

Estimating Aboveground Biomass of young *Acacia mangium* stands in Biliran, Philippines using multisource LiDAR

FELLICE GABRIELLE CATELO, PHD CANDIDATE
University of the Sunshine Coast

Supervision Panel

Dr. Nick Kokkas, UniSC

Prof. John Herbohn, UniSC

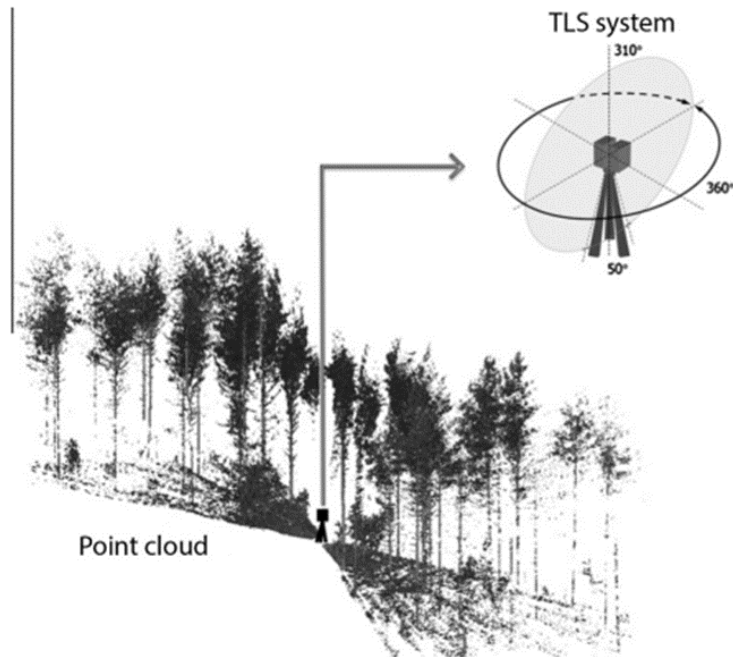
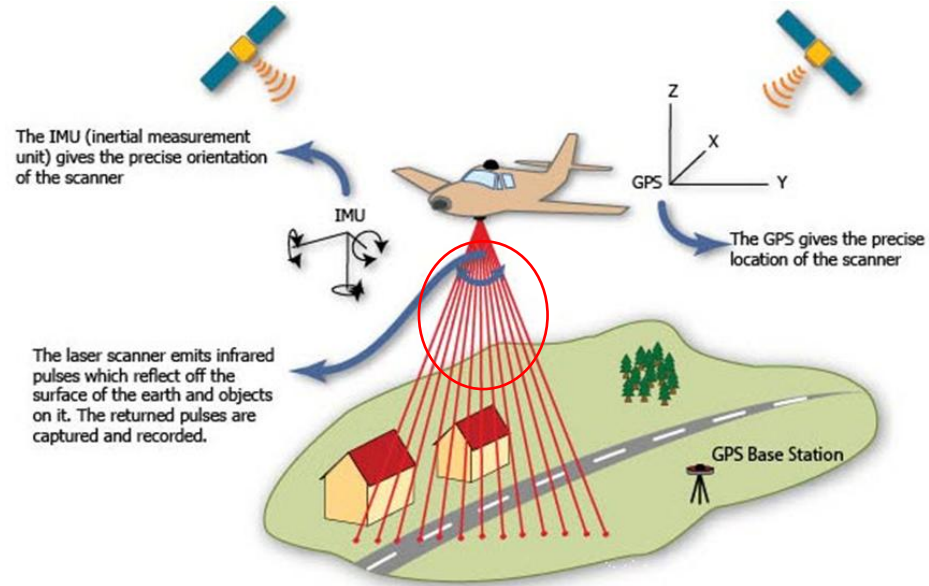
Dr. Adriana Vega Grau, University of Canberra

Dr. Catherine Waite, Cambridge University

OVERVIEW

- **REDD+ framework – tropical forest restoration**
- In 2011, **National Greening Program (NGP)** was implemented in the Philippines
 - 1B seedlings
 - **Tree cover increase**
- **Biomass accumulation** was overlooked
 - Frequent, early-stage monitoring
 - Site accessibility
 - Data accuracy of recorded information
- **Remote sensing -- LiDAR:**
 - accurate measurements
 - accessibility to remote areas

LiDAR remote sensing



- **Top of canopy (drone) & beneath the canopy (mobile/terrestrial) coverage**
- Represent **vegetation structure**
- allow **non-destructive aboveground biomass estimation**



DRONE

LiDAR Equipment

Zenmuse L1 LiDAR attached to a DJI Matrice 300 RTK (a.k.a drone LiDAR)

- detection range = 450 m
- point rate = 480,000 pts/sec
- accuracy = ± 3 cm (at 100 m)



HANDHELD

Emesent Hovermap ST-X (a.k.a. handheld LiDAR)

- **Simultaneous Localization and Mapping (SLAM)**
- detection range = 0.50-300 m
- point rate = up to 1.9M pts/sec
- accuracy = ± 0.5 -1.5 cm

Global Navigation Satellite System (GNSS) receivers for georeferencing and mapping

WHY TEST THE ACCURACY?

