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Preliminary note on above ground biomass and carbon stock in the Kimwenza Manresa forest in Kinshasa / DR CONGO

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Abstract: This note focuses on aboveground biomass and carbon stock in the Manresa forest in Kinshasa. It has set itself the main objective of estimating aerial phytomass in order to deduce the sequestered carbon stock in tree tissues and to show their interest in mitigating CO2 effects due to climate change.To achieve this, we used the method of observation and inventory of trees supported by statistical treatments. A total of 271 individuals belonging to 21 species. The results obtained showed that Milletia laurentii is the most representative species compared to all inventoried species. The aerial phytomass, the carbon mass and the carbon equivalent of the whole were estimated at 369.9t / ha corresponding to 173.9t / ha of sequestered carbon with an equivalent of 585.4 t / ha.Milletia laurentii is the dominant species with 53 individuals and therefore the one with the highest aerial phytomass, carbon mass and carbon equivalent estimated at 96.5t / ha; 45.3 t / ha and 152.7 t / ha respectively.

Keywords: Aerial Biomass, Carbon, Urban, Kinshasa

Résumé: Cette note porte sur la biomasse aérienne et le stock de carbone dans le massif forestier de Manresa à Kinshasa. Elle s'est assignée comme principal objectif d'estimer la phytomasse aérienne à fin de déduire le stock de carbone séquestré dans les tissusdes arbres et de montrer leur intérêt dans l'atténuation des effets de CO_2 dus au changement climatique. Pour y parvenir, nous avons recouru à la méthode de l'observation et inventaire d'arbres appuyé par des traitements statistiques. Un total de 271 individus appartenant à 21 espèces. Les résultats obtenus ont montré que *Milletia laurentii* est l'espèce la plus représentative par rapport à toutes les espèces inventoriées. La phytomasse aérienne, la masse de carbone ainsi que l'équivalent carbone de l'ensemble ont été estimée à 369,9t/ha correspondant à 173,9t/ha de carbone séquestré avec un équivalent de 585,4 t/ha. *Milletia laurentii* est l'espèce dominante avec 53 individus et par conséquent, celle qui a présenté la phytomasse aérienne, de la masse de carbone et l'équivalent carbone les plus élevées estimées à 96,5t/ha ; 45,3 t/ha et 152,7 t/ha respectivement.

Mots-Clefs: Biomasse aérienne, carbone, Urbain, Kinshasa

Introduction

Over the past few decades, nearly half of the world's tropical forests have been destroyed and converted into plantations, wastelands and scrub. Each year, some 300 km2 of forests are razed a day and we are witnessing a extinction of species and climate change because these forests are natural environments containing a very rich biological diversity and have ecological roles and functions; maintaining the balance of life and the environment (UNESCO, 1983).

The Democratic Republic of Congo knows during this last decade; huge losses of forest areas as a result of slash and burn agriculture and the use of woodfuel (wood energy).

The situation of loss of natural sites is also observed in Kinshasa capital of the Democratic Republic of Congo which once were well protected. The Méteo-Binza forest, the beautiful massif of a forest at Millethia laurentii in Bandalungwa synkin; a large one from the Mongata massif to the Bateke plateau in Kinshasa ', without having been the subject of a study of floristic composition or biomass measurement.

This study is part of the REDD + process and proposes to study the biomass of trees in the Manresa forest to estimate the sequestered carbon stock in order to have useful information on the carbon content when shopping for tree tissue. of this forest.

