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Air biomass and carbon stock of the parcellar trees of the district livulu in the commune of lamba in kinshasa

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Abstract: This study concerns the above-ground biomass and the sequestered carbon stock in the parcel trees of Quartier Livulu in Kinshasa.

The objective is to estimate the mass of carbon stored in the woody tissues of the parcel trees. We conducted tree inventories in the residential plots of Livulu District, Lemba Commune in Kinshasa. The data obtained were analyzed and subjected to some statistical tests.

The results obtained show 309 trees belonging to 14 species. Mangifera indica and Persea americana are dominant. The aerial phytomass, the carbon mass and the carbon equivalent of all the plots studied were estimated at 6.33t / ha, corresponding to 3, 16t / ha of sequestered carbon with an equivalent of 10.66t / ha. . Mangifera indica is the dominant species with 142 individuals and therefore the one with the highest aerial phytomass, carbon mass and carbon equivalent estimated at 1.79t / ha; 0.89t / ha and 3.02t / ha respectively.

Keywords: Aerial Biomass, Carbon, Livulu District, Kinshasa

Résumé: Cette étude porte sur la biomasse aérienne et le stock de carbone séquestré dans les arbres parcellaires du Quartier Livulu à Kinshasa. L'objectif assigné consiste à estimer la masse de carbone emmagasiné dans les tissus ligneux des arbres parcellaires. Nous avons mené des inventaires des arbres dans les parcelles résidentielles du Quartier Livulu, Commune de Lemba à Kinshasa. Les données obtenues ont été analysées et soumises à quelques tests statistiques. Les résultats obtenus font état de 309 arbres appartenant à14 espèces. *Mangiféra indica*et *Persea americana*sontdominantes. La phytomasse aérienne, la masse de carbone ainsi que l'équivalent carbone de l'ensemble des parcelles étudiées ont été estimée à 6,33t /ha, correspondant à 3 ,16t/ha de carbone séquestré avec un équivalent de 10,66t /ha. Le *Mangifera indica* est l'espèce dominante avec 142 individus et par conséquent, celle qui a présenté la phytomasse aérienne, la masse de carbone et l'équivalent carbone les plus élevées estimées à 1,79t/ha ; 0,89t/ha et 3,02t/ha respectivement.

Introduction

One of the environmental problems of concern to the international community is the increase in the rate 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 process (REDD +), advocating the conservation and reforestation of degraded forest lands and secondary forests (Lubini et al., 2014).

Climate change is now a matter of concern and concern for the entire international community, but at the same time a theme of seeking durable solutions. Among ecosystems, forests in general and tropical forests in particular play an important role in reducing greenhouse gas levels (Lubini, 2001).Trees planted in residential plots, along avenues, urban afforestation and urban forests are part of the process of deducting greenhouse gas (GHG) emissions from deforestation and tropical forest degradation ($REDD^+$) because they contribute effectively to climate change mitigation measures on the one hand and, on the other hand, they are a food source in producing edible fruits or medicinal substances.

Data on studies of aerial biomass and carbon sequestration estimates by trees planted in cities such as Kinshasa are rare. Thus, a study on aerial biomass and atmospheric carbon sequestration of trees planted in the residential plots of Quartier Livulu in Lemba Commune in Kinshsasa is proposed. It is part of urban metabolism studies and in the context of climate change mitigation.

The city of Kinshasa constitutes an urban ecosystem whose available data on measurements of above-ground biomass of fragmentary trees are incomplete.The general objective of this study is to identify the main trees encountered in the study area in order to estimate the aerial phytomass, allowing to deduce the sequestered carbon mass in their ligneous structure.

