Radlk.	Lign	Anthr	E	0.02	-	0.01	O
	Ruellia simplex C.Wright	Herb	Anthr	E	0.08	0.20	0.13	O, M
	Sanchezia speciosa Leonard	Lign	Anthr	E	0.04	0.20	0.05	M
Agavaceae	*Agave americana* L.	Herb	Anthr	E	0.02	-	0.03	O, M
	Agave sisalana Perrine	Herb	Anthr	E	0.04	0.02	0.04	O, M
	Yucca acuminata Sweet	Herb	Anthr	E	-	0.04	0.01	M

Table A1. *Cont.*

Family	*Taxa*	MT	*PS*	OS	Absolute Frequency			*Uses*
					UN	RN	PN	
Amaranthaceae	*Alternanthera bettzickiana* (Regel) G.Nicholson	Herb	Anthr	E	0.12	0.22	0.15	O
	Alternanthera brasiliana (L.) Kuntze	Herb	Anthr	E	0.12	0.14	0.10	F, O, M
	Amaranthus hybridus L.	Herb	Anthr	E	0.14	0.18	0.13	F
	Amaranthus spinosus L.	Herb	Aném	N	0.14	0.24	0.14	O
	Celosia argentea L.	Herb	Anthr	E	0.04	-	-	M
	Celosia trigyna L.	Herb	Aném	N	0.04	-	0.16	O, M
	Iresine herbstii Hook.	Herb	Anthr	E	0.06	0.08	0.03	C, O
Amaryllidaceae	*Hymenocallis littoralis* (Jacq.) Salisb.	Herb	Anthr	E	0.08	0.20	0.14	O, M
	Zephyranthes candida (Lindl.) Herb.	Herb	Anthr	E	-	0.06	0.03	O, M
Anacardiaceae	*Mangifera indica* L.	Lign	Anthr	E	0.52	0.68	0.69	F, M
Annonaceae	*Annona muricata* L.	Lign	Anthr	E	0.04	0.06	0.05	F, M
Apocynaceae	*Catharanthus roseus* (L.) G.Don	Herb	Anthr	E	0.16	0.14	0.09	O, M
	Nerium oleander L.	Lign	Anthr	E	0.02	0.06	0.01	O, M
	Plumeria alba L.	Lign	Anthr	E	0.04	-	0.01	O, M
	Plumeria rubra L.	Lign	Anthr	E	0.02	0.02	0.01	O, M
	Thevetia peruviana (Pers.) K.Schum.	Lign	Anthr	E	0.02	-	0.04	C, O, M
Araceae	*Aglaonema commutatum* Schott	Herb	Anthr	E	-	0.02	0.05	C, O
	Alocasia macrorrhizos (L.) G.Don	Herb	Anthr	E	0.18	0.08	0.06	O, M
	Alocasia sp.	Herb	Anthr	E	0.08	0.12	0.09	O, M
	Caladium bicolor (Aiton) Vent.	Herb	Anthr	E	0.10	0.16	0.05	O, M
	Caladium lowii Lem.	Herb	Anthr	E	0.06	0.10	0.01	O, M