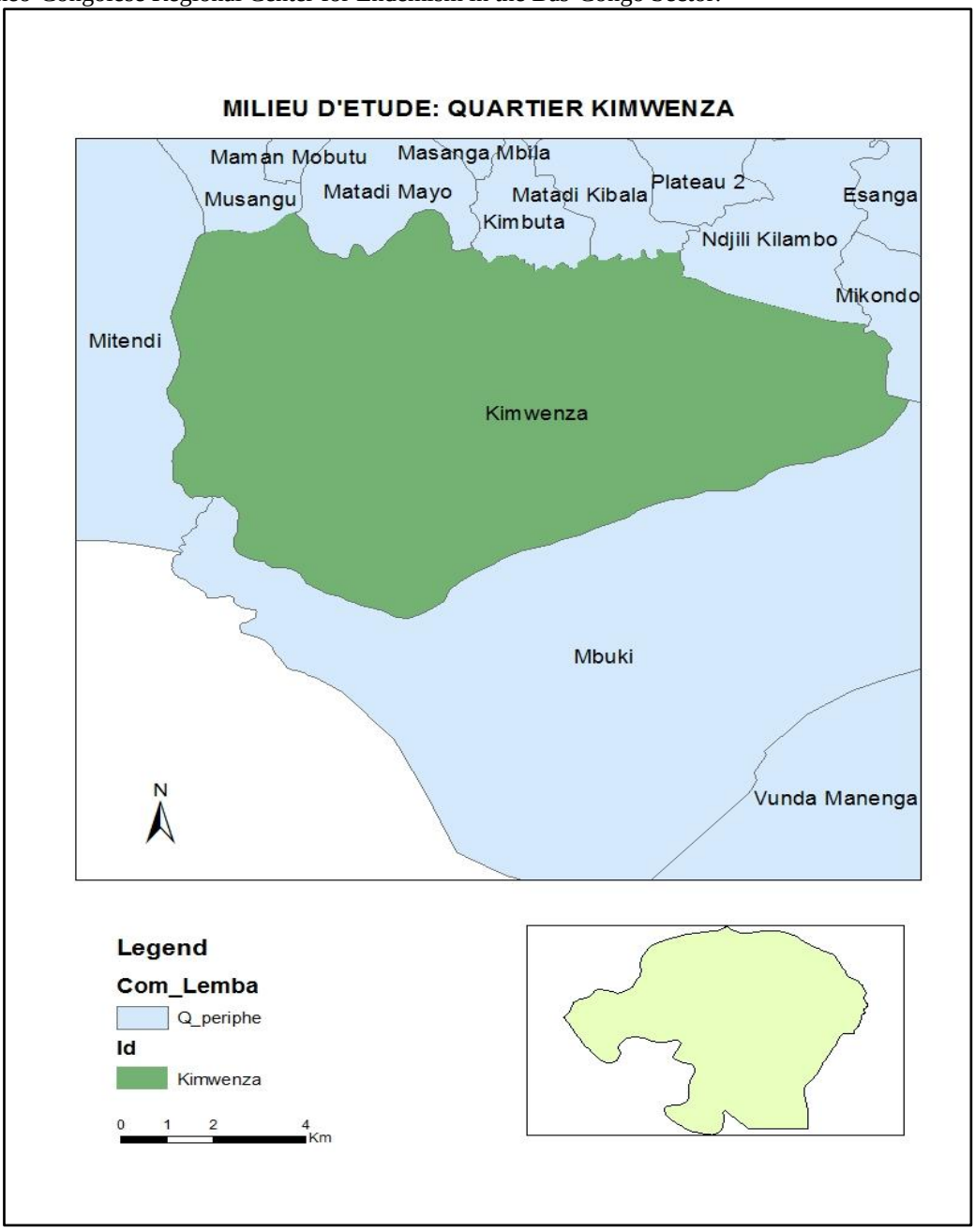
It is true, however, that the biomass (phytomass) of a species or a plant group is a function of the nature of that species, the type of vegetation and the ecological conditions of the environment. The forest formation of Manresa by their floristic composition and the nature of the site produce a considerable biomass. The general objective of this study is to estimate the measurement of above-ground biomass and carbon stock in the Manresa forest in tropical hot and humid climates. The specific objectives are:

- identify and list the trees and shrubs on well-defined devices to know the floristic composition to study;
- take diameter measurements of trees and shrubs to estimate the biomass of each identified species and form the diameter classes;
- calculate the biomass, carbon mass and carbon equivalent of each species and the total mass of organic matter as well as that of carbon and carbon equivalent.

The choice and interest of this study are motivated by the importance of trees today in contributing to the REDD + program in the Democratic Republic of Congo (DRC). The data in this note provide information on the potential capacity of woody plant species in the Manresa forest to sequester atmospheric carbon.

1.2. Field of study

Our study concerns the Kimwenza District in the Municipality of Mont-Ngafula where the forest is located Manrenza south of the city of Kinshasa. According to the Robyns (1948) classification taken up by Compère (1970), the periurban forest of Kinshasa and that of the natural site of Manrenza in particular belong to the Guineo-Congolese Regional Center for Endemism in the Bas-Congo Sector.



map 1. Location map of the study environment.

Material and methods

Material

To carry out this study we used crops from the essential parts of plants as botanical material and to make the reference herbarium.

Methods

Observations (analysis and descriptions), floristic inventories and statistical tests were used in this study. The observation consisted in the descent on the ground to describe the site of study and to carry out pre-inventory of the trees. To do this we proceeded as follows:

Delimitation of the inventory parcel

One hectare was the subject of a inventory of woody individuals. This plot has been subdivided into four subplots of 2500 m² or 50 m x 50 m each. The figure below shows the device installed in the field.

