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# Aerial Biomass and Carbon Stock Study in Plot Trees in the Boyera District in the City of Mbandaka, Equateur Province in DR-Congo

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**Abstract:** This note consisted in estimating the above-ground biomass and the carbon stock contained in plot trees in Quartier Boyera in the city of Mbandaka, Equateur Province in DR-Congo. The general objective of this study was to inventory the plot trees in order to assess the above-ground phytomass and the sequestered carbon stock. We used the method of observation (description, analysis and inventory) supported by allometric measurements. A one-hectare experimental set-up made it possible to identify all trees with a diameter ≥ 10 cm DBH. The data thus obtained was subjected to statistical processing. The main results obtained for the whole flower are 10 species belonging to 8 families of which the Anacardiaceae predominate. A density of 150 trees per hectare; the basal area measurements amount to 21.77 ± 0.07m2 / ha; an aerial phytomass of 46.02 ± 0.35 t .ha-1 equivalent to 21.63 ± 0.17 t .ha-1 of sequestered atmospheric carbon and 72.83 ± 0.56 t .ha-1 equivalent carbon. Mangifera indica prime or 47 trees, a basal area of 8.41 ± 0.07m2 / ha; 24.69 ± 0.52 t .ha-1 of above-ground biomass; and the calculated mass of organic carbon 11.60 ± 0.25 t .ha-1. For the rest of the species the results are poor. Thus, the Boyera District constitutes a relatively important site for sequestering atmospheric carbon, contributing to the fight against climate change. It turns out that this type of urban ecosystem really makes an obvious environmental service.

**Keywords:** aerial phytomass, carbon, trees, plots, Boyera district, Mbandaka, DR-Congo

**Résumé:** Cette note a consisté à estimer la biomasse aérienne et le stock de carbone contenu dans les arbres parcellaires au Quartier Boyera dans la ville de Mbandaka, Province de l'Equateur en RD-Congo. L'objectif général de cette étude a permis d'inventorier les arbres parcellaires afin d'évaluer la phytomasse aérienne et le stock de carbone séquestré. Nous avons utilisé la méthode de l'observation (description, analyse et inventaire) appuyée par les mesures allométriques. Un dispositif expérimental d'un hectare a permis de répertorier tous les arbres ayant un diamètre ≥ à 10 cm DHP. Les données ainsi obtenues ont fait l'objet de traitement statistique. Les principaux résultats obtenus pour l'ensemble de la florule font état de 10 espèces appartenant à 8 familles dont les *Anacardiaceae* prédominent. Une densité de 150 arbres par hectare ; les mesures de surfaces terrières s'élèvent à 21,77 ± 0,07$m^2$/ha ; une phytomasse aérienne de 46,02 ± 0,35 t .$ha^{-1}$ équivalent à 21,63 ± 0,17 t .$ha^{-1}$ de carbone atmosphérique séquestré et 72, 83 ± 0,56 t .$ha^{-1}$ d'équivalent carbone. *Mangifera indica* prime soit 47 arbres, une surface terrière de 8,41 ± 0,07$m^2$/ha ; 24,69 ± 0,52 t .$ha^{-1}$ de biomasse aérienne ; et la masse de carbone organique calculée 11,60 ± 0,25 t .$ha^{-1}$. Pour le reste d'espèces les résultats sont faibles. Ainsi, le Quartier Boyera constitue un site relativement important de séquestration de carbone atmosphérique, contribuant à la lutte contre le changement climatique. Il ressort que ce type d'écosystème urbain rend réellement un service environnemental évident.

**Mot-clés:** phytomasse aérienne, carbone, arbres, parcelles, Quartier Boyera, Mbandaka , RD-Congo

## 1. Introduction

One of the environmental issues of concern to the international community is the increased levels of greenhouse gases in the atmosphere (Raven et al. 2009). Of these gases, carbon dioxide is the most important (Kidikwadi, 2012). Our approach is part of the (REDD +) process, advocating the conservation and reforestation of degraded forest lands and secondary forests. Climate change is today a subject of concern and concern for the entire international community, but at the same time a theme for the search for lasting solutions. Among ecosystems, forests in general and tropical forests in particular play an important role in reducing the rate of greenhouse gases (Lubini, 2001; Lubini et al. 2014).