.....
LiDAR data sets and manual measurements give **accurate** data for **aboveground biomass** estimation
.....



.....
Existing studies look at **mature, tall trees**
.....

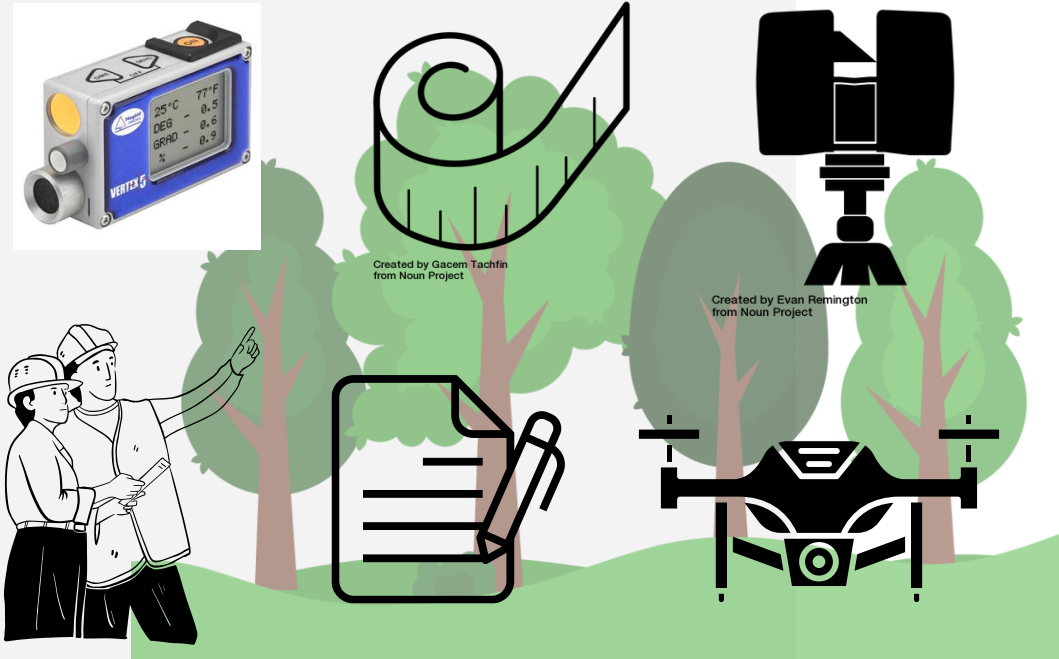
.....
Early-stage monitoring can be tricky with reported forest inventory information
.....



.....
Solid foundation for LiDAR in tropical reforestation sites from young trees
.....



WHY TEST THE ACCURACY?



Research questions:

- At the **individual tree level**: how does **accuracy in DBH and height** vary among handheld, drone LiDAR, and manual measurement?
- At the **plot-level**: how does the **AGB estimates** vary among tree metrics measured from handheld, drone-LiDAR, and manual hand measurement?

METHODOLOGY

STUDY AREA



Biliran Island

- 55,550 ha land area
 - 9546 ha – open forest
 - 7240 ha – community-based forest (agricultural, degraded grasslands)
- Location: Community-based forest site (Project Tarsier)