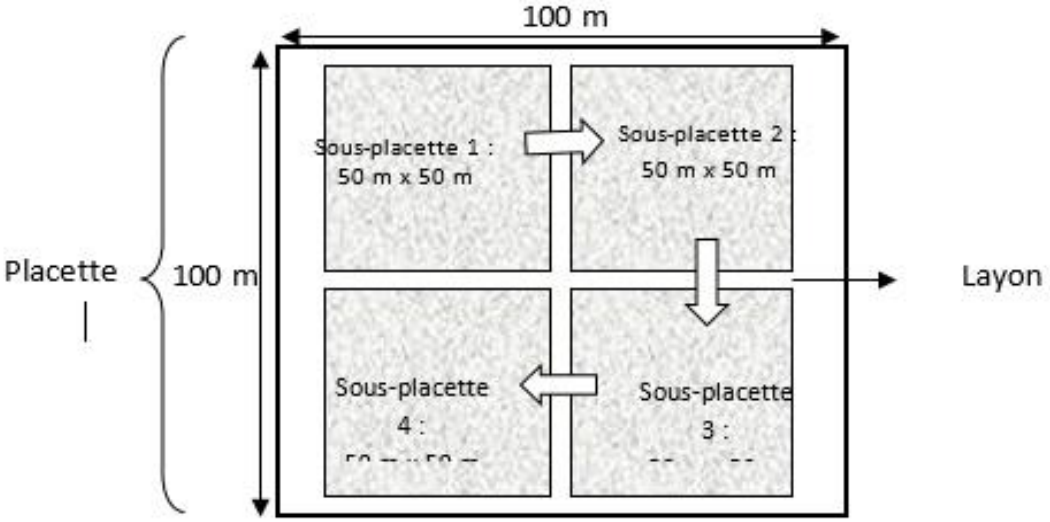


Figure 1. Inventory device

Collection of geographical coordinates

It was made using the Etrex Global Positioning System (GPS) (Garmin). This device was used to collect the geographic coordinates of the entire Manresa concession and each tree in particular. For the treatment of different data collected on the ground, we made use of the Arc Gis software.

Floristic inventory and diameter measurement

Any woody subject with a diameter greater than or equal to 10 cm and 1.30 m of breast height was identified and measured. Creepers and herbs were excluded.

For the calculation of diameters of inventoried individuals, we used the relation between the circumference and the diameter. Thus, the formula indicated is the following:

$$D = \frac{Circonférence}{ð}$$

This relationship was in turn used to calculate the basal area of the species concerned:

$R = \frac{D}{2}$ et $St = d^2 x ð / 4$

R = radius; D = diameter; St = basal area and π = 3.14

Aerial phytomass calculation

The estimation of the above-ground biomass of trees is calculated using the allometric equations by integrating the dendrometric parameters from the forest inventory as indicated. The following formula is used:

Tree biomass (kg) = 42.67-12.80DBH + 1.24DBH2, or tree biomass = aboveground biomass of the tree; DBH: diameter at 1.30m above the ground of the tree (Browns, 1997 taken up by Toung, 2010):

Estimated carbon sequestered

The calculation of the stored carbon stock in the woody tissue of the trees is obtained; for all trees and shrubs by multiplying the aerial biomass by k. Knowing that carbon constitutes 0.47% of the ligneous material, the formula used is as follows:
C = B.A. k with k = 0.47; C = carbon; B.A. = aboveground biomass.

Carbon equivalent

The amount of carbon obtained determines the actual mass of carbon stored in the structures of trees and shrubs and trees. The carbon equivalent is obtained using the formula: EQC = C x 3,667. With EQC = carbon equivalent; C = carbon and 3,667 the conversion factor.

Analysis of ecological spectra

a. Biological types The biological spectra of a group are a relative representation of the biological types. They provide valuable insights into the structure, physiognomy and adaptive strategies of the community (Gillet (2000), cited by Ngok (2005) and Habari (2009).

b. Types of diaspores

The spectra of the types of diaspores give information on the nature of the diaspores of the species and give indications as to their mode of dissemination, which reflects the physiognomy of the group or the community considered, in order to be able to speak about the nature of the diaspores as well as their possible disseminating agents.
Two types of diasporic classification have been used, namely: the morphological classification of Dansereau and Lems (1957) which is commonly used, notably by Evrard (1968), Lubini (1997), Masens (1997) and Molinier's eco-morphological classification. And Muller (1938) who is more suggestive of the possible dispersal agent.
The recognized foliar types are:
• nanophylls (nano): the surface of the leaf or leaflet between 0.2-2 cm^2;
• microphylls (micro): the surface of the leaf or leaflet 2-20 cm^2;
• mesophyll (meso): the surface of the leaf or leaflet 20-200 cm^2;
• macrophylls (macro): the surface of the leaf or leaflet between 2 dm^2 - 20 dm^2 (Habari, 2009).

Phytographic distributions

Phytogeographic distribution provides information on the geographical distribution of species throughout the terrestrial globe.

Results

In this part of the work, we present the results of the different parameters studied. These results concern the ecological spectrum, distribution of individuals by category of diameter class, basal area of species and aerial phytomass to estimate the amount of carbon sequestered in the woody tissues of trees.

Spatial distribution of measured trees

The information contained in stand mapping data can be reduced to the position of trees. All of these positions are called point seeding; it is about spatial distribution. Millettia laurentii has an aggregative distribution, followed by Trichilia gilletii. The rest of the species, their distribution is random, see Figure 2 on the map of spatial distribution of trees in the Manrenza forest.

map 2. Spatial distribution of trees in the Manresa forest

Ecological spectra

Biological Types

The analysis of biological types of vegetation provides information on the physiognomy and the height structure of the studied stand, and the adaptation of the individuals to the environmental conditions of the considered environment. The 21 species identified are phanerophytes which have been distributed in megaphanerophytes, mesophanerophytes, micro-phopherophytes and nanophanerophytes. This analysis shows four biological types whose numerical proportions are illustrated in Figure 3.

