In-house LiDAR for forestry companies? An appraisal of the DJI L1 sensor for forest inventory

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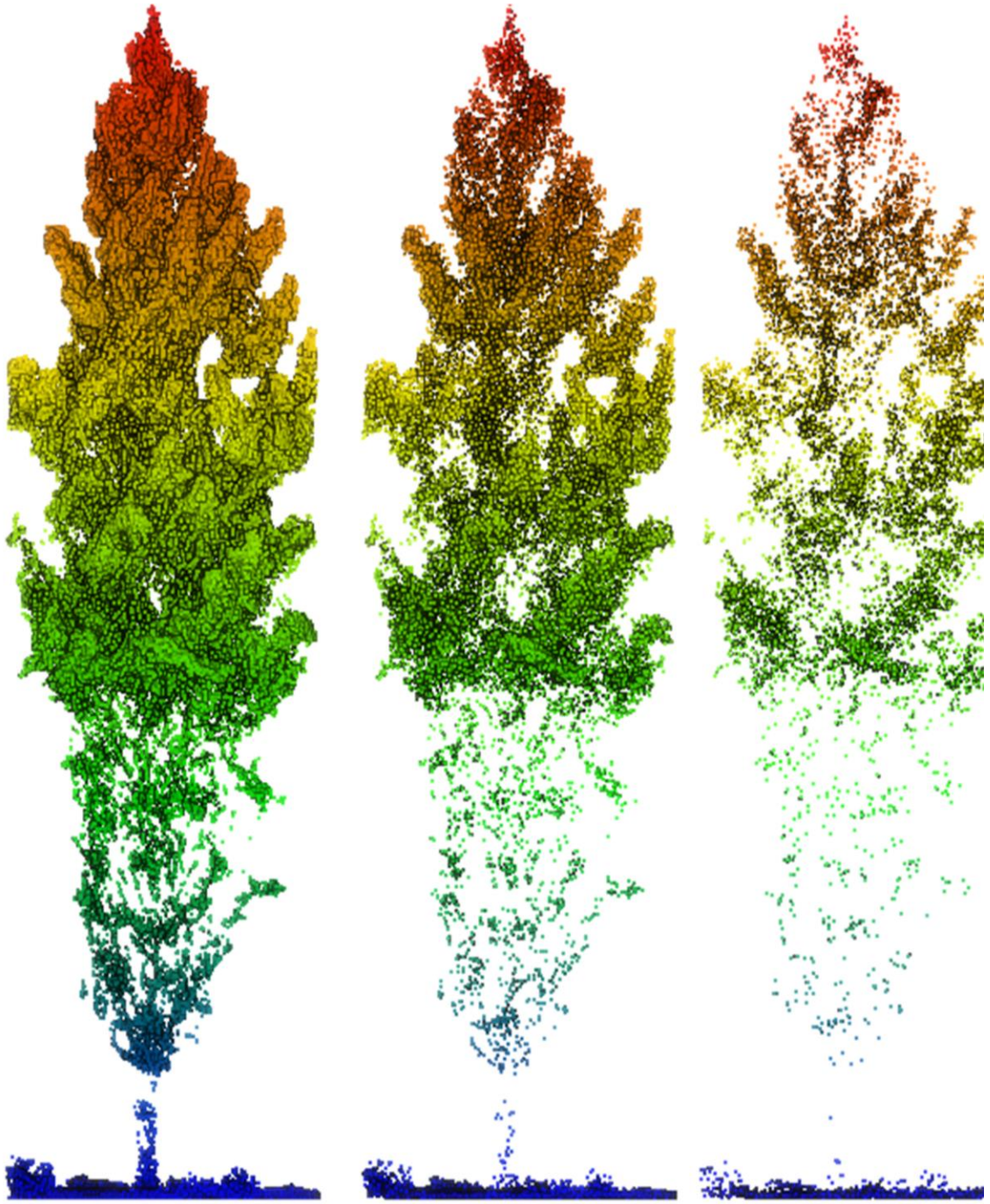
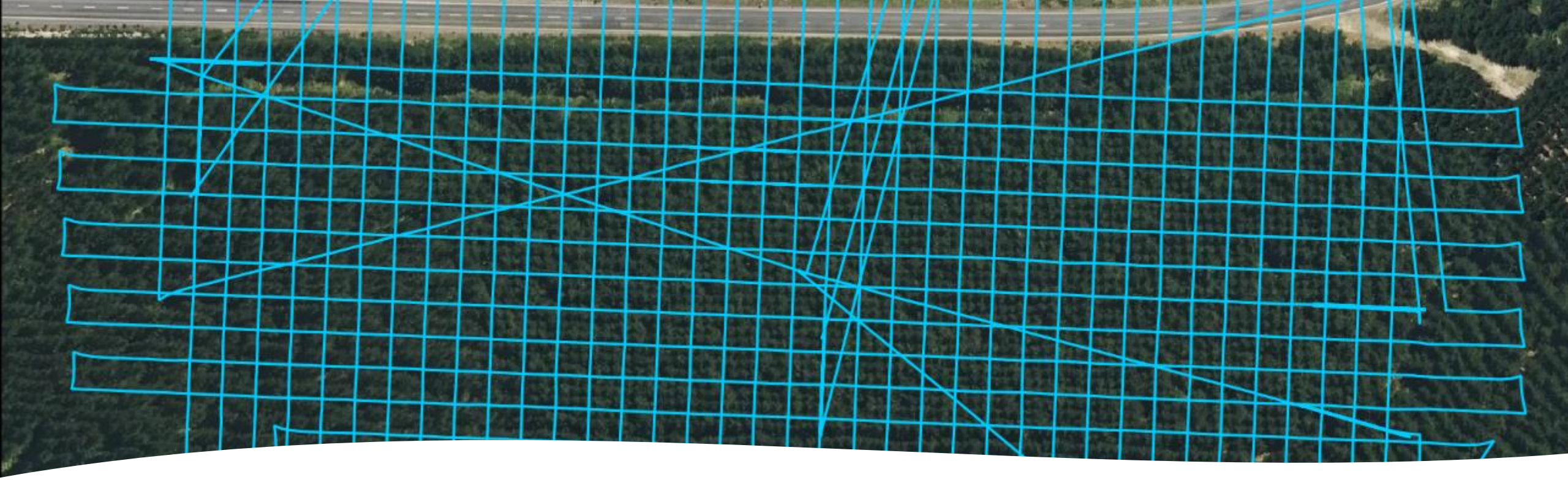


