Community-scale aboveground carbon estimations using lightweight drones

Ben Newport | University of Bristol
ben.newport@bristol.ac.uk

Dr. Tristram Hales | Cardiff University
Dr. Jo House | University of Bristol
Prof. Benoît Goossens | Cardiff University
Amaziasizamoria Jumail | Danau Girang Field Centre

University of BRISTOL

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

UKRI Economic and Social Research Council

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Community-scale forest restoration

- Tropical forest restoration can sequester large amounts of atmospheric carbon
- Important role of community-scale projects
- Funders require measurements of aboveground carbon
- Current Earth Observation methods for monitoring carbon are not appropriate for community-scale use

Source: restor.eco

The need for community-based carbon monitoring methods

- Consumer-grade drones offer a potential accessible solution
- Drone imagery can be used with Structure from Motion (SfM) photogrammetry to calculate biomass volume
- However, previous studies utilise professional hardware and software, destructive sampling

Source: Paneque-Gálvez et al., 2017

The need for community-based carbon monitoring methods

- Consumer-grade drones offer a potential accessible solution
- Drone imagery can be used with Structure from Motion (SfM) photogrammetry to calculate biomass volume
- However, previous studies utilise professional hardware and software, destructive sampling
- Can simplified drone methodologies enable communities to monitor aboveground carbon at the community scale?

Source: Paneque-Gálvez et al., 2017

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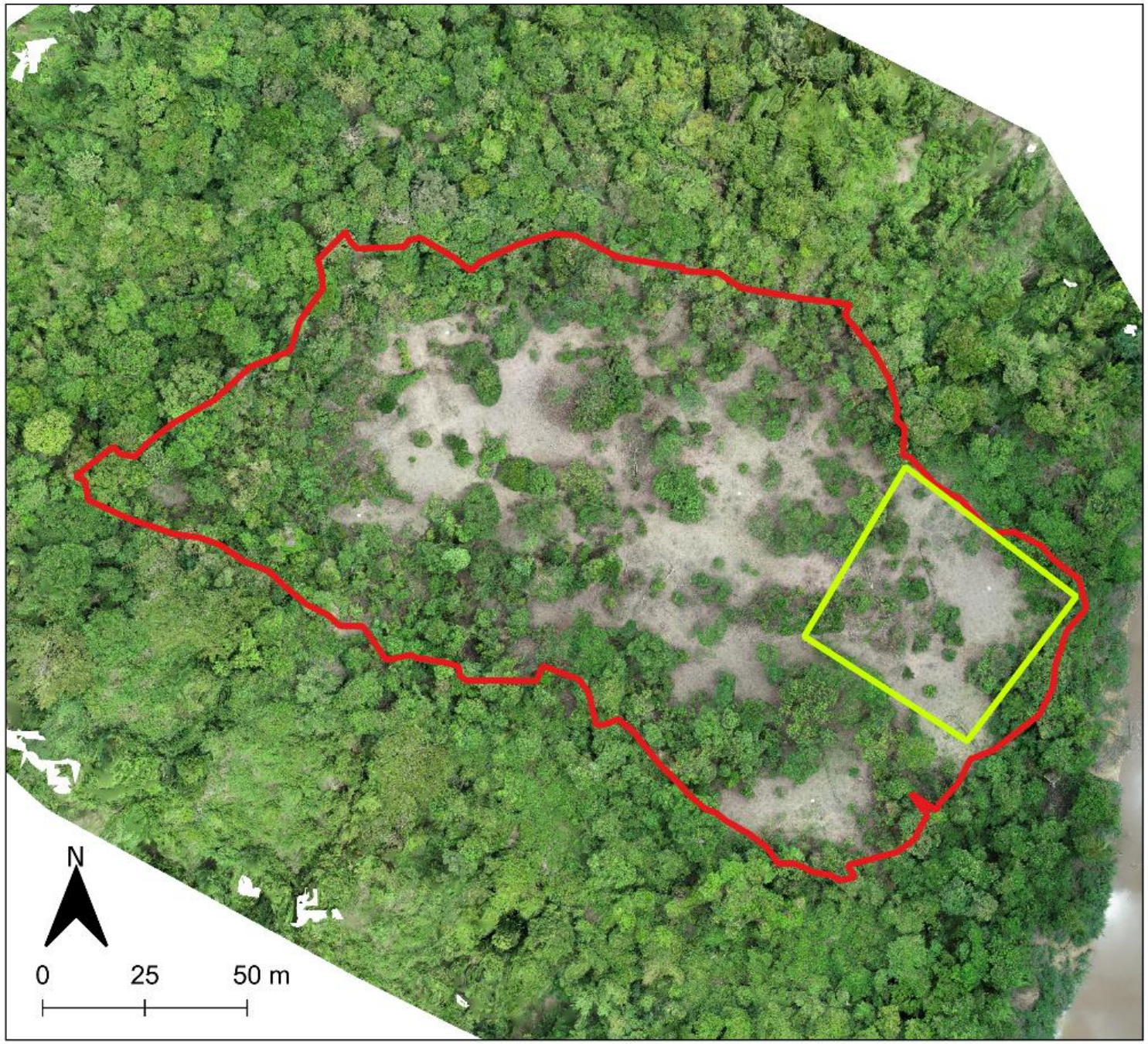
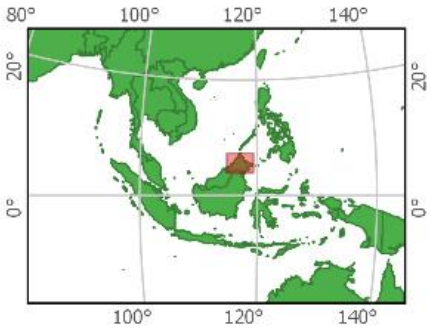
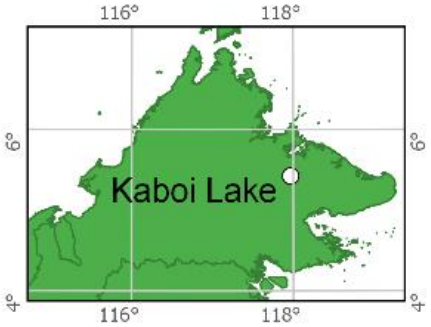
kinabalangan KOPEL







