Weighing trees with laser: vertical variations of wood specific gravity and their impacton volume-to-biomass conversion

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WEIGHING TREES WITH LASER

WHAT ABOUT VERTICAL VARIATIONS OF WOOD DENSITY?

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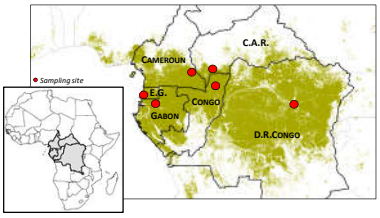
1. CONTEXT

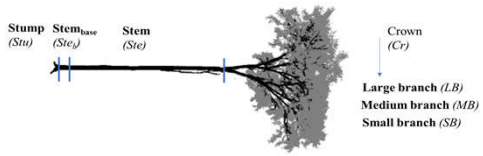
Terrestrial LiDAR (TLS) is a promising approach for indirect estimations of trees and stands aboveground biomass (AGB). TLS data provide precise estimations on wood volume but no information on wood density (WD). Hence, WD are typically extracted from global databases (e.g. Global Wood Density database, 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



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

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

Volume and AGB estimation

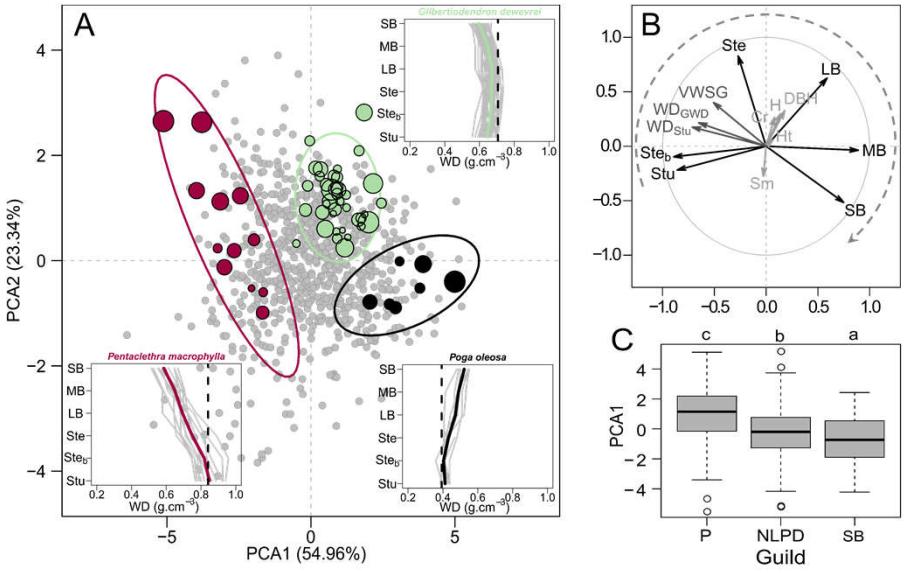
- Using direct weighting or indirect method on large chunks (volume * WD)
- Using Terrestrial LIDAR - QSM extraction on scanned trees (*SimpleTree*)

3. ANALYSES

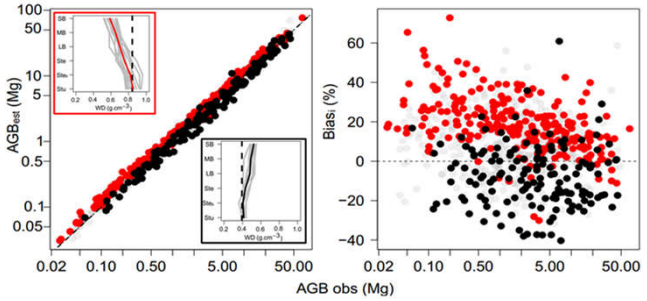
- Description of WD profiles with PCA analysis.
- Conversion of trees volume using different WD values (from global database, tree stump) and comparison with field-derived AGB estimation.
- Development of correction models for WD.

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.



5. Impact on volume conversion into AGB

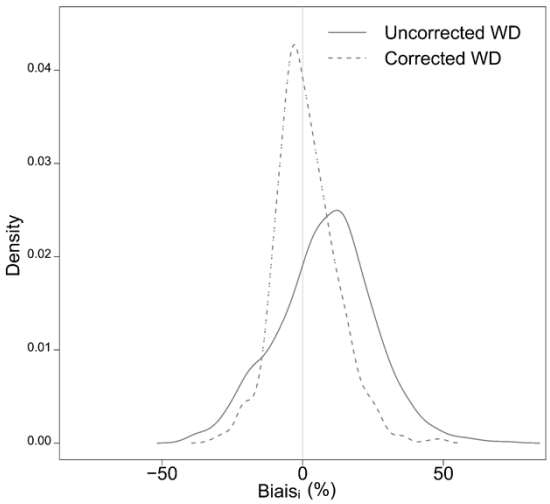


Vertical variations in WD induced systematic errors on tree AGB estimations : **18.5%** (red) and **-7.5%** (black) errors. Similar errors were observed when converting TLS-volume to AGB.

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

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