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Additional material Poster: “Quantification of Tropical Forest Biomass with Terrestrial LiDAR and 3D Tree Quantitative Structure Modelling”

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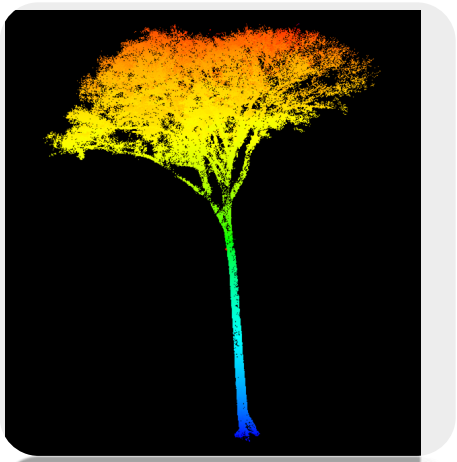

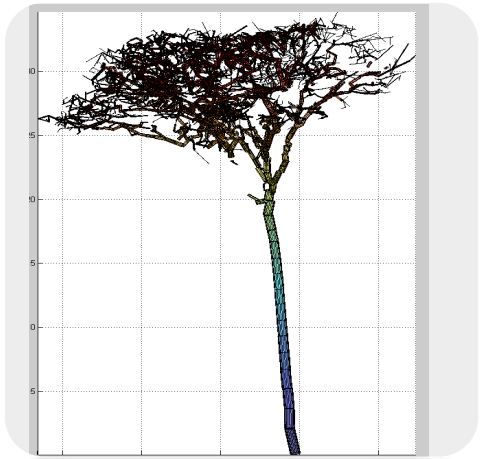

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[3] Tampere University of Technology

Introduction.

Measuring AGB of Tropical Forest

- Difficult to access and expensive to directly measure large trees AGB (destructive sampling)

- Current methods to estimate AGB in tropical forests based on **indirect estimations**:
  - generally based on **allometric equations**
  - can be very effective when applied within the species and productivity range of the **calibration data**
  - may lead to **large uncertainties** in broad scale biomass mapping

Objectives.

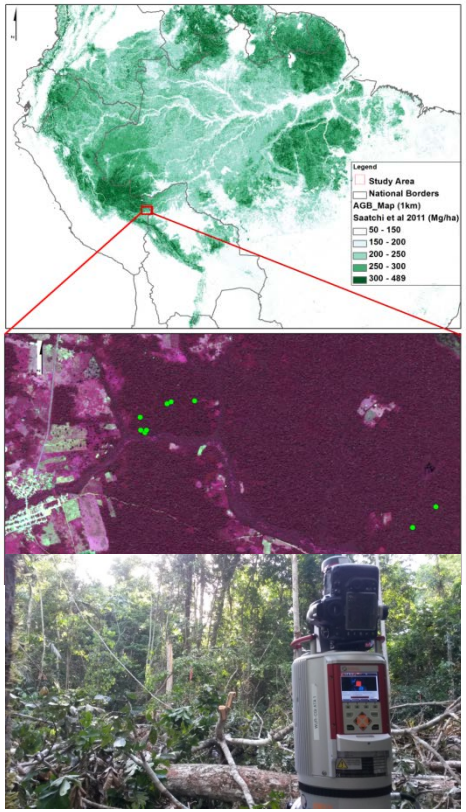
1. Infer tree wood volume directly from tree 3D models derived from TLS data. Derive AGB based on specific wood density
2. Compare with destructive detailed in-situ measurements of wood volume after harvest
3. Evaluate the capability of the tree reconstruction method to deal with very high occlusion and irregular shape trees (buttresses)

Experiment set-up.

- Selective logging in tropical forest in Peru, Guyana, and Indonesia
- 29 Plots (30x40 and 30x50m), around a major tree to be harvested
- 29 Harvested Trees: Height: 30 - 50 m; Diameter: 40 - 128 cm; AGB: 4 - 31 Mg

In this additional material:

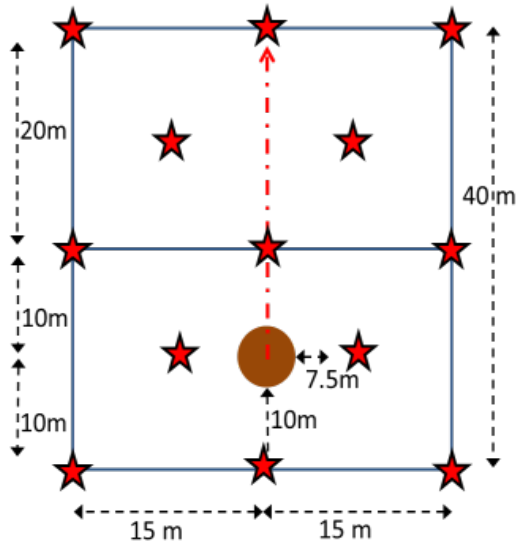
- Preliminary results from Peruvian Amazon Site
- 9 very large trees from 5 different species harvested



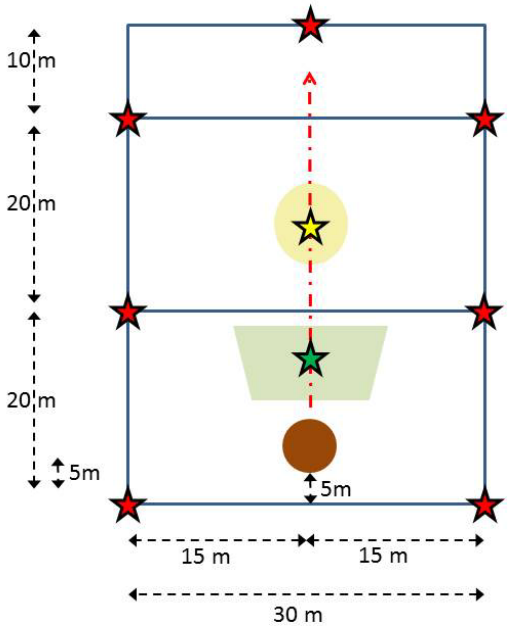
TLS data acquisition.

- Riegl VZ 400, Angular Resolution 0.06 degrees,
- Systematic Spatial Pattern: 8-13 scan positions / plot
- Spatial TLS sampling design:

Indonesia & Guyana (2014)



Peru (2013)



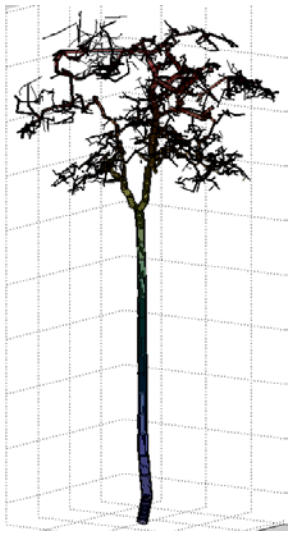
Tree harvested

scan positions

Validation Data. Field measurements

- Pre-harvest
  - DBH of Trees, palms, and lianas with D ≥ 10 cm
  - Alive status, X,Y, Family/Genus/species, decay class (dead)
  - Crop tree: Htot, Hstem, Crown width
- Post-Harvest
  - Stump height, Dimensions: buttresses, stem (D every 1m), branches (D≥10cm)

Methods.



TLS

single tree extraction

3D tree reconstruction

Wood volume + wood density

AGB from TLS

Field data (forest inventory and destructive Volume)

Wood Volume reconstruction

AGB (ref)

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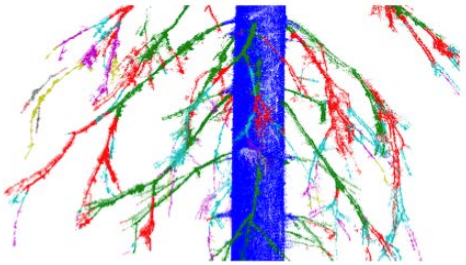
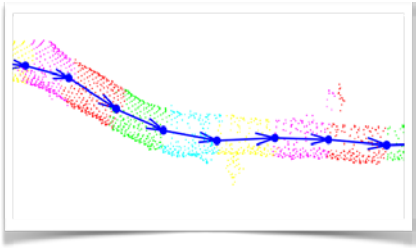
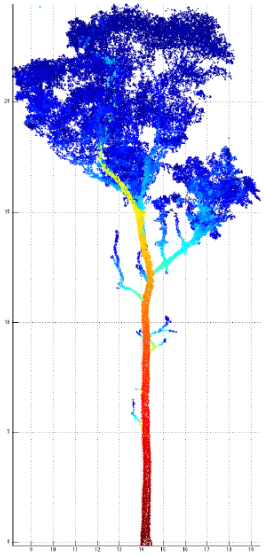
Methods. QSM 3D tree reconstruction