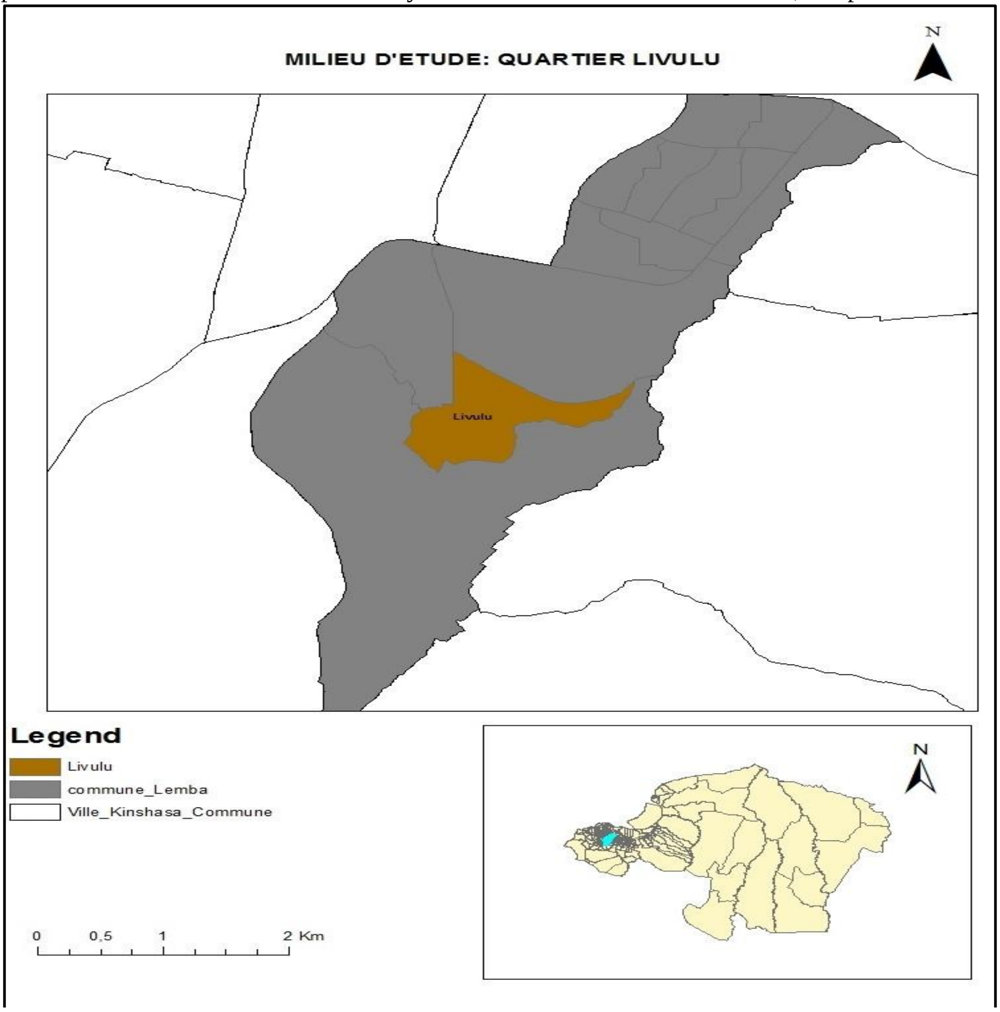
The interest of this study is justified to the extent that it can serve as a contribution to the establishment of allometric equation of parcel trees of the ecosystem in urban environment. The methods used may be a genesis of other similar sites.

Field of study

The Livulu District is bounded:
- in the north, the Righini District;
- in the south, the University of Kinshasa;
- in the east, the Municipality of Kisenso;
- to the west, the Kemi River.

Climatic characteristics

The Livulu District is a part of the Lemba Commune in the city of Kinshasa. The city of Kinshasa is in a climate of low altitude. It is therefore in a hot and humid tropical climate characterized by a dry season that runs from June to October and a rainy season from October to June, interrupted by a second small dry season between mid-January and mid-February. The average annual temperature is 25.5 ° C, the average annual precipitation is 1355 mm with an average atmospheric humidity of 76%. The District has an area of 500m²; the current population is 14. 426 inhabitants for the year 2016. The Livulu District has 1,556 plots.



The map above gives the location and delimitation of the studied area

Material and Methods of Study

In order to identify the trees in the residential plots of the Livulu District study site, we proceeded to collect botanical samples for their scientific identifications. The material thus collected constitutes a herbarium of references.

Harvested samples were identified using flora from Central Africa, Gabon and Rwanda. The classification used is that of APG IV. About calculating density, above-ground biomass and carbon, we used the forest technique and the allometric equations by integrating the dendrometric parameters from the inventory.

For inventory tree density, the residential parcel was considered as a unit of surface measurement and therefore, the total area of all the parcels involved in the inventory as the inventory tree substrate. On this basis, the density of the trees in the inventory was calculated.

For the estimation of the above-ground biomass, we have considered the lack of adequate allometric equations adopted in the forests of the Congo Basin, we propose to use the model developed by (Chave et al, 2005).

Sample

The Livulu District has 1,556 plots, we drew a tenth that is to say 156 plots was chosen at random. Only the plots that had the trees were part of our sample. On average, a residential plot has an area of 20m x 25m = 500m². The total area of the plots studied is 7.80 ha or 8 ha.