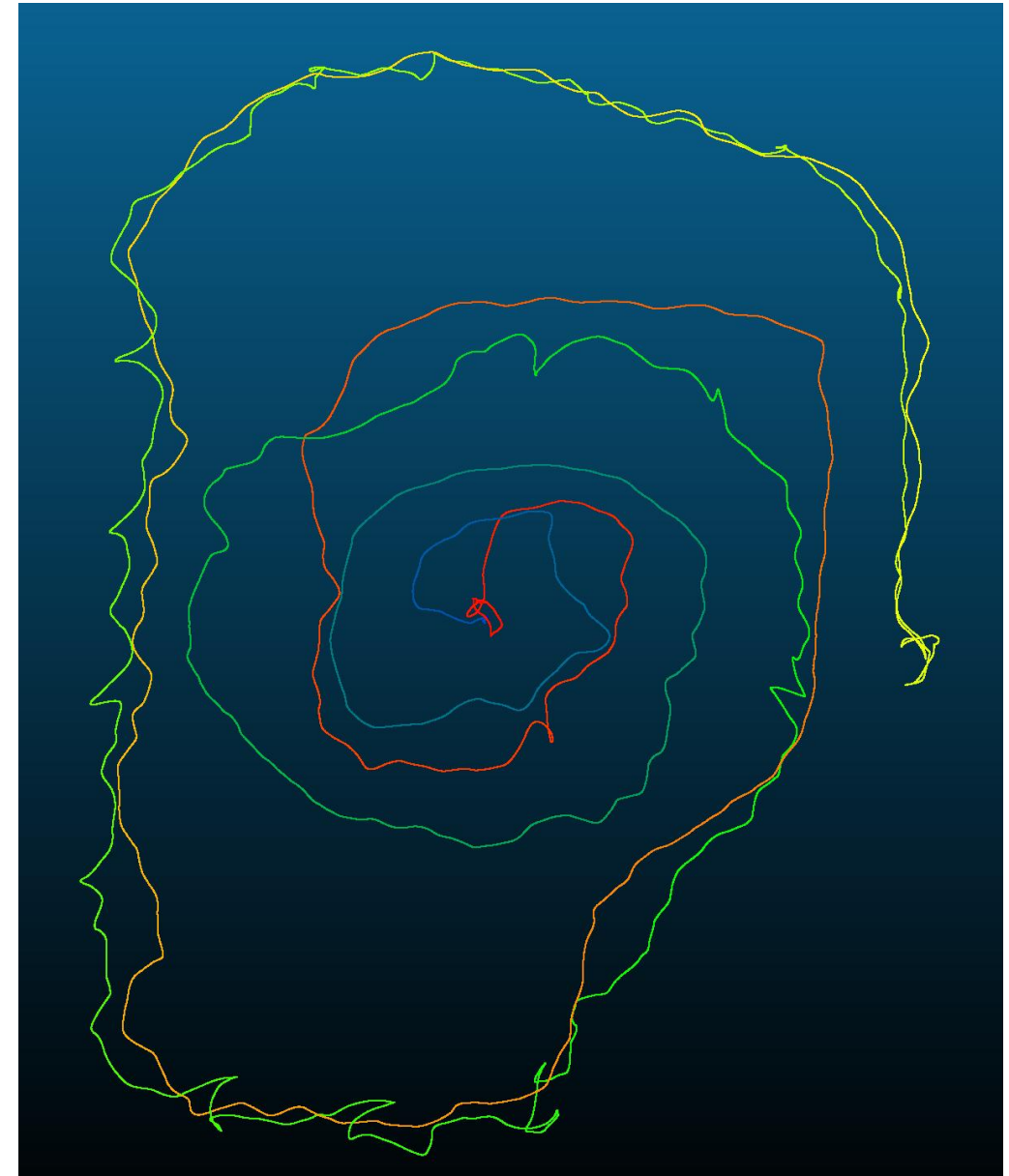
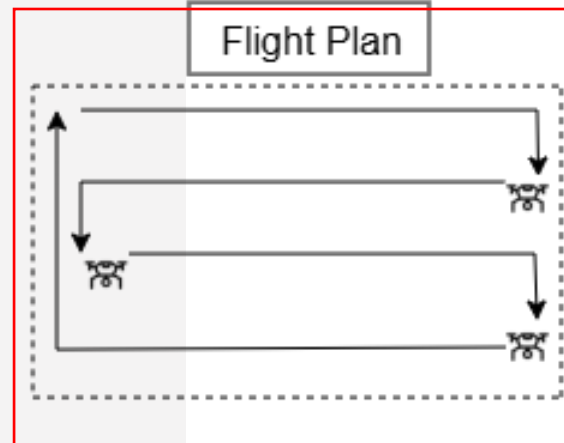
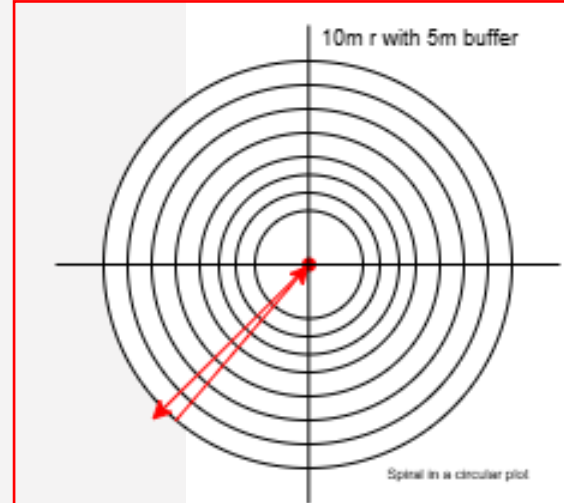
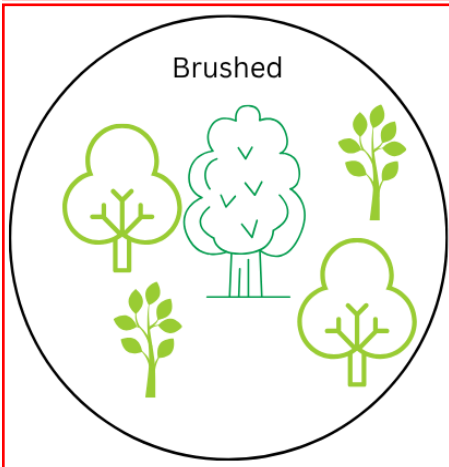
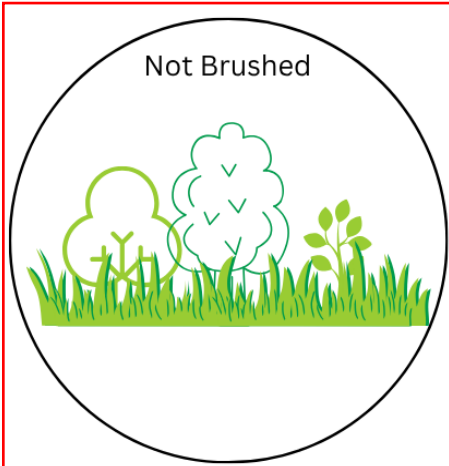