- Raumonen et al. (2013):
  - Input = individual tree point cloud
  - Output = cylinder model of the tree structure
  - Reconstruction method:
    i. Segmentation (and topology, axes)
    ii. Surface reconstruction (cylinder fitting)
- No prior assumptions of tree structure
- Direct calculation of tree wood volume
- Also triangulated surface model for base of stem (Raumonen et al. 2013 and Åkerblom et al. 2014)



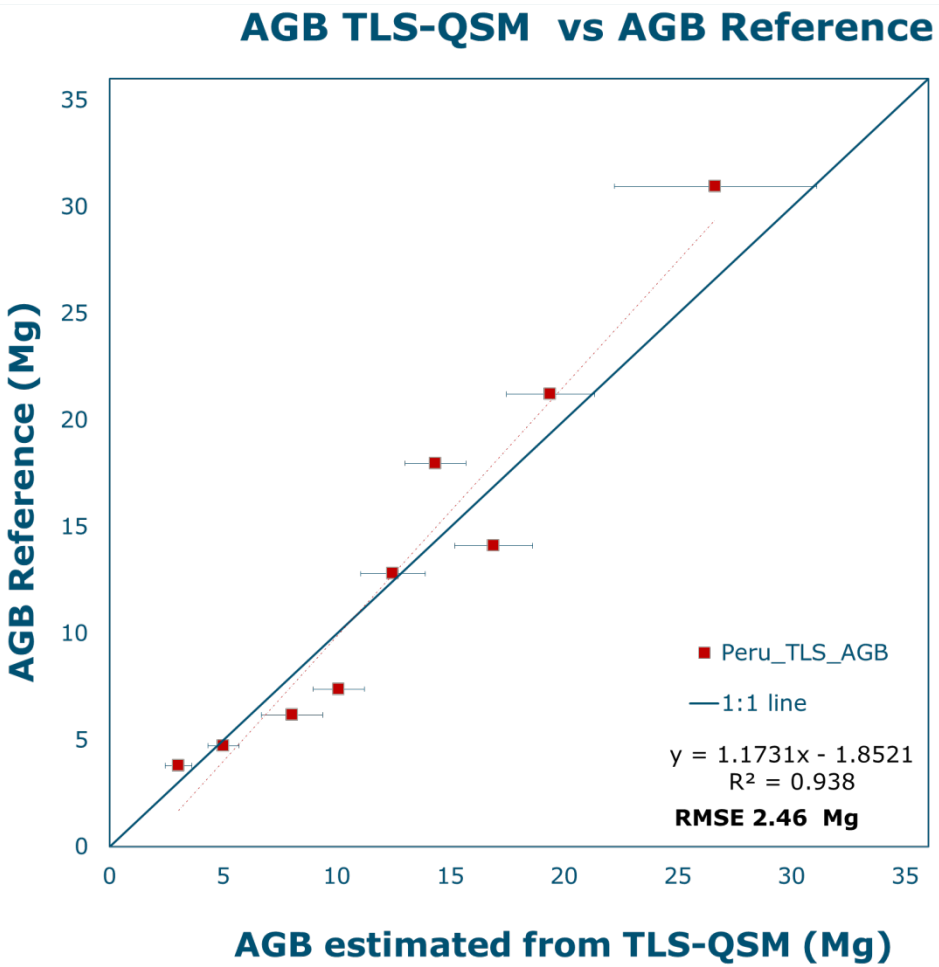




Raumonen, et al. (2013). Fast Automatic Precision Tree Models from Terrestrial Laser Scanner Data. *Remote Sensing, 5*, 491-520

Åkerblom et al. (2014) "Analysis of geometric primitives in quantitative structure models of tree stems" Remote Sensing,

