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Carbon stocks of dead wood in peatland swamp forests of Likouala, Republic of the Congo

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Abstract

In the context of climate change, Congo Basin forests play a major role in carbon regulation. However, dead wood remains poorly documented in peatland swamp forests. This study estimates dead-wood carbon stocks at Bodzale, in Likouala. Four 1-ha plots were established, including three in swamp forest and one in terra firme forest. Downed dead wood and standing dead wood were inventoried and then classified according to diameter and state of decomposition. In total, 795 dead-wood elements were recorded, comprising 750 logs and 45 snags. Carbon stocks in logs ranged from 0.062 to 0.194 tC ha-1, with the highest value in P1 and the lowest in P4. Stocks in snags were low, ranging from 0.0016 to 0.0025 tC ha-1. Stocks did not differ significantly among plots for logs ($p = 0.085$), but did differ according to decomposition class ($p = 0.001$). These findings highlight the value of integrating dead wood into carbon budgets for Congolese peatland forests.

Keywords: Necromass, logs, snags, diameter, decomposition, Central Cuvette

Introduction

Tropical forests are among the main carbon reservoirs of the terrestrial biosphere. They provide numerous ecosystem services, including biodiversity conservation, climate regulation and the maintenance of biogeochemical cycles (Achard *et al*., 2014; Pan *et al*., 2011) [1, 15]. In Central Africa, the Congo Basin is the second largest tropical forest massif in the world after the Amazon and contains extensive areas of humid forests, swamp forests and peatlands (Tchatchou *et al*., 2015) [17].

The peat swamp forests of the Central Congo Cuvette are now recognised as a major ecological complex for carbon storage, particularly in deep organic soils (Dargie *et al.*, 2017) [5]. However, assessments of the carbon balance of these ecosystems cannot be limited to soil and living biomass. They must also incorporate necromass compartments, especially dead wood, which constitutes both a temporary carbon stock, a gradual source of organic matter and an indicator of forest stand dynamics (Harmon *et al.*, 1986; Miles *et al*., 2017) [7, 13].

Dead wood, or woody necromass, includes downed stems, standing dead trees, stumps and woody fragments resulting from natural mortality, treefalls, stand ageing or disturbances. In the doctoral thesis of Ifo (2010) [8], plant woody debris is presented as a structuring compartment of forest ecosystems, contributing to stand structure, biogeochemical cycles, soil fertility, habitat availability and the recent history of disturbances. This approach makes it possible to consider dead wood not simply as a forest residue, but as a functional compartment of the carbon cycle.

The classification of dead wood is essential for comparing stocks among sites. IFO (2010) [8] distinguishes coarse woody debris lying on the ground, or logs, standing dead wood, or snags, and stumps. This distinction is important because these categories do not have the same ecological functions, conditions of contact with the soil or decomposition rates. The amount of carbon contained in dead wood also depends on diameter, wood density, the species of origin and the stage of decomposition. For carbon inventories, the use of a conversion factor close to 50% carbon in dry matter remains common when specific carbon contents are not available (Ifo, 2010; Woldendorp *et al*., 2004) [8, 21].

IFO's (2010) [8] work on the Teke Plateaux showed that woody debris can represent a very important forest carbon compartment in Central Africa. In the gallery and secondary forests studied, mean stocks of coarse woody debris reached 10,993 and 14,172 g m-2, respectively, with interannual fluxes of 1,776 and 545 g m-2 yr-1. Fine woody debris had lower stocks but significant fluxes, particularly in gallery forest. Carbon stocks associated with woody debris reached 5,978 gC m-2 in gallery forest and 7,128 gC m-2 in secondary forest, illustrating the potential weight of this compartment in carbon budgets for Congolese forests (Ifo, 2010) [8].

These local results are highly relevant to the swamp and peatland forests of Likouala. They show that dead-wood stocks vary strongly according to forest structure, stand age, tree density, hydrological conditions, treefalls and human pressures. In humid forests, tree falls, violent winds, the instability of water-saturated soils and slow decomposition may promote either the accumulation or the rapid transformation of woody necromass. Dead wood therefore becomes a sensitive indicator of the ecological condition, functioning and disturbance of stands.