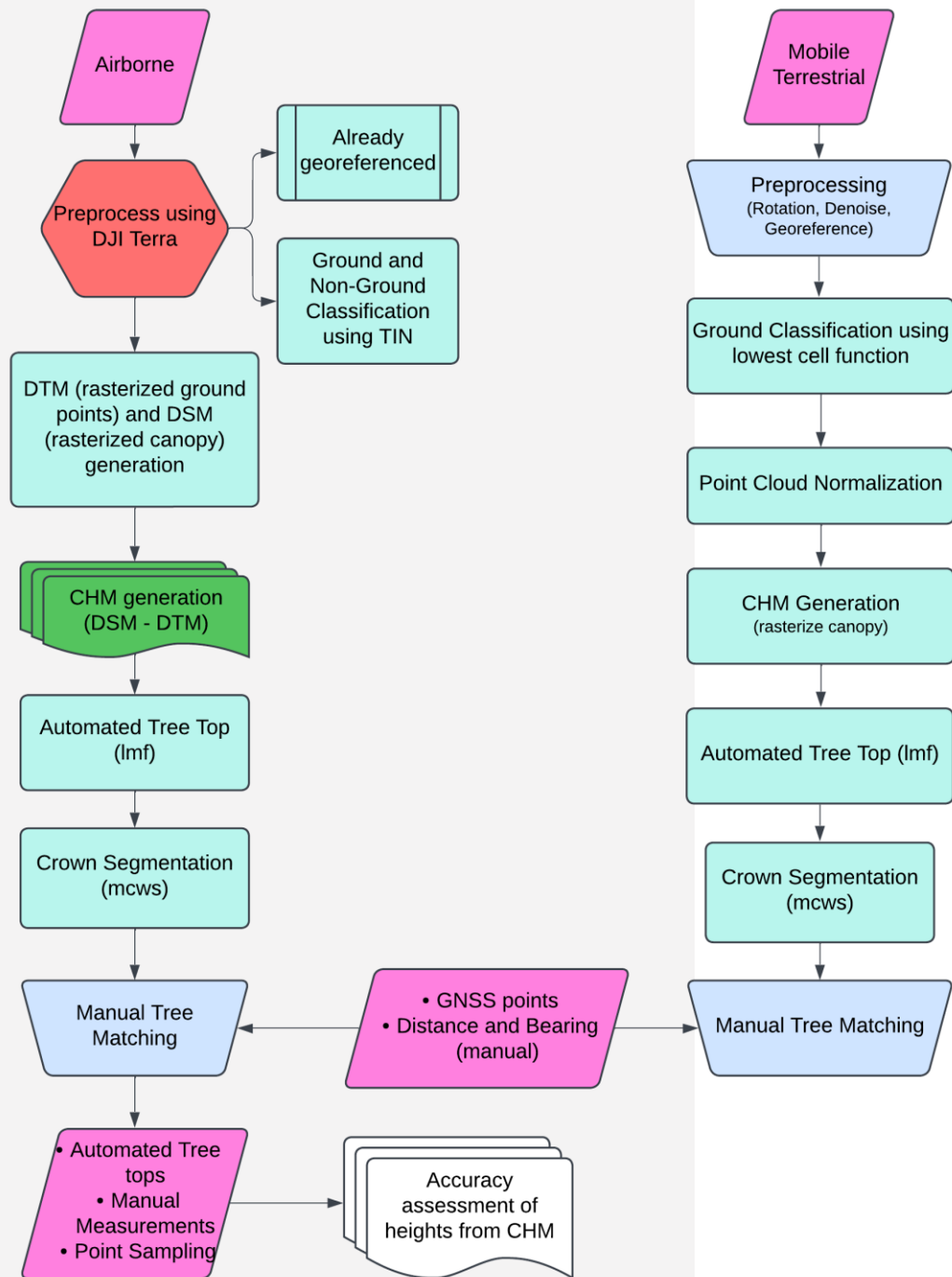
SITE CHARACTERISTIC

- *Imperata cylindrica*
- 3x3 m planting design
(~35 trees/plot)
- **Acacia mangium**
- Exotic, tropical
- Fast-growing, drought-tolerant