Sensor: DJI-L1 Zenmuse

- Consumer-grade solid-state LiDAR that integrates
  - a Lidar module
  - an RGB camera
  - a high-accuracy IMU
- Mounted on DJI Matrice 300 RTK
- 5 cm vertical and 10 cm horizontal accuracy
- Two scan modes: Repetitive and Non-repetitive
- Three pulse frequencies: 80, 160, 240 Hz
- Record up to three returns per laser pulse
- 2km^2 area coverage in a single flight

Test site

- 3 ha Radiata pine trial
- Age 9
- Stand density of 456 stems/ha
- Mostly flat terrain
- Moderately dense understory of thick Blackberry shrubs



Flight planning

- Gridded pattern: 10 m spacing between flight lines
- Flying speed: 3 m/s
- Altitude: 55 m above ground
- Scan mode: Repetitive
- Pulse frequency: 160 Hz
- 1 hour and 42 minutes flight time

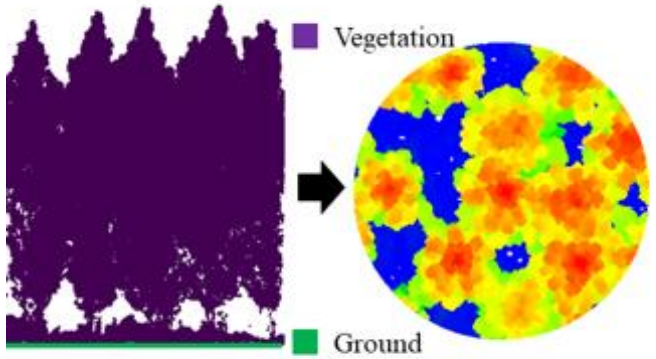