Trees are perennial plants and they play a major role in the terrestrial ecological functioning, due to their capacity to store carbon, their annual dry matter production corresponds to two thirds of the world production of terrestrial plants.

One way to mitigate global warming is to remove CO2 from the air by planting trees and keeping existing ones, like other green plants, trees incorporate carbon into the organic matter of leaves, stems and roots. through photosynthesis.

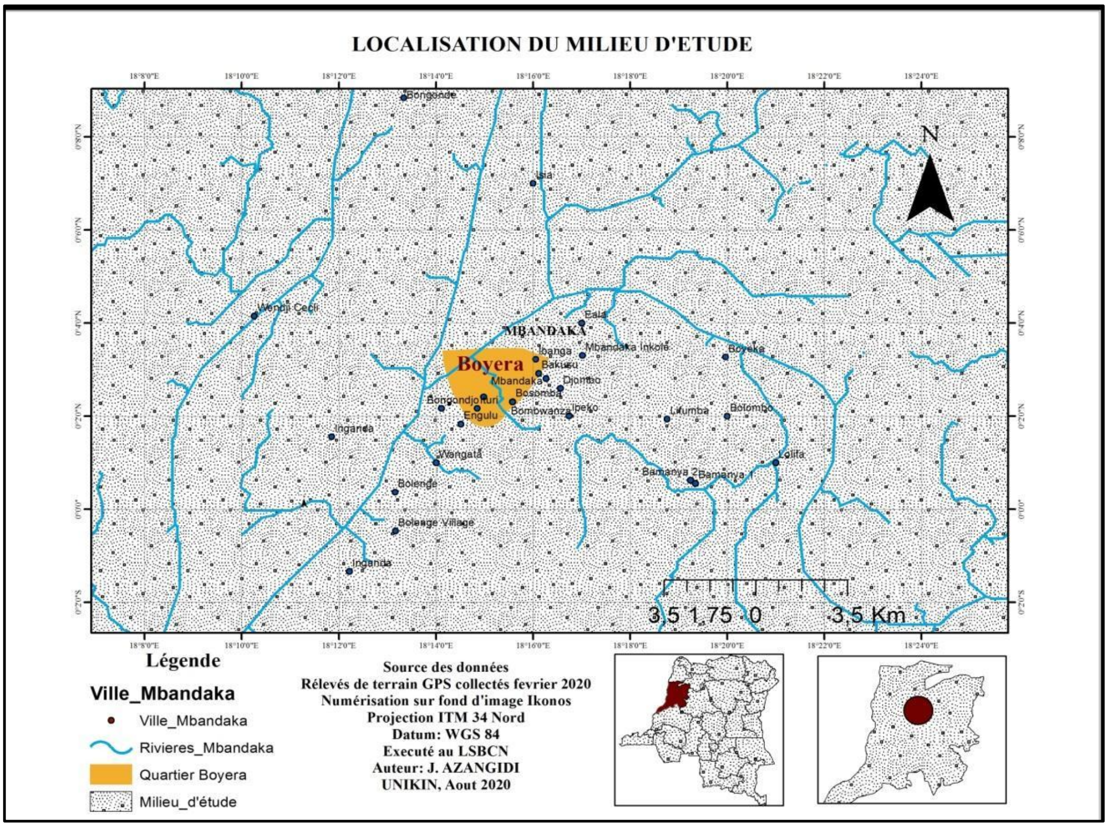
The town of Mbandaka constitutes an urban ecosystem for which the data available on the measurements of the above-ground biomass of trees planted in the plots are not known. In the absence of adequate allometric equations adopted in the forests of the Congo Basin, we propose to use the model developed by Chave et al. (2005); Lubini et al. (2014) ; Kidikwadi et al. (2015).

This is why we undertook this study on the estimation of the aboveground biomass and carbon stock contained in the plot trees of the Boyera Quarter located in the Wangata Commune in Mbandaka.