	Caladium sp.	Liane	Anthr	E	0.22	0.34	0.29	O, M
	Caladium lindenii (André) Madison	Herb	Anthr	E	0.06	0.04	0.02	O
	Colocasia esculenta (L.) Schott	Herb	Anthr	E	0.04	-	0.07	F, M
	Dieffenbachia amoena Bull.	Herb	Anthr	E	0.20	0.24	0.12	O
	Epipremnum pinnatum (L.) Engl.	Liane	Anthr	E	0.08	0.12	0.05	O, M
	Eucharis × *grandiflora* Planch. & Linden	Herb	Anthr	E	0.08	0.16	0.04	O
	Monstera deliciosa Liebm.	Herb	Anthr	E	0.12	0.12	0.05	O, M
	Philodendron speciosum Schott ex Endl.	Herb	Anthr	E	0.04	0.06	0.03	O
	Philodendron giganteum Schott	Herb	Anthr	E	0.12	0.10	0.10	O
	Philodendron lacerum (Jacq.) Schott	Herb	Anthr	E	-	0.04	0.06	O
	Philodendron xanadu Croat, Mayo & J.Boos	Herb	Anthr	E	0.02	-	0.04	O
	Spathiphyllum sp.	Herb	Anthr	E	0.02	0.08	0.03	C, O
	Syngonium auritum (L.) Schott	Herb	Anthr	E	0.06	0.06	0.07	O
	Xanthosoma sagittifolium (L.) Schott	Herb	Anthr	E	0.02	0.18	0.07	F, M
Araliaceae	*Polyscias balfouriana* (André) L.H.Bailey	Lign	Anthr	E	-	0.08	0.05	O
Arecaceae	*Archontophoenix alexandrae* (F.Muell.) H.Wendl. & Drude	Lign	Anthr	E	-	0.02	-	O
	Borassus aethiopum Mart.	Lign	Anthr	E	0.02	0.04	0.01	O
	Chrysalidocarpus lutescens H.Wendl.	Lign	Anthr	E	0.01	0.02	0.01	C
	Cycas revoluta Thunb.	Lign	Anthr	E	-	0.02	0.01	O, M
	Elaeis guineensis Jacq.	Lign	Anthr	E	0.22	0.30	0.14	F, O, M
	Phoenix dactylifera L.	Lign	Anthr	E	0.06	0.08	0.01	F, O, M
Asparagaceae	*Asparagus setaceus* (Kunth) Jessop	Herb	Anthr	E	0.04	0.02	-	O
	Dracaena reflexa Lam.	Lign	Anthr	N	-	0.08	0.05	O, M
	Ledebouria apertiflora (Baker) Jessop	Herb	Anthr	E	-	0.02	-	O, M
	Sansevieria hyacinthoides (L.) Druce	Herb	Anthr	E	0.18	0.12	0.17	C, O, M
Asphodelaceae	*Aloe striata* Haw.	Herb	Anthr	E	0.02	0.06	-	O, M
	Aloe vera (L.) Burm.f.	Herb	Anthr	E	0.34	0.46	0.33	O, M