PLOT DESIGN AND SCANNING PATTERN

3 year-old *A. mangium*



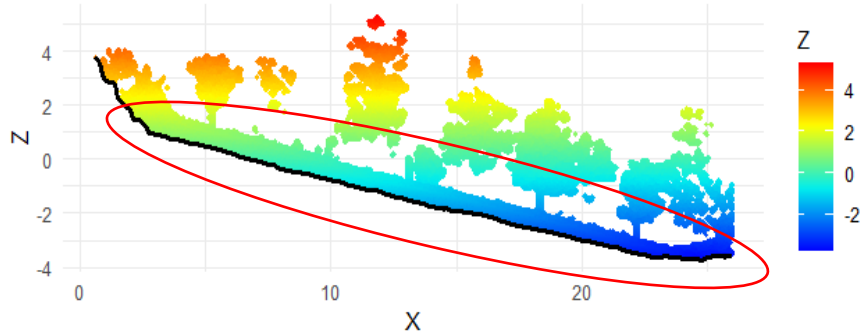


DATA PROCESSING WORKFLOW

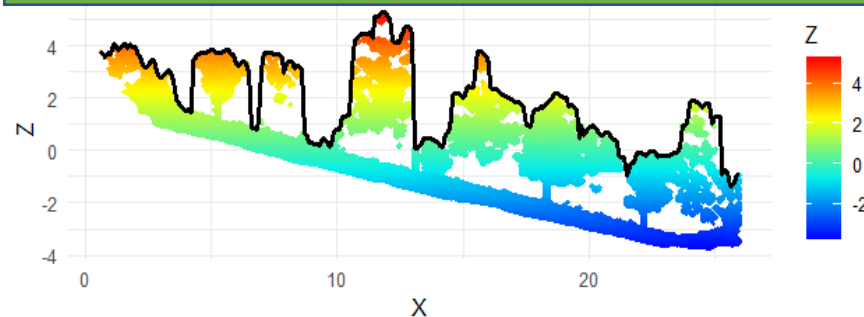
Tree Height Extraction

- **Digital Terrain Model (DTM)** contributes to accuracy of LiDAR
- **Ground classification:**
 - **Triangulated Irregular Network (TIN)** is **more effective** for drone LiDAR
 - **Lowest cell identification** is **more efficient** for handheld LiDAR

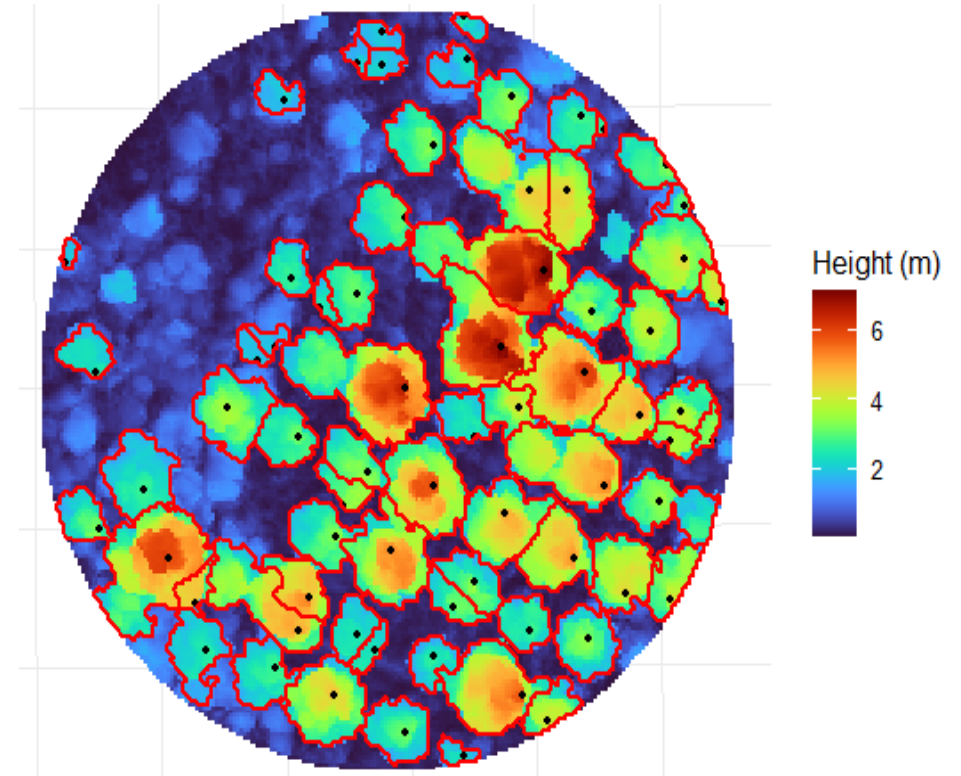
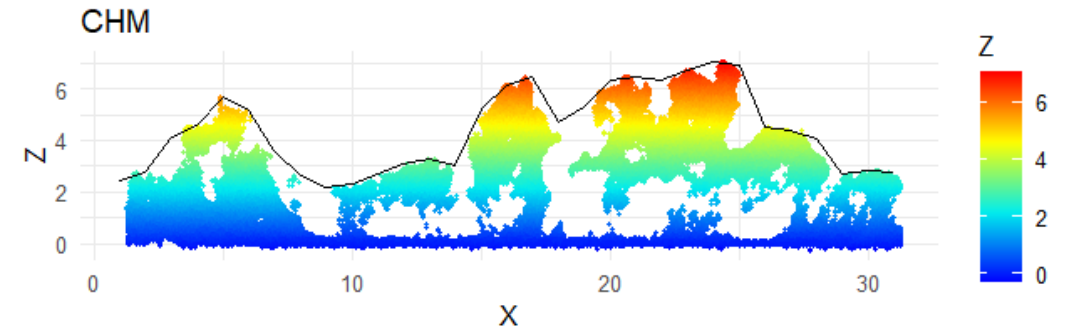
DTM