Inventory of trees and shrubs and measurement of circumference

This inventory covered all individuals in the study area and we limited ourselves to woody individuals of all species. Only individuals whose circumference reach a diameter ≥ 10 cm dbh were taken into account.

Identification of the material

The botanical material harvested has been scientifically identified using Flores from Central Africa and Flora of West. Tropical Africa. Other samples were identified by comparison with the material stored at the University Herbarium and INERA.

Density calculation

The density of a population also called abundance, is an important parameter, it can be defined as the number of individuals of a species per unit area. It is a function of the size of each species studied and its greater or lesser abundance (Anonymous, 1993). We were interested in calculating the frequency and number of all individuals of the woody shrub species present in the plots studied. The density is expressed in number of feet per hectare.

Diameter calculation

To calculate the diameters of the individuals of the studied species, we used the relation between circumference and π, ie D = Cir / π, this relation is in turn used to calculate the radius (R) is R = D / 2. The basal area is found by the following relation: St = R2.π. With D = diameter; cir = circumference; π = pie is 3.14; St = basal area; R = radius.

Aerial phytomass calculation

The estimation of the aerial phytomass of the trees is made from the allometric equations by integrating the dendrometric parameters resulting from the forest inventory as indicated:

- AGB = exp (-0.37 + 0.333 * ln (dbh) + 0.933ln (dbh) 2 -0.122 * ln (dbh)) Chave et al. 2005 cited by Toung in 2009, range of validity (cm) of Dhp 156;
- AGBtrees (kg) = 0.05378909 x D2, 828851 (Ibrahima et al. 2002), Range of validity (cm) of 1 D 79;
- Tree biomass (kg) = 42, 69-12.80DBH + 1, 24 DBH2 (Brown, 1997, Toung, 2010, Kidikwadi 2012). Range of validity (cm) of 5 DBH 148.

In the present study, we used Brown's formula taking into account a single dendrometric parameter which is the diameter measured on bark at breast height (1.30 m of soil) at the foot of trees with a diameter ≤ 10 cm.

Carbon calculation test sequestered by tree tissue

Several methods are used to estimate the amount of carbon sequestered in the woody tissues of trees. For our study, we used the equivalence method (Wasseige et al. 2008). The calculation of the carbon stock stored in the woody tissues of the trees is obtained for all the trees by multiplying the aerial biomass by k. Knowing that carbon constitutes 0.47% of the ligneous material, the following formula is used to calculate carbon:

C = B.A. k. With k = 0.47; C = carbon; B.A = aboveground biomass (Raven et al, 2009, Kidikwadi, 2018).

Results

Composition of the florule

The inventory of the florule conducted shows 14 species, grouping into 12 families and sub-families among which the Fabaceae and Moraceae predominate. Most are exotic species. Table 1 lists the identified species.

Family	*Genres and Species*
Anacardiaceae	*Mangifera indica* L.
Annonaceae	*Annona muricata*L.
Asparagaceae	*Dracaena mannii* Baker var.nitens
Burseraceae	*Dacryodes edulis* (G.Don) H.J. Lans
Combretaceae	*Terminalia mentaly* H. Perrier
Fabaceae/Faboideae	*Millettia laurentii* De Wild.
Fabaceae/Mimosoideae	*Acacia auriculiformis* A. Cunn Ex Benth
Moraceae	*Artocarpus altilis* Fosberg.
Lauraceae	*Persea americana* Mill.
Malvaceae	*Cola acuminata* (P.Beauv) Schott et Endl.
Moraceae	*Artocarpus heterophylla* Lam.
Moringaceae	*Moringa oleifera* Lam.
Myrtaceae	*Eugenia roseopetiolata* N.Snow S. Cable
Rutaceae	*Citrus limon* (L.)Burm.

Density

After inventory of the florule, the results on the density reported 309 trees. Of this value Mangifera indica has 142 trees. The abundance of this taxon is justified by the fact that it is widely grown for these fruits which are for food security. Figure 1 gives the density of the species studied.