Table A1. *Cont.*

Family	*Taxa*	MT	*PS*	OS	Absolute Frequency			*Uses*
					UN	RN	PN	
Asteraceae	*Ageratum albidum* (DC.) Hemsl.	Herb	Anem	N	0.16	0.14	0.04	O
	Ageratum conyzoides (L.) L.	Herb	Anem	N	0.20	0.22	0.05	O
	Bidens pilosa L.	Herb	Anthr	N	0.04	0.12	0.04	O, M
	Calea urticifolia (Mill.) DC.	Lign	Anthr	E	0.04	0.04	0.01	O, M
	Conyza pyrrhopappa Sch.Bip. ex A.Rich.	Herb	Anem	N	0.06	0.04	0.07	O, M
	Coreopsis lanceolata L.	Herb	Anthr	E	-	0.04	0.02	O
	Cosmos langlassei (Sherff) Sherff	Herb	Anthr	E	-	-	0.03	O
	Galinsoga parviflora Cav.	Herb	Anem	N	0.06	0.20	0.02	O
	Lactuca serriola L.	Herb	Anem	N	0.08	0.04	0.06	O, M
	Leucanthemum vulgare (Vaill.) Lam.	Herb	Anthr	E	-	-	0.02	O, M
	Sonchus arvensis L.	Herb	Aném	N	-	0.06	-	O, M
	Tagetes patula L.	Herb	Anthr	E	-	-	0.05	O
	Taraxacum sp.	Herb	Anem	N	0.04	0.04	0.06	O, M
	Tithonia diversifolia (Hemsl.) A.Gray	Lign	Anthr	E	0.02	-	0.01	O, M
	Wedelia trilobata A.St.-Hil.	Herb	Anthr	E	0.08	0.06	0.08	O
	Zinnia elegans L.	Herb	Anthr	E	-	-	0.01	O, M
Basellaceae	*Basella alba* L.	Herb	Anthr	E	0.02	0.14	0.05	F, M
Begoniaceae	*Begonia rex* Putz.	Herb	Anthr	E	-	0.12	0.02	C, O
	Begonia sp.	Herb	Anthr	E	0.02	0.14	0.04	C, O
Bignoniaceae	*Jacaranda mimosifolia* D.Don	Lign	Anthr	N	-	0.02	-	O
Brassicaceae	*Brassica chinensis* L.	Herb	Anthr	E	0.06	0.04	0.03	F
	Brassica juncea (L.) Czern.	Herb	Anthr	E	0.01	0.02	0.01	O
Bromeliaceae	*Ananas comosus* (L.) Merr.	Herb	Anthr	E	-	-	0.05	F
Cactaceae	*Opuntia ficus-indica* (L.) Mill.	Lign	Anthr	E	-	-	0.02	O, M
	Opuntia sp.	Lign	Anthr	E	0.02	0.06	0.01	O
Cannabaceae	*Cannabis sativa* L.	Herb	Anthr	E	0.02	0.02	0.01	M
Cannaceae	*Canna indica* L.	Herb	Anthr	E	0.14	0.26	0.14	C, O
Caricaceae	*Carica papaya* L.	Lign	Anthr	E	0.26	0.38	0.28	F, O, M
Caryophyllaceae	*Dianthus carthusianorum* L.	Herb	Anthr	E	0.02	0.06	0.01	O
Chenopodiaceae	*Chenopodium ambrosioides* L.	Herb	Anem	N	0.08	0.12	0.07	O, M
Cleomaceae	*Gynandropsis gynandra* (L.) Briq.	Herb	Anem	N	0.02	-	0.02	O, M
Clusiaceae	*Garcinia huillensis* Welw.	Lign	Anthr	N	-	0.02	-	F
Combretaceae	*Quisqualis indica* L.	Lign	Anthr	E	-	-	0.01	O, M
	Terminalia mantaly H.Perrier	Lign	Anthr	E	0.02	0.06	0.01	O
Commelinaceae	*Callisia fragrans* (Lindl.) Woodson	Herb	Anthr	E	-	0.02	0.06	O, M
	Callisia repens (Jacq.) L.	Herb	Anthr	E	0.10	0.12	0.08	O, M
	Commelina diffusa Burm.f.	Herb	Anthr	N	0.06	0.16	0.03	O, M
	Tradescantia pallida (Rose) D.R.Hunt	Herb	Anthr	E	0.10	0.20	0.05	O
	Tradescantia spathacea Sw.	Herb	Anthr	E	0.06	0.16	0.08	O
	Tradescantia zebrina Bosse	Herb	Anthr	E	0.14	0.24	0.18	O
Convolvulaceae	*Ipomoea batatas* (L.) Lam.	Liane	Anthr	E	0.38	0.40	0.31	F
	Ipomoea cairica (L.) Sweet	Liane	Anthr	N	0.02	0.10	0.06	F, O
	Ipomoea fistulosa Mart. ex Choisy	Lign	Anthr	E	0.04	-	0.02	O, M
Costaceae	*Costus* sp.	Herb	Anthr	E	-	0.02	0.06	O, M
Crassulaceae	*Bryophyllum daigremontianum* (Raym.-Hamet & Perrier) A.Berger	Herb	Anthr	E	0.12	0.18	0.14	O, M
	Bryophyllum pinnatum (Lam.) Oken	Herb	Anthr	E	0.14	0.24	0.16	O, M

