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## **Weighing trees with laser: vertical variations of wood specific gravity and their impact on volume-to-biomass conversion**

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### ► To cite this version:

Stephane Momo Takoudjou, Pierre Ploton, Faustin Boyemba, Pierre Couteron, A. Fayolle, et al.. Weighing trees with laser: vertical variations of wood specific gravity and their impact on volume-to-biomass conversion. Terrestrial laser scanning in forest ecology, May 2019, Gent, Belgium. hal-02445395

**HAL Id: hal-02445395**

**<https://hal.umontpellier.fr/hal-02445395>**

Submitted on 20 Jan 2020

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# WEIGHING TREES WITH LASER

## WHAT ABOUT VERTICAL VARIATIONS OF WOOD DENSITY?

Momo Takoudjou S.\* & Ploton P., Martin O., Lehnebach R., Fortunel C., Boyemba F., Couteron P., Fayolle A., Libalah M., Loumeto J., Medjibe V., Ngomanda A., Nchama N N., Pélissier P., Yongo O., Rossi V., Sagang Takougoum L B., Sonké B., Barbier N.

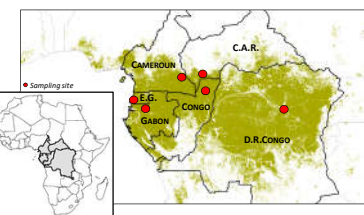


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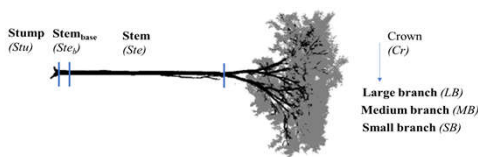
### 1. CONTEXT

Terrestrial LiDAR (TLS) is a promising approach for indirect estimations of trees and stands aboveground biomass (AGB). TLS data provide precise estimations on wood volume but no information on wood density (WD). Hence, WD are typically extracted from global databases (e.g. Global Wood Density database, GWD) to convert TLS-derived volumes to AGB. WD estimates from global databases rarely, if ever, account for within-trees variations in WD. Systematic variations of WD, notably along the stem and up to the small branches (i.e. vertical variations), may induce biases in available WD values, which would directly propagate into AGB estimates. Here, we used a large destructive dataset collected in tropical Africa to determine vertical variations in WD for 51 tree species, its relationship to plant functional groups and its implications for AGB estimation from volumetric (TLS) data.

### 2. DATA



#### WD estimations along a vertical gradient



Trees were subdivided in **6 compartments** from the stump to the small branches. WD was determined in each compartment.

12,181 wood samples



Destructive harvesting of **821 trees** of 51 species, from 6 distinct forest types in 6 countries ; 61 trees scanned with TLS.

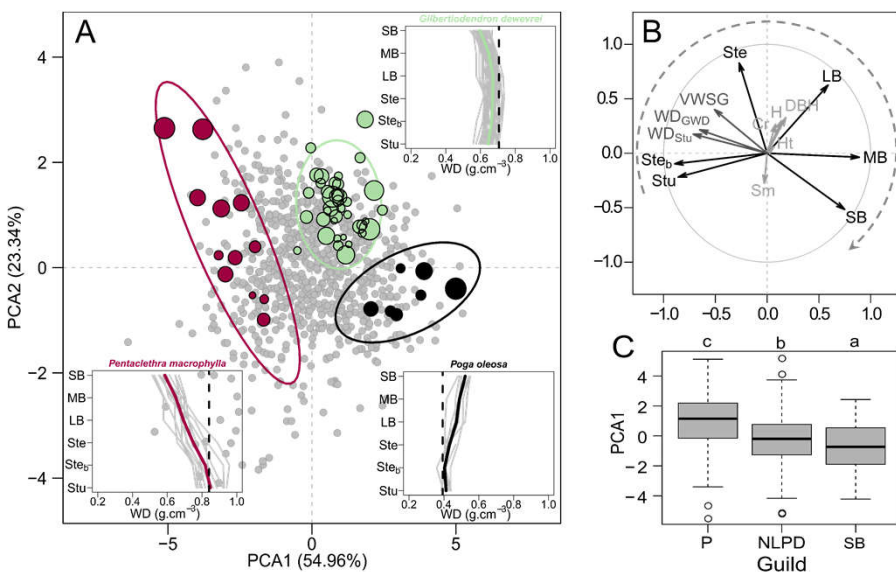
#### Volume and AGB estimation

- Using direct weighting or indirect method on large chunks (volume \* WD)
- Using Terrestrial LIDAR - QSM extraction on scanned trees (*SimpleTree*)

### 4. WD vertical variations

**A & B.** PCA axes efficiently discriminated WD vertical profiles (see the 3 illustrative species in panel A): **decreasing WD** profiles from stump to branches on PCA1-, convex/**constant** profiles on PCA2+, **increasing WD** profiles on PCA1+.

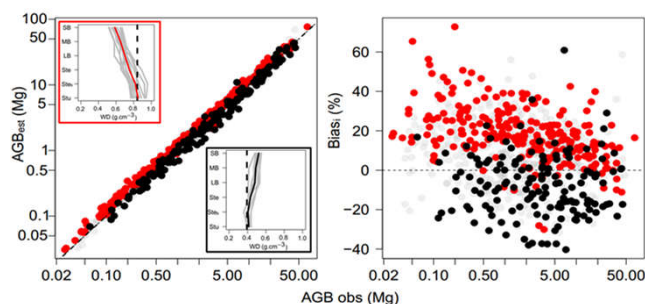
**C.** Aggregation of WD vertical profiles among species guilds.



### 3. ANALYSES

- Description of WD profiles with PCA analysis.
- Conversion of trees volume using different WD values (from global database, tree stump) and comparison with field-derived AGB estimation.
- Development of correction models for WD.

### 5. Impact on volume conversion into AGB

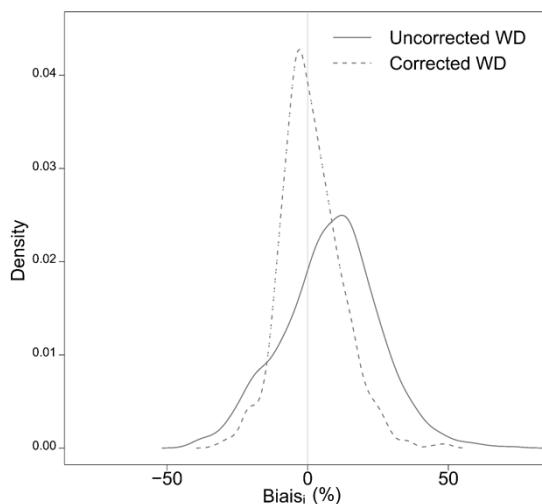


Vertical variations in WD induced systematic errors on tree AGB estimations : **18.5%** (red) and **-7.5%** (black) errors. Similar errors were observed when converting TLS-volume to AGB.

### 6. Correction model for WD

Simple and multi-species models based on WD derived from global databases and tree DBH were used to produce a WD representative of the whole tree.

Mean bias on tree AGB drop from **~ 8%** w/o WD correction to **< 1%** when applying corrections models.



### Acknowledgements

First authors are supported by an IRD grant (2017-2019) and 3DFORMOD project. This study benefited data from the regional project on REDD+ "Establishment of allometric equations for forest types in the Congo Basin" grant N° TF010038 from the Global Environment Facility administered by the World Bank and implemented by the COMIFAC.