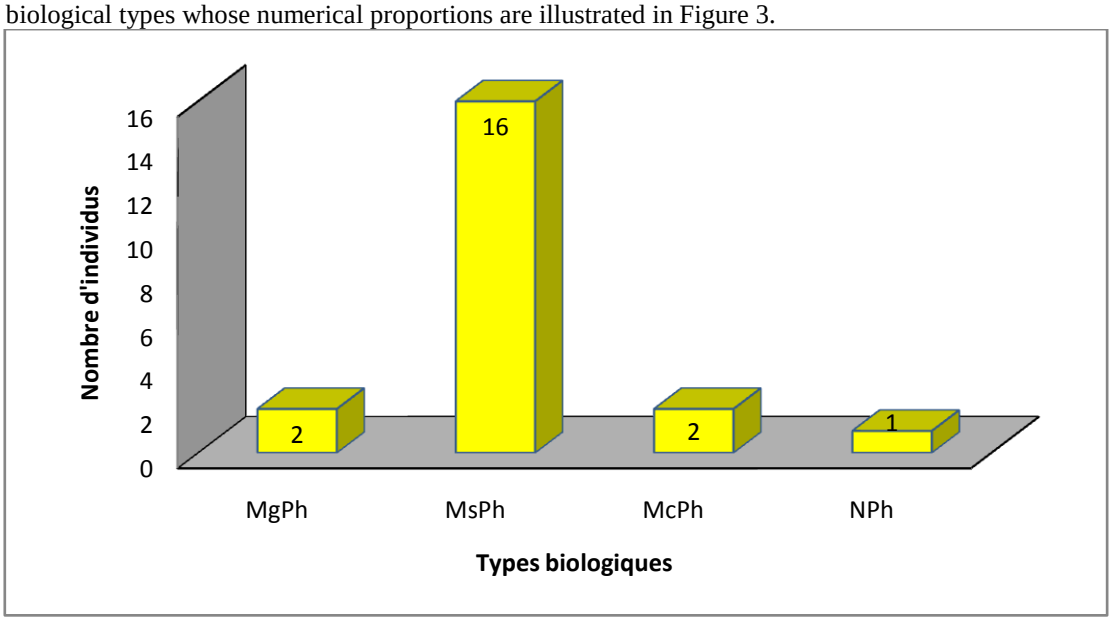


Figure 2. Details of biological types of species studied

The results obtained show that mesophanerophytes (MsPh) are predominant, followed by megaphanerophytes (MgPh) and microphanerophytes (McPh). Nanophanerophytes (NPh) are poorly represented.

Type of Diaspore

The species identified are classified into 5 types of diaspores, with numerical predominance of sarcochores, followed by Ballochores. The rest of the species have only been poorly represented.