Kaboi Lake

Restoration site

Botanical plot

Field-based measurements

- Height
- Diameter at breast height
- Wood density

Field-based measurements

- Height
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- Wood density

Allometric models

- 27 different allometric models
- 1000 Monte Carlo simulations
- Measurement error estimates from R BIOMASS package (Réjou-Méchain et al., 2017)

Aboveground carbon estimates for botanical plot

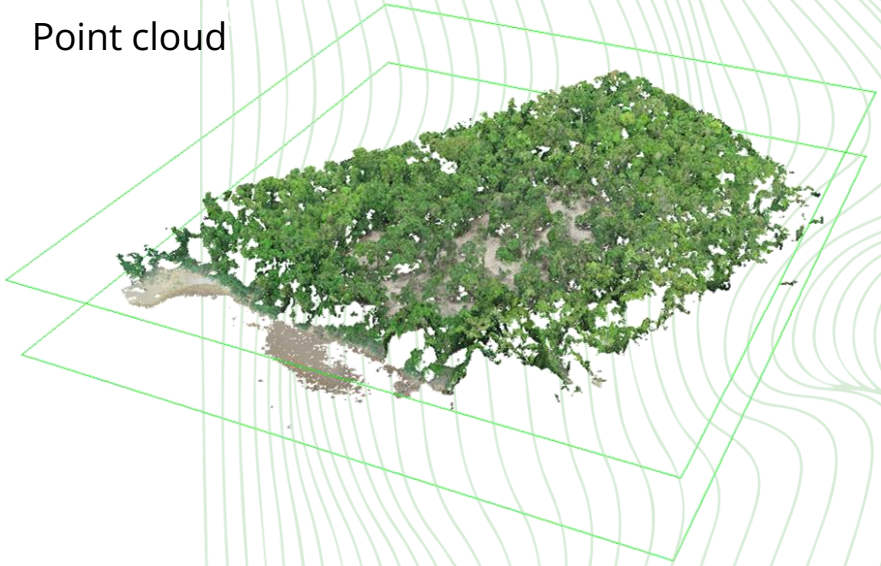
Drone-based measurements

Drone images

Open Drone Map
- Opensource SfM processing software
- Additional outputs - orthomosaics