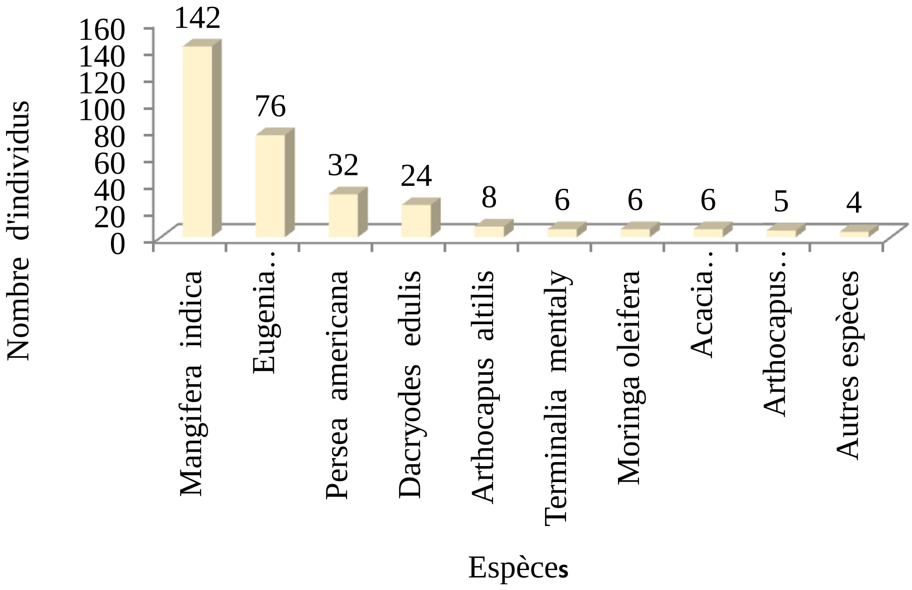


Figure 1 Numerical proportion of density by species

Analysis of ecological spectra

The ecological aspects analyzed in this chapter are: biological forms, diasporic types, leaf types and phytogeographic distribution.

Biological types

The research was conducted on the parcel trees encountered in Livulu District. The biological type plays an important role in determining the morphology of the listed trees. Examination of the biological type analysis of the species studied reveals the dominance of the mesophanerophytes, ie 64.2% and 22% of the microphanerophytes. The other categories the proportions are small. The prevalence of mesophalerophytes shows that the inventory was conducted on parcel trees. The applied Pearson test demonstrates no correlation between the biological types studied, with r = - 0.89119; p-value = 0.082297. Figure 2 illustrates the details of biological types of the species studied.

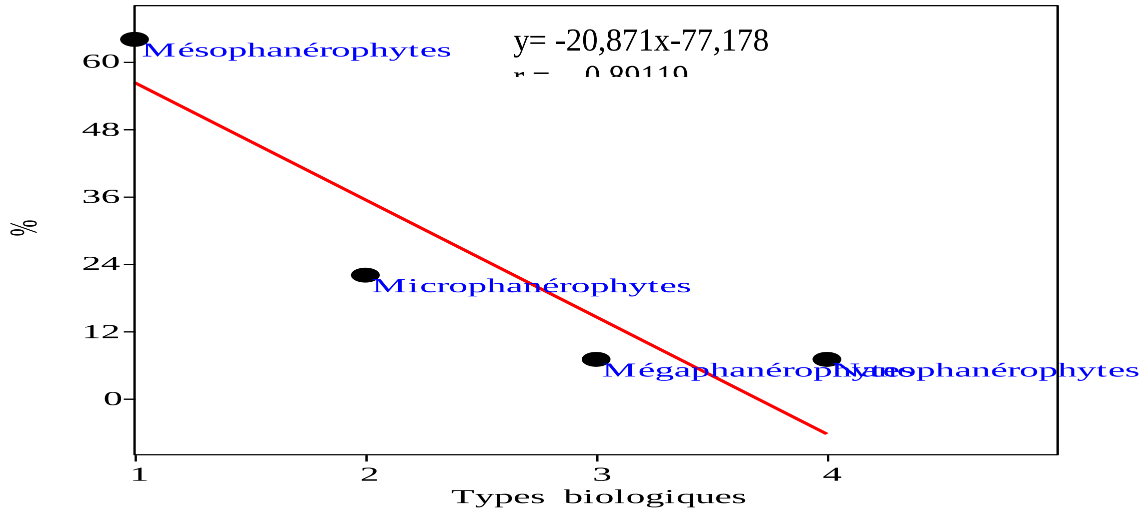


Figure 2 Details of biological types of trees planted in residential plots of Livulu District in Kinshasa.

Types of diaspores

The details of diasporous types show that sarcochores are the majority, ie 70%, followed by ballochores and anemochores 14 for each. The rest of the categories values are less indicated. The dominance of the sarcochores is justified by the fact that these species give fleshy fruits, supposed to be consumed by the populations of the Quarter. The Pearson test reveals no correlation between diasporic type categories, with r = -0.83198, p-value 0.064. Figure 3 views the details of types of diaspores.