Preliminary Results.
TLS–QSM for tropical biomass estimation



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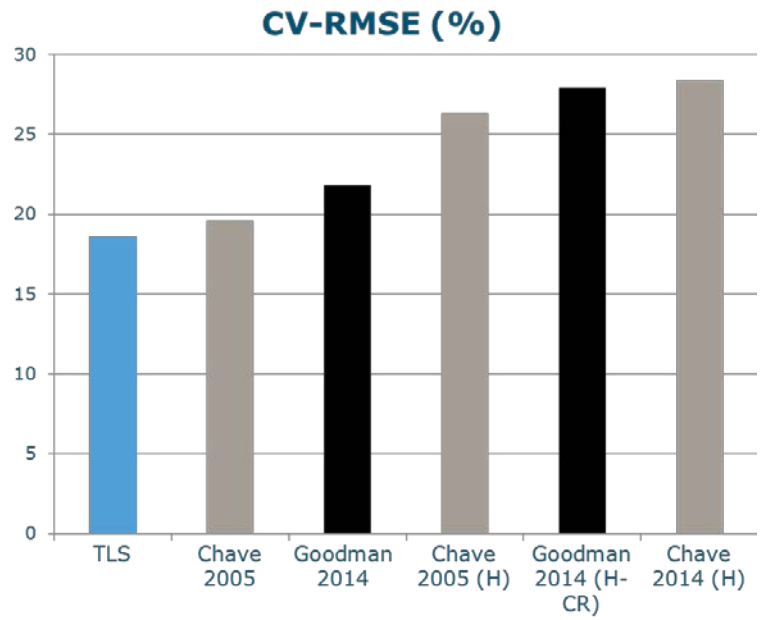
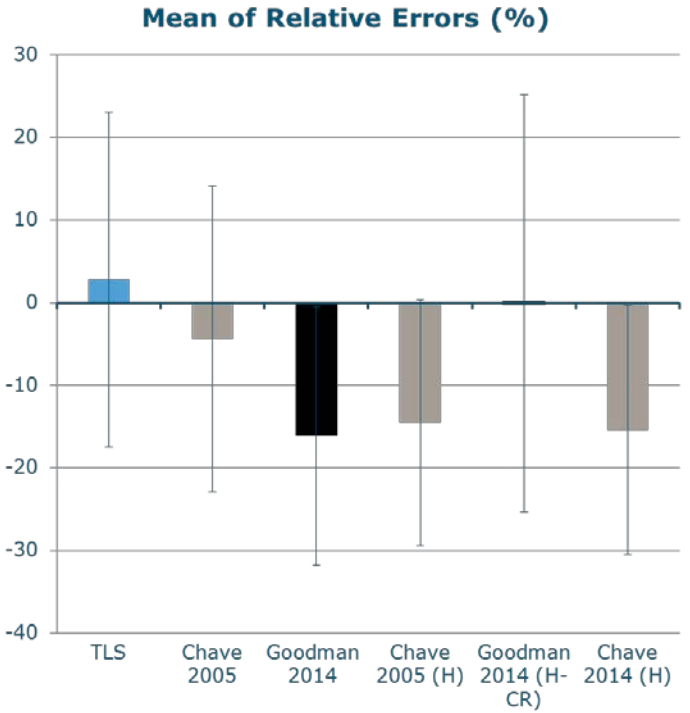
Preliminary Results.
TLS–QSM for tropical biomass estimation

- Accuracy and Bias in AGB from **TLS vs Allometry**:
  - TLS: Slightly more accurate. Overestimation of 2.8 %
  - Allometry: Less accurate. Underestimation of -0.1 to -16.2 %





