

The Role, Necessity, and Presence of Trees in the Urban Landscape of Kinshasa: The Case of the Ngomba-Kinkusa Neighborhood in the Ngaliema Commune

Ndalamba Kabonge Tundra¹; Lumpungu Lutumba Kevin²; Issa Ndeke Bladine³; Olivier Sawa-Sawa⁴; Mvemba Kiniumba Christian⁵; Ebashime Mamba Osée⁶

^{1,2,3,4,5,6} Geophysical Research Center, Environmental Geophysics Department

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Abstract: The results reveal the undeniable importance of trees in urban environments, as illustrated below. Most of the trees planted on individual plots are fruit trees. A total of 511 individuals, belonging to 22 genera, 24 species, and 15 families, were recorded on 111 plots. Among the identified species are: *Mangifera indica* (176 individuals), *Persea americana* (140), *Dacryodes edulis* (45), *Acacia auriculiformis* (27), *Moringa oleifera* (24), *Syzygium malaccenses* (14), *Terminalia mantaly* (12), *Dracaena mannii* (7), *Millettia laurentii* (7), and others. The local population recognizes the economic value of these trees, either by adding a price to the plot when it is sold or by selling the fruit. However, the inhabitants are willing to set a low price to cut down and sell tree stumps on their plots because of their poverty.

Keywords: Role; Tree; Landscape; Urbanization.

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I. INTRODUCTION

Urban life offers many attractions and advantages to those who live there, but it can also have serious consequences that jeopardize our environment and our well-being, both physical and mental (Selmi, 2016).

It is essential to understand the various functions that trees and wooded areas can fulfill in an urban landscape, as they help minimize harmful impacts on our environment (pollution) and our health in many ways. Furthermore, urban trees not only provide ecological and therapeutic benefits, but they can also contribute to our comfort and safety, and play a social, aesthetic, and even economic role (Lessard & Boulfroy, 2008).

Studies conducted over the past twenty years by researchers from around the world on the issue of climate change have shown that the Earth has been experiencing global warming since the beginning of the 20th century (Woodfine, 2010).

The magnitude of this phenomenon in the medium and long term, as well as the impact of corrective measures that humanity could implement, are still the subject of debate among experts. It is already accepted that our climate will inexorably warm over the coming decades, leading to an increase in average temperatures by the end of the 21st century ranging from +2°C for the most optimistic estimates to +6°C for the most catastrophic (Anon, 2011).

For several years, the Democratic Republic of Congo (DRC) has been plagued by secessionist wars, rebellions, and invasions. This situation has plunged the DRC into a socio-economic crisis, one likely consequence of which is its ranking among the poorest countries on the planet, despite its immense natural resources (Tollens, 2004). Tree planting is not only a rural phenomenon, but also, and perhaps primarily, an urban one. Even when not directly involved in agricultural activities, tree stands in cities are part of urban planning, beautification efforts, or agroforestry practices on inhabited plots (Biloso, 2006). The increase in the urban population, uncontrolled urbanization, and poverty are driving the inhabitants of Kinshasa to indiscriminately deforest urban and peripheral vegetation. This is why

Kinshasa is experiencing a serious crisis: environmental degradation, which is leading to a deterioration in the quality of life in urban areas. The link between environmental degradation and health problems is well established (Lelo, 2008).

In the city of Kinshasa, trees constitute an important resource, heavily exploited by the urban population. Trees provide several important services, including protection, economic benefits, regulatory functions, and cultural benefits. Despite the importance of trees in urban areas, they are heavily exploited and felled for various purposes, including the production of timber and charcoal (Biloso, 2006). Tree planting should not be solely a rural phenomenon, but also, and perhaps even more importantly, an urban one. Even when not directly involved in agricultural activities, tree stands in cities or agroforestry practices on inhabited plots play a vital role in improving the quality of life in urban environments.

This study was conducted to analyze the importance of trees in the urban environment of Kinshasa and to demonstrate the different roles they can fulfill.