## 2. Material and Methods

### 2.1.1 Materiel

Herbarium specimens were collected from the targeted plots in Quartier Boyera, Wangata Commune in Mbandaka City, Equateur Province. These botanical samples were collected for scientific identification in the laboratory and to constitute the reference herbarium. Map 1 locates the study area in the town of Mbandaka.




Map 1. Study cartographic area (Source: original map)

### 2.1.2 Methods

Plot trees were inventoried in a one-hectare scheme in Quartier Boyera. Inventories were limited to trees with dbh ≥ 10 cm at 1.3 m from the ground conventionally accepted (Lubini et al., 2014; Kidikwadi, 2018).

The measurement of the circumference of the trees was made using a circumferential tape in cm.

Measurements of the diameters of all individuals were used to establish the diameter classes. To determine the number of diameter classes, we were inspired by the formula established by Lethielleux (2013).

Burgun (2012) states that the number of diameter class noted k is given by the following formula:
$k = 1 + 3.3\log n$; where n = sample size. The amplitude noted h is calculated using the formula as shown:
h = Extent / k; where h = amplitude; E = extent; k = number of diameter class; the range is given by E = maximum value - minimum value (Kidikwadi, 2018; Kidikwadi et al., 2019).

he basal area corresponds to the sum of the areas of the sections 1.3 m above the ground of all the trees with dbh ≥ 10 cm inventoried in the inventory system. It is expressed in m2 / ha. The formula used looks like this:

G = πdhp2 / 4; Where: G = basal area; dbh = diameter at 1.3 m from the ground of the tree; π (pie) = 3.14 (Gounot, 1969; Sonké, 2004; Belesi, 2009; Boyemba, 2011; Lubini et al., 2014; Kidikwadi et al., 2015; Kidikwadi et al., 2019).

Calculations of the above-ground biomass of trees were made by applying the allometric equations established by Chave et al. (2005) applied by several authors (Ibrahima and Albib, 2008; Toung, 2010; Kidikwadi, 2012; Lubini et al., 2014; Kidikwadi et al., 2015). The aerial phytomass of the trees measured is obtained using allometric equations.

he estimated amount of carbon is multiplied by a coefficient of 3.667 in order to calculate the carbon equivalent as established elsewhere (IPCC, 2007a, 2007b; Lubini et al., 2014).

ANOVA's Fisher test verified the existence of a possible significant difference between the mass of biomass, carbon and carbon equivalent of each species studied. The Pearson correlation test consisted of establishing the relationship between the parameters studied: diameter, biomass.

## 3. Results

### 3.1.1 Florule composition

The inventory of parcel trees showed 10 species grouped into 8 families and subfamilies, of which the Anacardiaceae predominate. The prevalence of these species is justified by their food use. The results are shown in Table 1.

Table 1. Composition of the flower.

| Families | species |
|---|---|
| *Anacardiaceae* | *Mangifera indica* L. *Spondiase cytherea* Sonner *Spondiase mombin* L. |
| *Lauraceae* | *Persea americana* Mill. |
| *Combretaceae* | *Terminalia catappa* L. |
| *Burseraceae* | *Dacryodes edulis* G.Don) H.J. Lans |
| *Sapindaceae* | *Nephelium lappaceum* |
| *Myrtaceae* | *Syzygium malaccense* L. |
| *Fabaceae/Mimosoideae* | *Acacia auriculiformis* A. Cunn Ex Benth. |
| *Moraceae* | *Artocarpus altilis* Fosberg |

### 3.1.2 Density

We have identified a total of 150 trees in Quartier Boyera. Mangifera indica predominates with 47 stems and Syzygium malaccense 37 trees. The rest of the species the density is low. As we have reported, the dominance of Magnifera indica is justified by the fact that it is of interest from a dietary point of view. Figure 1 gives the details of the results obtained.