Comparisons with other tropical regions also show that dead wood can be a highly variable compartment. In the Peruvian Amazon, stocks of coarse woody debris may be low in some terra firme forests but higher in floodplain forests or palm-dominated peatlands. In Indonesia, tropical peatlands show that degradation, drainage, fire and land conversion strongly alter woody necromass stocks and their contribution to the carbon balance. These situations confirm the need for local studies, as dead-wood values cannot simply be transferred from one tropical biome to another (Baker *et al.*, 2007; Bhomia *et al*., 2019; Novita *et al*., 2020; Volkova *et al*., 2021) [2, 3, 14, 19].

Despite these advances, the peatland swamp forests of the Congolese Cuvette remain poorly documented with regard to dead wood. Available data mainly concern organic soils, living biomass or terra firme forests, whereas logs and snags are rarely measured systematically. The present study therefore contributes to filling this gap by estimating dead-wood carbon stocks in peatland swamp forests at Bodzale, in Likouala Department.

The general objective of the study is to evaluate dead-wood carbon stocks in the peatland swamp forests of Likouala. Specifically, the study aims to compare carbon stocks among plots, analyse their variation according to diameter classes and assess their distribution according to decomposition classes. The hypotheses tested are as follows: carbon stocks vary among plots; diameter classes influence stocks; and stocks differ according to decomposition classes.

Materials and Methods

Study Area

The study was conducted in Likouala Department, in the north of the Republic of the Congo, in the locality of Bodzale. This locality is situated approximately 18 km from Dongou District and about 40 km from Impfondo. It belongs to the ecological complex of the Congolese Cuvette, which is characterised by swamp forests, seasonally flooded forests, terra firme forests and peatlands.

The climate is humid equatorial. Mean annual temperature is close to 25-26 °C and annual rainfall is high. The area does not experience a pronounced dry season, although a reduction in rainfall is observed between December and February and between June and July. Soils mainly include hydromorphic soils in flooded areas and ferralitic soils in some terra firme areas.

The vegetation is dominated by swamp forests. The main human activities are hunting, fishing, shifting slash-and-burn agriculture and the collection of wood for domestic uses. These activities may locally influence the amount of dead wood available in forest stands.

Sampling Design

Four square plots of 1 ha each were established, corresponding to 100 m x 100 m per plot. Three plots were located in swamp forest and one plot in terra firme forest. The plots were demarcated using a compass and a measuring tape along south-north and west-east orientations. The characteristics of the plots are presented in Table 1.

Table 1: Characteristics of the study plots and number of dead-wood elements inventoried

Plot	Forest type	Area	Number of logs	Number of snags
P1	Swamp forest	1 ha	262	21
P2	Swamp forest	1 ha	205	7
P3	Swamp forest	1 ha	187	12
P4	Terra firme forest	1 ha	96	5
Total	-	4 ha	750	45

Dead-Wood Inventory

Two categories of dead wood were considered: downed dead wood, or logs, and standing dead wood, or snags. Logs correspond to woody debris lying or leaning on the ground, in direct or indirect contact with the soil, and with a diameter >= 2.5 cm. Snags correspond to standing dead trees with a height >= 1.5 m.

The inventory of logs was conducted using the line-intersect method, following Warren and Olsen (1964) [20] and Van Wagner (1968) [18]. In each plot, two diagonals and the four plot sides served as inventory lines. All dead wood located 1 m on either side of these lines was recorded, in accordance with the lines actually entered in the database (sides 1 to 4 and diagonals 1 to 2). The diameter of each log was measured using a measuring tape.

For snags, all standing dead individuals meeting the height criterion were inventoried. Diameter was measured at 1.30 m above the ground or 30 cm above buttresses. Height was measured with a measuring tape for shorter individuals and with a Vertex hypsometer for taller individuals.