Method

Raw LiDAR data

1 Standard Pre-processing

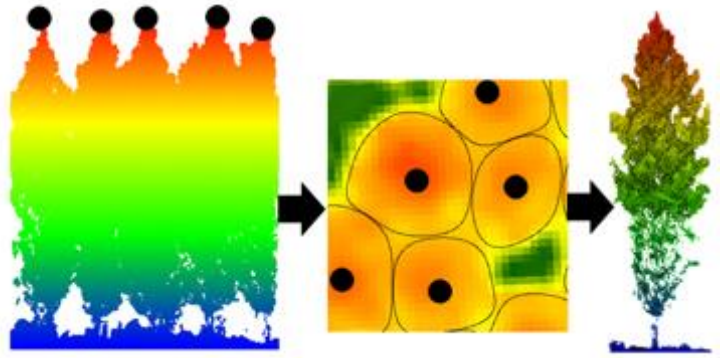
2 Homogenisation

3 CHM



4 Tree peak detection and crown delineation

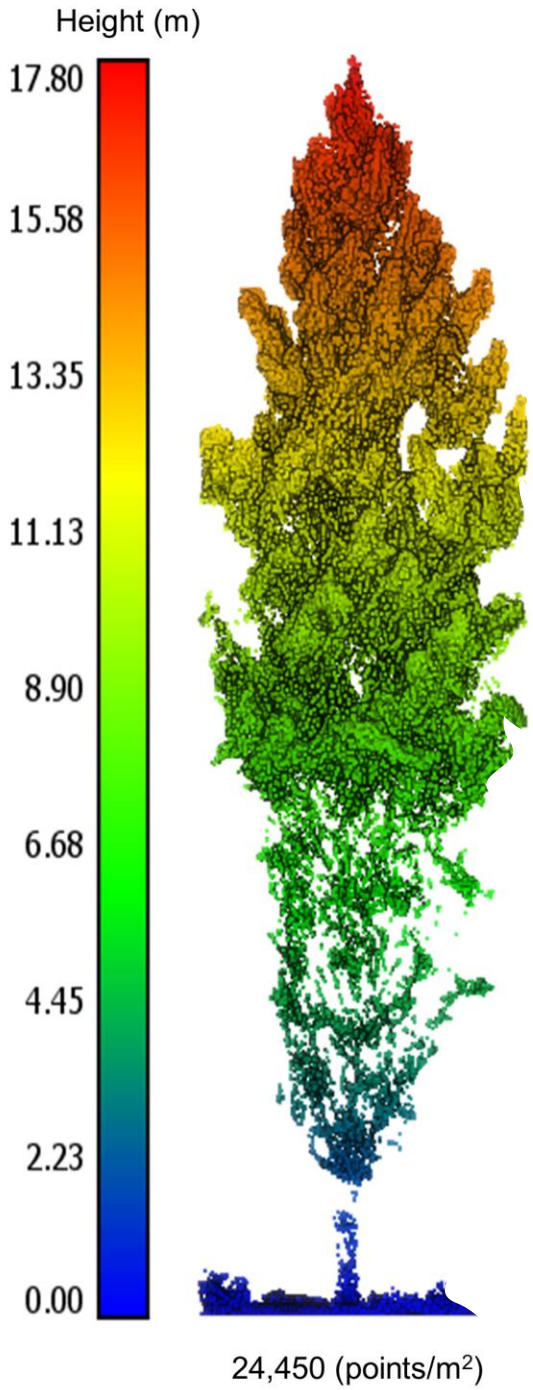
5 Individual tree segmentation

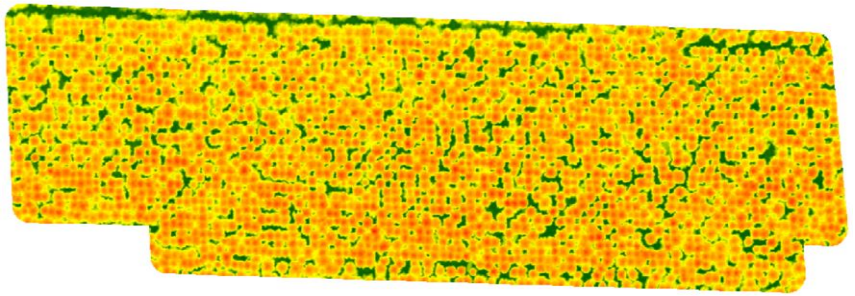


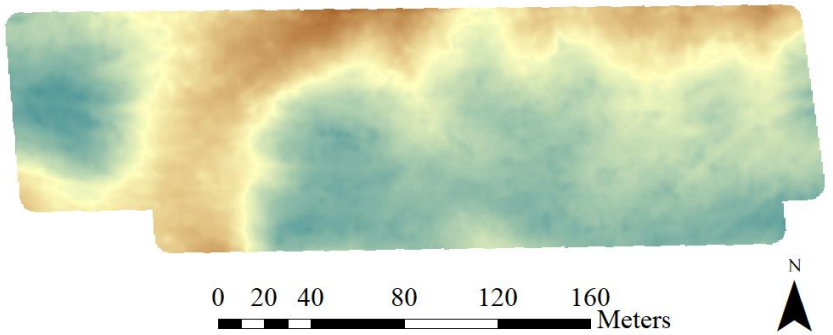
6 LiDAR metric extraction

Test impact of density: *DTM, tree attribute estimation*

Tree attribute Prediction: *Height, DBH, Volume*





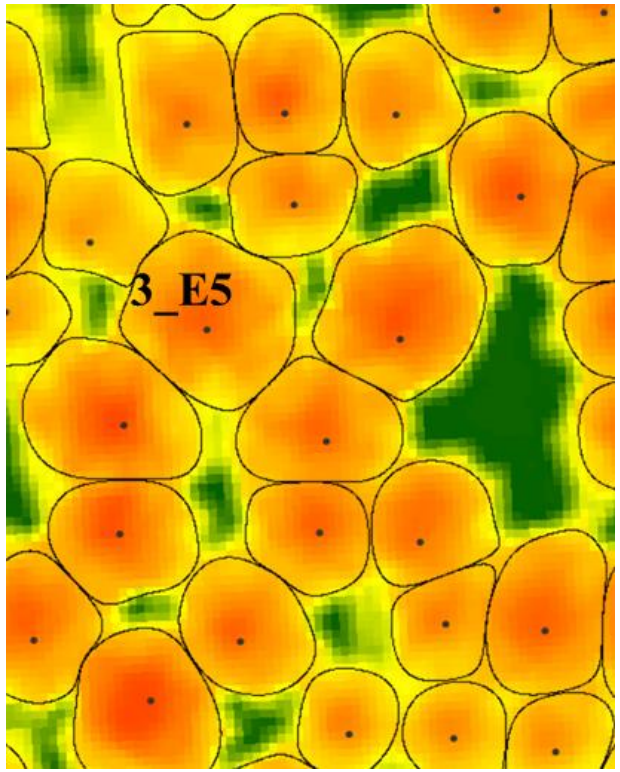


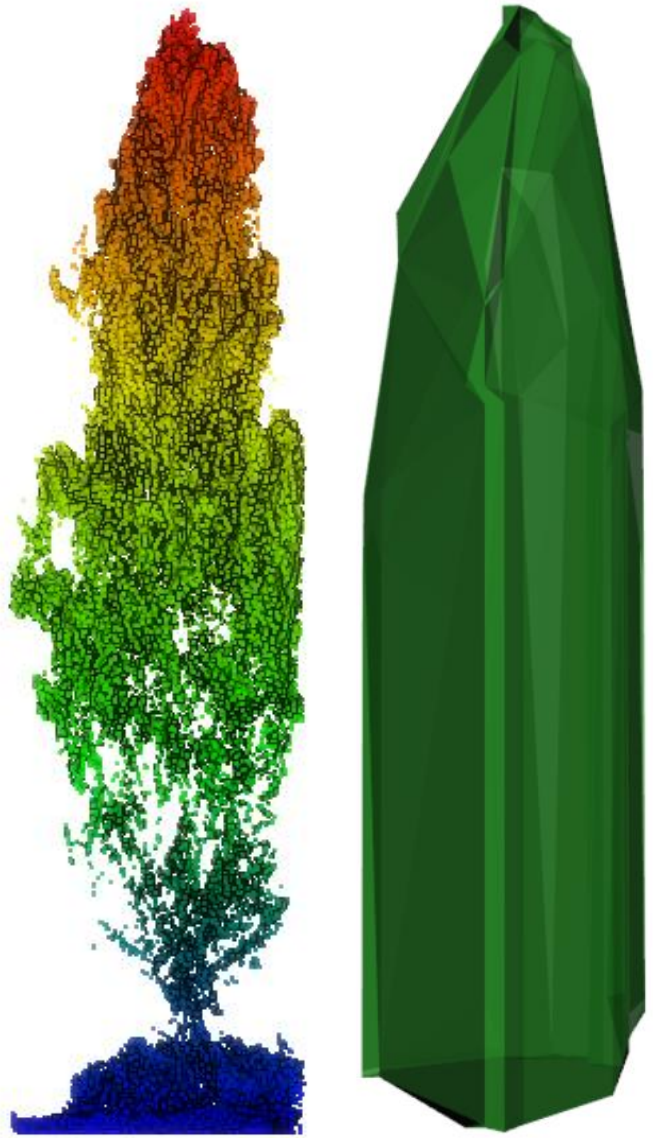
Point cloud characteristics

- High average point density
  - Raw : ~ 45,966 points/m^2
  - Homogenised: 24,450 points/m^2
- Good pulse penetration
  - Terrain characterisation
- Tree characterisation
  - Stem points
  - Foliage structure