Table A1. *Cont.*

Family	*Taxa*	MT	*PS*	OS	Absolute Frequency			*Uses*
					UN	RN	PN	
Cucurbitaceae	*Citrullus lanatus* (Thunb.) Matsum. & Nakai	Liane	Anthr	E	-	-	0.01	F
	Cucurbita moschata Duchesne	Liane	Anthr	E	0.14	0.12	0.14	F
	Luffa acutangula (L.) Roxb.	Liane	Anthr	E	-	0.02	0.02	F
Cyperaceae	*Cyperus involucratus* Rottb.	Herb	Auto	N	-	0.08	0.04	O, M
Dioscoreaceae	*Dioscorea alata* L.	Herb	Anthr	N	0.02	-	0.01	F
	Dioscorea bulbifera L.	Herb	Anthr	N	-	-	0.01	O, M
Dracaenaceae	*Cordyline terminalis* (L.) Kunth	Lign	Anthr	E	0.16	0.28	0.16	O
Euphorbiaceae	*Acalypha godseffiana* Mast.	Lign	Anthr	E	0.08	0.10	0.13	O
	Acalypha wilkesiana Müll.Arg.	Lign	Anthr	E	0.22	0.32	0.24	O
	Breynia disticha J.R.Forst. & G.Forst.	Lign	Anthr	E	0.06	0.04	0.03	O
	Codiaeum variegatum (L.) Rumph. ex A.Juss.	Lign	Anthr	E	0.04	0.10	0.03	O
	Euphorbia characias L.	Herb	Anthr	E	-	0.06	0.01	O, M
	Euphorbia cotinifolia L.	Lign	Anthr	E	0.04	0.02	0.03	O, M
	Euphorbia heterophylla L.	Herb	Aném	N	0.06	-	0.01	O, M
	Euphorbia hirta L.	Herb	Aném	N	0.06	0.08	0.04	O
	Euphorbia milii Des Moul.	Herb	Anthr	E	0.06	0.06	0.04	O, M
	Euphorbia pulcherrima Willd. ex Klotzsch	Lign	Anthr	E	-	0.02	-	O, M
	Euphorbia sp.	Lign	Anthr	E	0.12	0.08	0.17	O
	Euphorbia tirucalli L.	Lign	Anthr	E	0.06	-	0.02	O, M
	Euphorbia trigona Mill.	Lign	Anthr	E	-	0.06	0.01	O
	Jatropha curcas L.	Lign	Anthr	E	0.06	-	0.02	O, M
	Manihot esculenta Crantz	Lign	Anthr	E	0.24	0.16	0.13	F
	Manihot glaziovii Müll.Arg.	Lign	Anthr	E	0.32	0.36	0.15	F, O
	Phyllanthus muellerianus (Kuntze) Exell	Lign	Anthr	N	0.08	0.14	0.04	O, M
	Ricinus communis L.	Lign	Anthr	E	0.04	0.04	0.02	O, M
Fabaceae	*Acacia auriculiformis* Benth.	Lign	Anthr	E	0.08	0.02	0.01	O
	Arachis hypogaea L.	Herb	Anthr	E	-	-	0.03	F
	Bauhinia sp.	Lign	Anthr	E	-	0.02	-	O
	Cajanus cajan (L.) Millsp.	Lign	Anthr	E	0.04	-	0.01	O
	Leucaena leucocephala (Lam.) de Wit	Lign	Anthr	E	0.06	0.14	0.04	O
	Mimosa pudica L.	Herb	Aném	N	0.02	-	-	O
	Phaseolus lunatus L.	Herb	Anthr	N	-	0.02	0.01	F
	Phaseolus vulgaris L.	Herb	Anthr	E	0.02	0.04	0.09	F
	Senna occidentalis (L.) Link	Lign	Aném	E	0.02	0.04	0.02	O, M
	Senna siamea (Lam.) H.S.Irwin & Barneby	Lign	Anthr	E	0.04	-	-	O, M
	Glycine max (L.) Merr.	Herb	Anthr	E	-	-	0.01	F
	Tephrosia vogelii Hook.f.	Lign	Anthr	E	0.04	-	-	O
Iridaceae	*Iris domestica* (L.) Goldblatt & Mabb.	Herb	Anthr	E	0.02	0.04	0.04	O
Labiaceae	*Ocimum basilicum* L.	Herb	Anthr	E	0.06	0.10	0.07	F, M
Lamiaceae	*Ajuga reptans* L.	Herb	Anthr	E	-	0.04	0.02	O
	Ocimum gratissimum L.	Herb	Anthr	E	0.22	0.22	0.08	O, M
	Plectranthus amboinicus (Lour.) Spreng.	Herb	Anthr	N	0.10	0.22	0.12	O, M
	Plectranthus sp.	Lign	Anthr	E	0.12	0.18	0.11	O, M
	Prunella vulgaris L.	Herb	Anem	N	0.18	0.30	0.08	O
	Rosmarinus officinalis L.	Herb	Anthr	E	0.06	0.06	-	O, M
	Salvia officinalis L.	Herb	Anthr	E	-	0.02	0.01	O
	Solenostemon scutellarioides (L.) Codd	Herb	Anthr	E	0.04	0.08	0.08	O
Lauraceae	*Persea americana* Mill.	Lign	Anthr	E	0.48	0.68	0.48	F, M