DSM

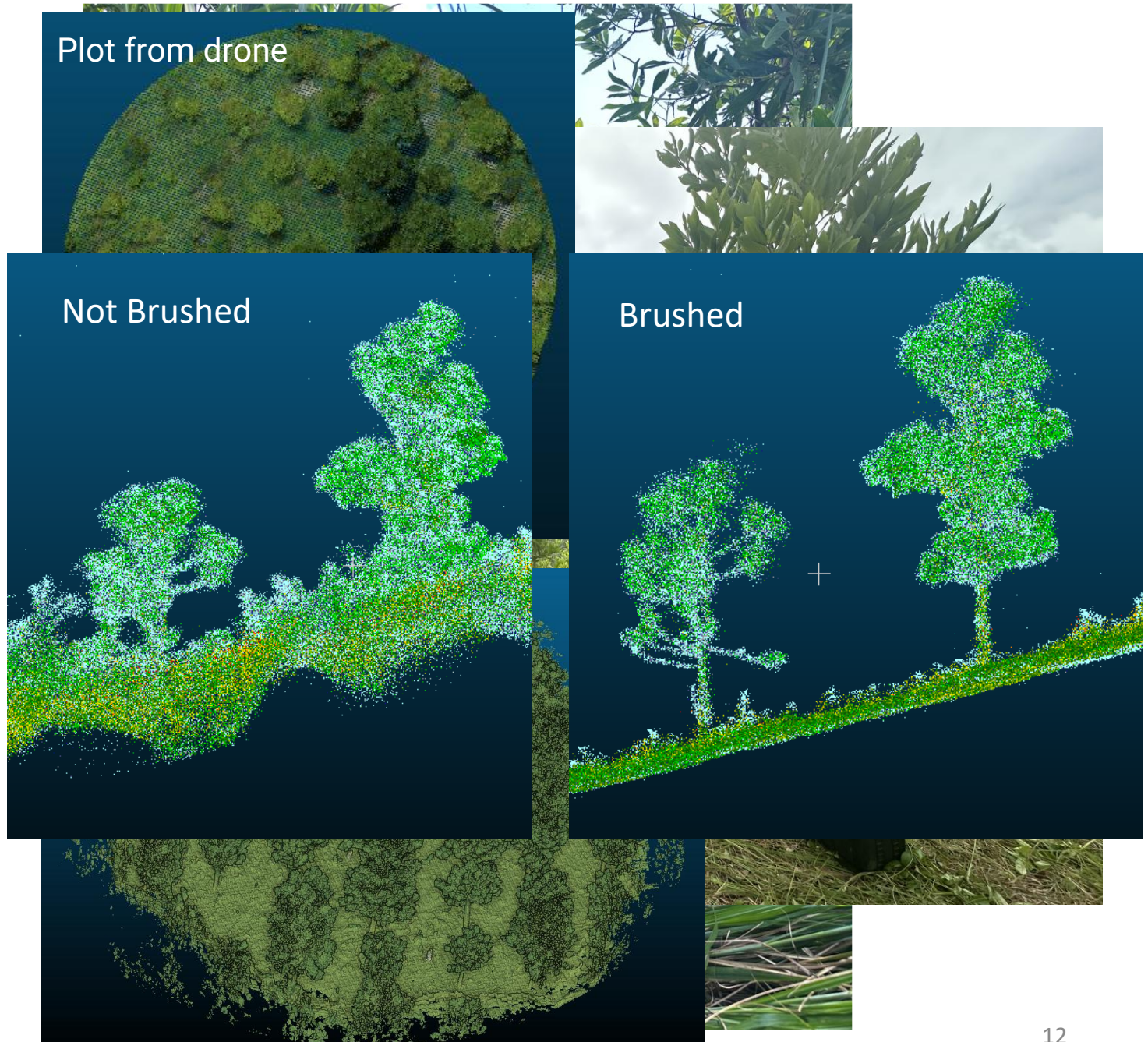


DSM – DTM = Canopy Height Model (CHM)