LiDAR metrics of individual trees

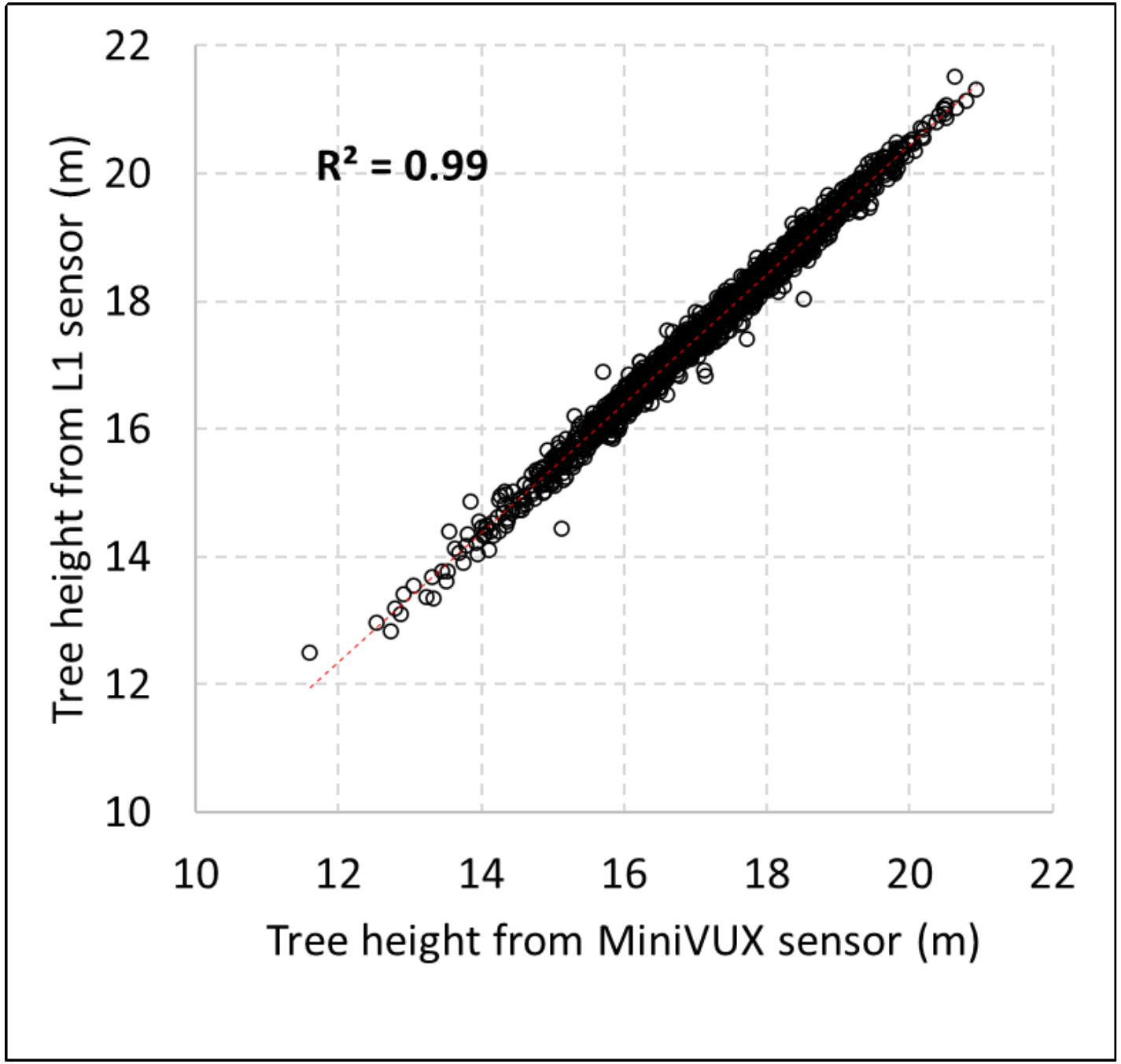
- Standard height and intensity metrics
- Area-based metrics (e.g., 2D crown area)
- 3D metrics (3D crown area and volume)
- Voxel-based metrics
- Gap fraction and LAI metrics