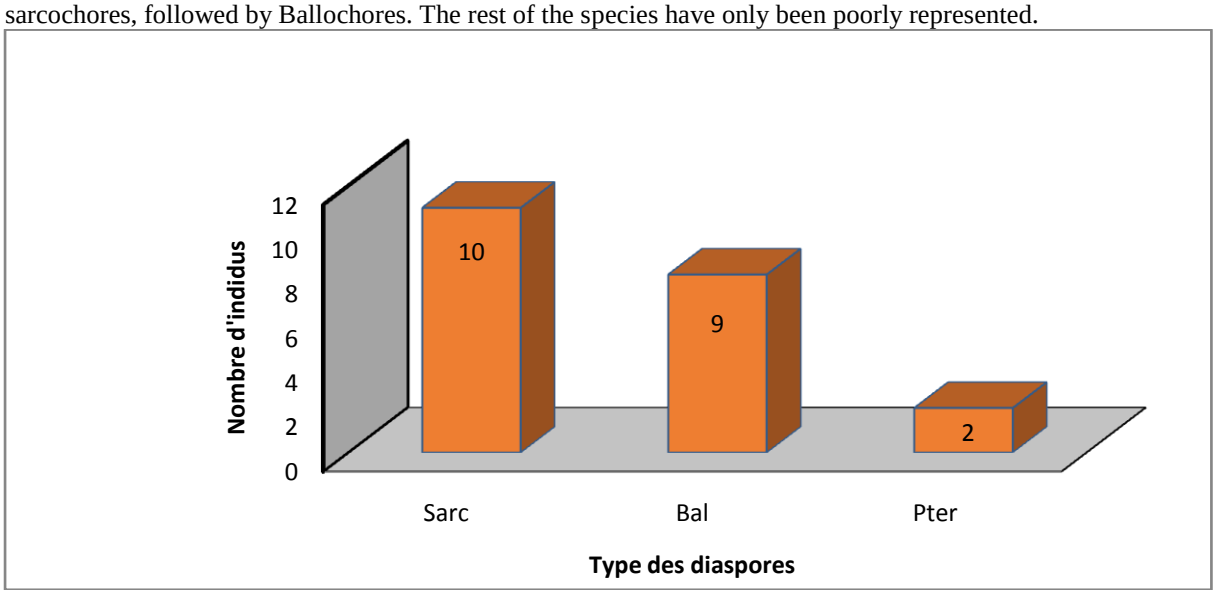


Figure 3. Detail of diaspore types of the species studied

The result obtained shows that: sarcochores (Sarc) dominate with 11 studied species followed by ballochores (Bal) with 8 species and Pterochores (Pter) is poorly represented with 2 species. The dominance of sarcochores is justified by the fact that its diaspores are totally or partially fleshy likely to be consumed by an animal or by the man (Stromatozoochorie, endozochorie) LUBINI,2013).

Foliar Types The types of leaf sizes of the species provide information on the adaptation of the species to the local climate and the internal microclimate in the different plant groups and associations. The results obtained on the types of leaf sizes of the studied species are represented in the figure below:

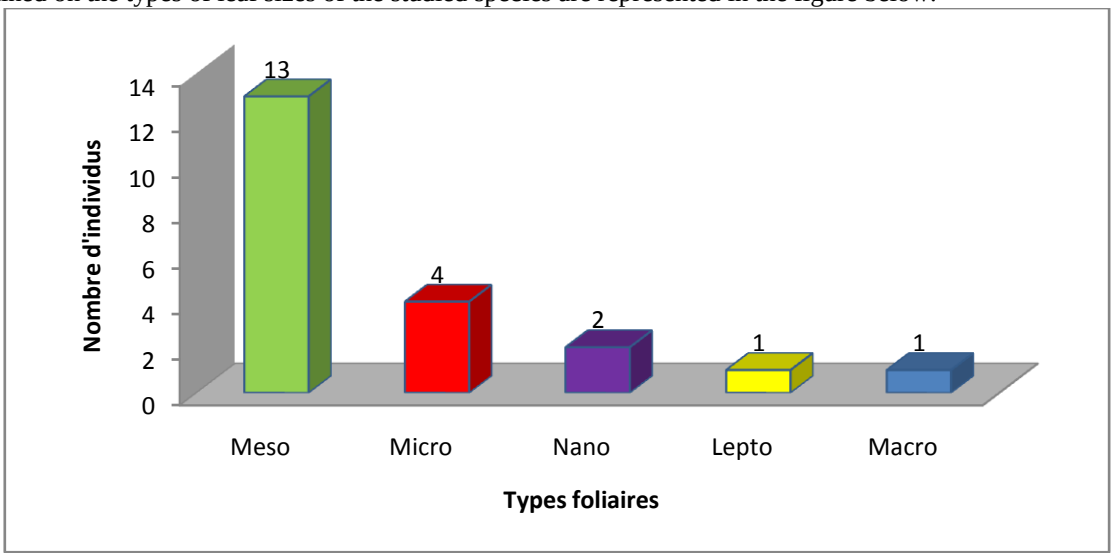


Figure 4. Detail of leaf types of the species studied

Figure 4 shows that mesophylls (Meso) dominate with 13 species studied followed by microphylls (Micro) and nanophylls (Nano), leptophylls (Lepto) and macrophylls (Macro) are poorly represented. The dominance of mesophyll in the forest is explained by the atmospheric humidity that reigns there. Plants have a tendency to reduce their leaf area to reduce transpiration (BELESI, 2009).

Phytogeographic distribution

Figure 5 gives the distribution of species according to phytogeographic grouping.