Estimation of Volume, Biomass and Carbon

The volume of logs was estimated using the line-intersect method. The volume of snags was estimated from diameter, height and a form factor. Volumes were then converted into dry mass using wood density and subsequently into carbon stock. The general relationship used was: carbon stock = dry matter x 0.5 (Woldendorp *et al*., 2004) [21]. In the calculation database, the density applied was 0.47. Dry matter was obtained as Volume x 0.47, and carbon as dry matter x 0.5; division by 1000 was used to express the results in tC ha-1.

Decomposition and Diameter Classes

Each dead-wood element was classified according to its state of decomposition following the protocol used by IFO (2010) [8]. Four classes were retained: class I, slightly decomposed wood with bark largely present; class II, partially soft wood with bark partially present; class III, strongly decomposed wood with degraded bark; and class IV, very strongly decomposed wood. Dead wood was also grouped into diameter classes in order to assess the contribution of different sizes to carbon stock.

Statistical Analyses

Data were processed using Excel and R software. Carbon stocks were calculated by plot, dead-wood category, diameter class and decomposition class. As the data did not follow a normal distribution, the non-parametric Kruskal-Wallis test was used to compare groups. The significance threshold was set at 5%. The tests were applied to individual stocks calculated for each dead-wood element in order to avoid testing only totals aggregated by plot.

Results

Abundance of Inventoried Dead Wood

In total, 795 dead-wood elements were recorded across the four plots, including 750 logs and 45 snags. Logs therefore represented the largest share of the inventoried dead wood. Plot P1 had the highest number of logs, with 262 individuals, followed by P2 with 205 individuals, P3 with 187 individuals and P4 with 96 individuals. For snags, P1 also had the highest number, with 21 individuals, whereas P4 had the lowest number, with 5 individuals (Table 1).

This distribution indicates a higher abundance of dead wood in the swamp plots than in the terra firme plot. It suggests that local ecological conditions, treefalls and anthropogenic pressures may influence the amount of dead wood present in the stands.

Carbon Stocks by Plot

Carbon stocks in logs varied among the plots studied. The highest stock was observed in plot P1, with 0.194 tC ha-1, followed by P2 with 0.121 tC ha-1 and P3 with 0.098 tC ha-1. Plot P4 had the lowest stock, with 0.062 tC ha-1. The Kruskal-Wallis test applied to individual log values did not indicate a significant difference among plots (H = 6.61; p = 0.085).

Carbon stocks in snags were very low compared with those in logs. They ranged from 0.0016 to 0.0025 tC ha-1. The highest value was observed in P2, very close to P4, whereas the lowest value was observed in P3 (Table 2).

Table 2: Carbon stocks in logs and snags by plot

Plot	Logs (tC ha-1)	Snags (tC ha-1)
P1	0.194	0.0017
P2	0.121	0.0025
P3	0.098	0.0016
P4	0.062	0.0025

Carbon Stocks According to Decomposition Classes

Carbon stocks in logs varied according to decomposition classes and plots. In P1, class I had the highest stock, with 0.094 tC ha-1. In P2, P3 and P4, class III had the highest stocks, with 0.049, 0.038 and 0.032 tC ha-1, respectively. Differences among decomposition classes were significant for logs (H = 16.42; p = 0.001). For snags, class II had the highest stocks in P1, P2 and P4. In P3, class I had the highest stock. No class IV snag was recorded in P2, P3 or P4 (Tables 3 and 4).

Table 3: Carbon stocks in logs by decomposition class (tC ha-1)

Decomposition class	P1	P2	P3	P4
I	0.094	0.012	0.020	0.007
II	0.023	0.041	0.025	0.014
III	0.047	0.049	0.038	0.032
IV	0.030	0.019	0.015	0.010

Table 4: Carbon stocks in snags by decomposition class (tC ha-1)

Decomposition class	P1	P2	P3	P4
I	0.000345	0.000347	0.000616	0.000058
II	0.001067	0.002170	0.000446	0.001560
III	0.000269	0.000026	0.000540	0.000893
IV	0.000015	0	0	0

Carbon Stocks According to Diameter Classes

Carbon stocks in logs varied according to diameter classes. Class II had the highest total stock, with 0.163 tC ha-1 for 103 individuals, followed by class I with 0.154 tC ha-1 for 286 individuals. Class 0, despite having the highest number of individuals, with 333 individuals, represented only 0.053 tC ha-1. This result shows that the most abundant classes are not necessarily those storing the most carbon.