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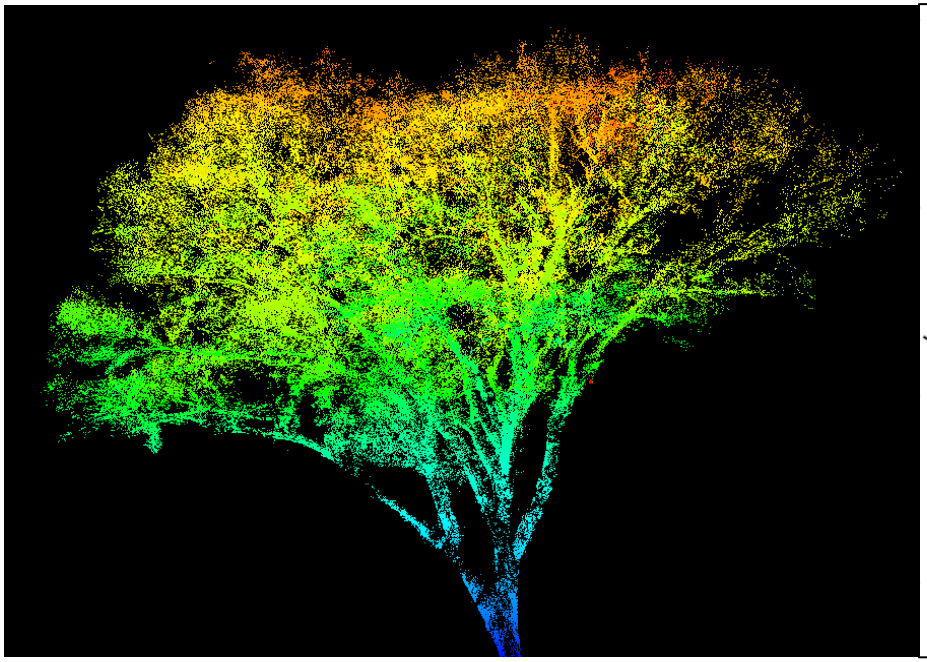
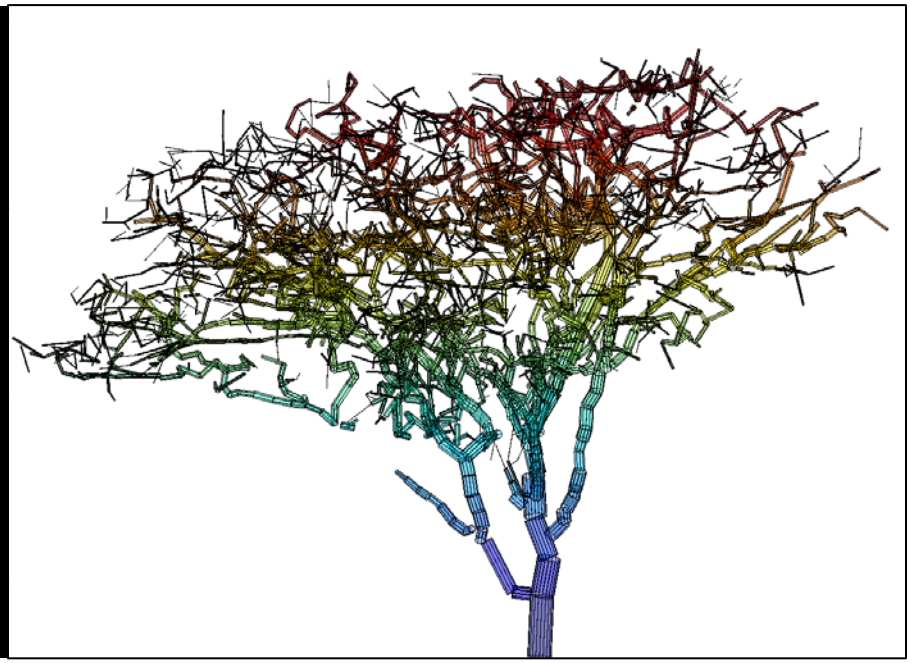
Results. TLS – 3D tree model in Tropical Forest

- Stems well reconstructed despite gaps in the cloud points and challenging shapes
- Crowns still overestimation due to low point density at tip of branches/ noise points from leaves (filter)

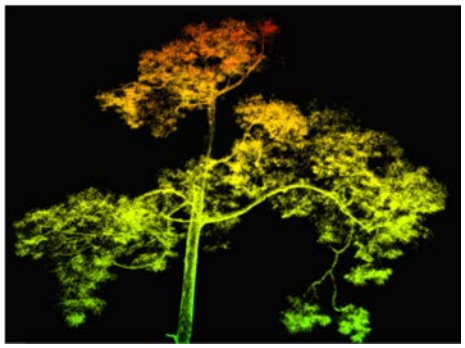


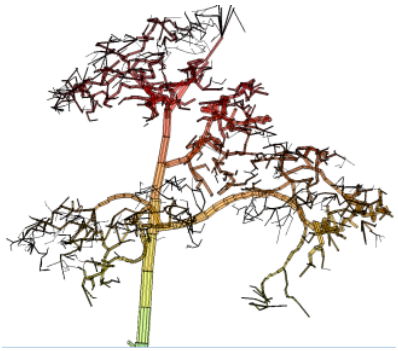


On-going work

- Scaling up: data from 3 Selective logging field experiments across tropics (Peru, Indonesia, Guyana)

- 29 tropical trees harvested and measured





Watch video animation:

https://youtu.be/YnLihYyrNxc

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