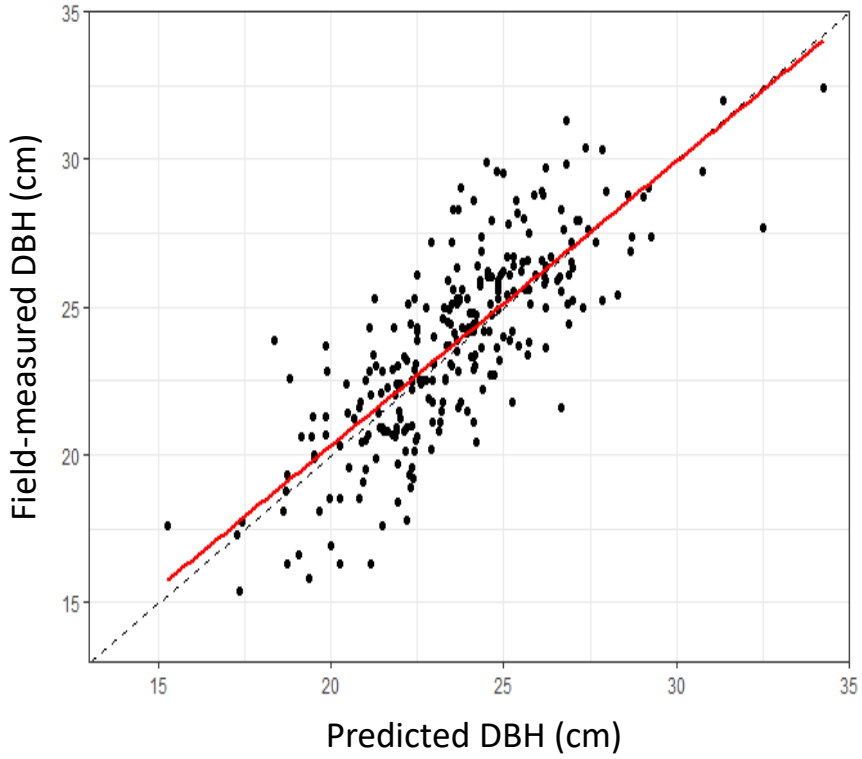
Tree height

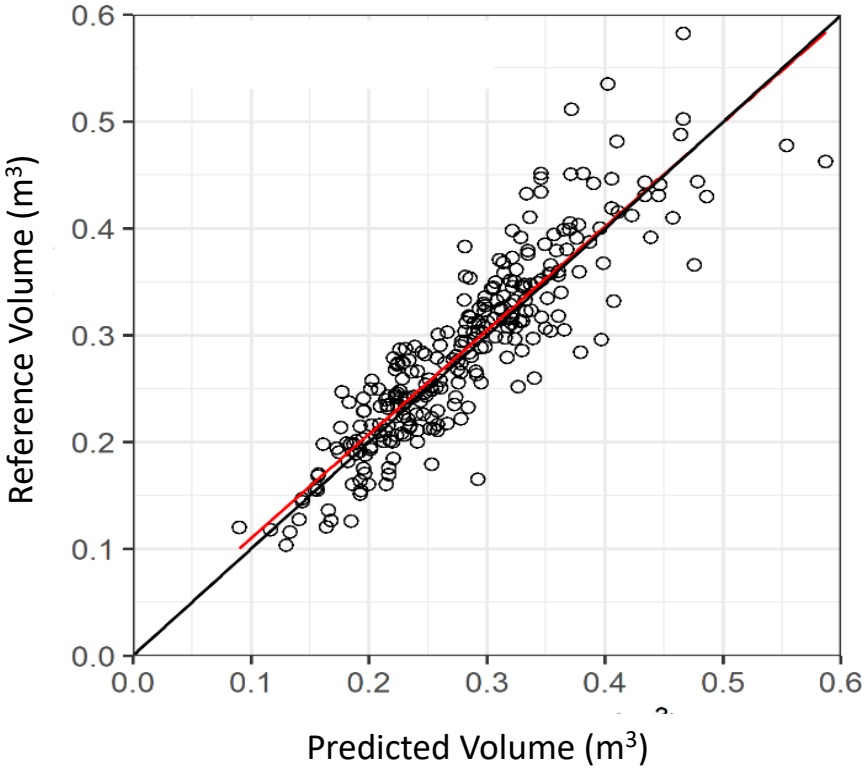
- Comparable accuracy to scientific grade and more expensive MiniVUX sensor