For snags, the larger diameter classes contributed strongly to the total stock. Classes VII-VIII had the highest combined stock, with 0.00498 tC ha-1 for four individuals; within this group, class VIII represented 0.00451 tC ha-1 for three individuals. Large diameters therefore made an important contribution to carbon stock despite low numbers of individuals (Table 5).

Table 5: Carbon stocks in logs and snags by diameter class

Diameter class	Number of logs	Log stock (tC ha-1)	Number of snags	Snag stock (tC ha-1)
Class 0 (2.5-<10 cm)	333	0.053	12	0.00003
Class I (10-<20 cm)	286	0.154	4	0.00005
Class II (20-<30 cm)	103	0.163	10	0.00055
Class III (30-<40 cm)	19	0.062	9	0.00128
Class IV (40-<50 cm)	9	0.044	6	0.00146
Class VII (70-<80 cm)	-	-	1	0.00048
Class VIII (>=80 cm)	-	-	3	0.00451

Discussion

Spatial Variability in Carbon Stocks

The results obtained at Bodzale reveal a descriptive gradient in dead-wood carbon stocks, with higher values in the swamp plots, particularly P1, and a lower value in the terra firme plot P4; however, the Kruskal-Wallis test applied to individual log values did not confirm a significant difference among plots. Beyond this variability among plots, however, the overall level of stocks remained very low. This result must be explicitly linked to the developmental stage of the stands studied. The inventoried plots probably correspond to forest formations that are still young or in an active growth phase and have not yet accumulated a large amount of coarse dead wood. In a young stand, mortality of large trees remains limited, large diameters are poorly represented and the production of voluminous logs or major snags remains low. The low stocks observed therefore do not indicate a low ecological importance of dead wood, but rather a structural condition in which woody necromass has not yet reached the levels expected in older or more disturbed forests.

Another major factor that may explain these low values is the apparent absence of major and repeated treefalls during the recent growth of the plots. In tropical forests, treefalls are one of the principal pathways through which coarse woody debris is produced, because they rapidly transfer part of the living biomass to the dead-wood compartment. When stands do not experience massive tree falls, episodes of clustered mortality or major mechanical disturbances, the necromass produced remains low and is mainly limited to small- or medium-diameter fragments. The relatively higher value observed in P1, associated with a high abundance of logs and a substantial contribution from decomposition class I, may indicate a localised and recent input of dead wood, but it is insufficient to characterise a generalised treefall regime across the whole sampling design. By contrast, the low stock observed in P4 may result from a combination of the young age of the stand, lower local production of dead wood, greater accessibility in terra firme forest and more frequent collection of dead wood for domestic uses. This interpretation should be confirmed through temporal monitoring of the plots, approximate dating of fall events and a finer characterisation of stand age and structure.

The stocks estimated in this study are therefore lower than those reported in some local and intertropical studies. For example, in the swamp forests of Likouala, Bocko *et al.* (2017) [4] reported higher dead-wood carbon stocks, whereas work conducted on the Teke Plateaux showed that woody debris can constitute an important fraction of carbon inputs to the soil in gallery and secondary forests (Ifo, 2010; Ifo *et al.*, 2015) [8, 10]. This difference is consistent with the hypothesis that the sampling design was established in young stands little affected by major treefalls. It should not be considered contradictory to previous studies, because the amount of dead wood depends strongly on stand age, the availability of large diameters, the recent disturbance history, the minimum diameter threshold, the sampling method, the wood density used and whether or not fine woody debris is included. The Bodzale results should therefore be interpreted as a local snapshot of a forest stage with low necromass accumulation, rather than as an average value generalisable to the whole Congolese Cuvette.