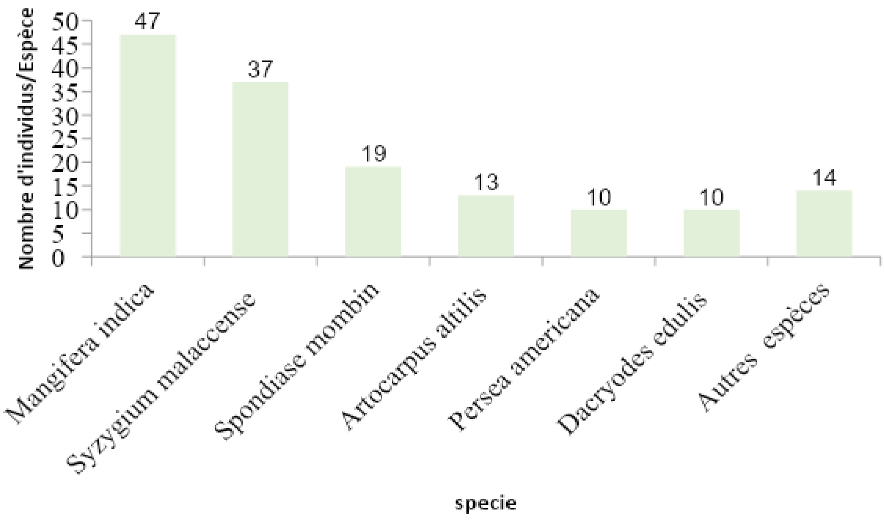
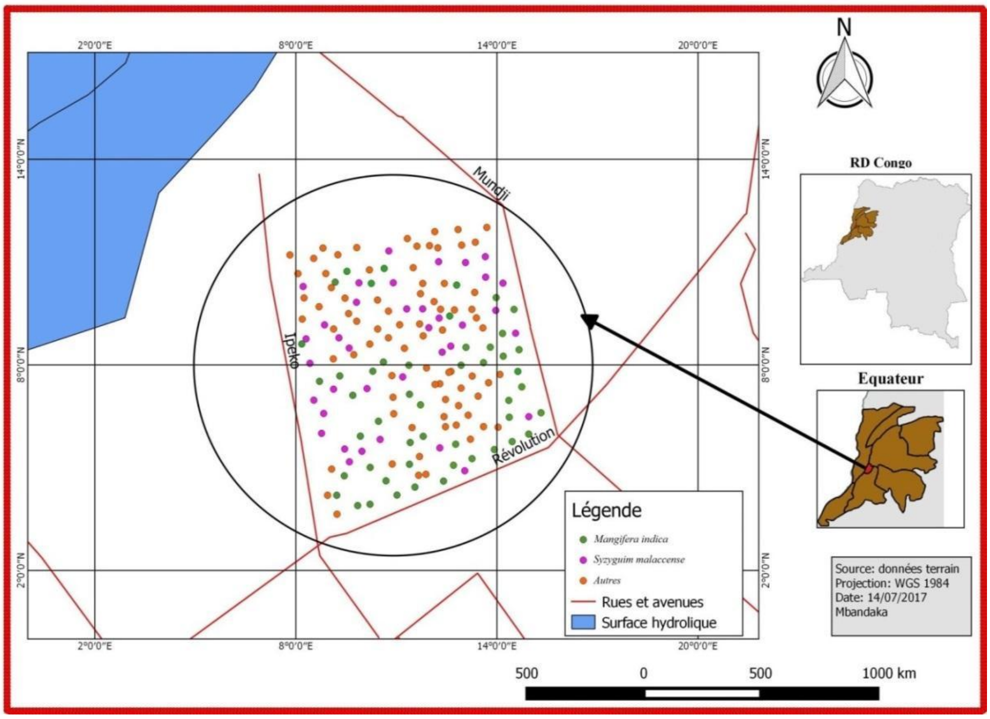



Figure 1. Stem density by species in the study area

### 3.1.3 Spatial distribution of parcel trees

Map 2 gives the spatial distribution of plot trees in Quartier Boyera in the town of Mbandaka. Individuals of Mangifera indica are concentrated in residential plots.




Map 2. Spatial distribution of parcel trees

### 3.1.4 Individual variation in circumference and diameter

Egarding the circumference and diameter measurements of the species, we calculated for each of the individuals of the urban florula studied. Circumference and diameter measurements vary from individual to individual (Appendix Table 1).