II. MATERIALS AND METHODS

➤ Study environment

This study was conducted in the Ngomba-Kinkusa neighborhood, Ngaliema commune, in the city of Kinshasa, Democratic Republic of Congo. The Ngomba-Kinkusa neighborhood is bordered by:

- To the north, the districts of Bumba and Djelo-Binza;
- to the south, by the Matshotsho river and the commune of Mont-Ngafula, along the Lukunga river;
- to the east, the municipality of Selembao and the district of Binza-Pigeon;
- To the west, the commune of Mont-Ngafula, more precisely along the Lukunga river (Ngoy, 2016).

➤ Materials

The botanical samples collected, particularly tree leaves, which enabled us to identify species during fieldwork, constituted the main material of our study.

In addition to this material, we used several tools to supplement our research. These tools included:

- Survey forms to collect information from residents of the neighborhood;
- Notepads to record this information for later processing;
- Pens for taking notes and keeping this information on paper;
- A camera with an integrated phone to take pictures of trees and certain samples in plots where owners did not allow the collection of biological material for identification purposes.

➤ Methods

To achieve our objective, we used an observational method which enabled us to create a description, supported by preliminary survey techniques, a questionnaire survey, a floristic inventory, documentation and statistical data analysis.

Given the large number of inhabited plots, which could have been costly for us, we conducted a sample survey, as it covers a representative fraction of the population. A sample of 111 plots with trees was selected in the Ngomba-Kinkusa neighborhood for our survey. We used the following formula:

$$\text{Bernoulli's law: } n = \frac{(1,96)^2 \times N}{(1,96)^2 + i^2 (N-1)}$$

n = sample size

N = number of plots containing trees or statistical universe (equal to 4008)

i = width of the range expressing the margin of error, set at 5% or 0.05

1.96 = the Z value (95%), confidence level (Biloso, 2018).

With this formula, we have a sample of 1111 plots, and given the difficulty of working with such a large number, we took 10% of this number, which gave us a sample of 111 plots with trees.

The data collected in the field were processed manually, but some software, including Word and Excel, was also used to perform statistical analysis of the results. The basic calculations used for the analysis were percentage, mean, standard deviation, and coefficient of variation, which we applied to the different responses, thus categorized, in order to measure central tendency and dispersion.

III. RESULTS

A. Floristic inventory and species diversity

The tree species inventoried in our study area are presented in Table 1 below.

Table 1. Tree Species Identified in the Plot

N°	Vernacular name	Scientific name	Family	Density	%
1	Acacia	<i>Acacia auriculiformis</i> A. Cunn	<i>Fabaceae</i>	27	5.3
2	Woman's tongue	<i>Albizia lebbek</i> Raf.	<i>Fabaceae</i>	06	1.1
3	Mpukumpuku	<i>Anthocleista schweinfurthii</i> Gilg.	<i>Loganiaceae</i>	01	0.1
4	Jackfruit	<i>Artocarpus heterophyllus</i> Lam.	<i>Moraceae</i>	05	0.9
5	Breadfruit tree	<i>Artocarpus incisia</i> Fos.	<i>Moraceae</i>	04	0.7
6	Starfruit Tree	<i>Averrhoa carambola</i> L.	<i>Oxalidaceae</i>	04	0.7
7	Perfume tree	<i>Cananga odorata</i> Lam.	<i>Annonaceae</i>	05	0.9

8	Safoutier	<i>Dacryodes edulis</i> Don.	<i>Burseraceae</i>	45	8.8
9	Boma libala	<i>Dracaena mannii</i> Bak.	<i>Agavaceae</i>	07	1.3
10	Eucalyptus	<i>Eucalyptus citriodora</i> Hook.	<i>Myrtaceae</i>	06	1.1
11	Fig tree	<i>Ficus bubu</i> Warb.	<i>Moraceae</i>	06	1.1
12	Mangosteen	<i>Garcinia mangoustan</i> L.	<i>Clusiaceae</i>	01	0.1
13		<i>Leucena leucocephala</i> Lam.	<i>Fabaceae</i>	01	0.1
14	Mango	<i>Mangifera indica</i> L.	<i>Anacardiaceae</i>	176	34.4
15	Black wood/wenge	<i>Millettia laurentii</i> De Wild.	<i>Fabaceae</i>	07	1.3
16	Moringa	<i>Moringa oleifera</i> Lam.	<i>Moringaceae</i>	24	4.6
17	Lawyer	<i>Persea americana</i> Mill.	<i>Lauraceae</i>	140	27.3
18	Fir tree	<i>Pinus caribaea</i> Morelet	<i>Pinaceae</i>	07	1.3
19	Mbwenge-mputu	<i>Senna spectabilis</i> DC	<i>Fabaceae</i>	0	0.3
20	Manga sende	<i>Spondia cytherea</i> Sonn.	<i>Anacardiaceae</i>	05	0.9
21	Red Apple	<i>Syzygium malaccenses</i> Men.	<i>Myrtaceae</i>	14	2.7
22	Almond tree	<i>Terminalia catapa</i> L.	<i>Combretaceae</i>	03	0.5
23	Thatched tree	<i>Terminalia mantaly</i> L.	<i>Combretaceae</i>	12	2.3
24	Mushakushaku	<i>Trema orientalis</i> (L.) Blume	<i>Ulmaceae</i>	03	0.5
Total				511	100