Relative Contribution of Logs and Snags

The markedly higher contribution of logs compared with snags is a central result of this study. It is explained first by the much greater abundance of downed dead wood: 750 logs were recorded compared with 45 snags. It is also explained by the natural trajectory of dead wood in humid forests: standing dead trees are progressively weakened by humidity, fungi, termites and mechanical constraints, and ultimately enter the compartment of downed wood. Logs therefore represent both an already accumulated stock and the endpoint of part of the mortality of standing trees.

The low contribution of snags to carbon stock does not mean that this compartment is secondary from an ecological perspective. Snags play an important role in the structural diversity of stands and provide microhabitats for birds, insects, fungi and other saproxylic organisms (Siitonen, 2001) [16]. They may also provide information on recent mortality, especially when they are little decomposed. Their low stock in the Bodzale plots could reflect low recent standing mortality, rapid collapse of dead stems in hydromorphic soils or under-representation linked to inventory criteria. This distinction is important: logs provide more information on the accumulation and transformation of necromass, whereas snags provide information on recent vertical mortality and the structural dynamics of the forest.

The comparison with Ifo (2010) [8] reinforces this interpretation. In gallery and secondary forests of the Teke Plateaux, stocks of coarse woody debris and snags were high and varied according to forest type, showing that woody necromass responds strongly to stand structure, environmental conditions and recent disturbances. The Bodzale results follow the same logic, but in a different ecological context, that of peatland swamp forests. The strong dominance of logs indicates that the downed compartment should be prioritised in carbon inventories, without excluding snags, which retain a high functional and ecological value.

Effect of Decomposition and Diameter on Stocks

The distribution of stocks according to decomposition classes shows that class III dominates in several plots, whereas class I dominates in P1. This contrast suggests a mosaic of local situations. Plots P2, P3 and P4 appear to be characterised by older or already strongly transformed necromass, whereas P1 seems to have received recent inputs of dead wood. Dead wood is therefore not a static compartment: it results from a dynamic balance among tree mortality, stem fall, fragmentation, density loss and the gradual incorporation of organic matter into the soil.

The state of decomposition is a major determinant of the accuracy of carbon estimates. The thesis of Ifo (2010) [8], as well as syntheses and studies on woody debris (Laiho and Prescott, 2004; Ifo *et al.*, 2018) [9, 12], show that decomposition depends on biotic and abiotic factors such as moisture, temperature, wood quality, lignin content, fragment size and the activity of fungi or bacteria. In the swamp forests of Likouala, these factors may act in contrasting ways: permanent moisture may slow some stages of mineralisation by limiting oxygenation, but it may also accelerate the physical and biological disintegration of certain fragments in contact with the soil. It would therefore be reductive to interpret decomposition classes solely as a simple chronosequence; they reflect not only the age of the dead wood, but also its initial quality, position and micro-environmental conditions.

The effect of diameter is also decisive. Even when small diameters dominate numerically, they contribute less to the total stock than intermediate or larger diameter classes. This result is expected geometrically, because the volume of a woody fragment increases strongly with diameter. It confirms that inventories based only on the number of dead-wood elements may lead to erroneous interpretations. In this study, the most abundant classes are not necessarily the most important for carbon; large fragments, even when few in number, can contain a substantial share of the stock. This observation is consistent with the methodological recommendations of Woldendorp *et al.* (2004) [21], according to which measurement of diameter, position and state of decomposition is essential for accurately estimating necromass.

The use of a mean carbon conversion factor of 0.5 remains acceptable for a first estimate, but it is a source of uncertainty. Wood density varies according to species, decomposition class, degree of moisture and the proportion of bark or sapwood retained. In a highly species-diverse swamp forest, the application of a mean density may lead to underestimation for dense, slightly decomposed woods or overestimation for highly decomposed woods. Direct measurements of density by species or by decomposition class would therefore improve the precision of future carbon budgets.