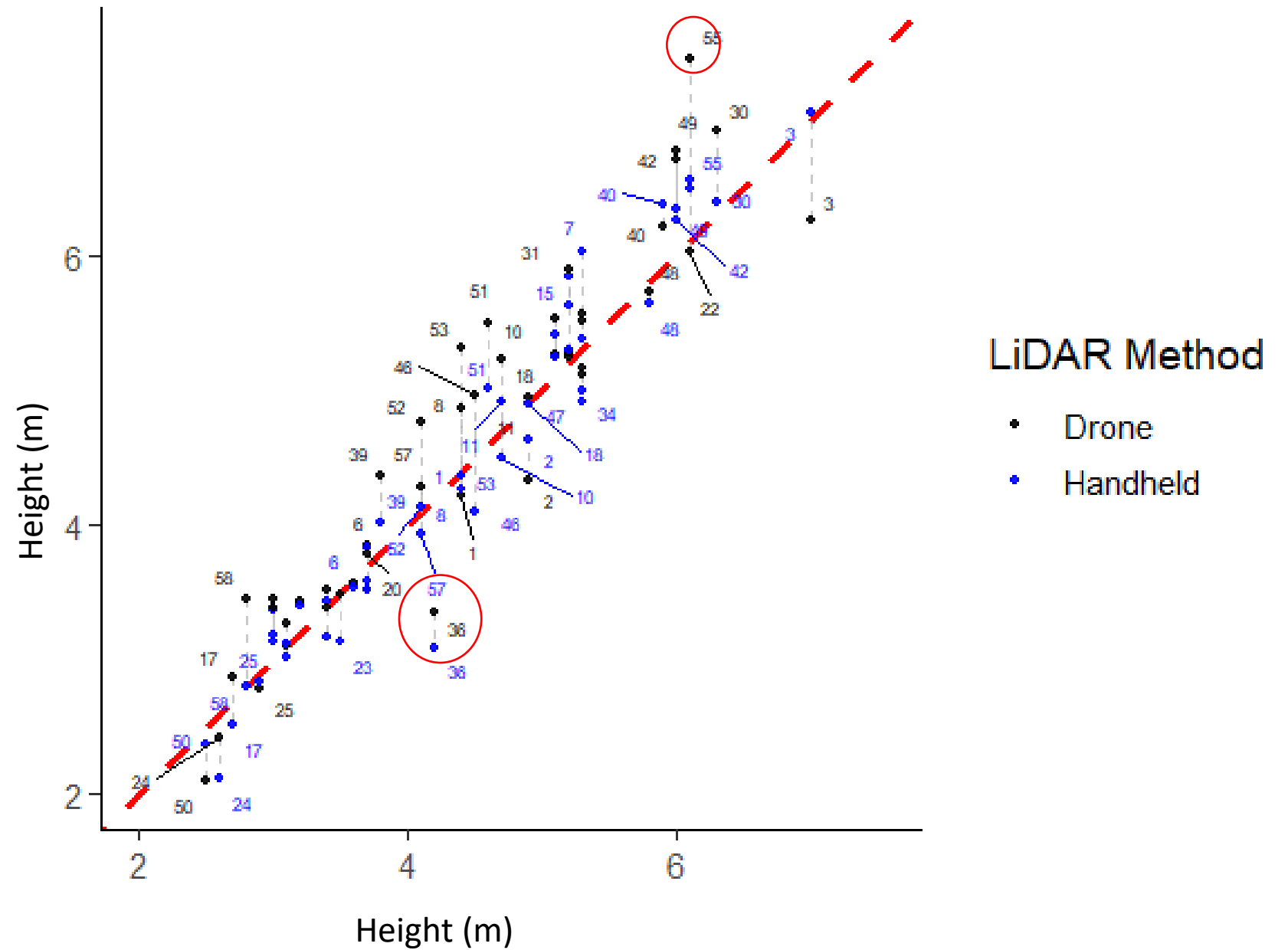


RESULTS

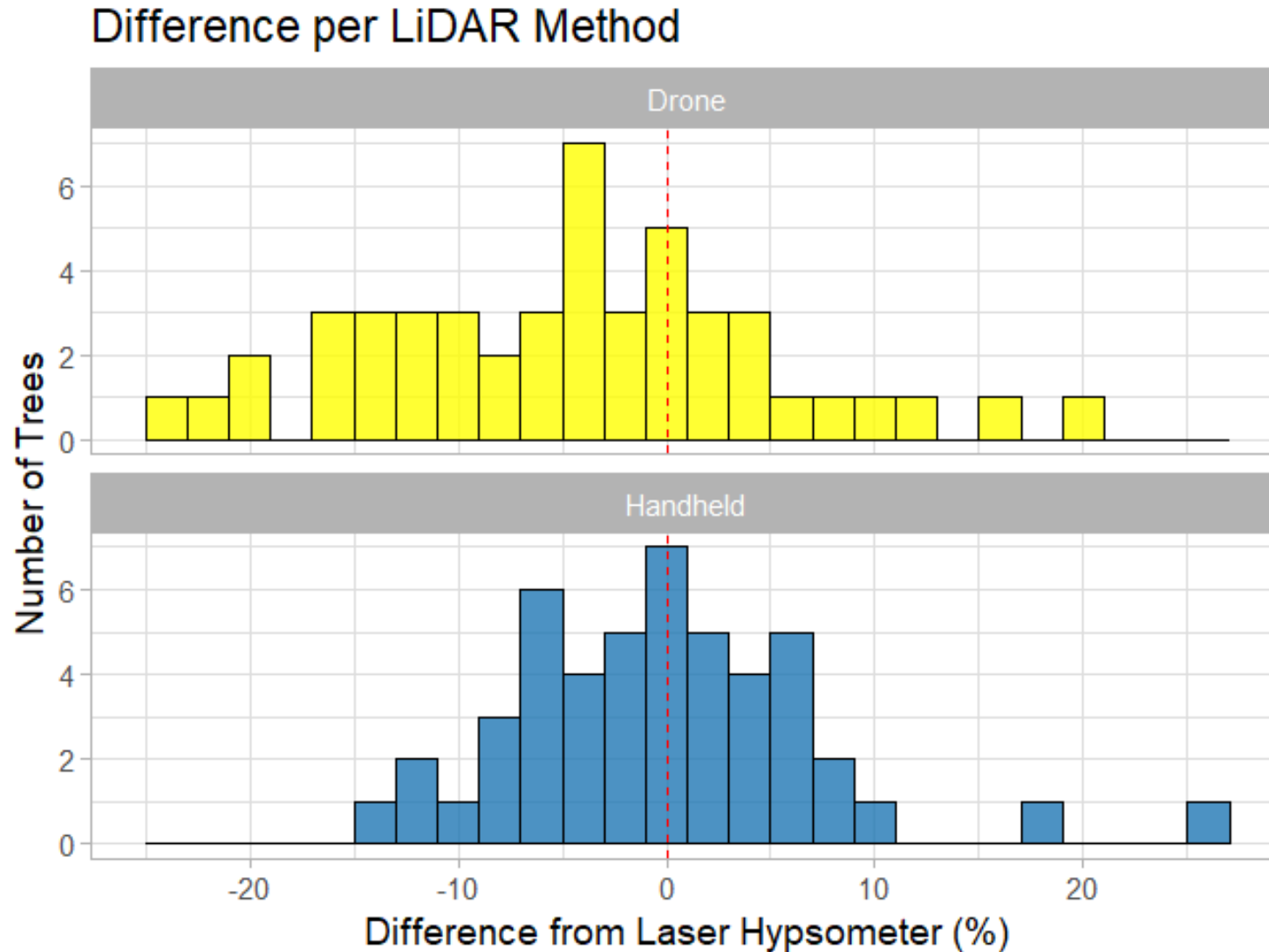
- **Brushed** – worked!
 - Clear representation of individual trees
 - Less processing time