The results recorded in the table above mention 511 individuals, distributed across 22 genera, 24 species, and grouped into 15 families, which were inventoried in 111 plots. Among the identified species are: *Mangifera indica* (176 individuals), *Persea americana* (140), *Dacryodes edulis* (45), *Acacia auriculiformis* (27), *Moringa oleifera* (24), *Syzygium malaccenses* (14), *Terminalia mantaly* (12), *Dracaena mannii* (7), *Millettia laurentii* (7) ... The other species are poorly represented.

B. Families Represented

The results recorded in Figure 1 below tell us that the *Fabaceae* family dominates with 5 species, followed by the *Moraceae* (3 species), the *Anacardiaceae* (2 species), the *Combretaceae* (2 species), the *Myrtaceae* (2 species); while the other families have only one species each.

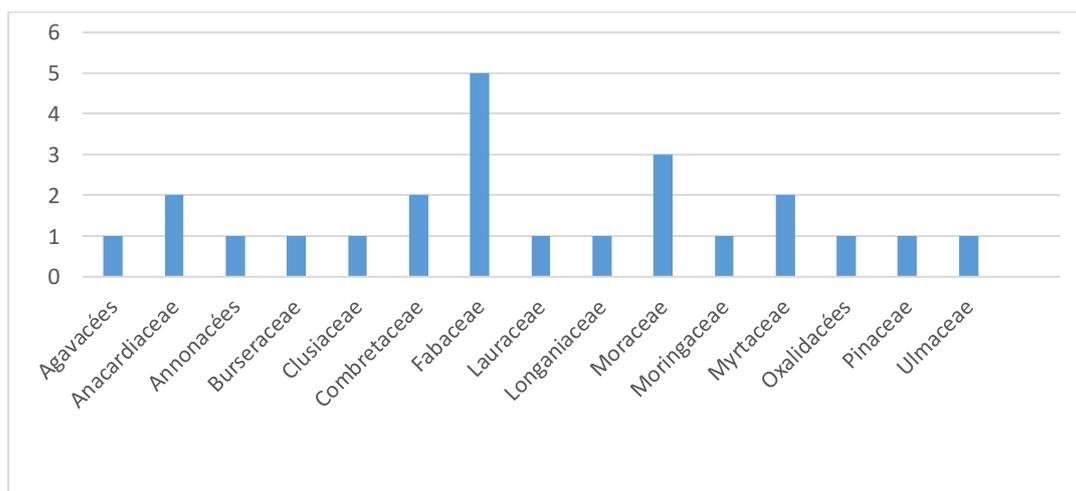


Fig 1. Specific Wealth of Families

C. Origin of the Trees on the Plot

The results on the origin of the trees in the surveyed plots are presented in Table 2 below.

Table 2. Distribution of Respondents According to the Origin of Trees in the Plot

Origin of trees	Frequency	%
Planting	100	90.1
Spontaneous regeneration	11	09.9
Total	111	100

The table above shows that the trees in the studied plots are mostly planted, i.e. 90.1%; compared to 9.9% of the trees which have undergone natural tree regeneration.

D. Tree Planting Methods

The data in Table 3 below provides information on the method of planting the trees.