Comparison with Local and Intertropical Studies

The Bodzale results should be placed within a broader gradient of humid tropical forests, swamp forests and peatlands. In Central Africa, studies are still scarce, but they already show strong variability in dead-wood stocks among sites. The work of Ifo (2010) [8] and Ifo *et al.* (2015) [10] on the Teke Plateaux showed that gallery and secondary forests may have substantial stocks and fluxes of woody debris, with differences linked to forest structure and disturbance events. In Likouala, Ifo *et al.* (2017) [11] and Bocko *et al.* (2017) [4] also highlighted the importance of dead wood in humid tropical and swamp forests. The present study extends these works by specifically targeting peatland swamp forests, which are still poorly represented in necromass inventories for the Congo Basin.

Comparisons with the Peruvian Amazon and Indonesia must be made with caution, but they are useful for contextualising the results. In the Peruvian Amazon, Baker *et al*. (2007) [2] showed that stocks of coarse woody debris may be relatively low in some south-western Amazonian forests, whereas studies conducted in *Mauritia flexuosa* peatlands indicate that stand degradation can strongly alter above-ground, below-ground and dead-wood carbon stocks (Bhomia *et al*., 2019; Dezzeo *et al*., 2021) [3, 6]. In Indonesia, degraded, drained or converted peatlands may retain a substantial share of above-ground carbon in the form of woody debris, especially after mortality, fire or forest conversion (Novita *et al*., 2020; Volkova *et al*., 2021) [14, 19]. These examples show that dead wood becomes a particularly sensitive compartment in environments where hydrology and disturbances alter tree mortality and decomposition rates.

The specificity of the peatlands of the Congolese Cuvette lies in the combination of a large soil carbon stock, long-term waterlogging and anthropogenic pressure that remains spatially heterogeneous. In this context, dead wood can play a dual role: it is a temporary stock of above-ground carbon and a potential source of organic inputs to the soil. Its importance is therefore not measured solely by the instantaneous value of the stock, but also by its role in matter transfers, fertility, habitats and the memory of disturbances. Even when measured stocks are low, taking them into account improves understanding of the functioning of peatland swamp forests.

Methodological Scope, Limitations and Implications

The scope of this study is important because it provides field data on a compartment that is still poorly documented in the peatland swamp forests of the Congo. Nevertheless, several limitations must be acknowledged. First, the study is based on four plots, which makes it possible to compare local situations but is not sufficient to represent the full landscape variability of Likouala. Second, stocks were estimated at a given point in time; they do not yet allow calculation of annual fluxes of production, fall, fragmentation and decomposition. Third, the use of mean values for density and carbon content limits the precision of the estimates, especially when species and decomposition stages are varied. These limitations do not reduce the value of the results; rather, they define priorities for future research. Multiannual monitoring would make it possible to distinguish stable stocks from recent inputs, estimate residence times and link necromass variations to treefall episodes, hydrological fluctuations and human uses. The integration of fine woody debris, stumps, real density measurements and decomposition rates would also improve the robustness of carbon budgets. Finally, comparison of plots located along gradients of flooding, distance from villages and forest structure would help identify the dominant factors controlling necromass in Congolese peatlands.

From an applied perspective, these results support the systematic integration of dead wood into carbon inventories and monitoring schemes for Congo Basin forests. Inventories limited to living trees and soil risk neglecting a compartment which, even when quantitatively modest, provides information on stand dynamics, recent disturbances and carbon transfers to the soil. For peatland swamp forests, the most robust approach is therefore to distinguish logs, snags, stumps, diameter classes and decomposition classes, while linking this information to hydrology and local uses.