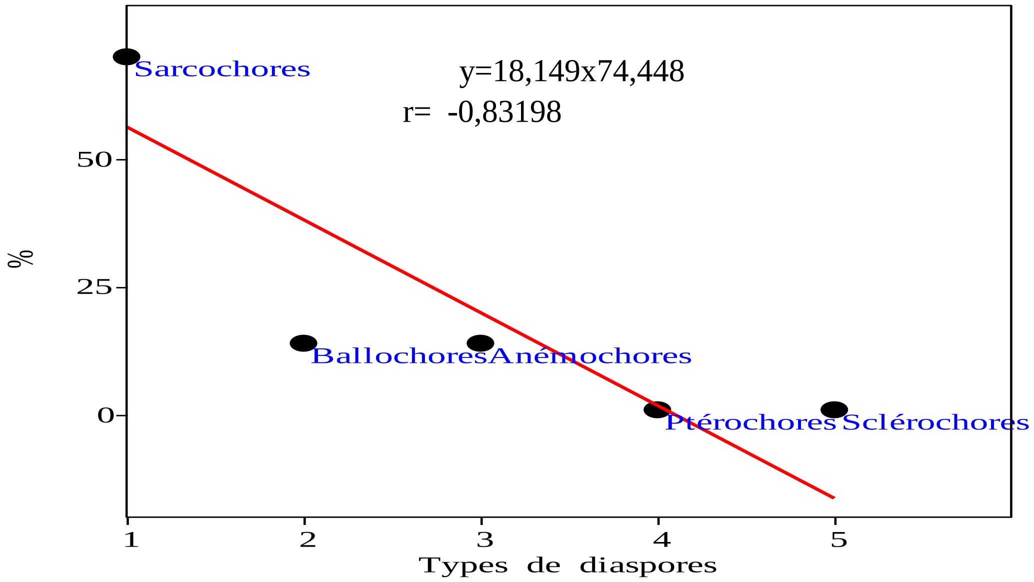


Figure 3 Percentage proportion of parcel trees in Livulu District in Kinshasa

Types of leaf sizes

Examination of the analysis of types of leaf sizes reveal that 57% of species are mesophyllous followed by microphylls with 21.4%. The rest of categories are less represented (Figure 4).

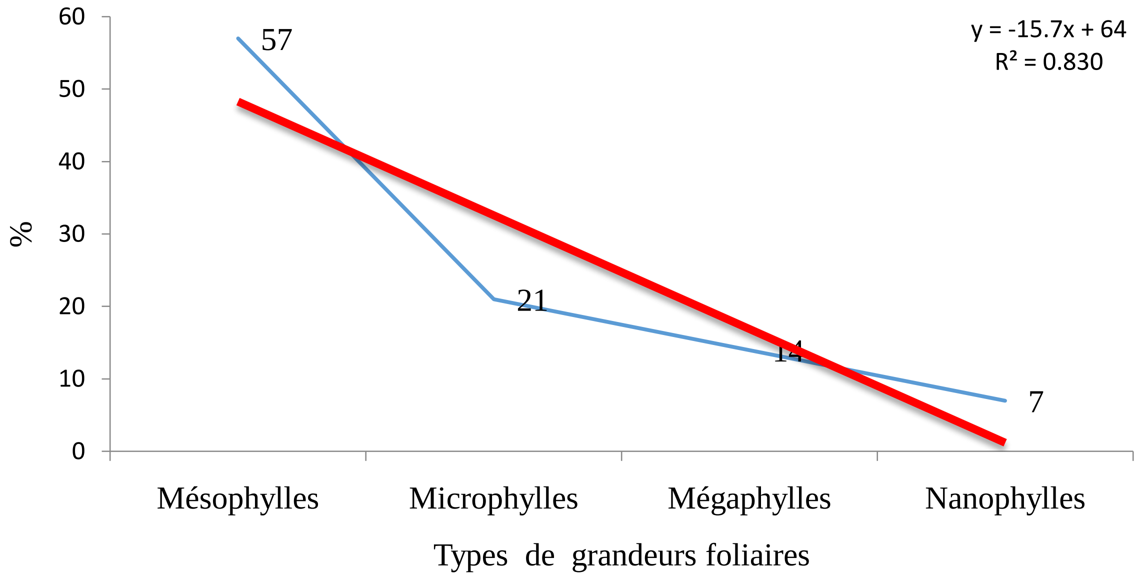


Figure 4. Details of leaf size types of species inventoried in residential plots in Livulu District in Kinshasa

Phytogeographic distribution

Figure 5 gives the phytogeographic distribution of the tree species considered. The analysis of the results reveals the predominance of pan-tropical species with a wide pan-tropical distribution, ie 64.2% followed by Guineo-Congolese species 14.2%. Note that most of the introduced species in the plots belong to the exotic group. Figure 5 shows the phytogeographic groups of the inventoried species.