Diameter at Breast Height (DBH) and Volume

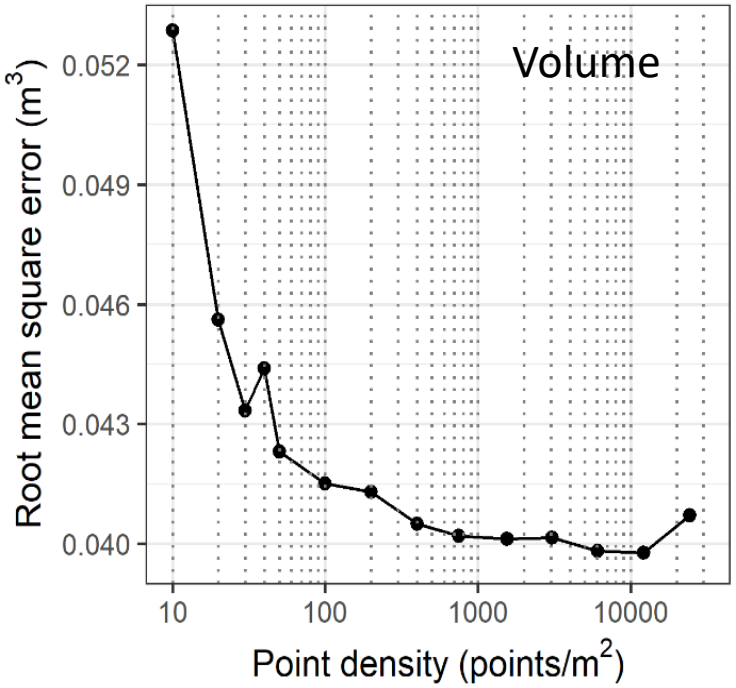
- DBH predicted using two modelling methods (RF and PLS)
  - R^2: 0.71
  - RMSE: 1.78 cm
- Volume predicted with R^2 of 0.79
- **3D crown area** metric had the highest importance in predicting DBH