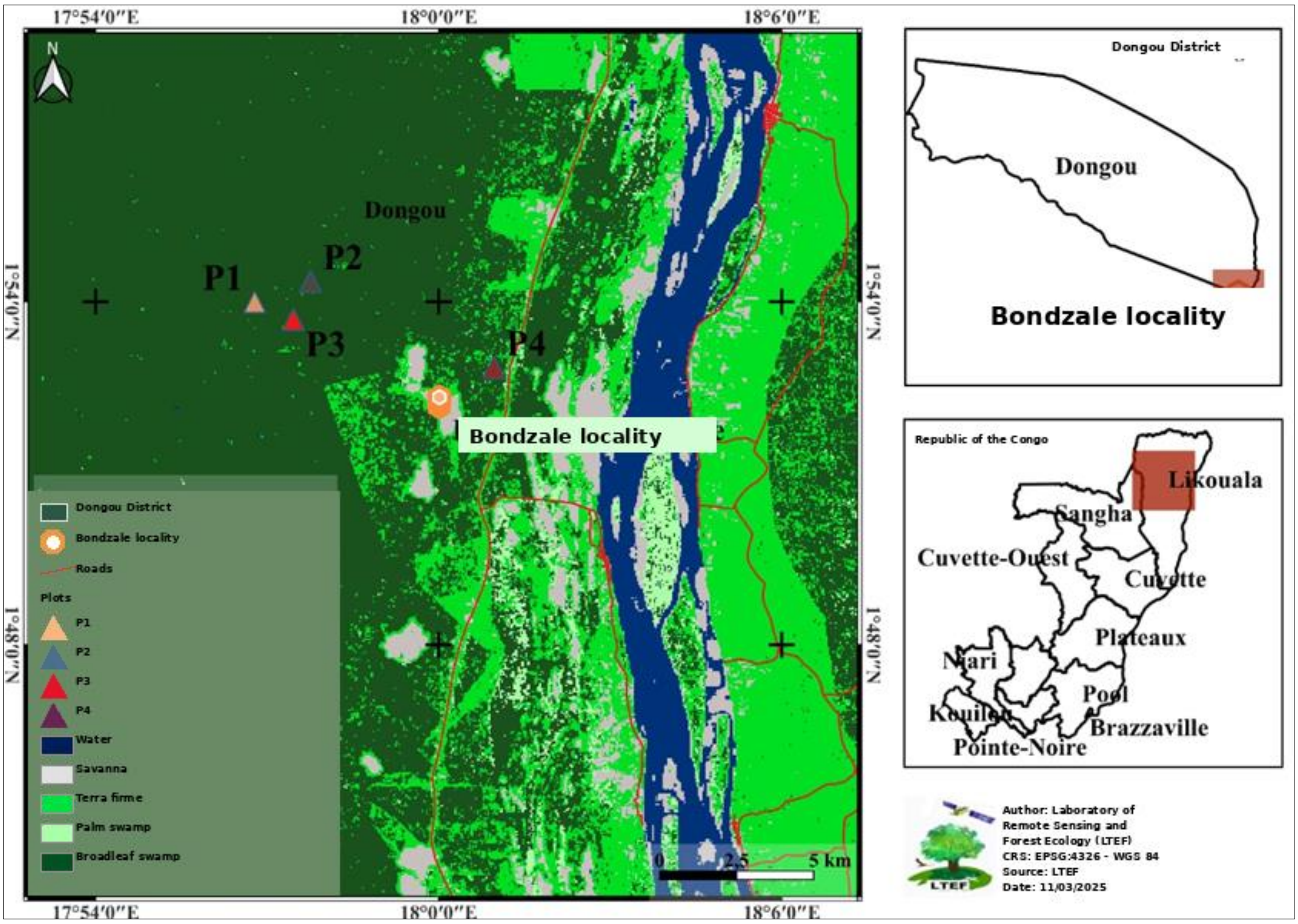

Fig 1: Location of the study area

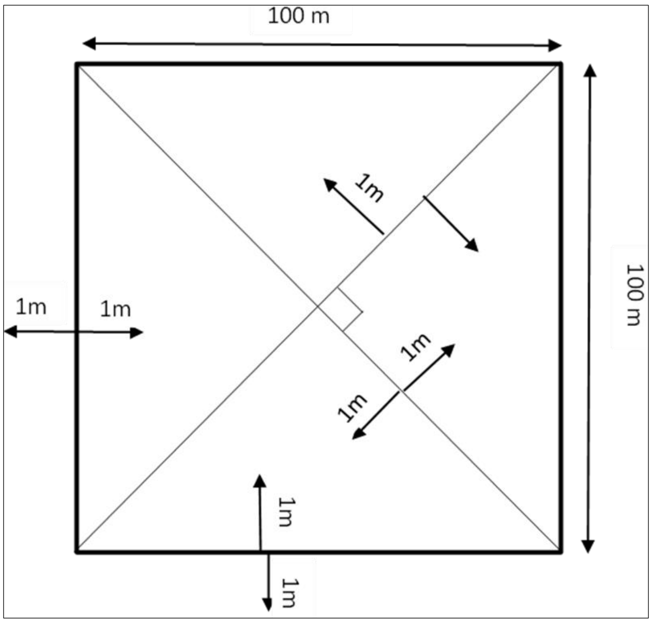

Fig 2: Sampling design used in the plots

Conclusion

This study estimated dead-wood carbon stocks in the peatland swamp forests of Likouala. The results show that stocks vary descriptively among plots, diameter classes and decomposition classes; statistically, the difference is confirmed for log decomposition classes, but not among plots. Logs constitute the main category of dead wood in terms of abundance and carbon stock, whereas snags have lower stocks. This dominance of downed wood confirms that ground necromass should be considered a priority compartment in carbon inventories of swamp forests.

The lessons from Ifo's (2010) [8] thesis strengthen the interpretation of these results. This thesis shows that plant woody debris is not merely residue resulting from tree mortality, but an indicator of forest structure, stand stability or disturbance, carbon fluxes to the soil and decomposition dynamics. The high stocks and fluxes measured in gallery and secondary forests of the Teke Plateaux show that dead wood can represent a major fraction of above-ground necromass and must be integrated into carbon budgets for Congolese forests.

In the Bodzale plots, intermediate or large diameter classes contribute more to the total stock than small diameters, even when the latter are numerically more abundant. Nevertheless, the total stock remains low, which is an important result of the study. This low level is probably explained by the relatively young age of the forest plots and by the apparent absence of major treefalls during their growth. Under these conditions, the stands have not yet produced or accumulated large volumes of logs and snags. Decomposition classes nevertheless reflect an active dynamic of dead-wood transformation, with class III being particularly important in several plots. The dominance of this class suggests an accumulation of relatively old or already strongly transformed debris, whereas the dominance of class I in P1 indicates recent but localised inputs, which do not call into question the overall low level of necromass observed.