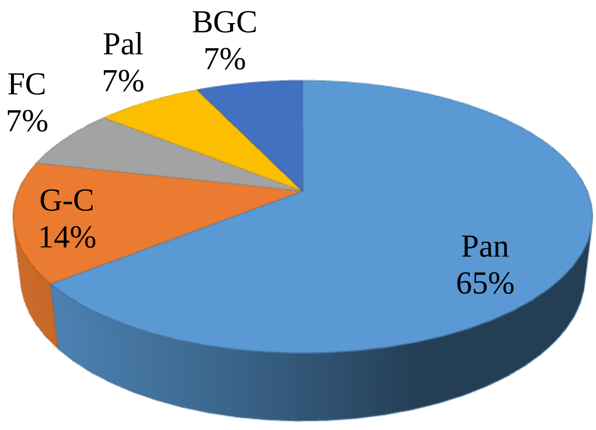


Figure 5 Details of phytogeographic distribution of species trees planted in residential plots in Livulu District in Kinshasa.

Individual variation of circumference and diameter

The circumferences and diameters of each individual were measured. The maximum circumference reaches 275 cm and minimum 34 cm. The maximum diameter is 65 and 10 cm minimum (Figure 6).

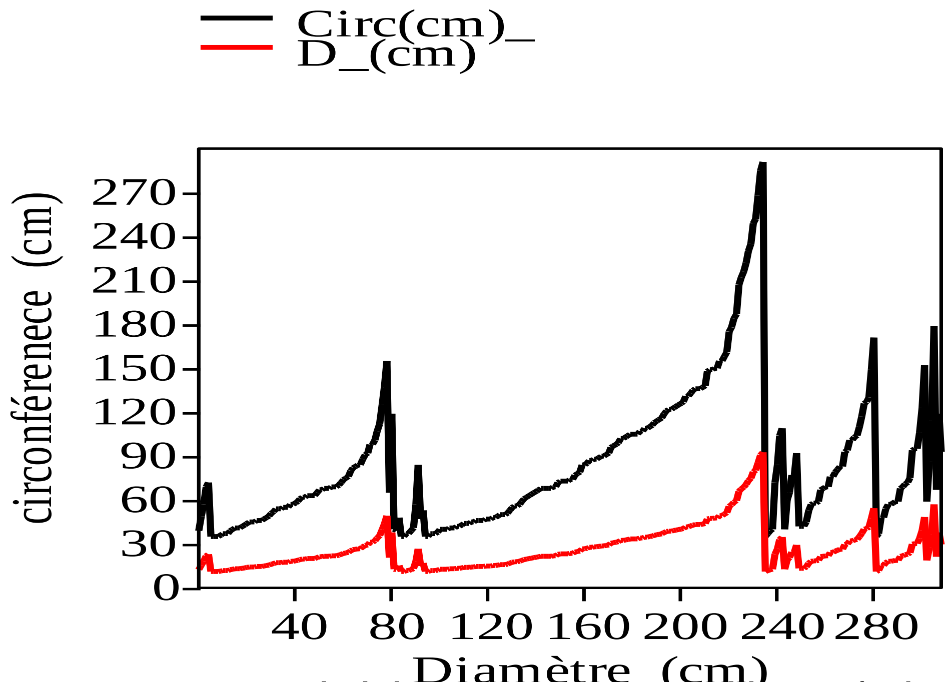


Figure 6 Individual variation in circumference and diameter of each tree.

Relationship between diameter and biomass of trees

There is a relationship between the diameter and the biomass of the trees measured. The Pearson test shows a correlation between the two variables studied. The larger the diameter, the larger the amount of biomass, with r = 0.97 at p-value 0.0001 (Figure 7).