Table A1. *Cont.*

Family	Taxa	MT	PS	OS	Absolute Frequency			Uses
					UN	RN	PN	
Liliaceae	*Allium fistulosum* L.	Herb	Anthr	E	0.04	0.12	0.05	F
	Allium sativum L.	Herb	Anthr	E	-	0.02	0.01	F, M
	Chlorophytum comosum (Thunb.) Jacques	Herb	Anthr	E	0.02	0.10	0.01	O
	Tulbaghia violacea Harv.	Herb	Anthr	E	0.02	0.02	0.04	O
Lythraceae	*Cuphea hyssopifolia* Kunth	Lign	Anthr	E	0.04	0.04	0.05	O
	Punica granatum L.	Lign	Anthr	E	0.04	0.02	0.01	O, M
Malvaceae	*Abelmoschus esculentus* (L.) Moench	Herb	Anthr	E	0.12	0.06	0.21	F
	Gossypium hirsutum L.	Lign	Anthr	E	-	-	0.01	O
	Hibiscus acetosella Welw. ex Hiern	Herb	Anthr	E	0.14	0.08	0.10	F, O, M
	Hibiscus rosa-sinensis L.	Lign	Anthr	E	0.06	0.10	0.09	F, O, M
	Hibiscus sabdariffa L.	Herb	Anthr	E	0.06	0.03	0.08	F, M
	Hibiscus tiliaceus var. abutiloides (Willd.) Hochr.	Lign	Anthr	E	0.02	0.01	0.01	O
	Malva arborea (L.) Webb & Berthel.	Herb	Anthr	E	-	-	0.07	O
	Malvaviscus arboreus Cav.	Lign	Anthr	E	0.07	0.10	0.15	O
Marantaceae	*Maranta arundinacea* L.	Herb	Anthr	E	-	-	0.06	O, M
Marsileaceae	*Marsilea hirsuta* R. Br.	Herb	Hydr	N	-	0.18	-	O
Meliaceae	*Melia azedarach* L.	Lign	Anthr	E	-	0.02	-	O, M
Moraceae	*Ficus benjamina* L.	Lign	Anthr	E	-	0.04	0.01	O
	Ficus pumila L.	Lign	Anthr	N	-	0.02	0.01	O, M
	Ficus sp.	Lign	Zooc	N	0.01	0.04	0.01	O
	Ficus thonningii Blume	Lign	Anthr	N	-	-	0.01	F, O
	Morus alba L.	Lign	Anthr	E	0.10	0.12	0.01	F, M
Moringaceae	*Moringa oleifera* Lam.	Lign	Anthr	E	0.06	0.04	0.07	M
Musaceeae	*Musa* sp.	Herb	Anthr	E	0.26	0.10	0.10	F
Myrtaceae	*Callistemon speciosus* (Sims) Sweet	Lign	Anthr	E	0.04	0.06	0.03	O
	Eucalyptus sp.	Lign	Anthr	E	0.06	0.04	-	O
	Psidium guajava L.	Lign	Anthr	E	0.36	0,50	0.23	F, M
	Syzygium guineense (Willd.) DC.	Lign	Anthr	E	0.10	0.14	0.11	M
Nyctaginaceae	*Bougainvillea* sp.	Lign	Anthr	E	0.02	0.04	0.05	O
	Mirabilis jalapa L.	Herb	Anem	N	0.02	0.10	0.16	O
Oxalidaceae	*Oxalis triangularis* A. St.-Hil.	Herb	Anem	N	0.08	0.10	0.04	O
Pandanaceae	*Pandanus butayei* De Wild.	Herb	Anthr	E	0.02	0.08	0.09	O
Passifloraceae	*Adenia lobata* (Jacq.) Engl.	Liane	Anthr	E	-	-	0.01	F, O, M
	Passiflora edulis Sims	Liane	Anthr	E	0.06	0.10	0.02	F, O
Pinaceae	*Pinus* sp.	Lign	Anthr	E	0.10	0.08	0.08	C, O
Poaceae	*Arundo donax* L.	Hebarcée	Anthr	E	-	-	0.03	O
	Cymbopogon citratus (DC.) Stapf	Herb	Anthr	E	0.26	0.30	0.15	O, M
	Cymbopogon densiflorus (Steud.) Stapf	Herb	Anthr	E	0.02	-	-	O, M
	Cynodon dactylon (L.) Pers.	Herb	Anthr	N	0.24	0.20	0.10	O
	Eleusine indica (L.) Gaertn.	Herb	Aném	N	0.04	0.20	0.03	O
	Imperata cylindrica (L.) Raeusch.	Herb	Aném	N	0.06	0.06	0.01	O
	Panicum maximum Jacq.	Herb	Aném	N	-	0.02	-	O
	Paspalum notatum Flüggé	Herb	Anthr	E	0.16	0.32	0.01	O
	Pennisetum purpureum Schumach.	Herb	Anem	N	-	0.06	-	O
	Phragmites australis (Cav.) Trin. ex Steud.	Herb	Anthr	N	-	0.02	-	O
	Saccharum officinarum L.	Herb	Anthr	E	0.14	0.22	0.09	F
	Setaria pallide-fusca (Schumach.) Stapf & C.E. Hubb.	Herb	Aném	N	-	-	0.03	O
	Zea mays L.	Herb	Anthr	E	-	0.06	0.04	F