Comparisons with local studies in the Congo Basin, the Peruvian Amazon and Indonesian peatlands show that hydrology, forest structure, stand age, natural disturbances and human uses strongly control the quantity of dead wood available. In the case of Bodzale, the low values measured should therefore be interpreted primarily as the consequence of a young forest stage and a low occurrence of major treefalls. The low value observed in the terra firme plot may also be linked to proximity to domestic uses, whereas swamp plots may locally favour the accumulation of logs when treefalls occur. The absence of such large-scale events in the studied plots largely explains the current low stock of dead wood.

These results underline the need to integrate dead wood systematically, distinguishing logs, snags and decomposition classes, into carbon assessments of peatland swamp forests in the Congo Basin. They also show that a low point-in-time stock of dead wood should not be interpreted as low ecological importance of necromass, but as the reflection of a stage of forest development and a recent disturbance history. Future research should therefore document stand age, treefall frequency, actual wood density according to species and decomposition stages, decomposition rates under hydromorphic conditions, the contribution of fine woody debris, the effect of hydrology and comparisons among primary, secondary, swamp and terra firme forests. Such an approach will make it possible to better assess the role of the forests of Likouala in carbon sequestration and in the conservation of the ecological functions of the Congolese Cuvette.

Authors' Contributions

BM participated in data collection and in the initial drafting of the manuscript. GB contributed to data processing, analysis and scientific proofreading. GKK participated in data collection, data processing and improvement of the manuscript. SAI designed the study, supervised the work, contributed to the scientific interpretation of the results and carried out the critical revision of the manuscript. BM, GB, GKK and SAI read, corrected and approved the final version of the manuscript.

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