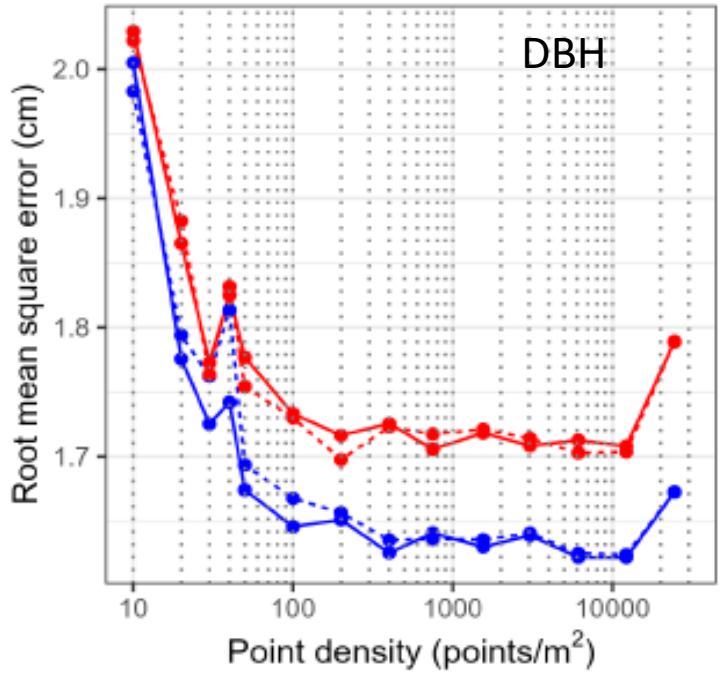




Impact of point density on tree attribute prediction

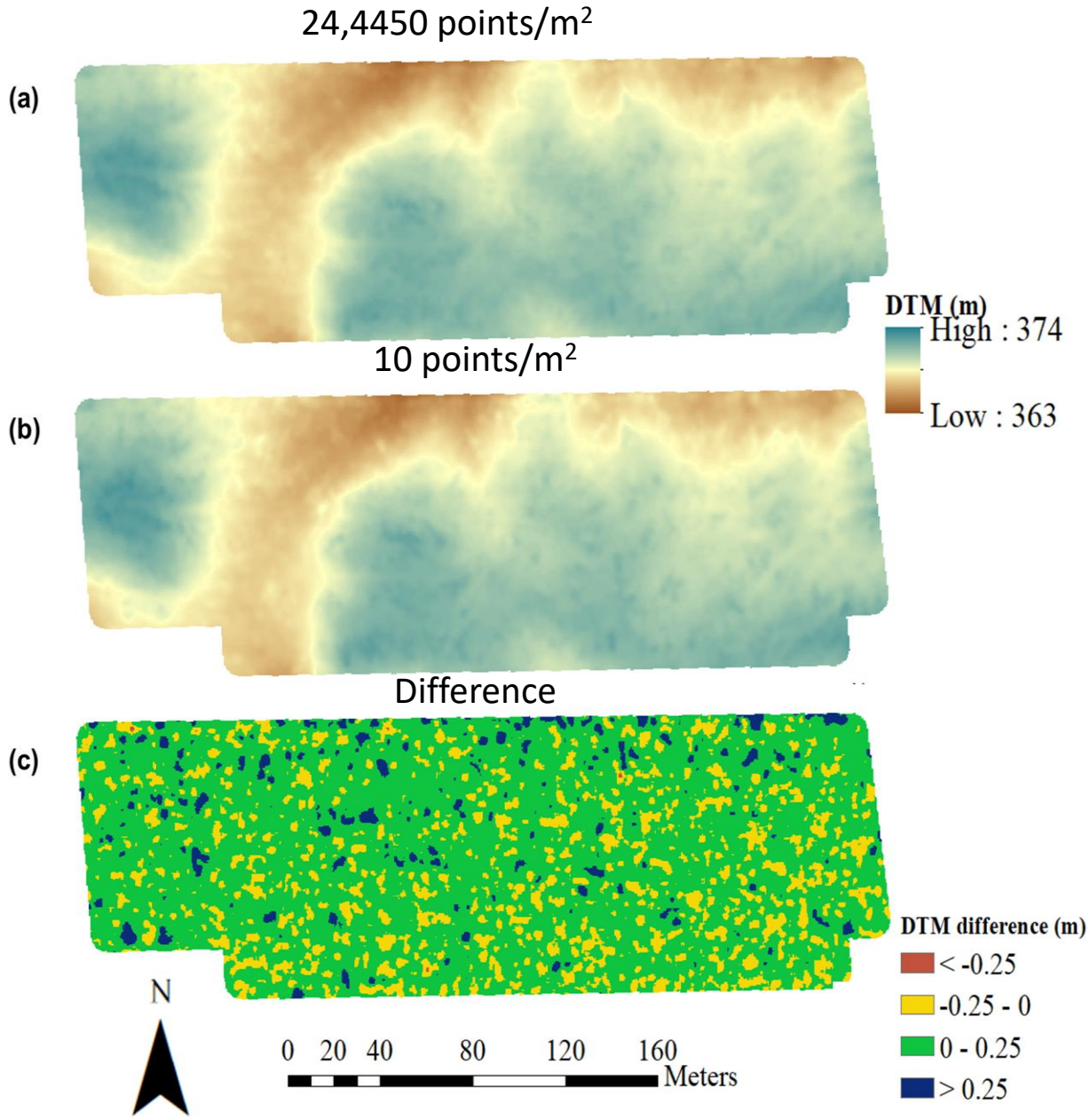
- Accuracy increased with increasing point density up to 400 points/m^2
- Highest accuracy at 12,200 points/m^2





Impact of point density on DTM

- Tested 14 densities ranging between 10 and 24,450 points/m^2
- No significant differences between DTMs created from varying point densities
- Maximum difference: 11 cm



In conclusion

- DJI-L1 sensor is capable of supplementing reliable information essential for forest inventory and assessment, including **DTMs, CHMs, tree segmentation and LiDAR metrics at individual tree level**.

- Important tree attributes like **height, DBH and stem volume** can be predicted with high accuracy using a range of 2D and 3D LiDAR metrics derived from DJI-L1 point clouds.

- Accuracy of these products increases with increasing density up to 400 points/m^2.

- The flight time further highlights the potential of this consumer-grade sensors for the **rapid and frequent assessments and monitoring** of forest stands.

Future implications

- Our findings demonstrated that these cost-effective LiDAR sensors offer **opportunities for forestry companies to enhance the application of LiDAR technology in their forest management activities.**

Coming soon!!!

remote sensing

MDPI

Article

Unlocking the potential of consumer-grade UAV laser scanners: a revolutionary tool for forest management.

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Abstract: The sustainable management of plantation forests necessitates precise inventory techniques. Unmanned aerial vehicle laser scanning (ULS) offers a cost-effective approach to accurately

- **Exploring the application and versality** of this sensor
  - ➢ in diverse forestry settings, including various tree species, age classes, terrains, and stand densities
  - ➢ to derive additional tree attributes

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