Indeed, the large individual reaches a circumference of 141.4 cm at most and 52 cm at minimum. The maximum diameter is a minimum of 45 cm and 16.56 cm (Figure 2). Analysis of variance applied between the circumferences and diameters of different individuals yields a significant difference between individuals, with (ANOVA, F = 506.1; df = 178.9; p = 4.783).

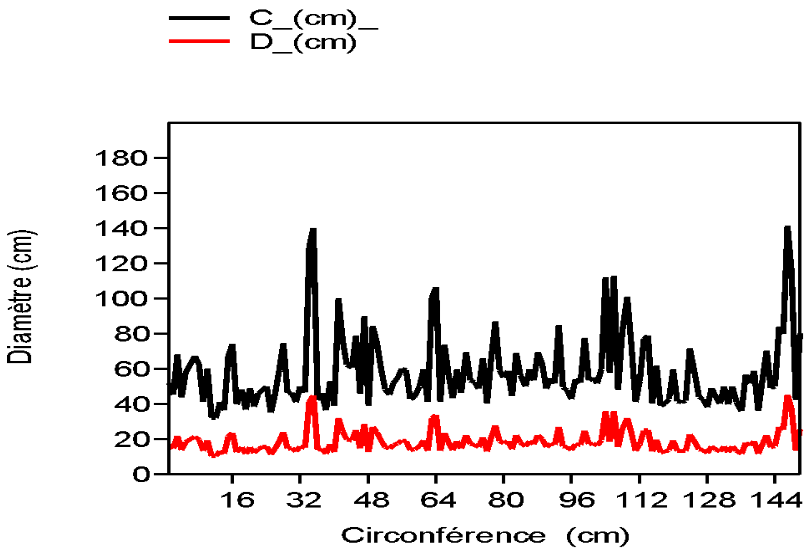



Figure 2. Individual variation in circumference and diameter

**3.1.5 Relationship between circumference and diameter**

We sought to establish the relationship between the circumference and the diameter of the trees listed. The Pearson test applied demonstrates a relationship between the two variables studied, with r = 1; at p-value 0.0001. Figure 3 shows the simple allometry between circumference and diameter.