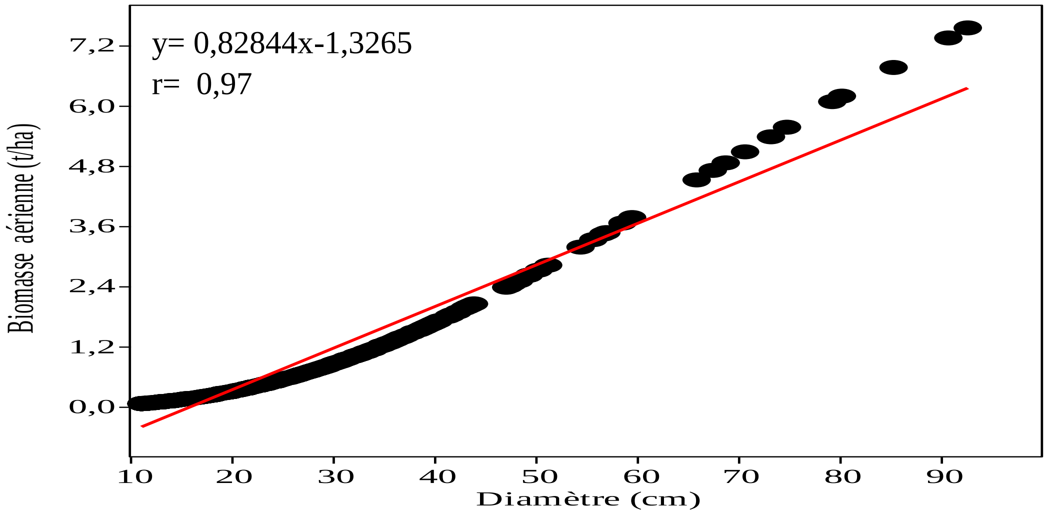


Figure 7 Relationship between diameter and above-ground biomass of trees

Principal component analysis Recall that this test is used to look for the factors that influence the amount of above-ground biomass, carbon and carbon equivalent of trees. This test shows that the diameter and the basal area are the factors that influence the structural parameters studied. The first ordered factorial axis of the principal component analysis is interpreted as expressing more than 99, 985% of the total inertia. This axis shows a positive correlation between the amount of carbon, the carbon equivalent, the above-ground biomass, the basal area and the diameter of the trees measured. Calculated values are shown in Figure 7

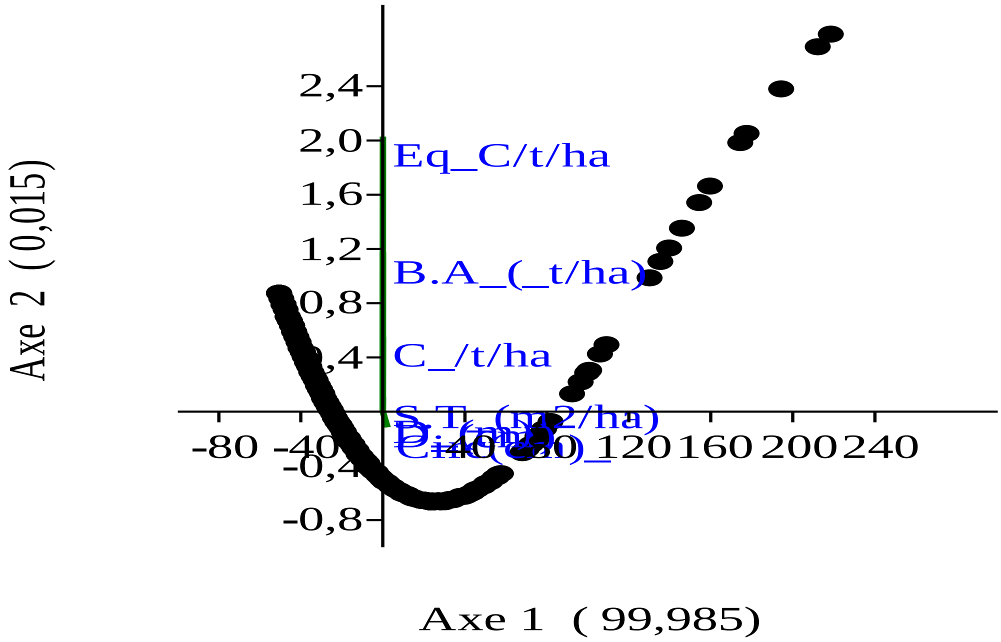


Figure 7 Representation of the parameters on the space defined by the first two axes of the ACP

Discussion

The study on the biomass of trees in the plots of the Livulu District gives us some information that we will discuss in this part of the work. The results obtained show that Mangifera indica is the most representative species compared to all the inventoried species (45.9%), followed by Persea americana (24.5%). The dominance of the species over others seems to be justified by the fact that these species are part of highly valued trees following the production of fruits, according to the population surveyed.