Table A1. *Cont.*

Family	*Taxa*	MT	*PS*	OS	Absolute Frequency			*Uses*
					UN	RN	PN	
Polygonaceae	*Rumex usambarensis* (Dammer) Dammer	Herb	Anthr	E	0.02	-	0.04	O, M
Polypodiacdeae	*Drynaria laurentii* (Christ) Hieron.	Herb	Anthr	N	0.04	0.08	0.02	O
Pontedieraceae	*Eichhornia crassipes* (Mart.) Solms	Herb	Anthr	E	0.02	-	0.01	O
Portulacaceae	*Portulaca grandiflora* Hook.	Herb	Anthr	N	-	-	0.02	O
	Portulaca oleracea L.	Herb	Aném	N	0.06	0.14	0.06	O
Rosaceae	*Fragaria* sp.	Herb	Anthr	E	-	0.02	0.01	F
	Malus domestica Baumg.	Lign	Anthr	E	0.02	-	0.01	F
	Rosa sp.	Lign	Anthr	E	0.10	0.12	0.05	O
Rubiaceae	*Coffea* sp.	Lign	Anthr	E	0.04	-	-	O
Rutaceae	*Casimiroa edulis* La Llave	Lign	Anthr	E	0.06	-	0.02	O, M
	Citrus limon (L.) Osbeck	Lign	Anthr	E	0.34	0.38	0.13	F
	Citrus sinensis (L.) Osbeck	Lign	Anthr	E	0.14	0.06	0.09	F
Solanaceae	*Brugmansia candida* Pers.	Lign	Anthr	E	0.02	0.08	0.01	O
	Capsicum annuum L.	Herb	Anthr	E	0.06	0.02	0.03	F
	Capsicum chinense Jacq.	Herb	Anthr	E	-	0.02	0.01	F
	Capsicum frutescens L.	Herb	Anthr	E	0.02	0.06	0.07	F
	Cestrum nocturnum L.	Lign	Anthr	E	0.06	0.12	0.03	O
	Lycopersicon esculentum Mill.	Herb	Anthr	E	0.12	0.26	0.23	F
	Nicandra indica Roem. & Schult.	Herb	Aném	N	0.02	0.04	0.02	O
	Nicotiana tabacum L.	Herb	Anthr	E	0.04	-	-	M
	Physalis peruviana L.	Herb	Anthr	N	-	-	0.01	O
	Solanum aethiopicum L.	Herb	Anthr	E	0.08	0.04	0.02	F
	Solanum anguivi Lam.	Herb	Anthr	E	-	0.02	0.01	O
	Solanum melongena L.	Herb	Anthr	E	0.02	0.04	0.05	F
	Solanum torvum Sw.	Herb	Anthr	N	0.02	-	0.01	O, M
Typhaceae	*Typha* sp.	Herb	Anem	N	-	0.04	0.01	O
Urticaceae	*Pilea cadierei* Gagnep. & Guillaumin	Herb	Anthr	E	0.02	-	0.03	O
Verbenaceae	*Duranta erecta* L.	Lign	Anthr	E	0.18	0.24	0.16	O
	Duranta repens L.	Lign	Anthr	E	-	0.02	0.01	O
	Lantana camara L.	Lign	Anthr	E	0.10	0.18	0.02	O
	Stachytarpheta indica (L.) Vahl	Herb	Anthr	N	-	-	0.01	O, M
	Vitex trifolia L.	Lign	Anthr	E	0.22	0.32	0.20	O, M

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