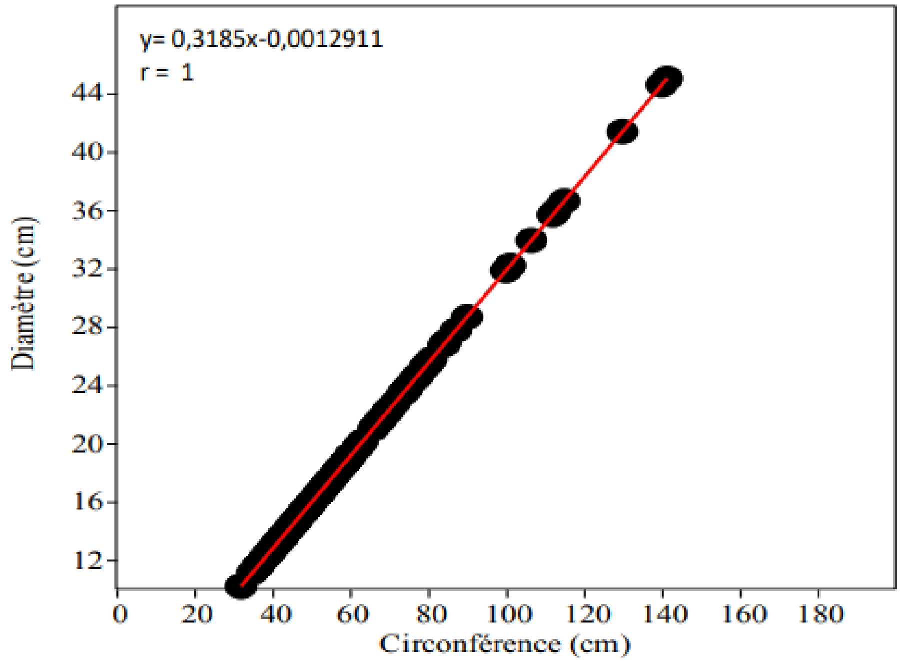
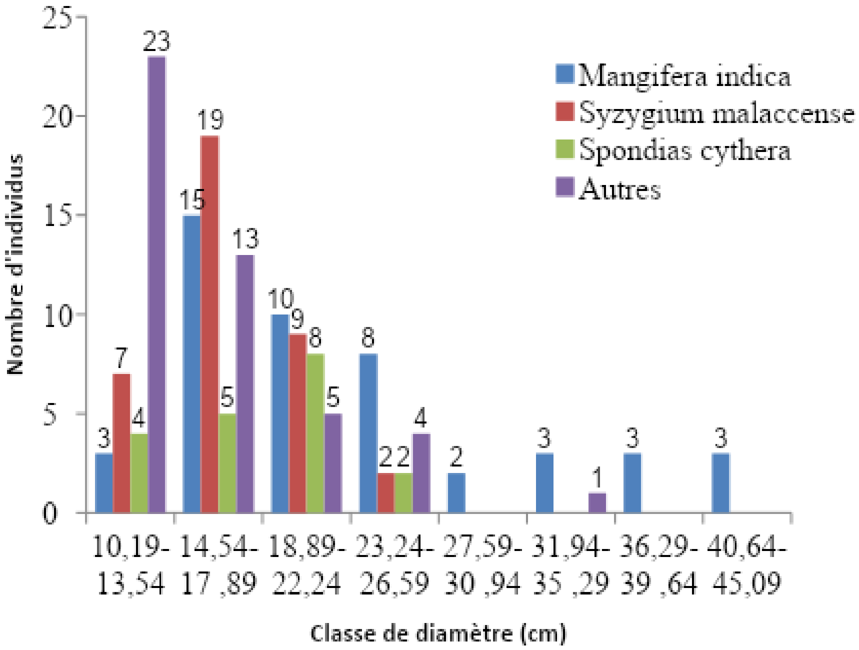



Figure 3. Simple allometry between circumference and diameter

**3.1. 6 Diameter structure of the measured shafts**

The diameter structure of the trees inventoried can be clearly seen from the examination of Figure 4. Mangifera indica always occurs in all diameter classes. This diameter structure helps the dominance of the species in inhabited patches. The future of Mangifera indica looks bright.



**3.1.7 Basal area measurement**

Basal area measurements were calculated for all the trees inventoried, ie 21.77 ± 0.07 m2 / ha. Of this value, Mangifera indica prime is 8.41 ± 0.07 m2 / ha. Figure 5 gives the basal area details of the trees measured.