Ecological spectrum analyzes reveal the dominance of Mesophaneropytes (50%), followed by Microphanerophytes (42.8%) in all the inventoried species. Leaf-type analysis states that the most represented types are Mesophyllous (57.1%), followed by Microphylls (35.7%). The type analysis of diaspore reveals the most represented types are in order of numerical importance the sarcochores (71.4%), ballochores and anemochores (14.2%) of species.

The dominance of sarcochores is justified by the fact that these sarcochorous species are presumed to be propagated by fruit consumers. These fleshy diaspores are the rule in most undergrowth plants and are still well represented in species on the upper floors. They characterize the forest flora. On the other hand, the category of ballochores also called powdery diaspores (Belesi, 2009) is a characteristic of a dry flora, which characterizes semi-evergreen semi-evergreen forests in subequatorial. Our results corroborate with the work of Lubini (1990, 2001); Masens (1997) and Habari (2009).

The analysis of the phytogeographic distributions of the inventoried species reveals the numerical and centesimal predominance of Pantropical-like species with a wide distribution of the Pantropical type of Africa, America, and Australia (71.4%) followed by species of the Congolese Guinean region (28.5%).

The trees inventoried in Quartier Livulu have an aerial biomass of 6.33 t / ha corresponding to a sequestered carbon stock estimated at 3.16 t / ha with a carbon equivalent of 10.66 t / ha.

The results obtained on the above-ground biomass, the sequestered carbon stock and their carbon equivalence show that Mangifera indica is the species with the highest above-ground biomass at 1.79 t / ha and a sequestered carbon stock of 0, 89 t / ha with a carbon equivalent of 3.02 t / ha followed by Persea americana with a biomass of 1.70 t / ha which corresponds to a sequestered carbon amount of 0.85 t / ha and a carbon equivalent of 2.87 t / ha.

The results of our research (6.33 t / ha of aboveground biomass corresponding to 3.16 t / ha of sequestered carbon with a carbon equivalent of 10.66 t / ha) are lower than those obtained by Nacy et al. (2008). Estimating the aboveground biomass at 125 t / ha or 62 t / ha of carbon in a tropical forest.

In contrast, FAO (2010) estimates sequestered carbon in a tropical forest at 82.2 t / ha, which is similar to that found by Pearson and Brown (2005); Chave (2001) also presents biomass estimates in a typical lowland tropical rainforest at 400 t / ha, ie 200 t / ha of carbon. These results appear to be superior to those found by Chave (2001), Pearson and Brown (2005) and Chambers et al. (2001), Kidikwadi (2012).

The values of the estimates of aerial biomasses and carbon stocks sequestered by the various authors mentioned above are all much higher than those found in our study (6.33 t / ha of BA corresponding to 3.16 t / ha of sequestered carbon). This study could be explained by the fact that the Livulu Quarter is very poor in forest species and most of the species found there are species that are easily domesticated by humans and do not have considerable diameters and therefore do not absorb a significant amount of carbon from the atmosphere.

Variations in the estimates of aerial biomasses, sequestered carbon stocks and carbon equivalent depend on where measurements were taken, allometric equations used, calculation errors, and also observed changes in forest cover. Knowledge of these variations in terms of biomass and carbon is important for assessing ecosystem productivity but also for assessing the role of forests in climate change.

Conclusion

The objective pursued in our study is to estimate the above-ground biomass of trees and shrubs identified in the Livulu District, in order to deduce the sequestered carbon stock. We used the observation method (description and analysis) and the inventory of trees and shrubs. From this study follows the following results: the basal area was evaluated at 5.215,79m². In relation to the species identified, Fabaceae and Moraceae are the most abundant and dominant families.

Mangifera indica and Persea americana are the main species. Inventoried trees have an amount of above-ground biomass corresponding to a large sequestered carbon stock. The results show that Mangifera indica is the main species with the largest biomass, followed by Persea americana.

The results of our study are far inferior to those obtained by Nacy et al. (2008) in his study on the estimation of aboveground biomass and carbon sequestered in a tropical forest. We suggest the setting up of a number of devices for the continuous evaluation of the biomass of parcel trees in the different Communes of Kinshasa, especially since Kinshasa is currently suffering from a deficit in terms of parcel trees.

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