Table 3. Distribution of Respondents According to Tree Planting Method

Planting Method	Frequency	%
Sowing	99	99
Cuttings	01	01
Total	100	100

The results in Table 3 show that almost all respondents, 99%, used sowing for tree propagation, while 1% used cuttings. It should be noted that cuttings were used for planting *Moringa oleifera* .

➤ **Conflicts Relating to Trees on Plots of Land**

The results presented in Figure 2 below on conflicts related to trees planted near neighboring plots tell us that the majority of respondents, 61%, do not acknowledge having conflicts related to trees, compared to 39% who claim to have conflicts related to plot trees .

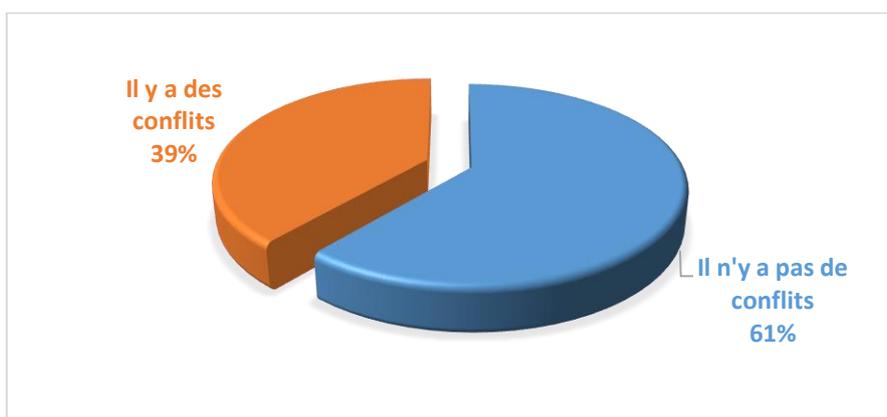


Fig 2. Conflicts Related to Trees on Plots of Land

E. Contribution of Trees to Climate Change

Table 4 below presents the results on the contribution of trees to climate change.

Table 4. Distribution of Respondents According to the Contribution of Trees to Climate Change

Contribution of trees on individual plots	Frequency	%
Heat reduction	43	38.7
Oxygen release	32	28.8
Creating shade	24	21.6
Carbon sequestration	7	6.3
Participation in the water cycle	5	4.5
Total	111	100

The table above shows that 38.7% of respondents mention heat mitigation, 28.8% oxygen release, 21.6% shade creation, 6.3% carbon sequestration and finally 4.5% participation in the water cycle.

➤ **Tree Cutting Procedure**

The results regarding the procedure followed by respondents for cutting down trees on their property lines, presented in Figure 4 below, reveal that 79% cut down trees without a felling permit; conversely, 21% request permission before felling the tree. This request for permission is submitted to the municipal authority for its opinion.

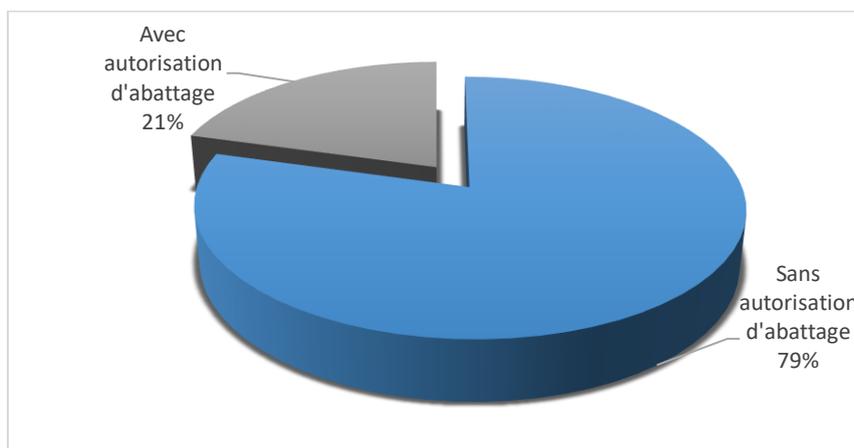


Fig 4. Slaughtering Procedure Followed

➤ *Economic Value of Trees in Urban Areas*

The results on the influence of trees in the sale of plots, which are presented in Figure 5 below, reveal that 78% of respondents stated that the base of trees influences the sale price of the plot, while 22% do not attach importance to trees when selling plots.