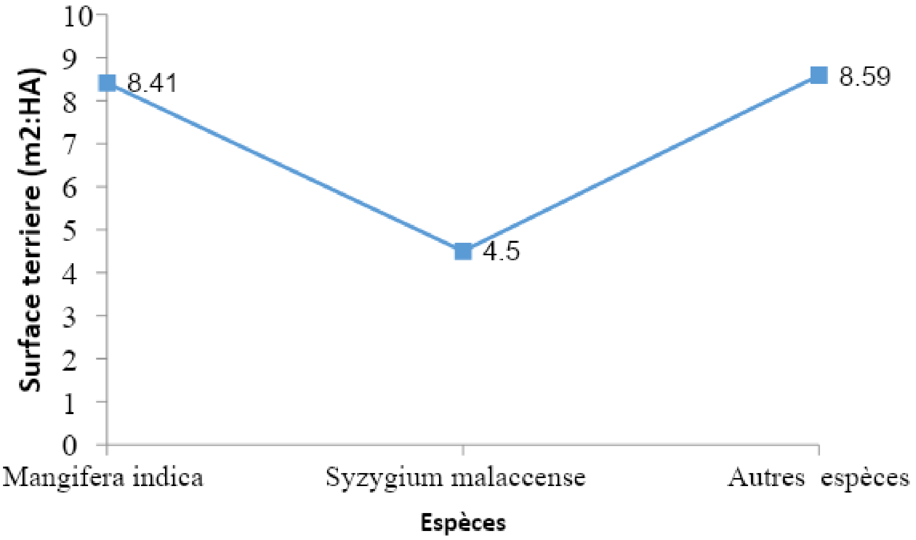



Figure 6. Basal area details of the species studied

**1.8 Aboveground Biomass, Carbon and Carbon Equivalent**

Overall we obtained 46.02 ± 0.35 t / ha of aerial phytomass; 21.63 ± 0.17 t / ha of the mass of carbon sequestered and 72.83 ± 0.56 t / ha of carbon equivalent. The contribution of Mangifera indica amounts to 24.69 ± 0.52 of above-ground biomass, or 11.60 ± 0.25 t / ha of carbon (Figure 7). The analysis of variance applied indicates a significant difference between the species studied, with (ANOVA, F = 2.136, df = 3.299, p = 0.2541).

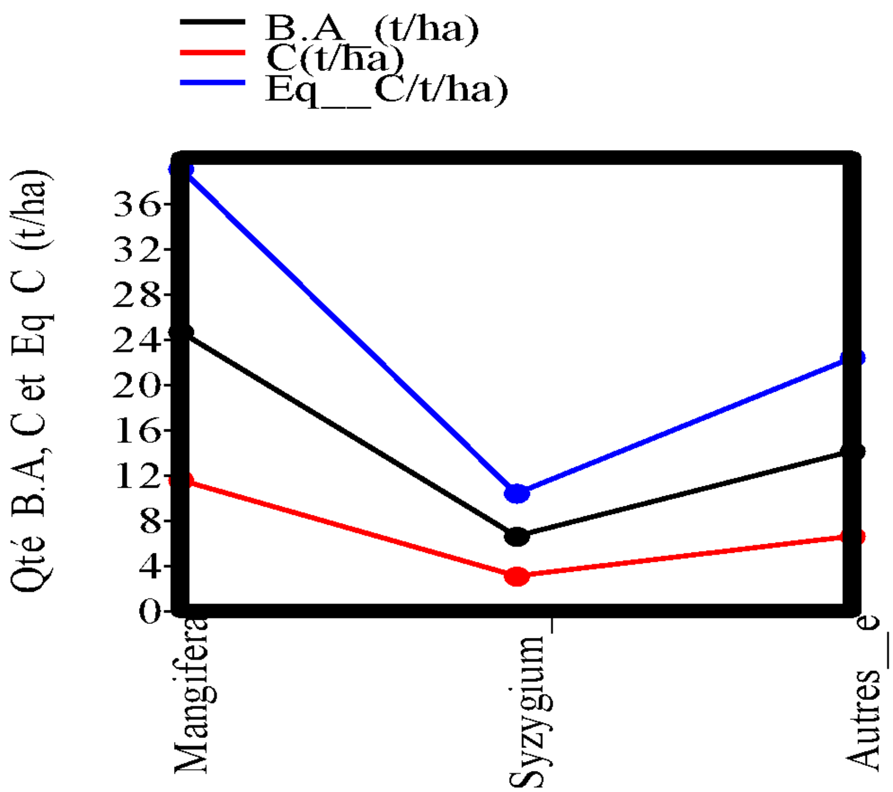



Figure 8. Aerial phytomass, carbon and carbon equivalent (t / ha) Caption: B.A = aboveground biomass, C = carbon, Eq C = carbon equivalent (ton per hectare).

**3.1.9 Relationship between diameter and biomass**

The production of the above-ground biomass contained in a tree depends on its growth in thickness. Thus, the larger the diameter, the more biomass increases. The Pearson test applied shows that there is a relationship between the diameter and the above-ground biomass of the trees measured, with the Pearson correlation coefficient r = 0.96; p-value <0.0001. Figure 9 indicates the correlation between the diameter and the biomass of the trees inventoried.