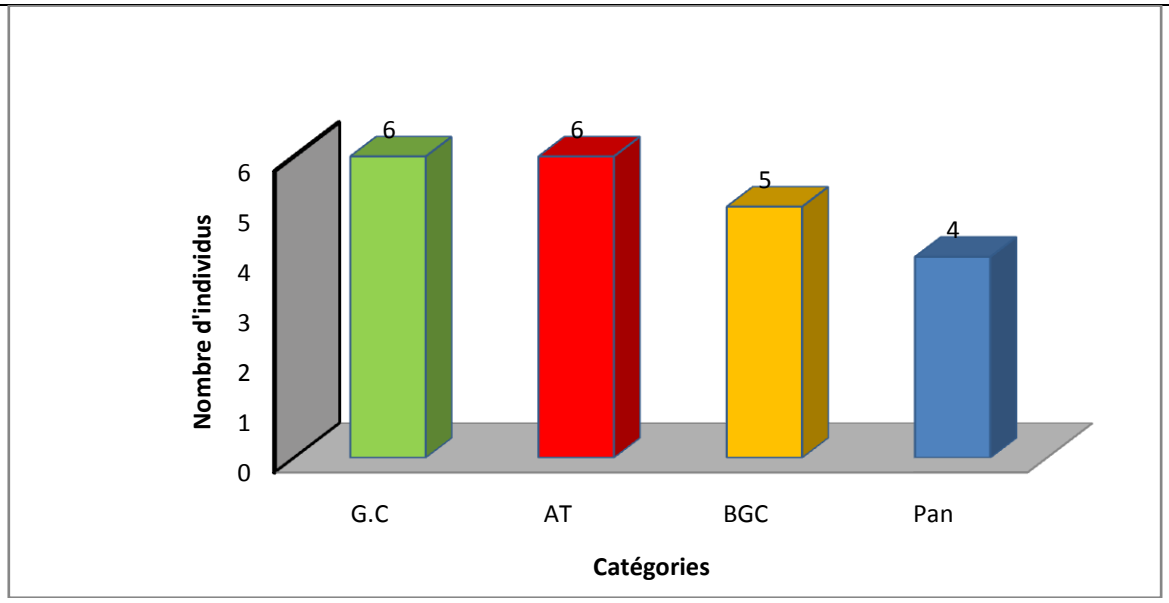


Figure 5. Phytogeographic Distribution Detail of Species Studied

The analysis of results reveals the numerical and centesimal predominance of species with a wide Guineo-Congolese (CG) type geogeographical distribution with 6 species and tropical Africa (AT), ie 6 species followed by Guinean-Congolese Basin (BGC) with 5 species and Pan tropical (Pan) is poorly represented.

Distribution of trees by diameter classes (cm)

The important distribution characteristics of diameters per class indicate the variability of many of the trees within a class (UNESCO, 1979).

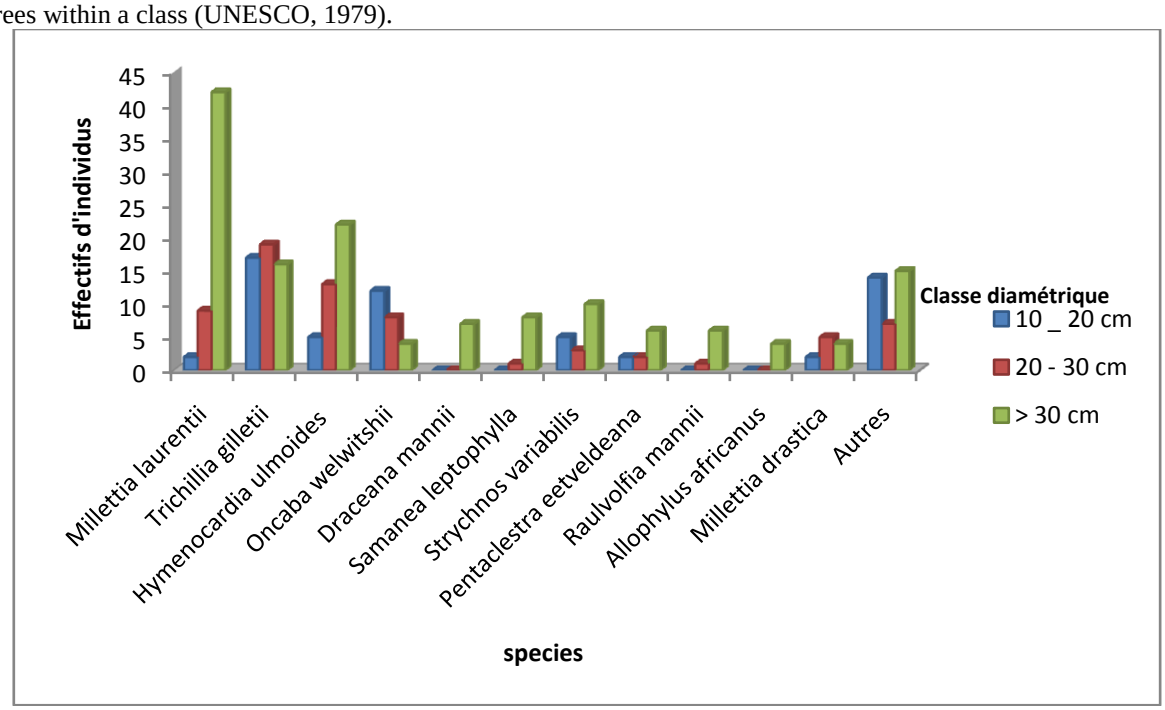


Figure 6. Distribution of trees by diameter classes (cm)

In this graph we find the following: the distribution of trees is more abundant in the first class which ranges from 10-20 to the order of 59 individuals dominated by Trichillia gilletii, the second class 20-30 with 68 individuals dominated by Trichillia gilletii and the third class> 30 up to 129 with 144 individuals dominated by Millettia laurentii. According to the author CHAVE.