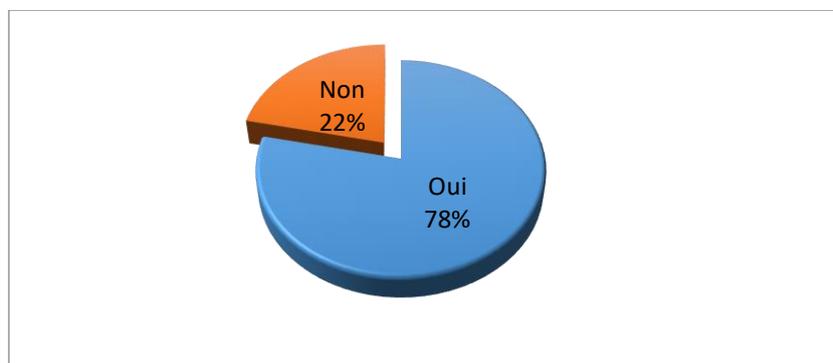


Fig 5. Respondents' Opinions on the Influence of the Tree in the Sale of the Plot

➤ *Estimated Selling Price of Trees*

The estimates given by the respondents and the statistical analyses are shown in Table 05 below.

Table 5. Estimated selling price of each tree

No.	Species	Selling price in FC					
		N	min	max	\bar{x}	S	resume
1	<i>Acacia auriculiformis</i> A. Cunn.	27	5000	14,000	9129.6	2827.0	30.9
2	<i>Albizia lebbek</i> Raf.	06	5000	14,000	9666.6	3141.1	32.4
3	<i>Anthocleista schweinfurthii</i> Gilg.	01	6000	6000	6000	-	-
4	<i>Artocarpus heterophyllus</i> Lam	05	7000	20,000	14300	5118.5	35.7
5	<i>Artocarpus incisia</i> Fos.	04	8000	28,000	17750	8421.2	47.4
6	<i>Averrhoa carambola</i> L.	04	5000	18,000	12000	5715.4	47.6
7	<i>Cananga odorata</i> Lam.	05	10,000	60,000	34000	19170.2	56.3
8	<i>Dacryodes edulis</i> Don.	45	8000	45,000	16966.6	7451.6	43.9
9	<i>Dracaena mannii</i> Bak.	07	3000	12,000	7357.1	3275.1	44.5
10	<i>Eucalyptus citriodora</i> Hook.	06	4000	15,000	9750	4168.3	42.7
11	<i>Ficus bubu</i> Warb.	06	3000	9000	6083.3	2289.4	37.6
12	<i>Garcinia mangoustan</i> L.	01	60,000	60,000	60,000	-	-
13	<i>Leucena leucocephala</i> Lam.	01	4000	4000	4000	-	-
14	<i>Mangifera indica</i> L.	176	7000	50,000	22343.7	13465.7	60.2
15	<i>Millettia laurentii</i> De Wild.	07	4000	15,000	10071.4	3812.5	37.8
16	<i>Moringa oleifera</i> Lam.	24	10,000	30,000	19,437.5	5780.9	29.7
17	<i>Persea americana</i> Mill.	140	10,000	55,000	22353.5	8648.7	38.6
18	<i>Pinus caribaea</i> Morelet	07	30,000	70,000	49714.2	11714.8	23.5
19	<i>Senna spectabilis</i> DC	02	4000	16,000	10000	8485.2	84.8

20	<i>Spondia cytherea</i> Sonn.	05	6000	25,000	16600	7127.4	42.9
21	<i>Syzygium malaccenses</i> Men.	14	12,000	40,000	25607.1	8797.2	34.3
22	<i>Terminalia catapa</i> L.	03	6000	17,000	11000	5567.7	50.6
23	<i>Terminalia mantaly</i> L.	12	4000	20,000	6583.3	2244.5	34.1
24	<i>Trema orientalis</i> (L.) Blume	03	4000	10,000	6666.6	3055.1	45.8

Legend: (n): frequency; (min): minimum; (max): maximum; (\bar{x}): mean; (S): standard deviation; (CV): coefficient of variation.