Point cloud

Point cloud



Drone-based measurements

Drone images

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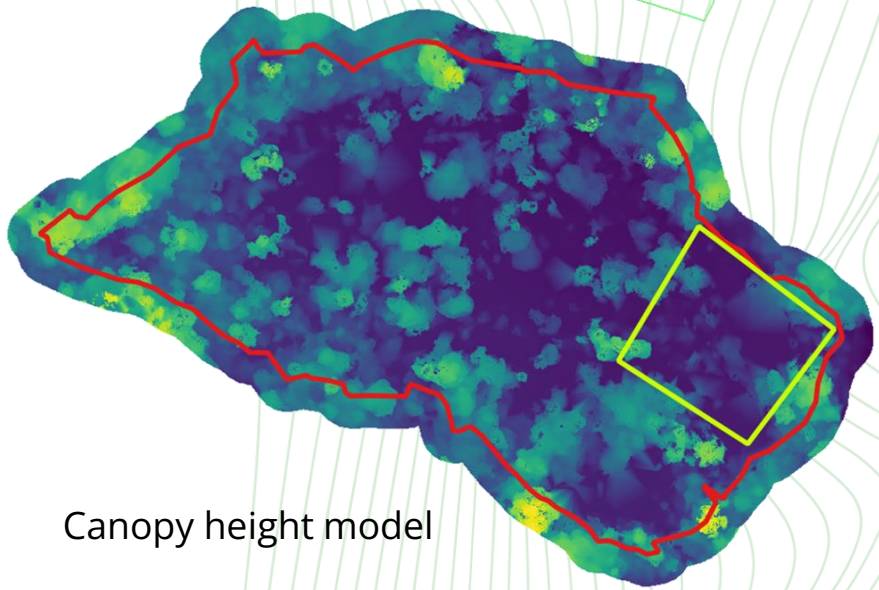
Point cloud