a. aboveground biomass and carbon stock

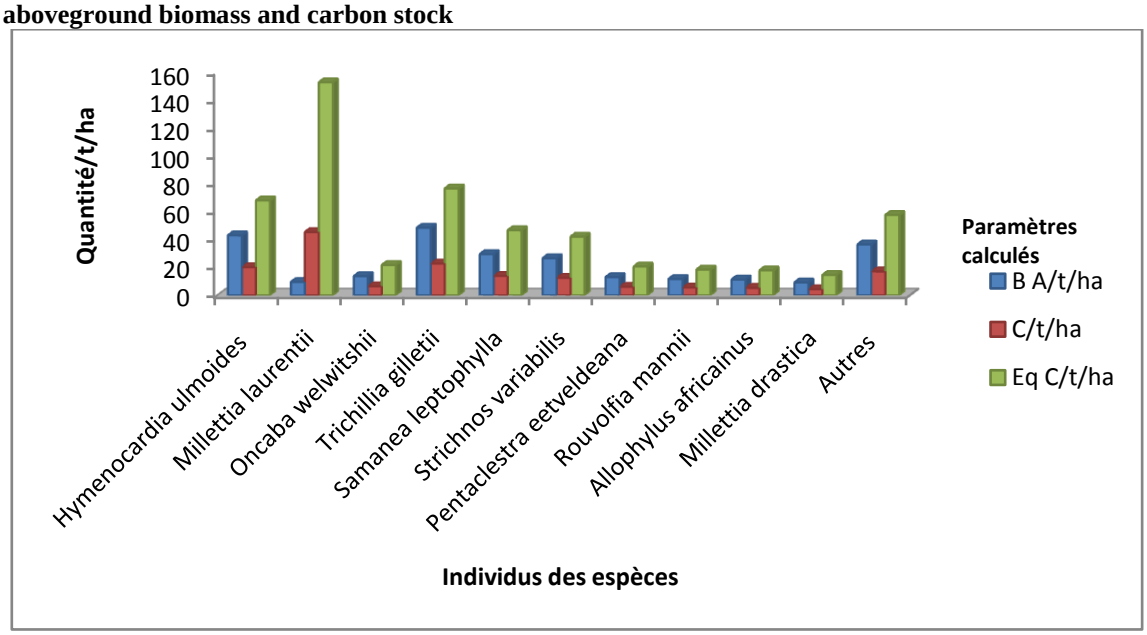


Figure 7. Aerial biomass and carbon stock in the study environment

This figure gives the quality of aerial phytomass of Millettia laurentii with 96.54 t / ha and in the stock a carbon stock of 45.37 t / ha and carbon Eq of 152.78 t / ha followed by Trichillia gilletii with 48.424 t / ha. phytomass and a stock of 22.75t / ha of carbon and 76.63t / ha of carbon Eq followed by Hymenocardia ulmoides or 42.98t / ha of aerial phytomass and the carbon stock of 20.20t / ha and 68 , 03t / ha of Eq carbon followed by Draceana mannii with a phytomass of 30.60t / ha and 14.38 of carbon stock, and 48.43t / ha of carbon Eq followed by Samanea leptophylla with 29.47t / ha of BA and 13,85t / ha of C, and 46,64t / ha of Eq C, followed by Strichnos variabilis 26,59t / ha of BA and 12,49t / ha of C and 42,07t / ha of Eq C, followed by Oncoba welwitshii 13.71t / ha BA and 6.44t / ha C, and 21.70t / ha carbon Eq, followed by Pentaclestra eetveldeana with 13.03t / ha BA and 6.12t / ha of carbon and 20.62t / ha of carbon Eq, followed by Rouvolfia mannii with 11.67t / ha of BA and 5.48t / ha of carbon one and 18,46t / ha of carbon Eq, followed by millettia drastica with 9,20t / ha of BA and 4,32t / ha of carbon and 11,56t / ha of Eq carbon the other species have a phytomass of 27 , 32 t / ha and 12.18 t / ha of carbon stock and carbon equivalent of 43.24 t / ha.

The above-ground biomass and the carbon stock of the species depend on their diameters.