Based on the results recorded in the table above, it is clear that *Pinus caribaea* has the highest economic value ($49,714.28 \pm 11,714.8$ Fc), followed by *Cananga odorata* ($34,000 \pm 19,170.2$ Fc), *Syzygium malaccenses* ($25,607.14 \pm 8,797.2$ Fc), *Persea americana* ($22,353.57 \pm 8,648.7$ Fc), *Mangifera indica* ($22,343.75 \pm 13,465.7$ Fc), *Moringa oleifera* ($19,437.5 \pm 5,780.9$ Fc), *Arthocarpus incisia* ($17,750 \pm 8,421.2$ Fc), *Dacryodes edulis* ($16,966.66 \pm 7,451.6$ Fc), and *Spondia cytherea* (16600 ± 7127.4 Fc), *Arthocarpus heterophyllus* (14300 ± 5118.5 Fc), *Averrhoa carambola* (12000 ± 5715.4 Fc). The other species have low economic value.

IV. DISCUSSION

The analysis of data from our research in 111 plots in the Ngomba-Kinkusa district has highlighted the results which we analyze and compare with similar studies.

Regarding the inventory, 511 individual trees, belonging to 22 genera, 24 species, and 15 families, were recorded in 111 plots. Among the species recorded were: *Mangifera indica* (176 individuals), *Persea americana* (140 individuals), *Dacryodes edulis* (45 individuals), *Acacia auriculiformis* (27 individuals), *Dracaena mannii* (7 individuals), and other species with low density. This differs from the results of Mwabikungu (2017), who inventoried 587 individual trees belonging to 32 genera, 35 species, and 22 families in a sample of 100 plots in the Residential Quarter of the Limete Commune.

Regarding origin, the majority of trees in the studied plots were planted (90.1%), while 9.9% had undergone natural regeneration. This aligns with the findings of Bimbeni (2015), who indicated that most of the trees present were planted (88%), while 12% of respondents had trees resulting from natural regeneration. This also corroborates the results of Ncutirakiza et al. (2017), who found that the majority of trees in the plots were planted.

Furthermore, the results on the average price estimation of each tree indicate that the species *Pinus caribaea* has the highest economic value ($49,714.28 \pm 11,714.8$ Fc), followed by *Cananga odorata* ($34,000 \pm 19,170.2$ Fc), *Syzygium malaccenses* ($25,607.14 \pm 8,797.2$ Fc), *Persea americana* ($22,353.57 \pm 8,648.7$ Fc), *Mangifera indica* ($22,343.75 \pm 13,465.7$ Fc), *Moringa oleifera* ($19,437.5 \pm 5,780.9$ Fc), *Arthocarpus incisia* ($17,750 \pm 8,421.2$ Fc), *Dacryodes edulis* ($16,966.66 \pm 7,451.6$ Fc), and *Spondia cytherea* (16600 ± 7127.4 Fc), *Arthocarpus heterophyllus* (14300 ± 5118.5 Fc), *Averrhoa carambola* (12000 ± 5715.4 Fc). The other species have low economic value.

Looking at the prices estimated by the respondents mentioned above, we say that the economic value given to plot trees is not well known, because according to Lelo (2008), in the case of compensation after expropriations for reasons of public utility, the damages and interest set at:

\$295/avocado tree; \$251/mango tree; \$170.76/apple, safou and breadfruit tree.

V. CONCLUSION

The constant concern of this study has been to analyze the importance of trees in the urban environment of the DRC, with a view to supporting political decision-makers and planners in reforesting degraded sites.

To achieve our objectives, we proceeded by the method of direct observation in the field, supplemented by floristic inventory and survey.

At the end of our investigations, the results found reveal that the importance of trees in urban environments is undeniable, as illustrated in the following lines.

The majority of trees on the plots are planted; and among these trees, almost all are fruit trees. This proves that the inhabitants of the Ngomba-Kinkusa neighborhood value planting fruit trees.

Regarding their role, the inhabitants attribute to the trees more the function of releasing oxygen and creating shade; while for their use, food and aesthetics dominate.

Regarding the economic value attributed to trees, the majority believe that the presence of tree bases influences the selling price of the plot; on the other hand, the inhabitants are willing to set a low price to cut down and sell the tree bases on their plots because of poverty.

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