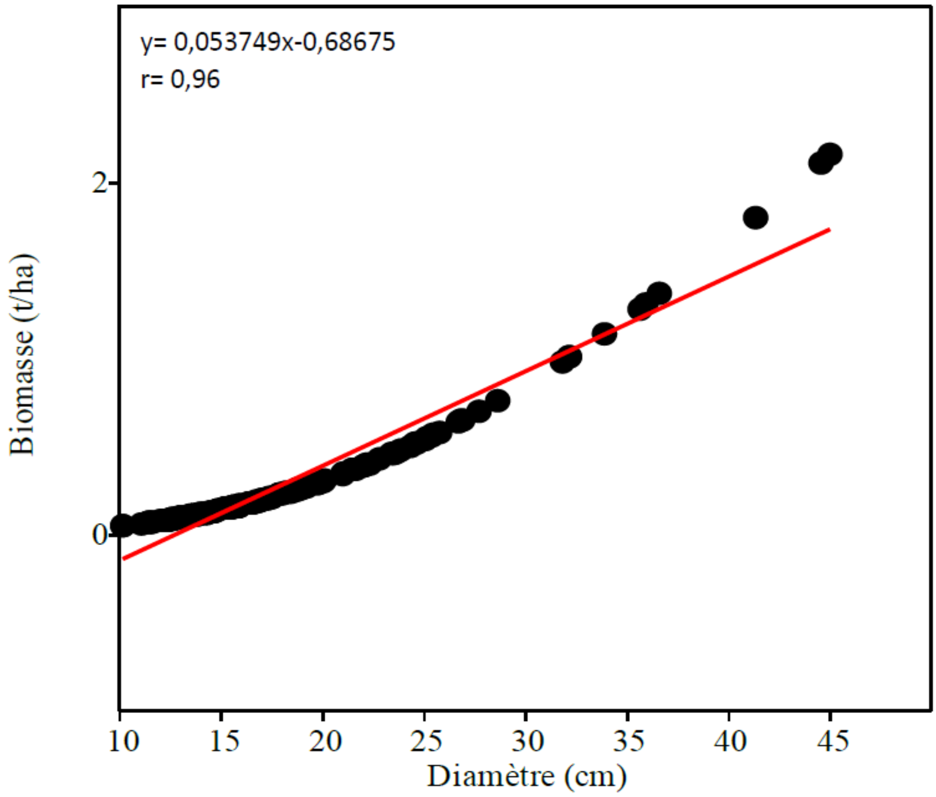



Figure 9. Simple allometry between aboveground biomass and tree diameter represented by the linear relationship between the logarithms of two values.

**3.2 Discussion**

This study consisted in estimating the above-ground biomass and the carbon stock sequestered by plot trees in the Boyera district, Wangata commune in the city of Mbandaka. Observations and inventories were made in a one ha device. The main results obtained for the whole flower are 10 species belonging to 8 families of which the Anacardiaceae predominate. A density of 150 trees per hectare; the basal area measurements amount to 21.77 ± 0.07m2 / ha; an aerial phytomass of 46.02 ± 0.35 t. ha-1 equivalent to 21.63 ± 0.17 t. ha-1 of sequestered atmospheric carbon and 72.83 ± 0.56 t. ha-1 of carbon equivalent. Mangifera indica the main species consists of 47 trees, a basal area of 8.41 ± 0.07m2 / ha; 24.69 ± 0.52 t. ha-1 of above-ground biomass; and the calculated mass of organic carbon 11.60 ± 0.25 t. ha-1. Mayanu (2019) studied the measurements of above-ground biomass and the carbon stock of plot trees in Quartier Livulu in Kinshasa. According to the author, Mangifera indica has been indicated as the dominant species in residential plots. The above-ground biomass and carbon stock measurements sequestered in the woody tissues of Mangifera indica individuals corroborate our results.

## Conclusion

This study consisted of estimates of above-ground biomass and carbon stock stored by plot trees in Quartier Boyera in the city of Mbandaka in DR-Congo. It emerges from this study that the results obtained are encouraging. These fragmented trees constitute active sites in the sequestration of atmospheric carbon in urban areas by creating a local microclimate. This is an upstream contribution to the REED + process in R.D. Congo as it provides information likely to motivate interest in domesticating trees in residential plots.

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