RESULTS



RESULTS

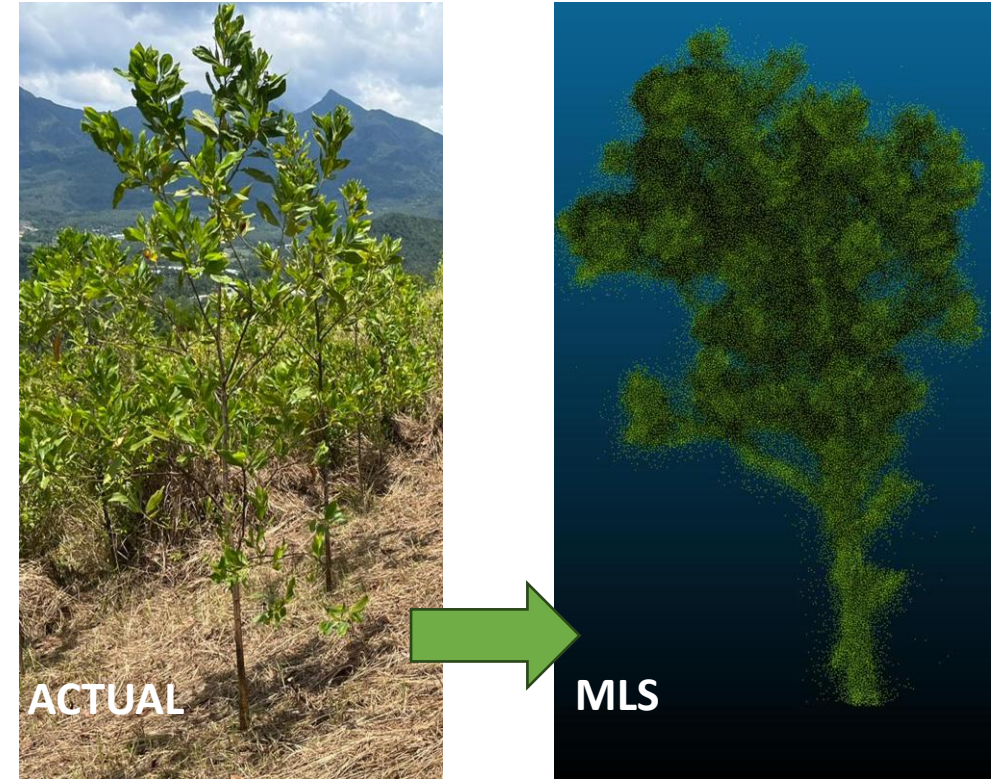


Method	RMSE	mean bias
ALS	0.47	-4.52
MLS	0.32	-0.17

NEXT STEPS

- DBH extraction from handheld
 - Using quantitative structure models (package: TreeQSM, lidR or rTLS)
 - Using cloudcompare (manual approach)
- DBH estimation from canopy/crown area (drone)
 - Power-law relationship
- **Overall accuracy assessment** of all measurements from all methods
- **Estimate the AGB** from these measurements and **destructive sampling for validation** of estimations
- For further steps, **data fusion of drone and handheld data for 3D volumetric analysis**

Manual Tree Segmentation



THANK YOU



fellicegabrielle.catelo@research.usc.edu.au