LAStools
- Opensource GIS package
- Produces DEM and DSM

Canopy height model

Point cloud



Canopy height model

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Point cloud

LAStools
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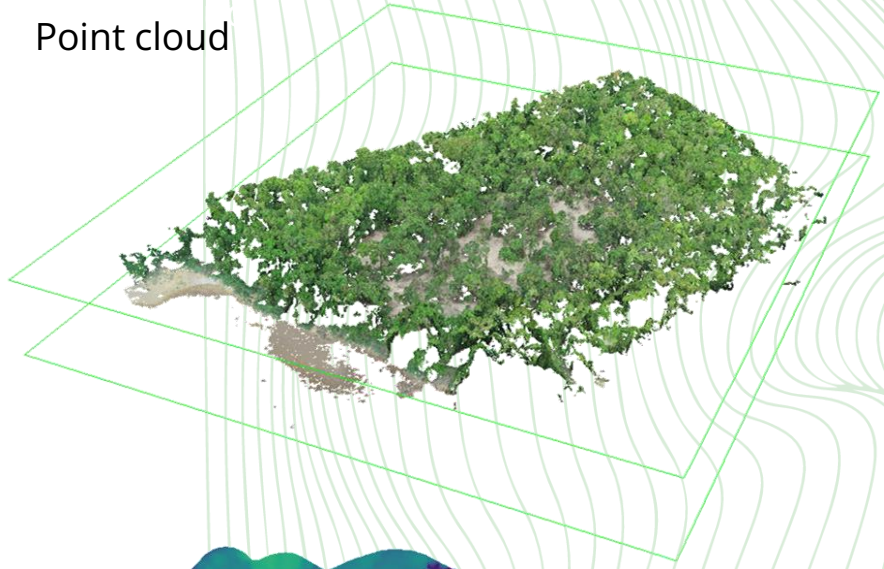
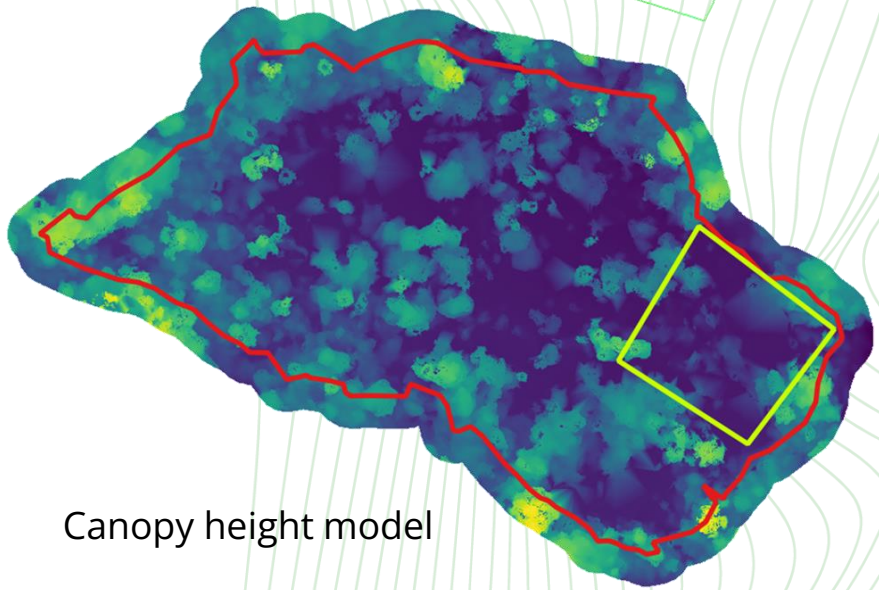
Canopy height model

Allometric models
- 5 different models
- 1000 Monte Carlo simulations
- Drone measurement error estimates

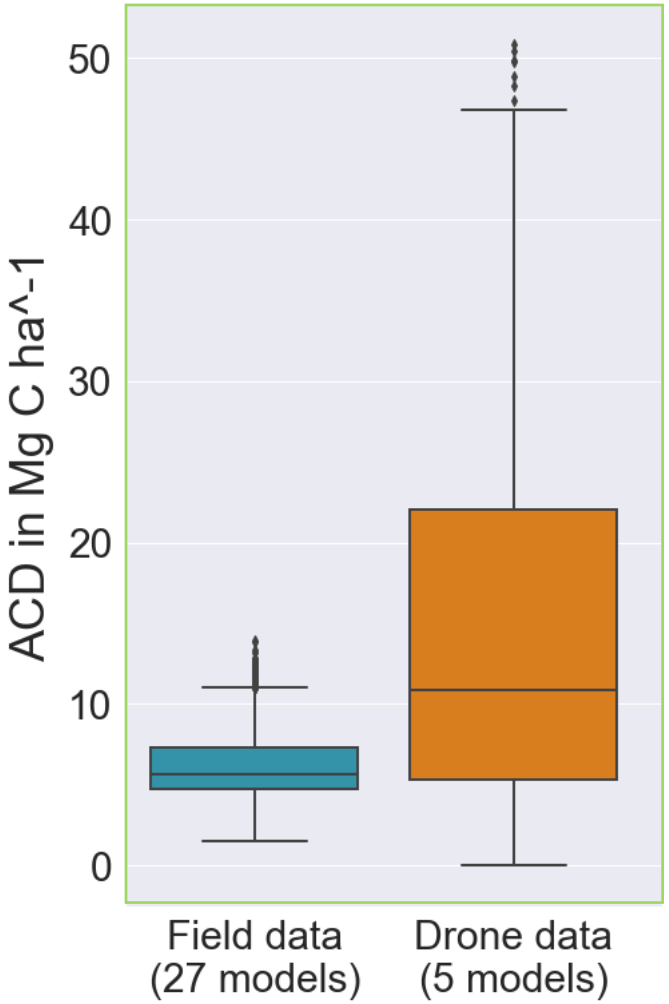
Aboveground carbon estimates for botanical plot