b. Quantification of calculated parameters

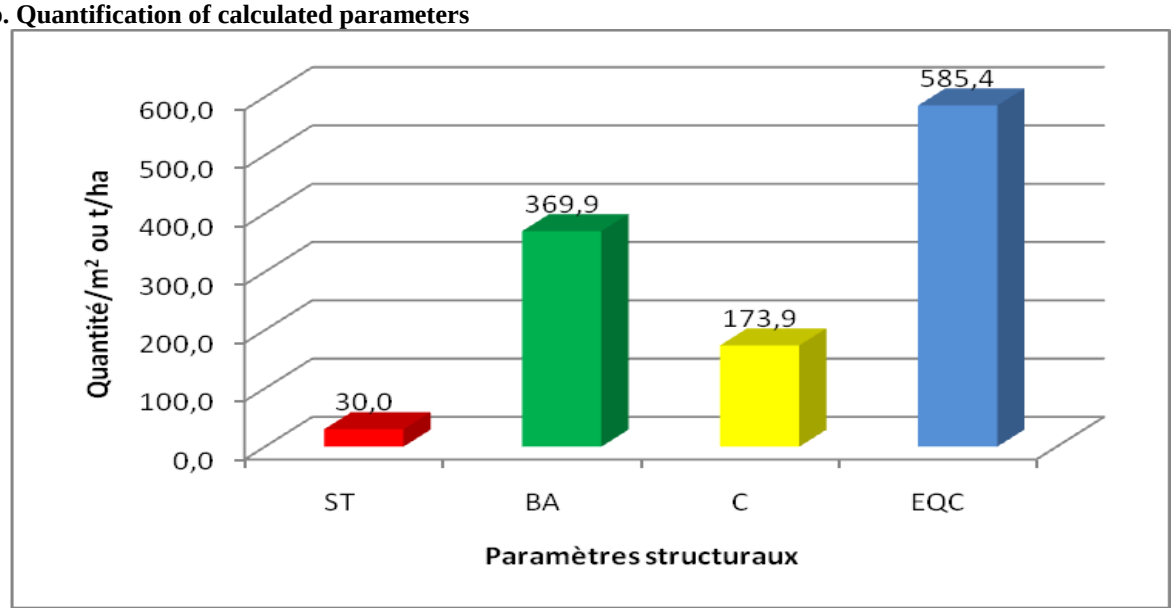


Figure 8. Calculated structural parameters

Figure 8 shows that of 271 inventoried individuals comprising 21 species distributed in 18 families, the basal area is estimated at 30 m2 / ha; aboveground biomass is 369.9 t / ha; the carbon stock is estimated at 173.9 t / ha and the carbon equivalent is estimated at 585.4 t / ha.

Discussion

The study conducted on the above-ground biomass of KIMWENZA-MANRESA forest trees gives us some information that we will discuss in this part of the work. The results obtained show us that out of 21 identified species, Millettia laurentii is dominant.

The biological characteristics studied underline the predominance of mesophanerophytes with 16 species, the analysis of the diasporous types of the specific set shows that the species with diaspore sarcochores are largely majority with 10 species; similarly, examination of the leaf size spectrum indicates that mesophylls are important with 13 species. The analysis of the phytogeographic groups of this forest flora notes the predominance of the 6 species of the regional center of Guinean-Congolese endemism and tropical Africa. The majority of trees measured have diameters in the following classes: 20-30 with 68 individuals, and> 30 with 144 individuals of trees.

The estimation of aboveground biomass and carbon stock depends on identified species. The Millettia laurentii values are very high compared to other species, ie 96.54t / ha of aboveground biomass and 45.37 t / ha of carbon stock, due to the fact that this species is abundant, with individuals large diameters. The lowest recorded mass is 0.35t / ha of sclerocroton cornitus and 0.16t / ha of carbon stock. This is justified by the presence of small diameter individuals.

The total aboveground biomass of our study site was about 369.93 t / ha, or 173.87 t / ha of carbon value greater than that obtained by MINGASHANGA, estimating the aerial biomass in the order of 75, 20t / ha in the UNIKIN residential plateau forest massif, NASI et al. (2008) estimating above-ground biomass in the order of 125t / ha or 62t / ha of carbon in a tropical rain forest. Our estimate remains higher than that reported by KIDIKWADI (2012) an aerial phytomass of 45 ± 8,4t / ha at the Bombo-Lumene reserve.

For the total sequestered carbon stock, it was estimated at 173.87t / ha in the study site, which remains higher than the FAO results (2010); Pearson and BWON (2005) estimate that carbon sequestered in a tropical forest of about 82.2t / ha. On the other hand, it is lower than that reported by CHAVE et al. (2005) of 400t / ha in a tropical rainforest.

Conclusion and Suggestion

Our work focused on "the study of biomass in the kimwenza-manresa forest".The main objective was to estimate aboveground biomass and carbon stock in the tissue of trees and shrubs. To achieve this, the observation method and inventories were done in a one-hectare device, supported by allometric measurements as well as statistical analyzes. The floristic inventories have identified 271 individuals grouped in 21 species and 18 families, there is the dominance of Millettia laurentii and the dominant family is Fabaceae / Faboideae, which reflects the important special occupation of this species and its role in processes of sequestration of atmospheric carbon. The ecological spectrum of this forest is characterized by the dominance of mesophanerophyte, sarcochore, and mesophyll, the phytogeographic distribution is dominated by the species of the endemic center Guinéo-Congolais and tropical Africa.

The estimate of aboveground biomass and carbon stock gave satisfactory results of 369.93t / ha aboveground biomass and 173.87t / ha carbon stock. Millettia laurentii, the dominant species in our forest, has an above-ground biomass of 96.54 t / ha and 45.37 t / ha of carbon stock. The species with the largest diameter has the highest value of above-ground biomass and carbon. This study demonstrates how much the kimwenza-manresa forest mass contributes to the mitigation of atmospheric CO2 and fights climate change by the high carbon sequestration provided by its plant population. This forest ecosystem is an important carbon stock site in the city of Kinshasa.

From the above, we suggest the following:

• that a study be done on the autoecological characteristics: character related to the growth of each species in relation to external factors;

• that the concession manager strengthens security measures and undertakes reforestation activities in the surrounding sites;

• that the government organize the sustainable management of the forest massifs of the city of Kinshasa

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