Point cloud





Canopy height model

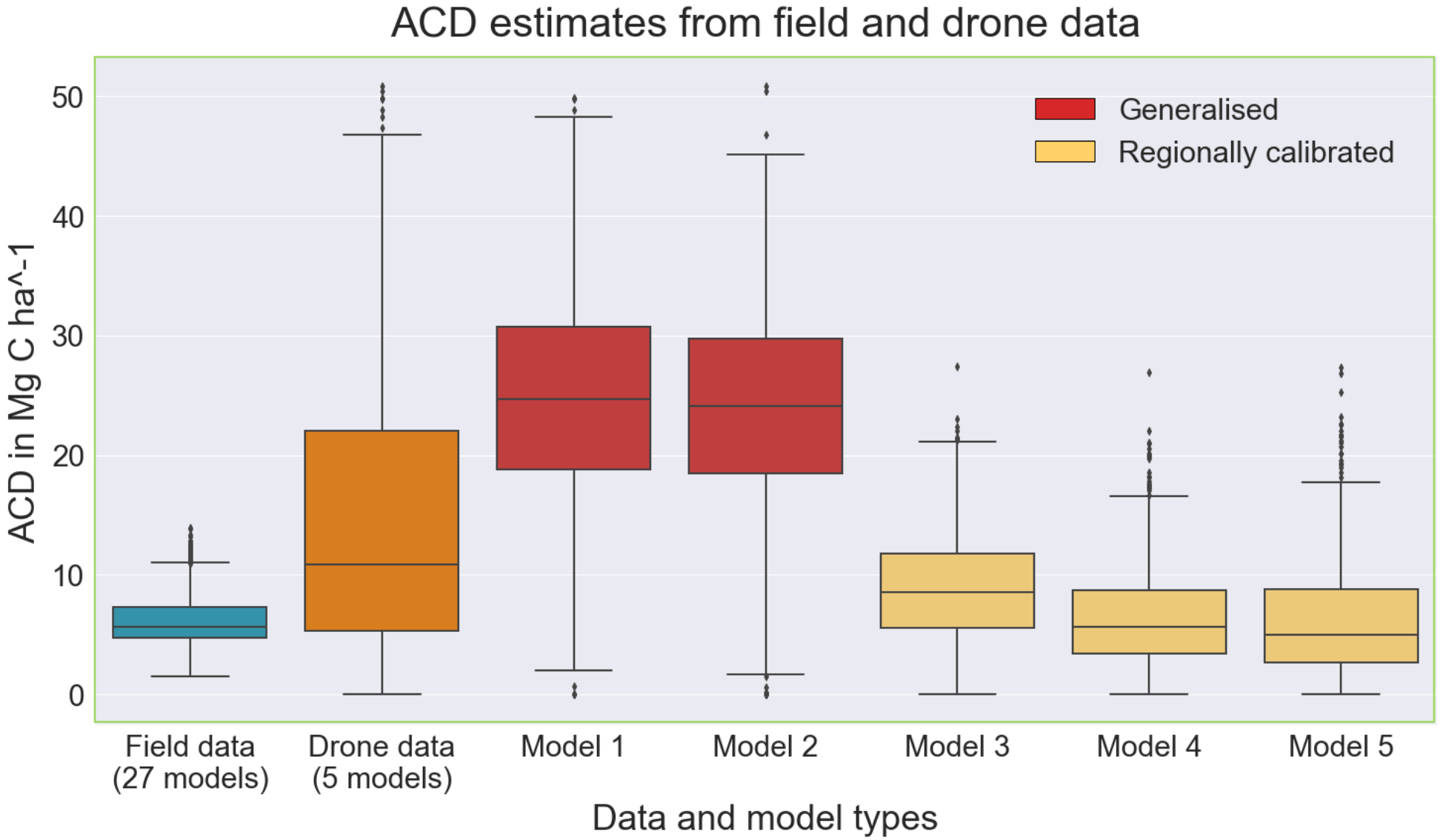


Field data:

- Mean: 6.05 ± 2.07 Mg C ha^{-1}
- Median: 5.66 Mg C ha^{-1}

Drone data:

- Mean value: 14.06 ± 10.64 Mg C ha^{-1}
- Median value: 10.87 Mg C ha^{-1}


ACD estimates from field and drone data
ACD in Mg C ha^-1
0
10
20
30
40
50
Generalised
Regionally calibrated
Field data (27 models)
Drone data (5 models)
Model 1
Model 2
Model 3
Model 4
Model 5
Data and model types

Implications for community-scale monitoring

Benefits

- Aboveground carbon estimates similar to established field-based methods
- More appropriate for the community scale than current EO options
- Fast and repeatable methodology
- Useful secondary outputs

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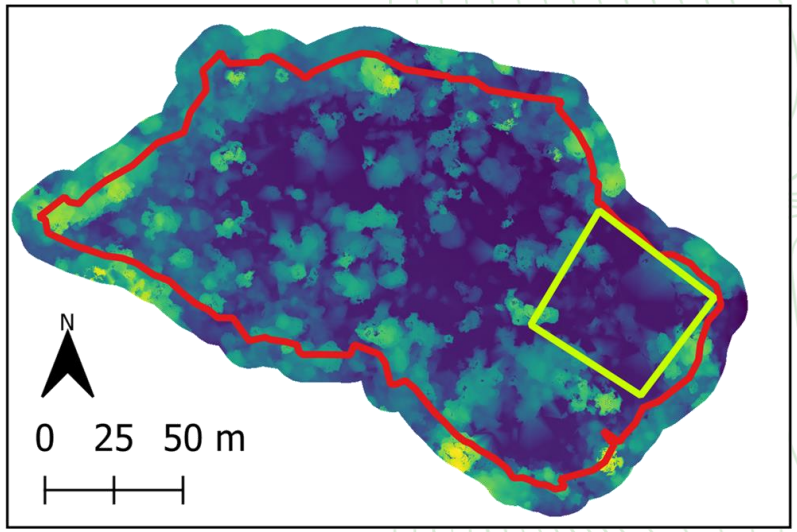
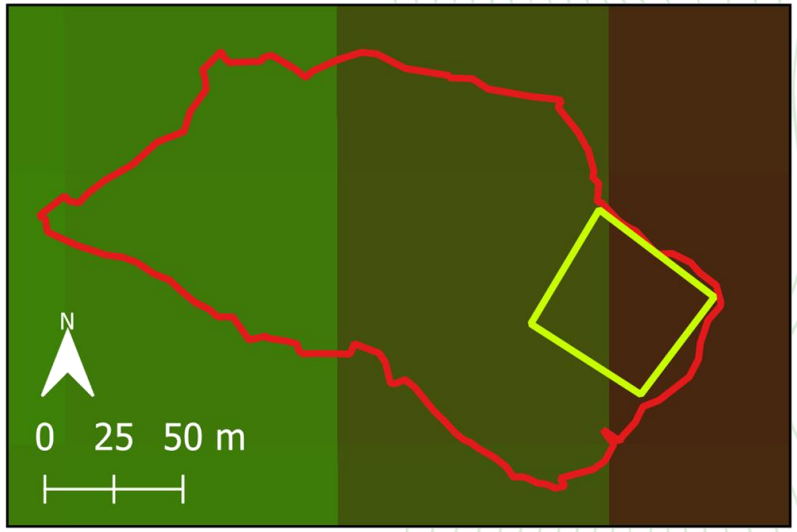


Drone canopy height model



ESA-CCI dataset

Botanical plot
Restoration site

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Barriers

- Allometric models are a source of uncertainty
- Data processing may present technical and financial barriers
- Training needed to get best imagery from drone flights

Conclusions

- Consumer-grade drones and opensource software are appropriate for community scale forest monitoring
- This presents a promising pathway for integrating EO at the community level
- More focus needed on developing regionally-calibrated allometric models and increasing accessibility of data processing

Ben Newport
ben.newport@bristol.ac.uk
@BRNewport
regrowborneo.org

University of BRISTOL

Cardiff University / Prifysgol Caerdydd

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