



Tree-Quest: A Citizen Science App for Collecting Single-Tree Attributes

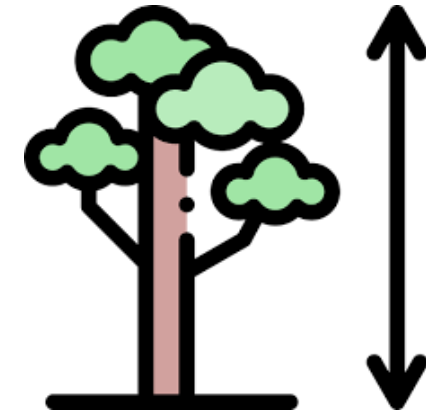
Introduction: forests inventory measurements



1. Tree diameter



2. Tree Height



3. Species Composition



4. Forest biomass



Tree-Quest: single-tree attributes (DBH, TH, ID)



Ash

Esche (Fraxinus excelsior)
density = 0,64 g/cm³



Maple

Ahorn (Acer spp)
density = 0,6 g/cm³



Oak

Eiche (Quercus spp)
density = 0,8 g/cm³



Walnut

Walnuss (Juglans regia)
density = 0,52 g/cm³

Tree-Quest: estimate tree diameter (DBH)

Seedpoint



Circle Fit



Diameter of circle



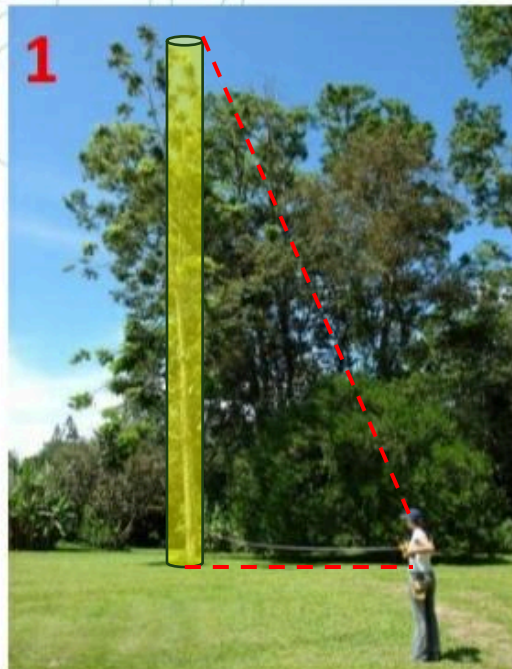
Height of cylinder



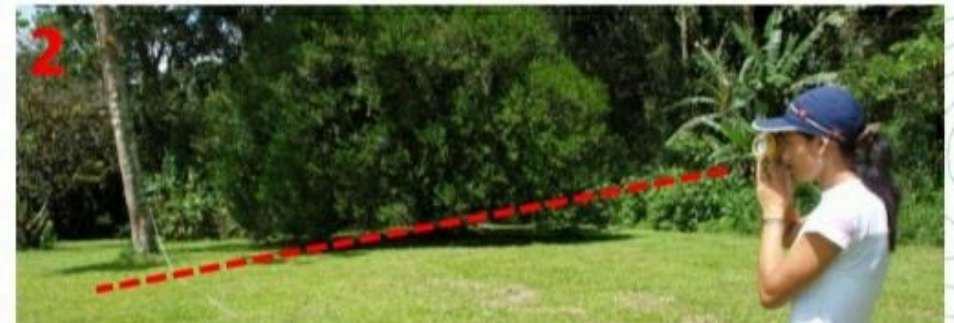
- Choose a seed point in the center of the stem at a height of ca 1,3 m
- Use augmented reality to fit points with similar spectral properties
- Estimate diameter of a circle around the stem
- Estimate height of cylinder to stem base

Tree-Quest: estimate tree height (TH)

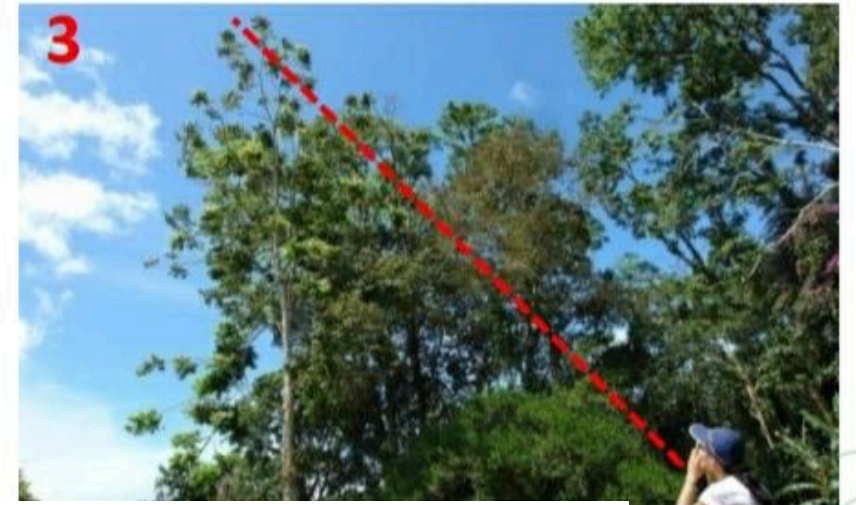
Estimation of tree height



1. Measure Distance



2. Target base of the stem

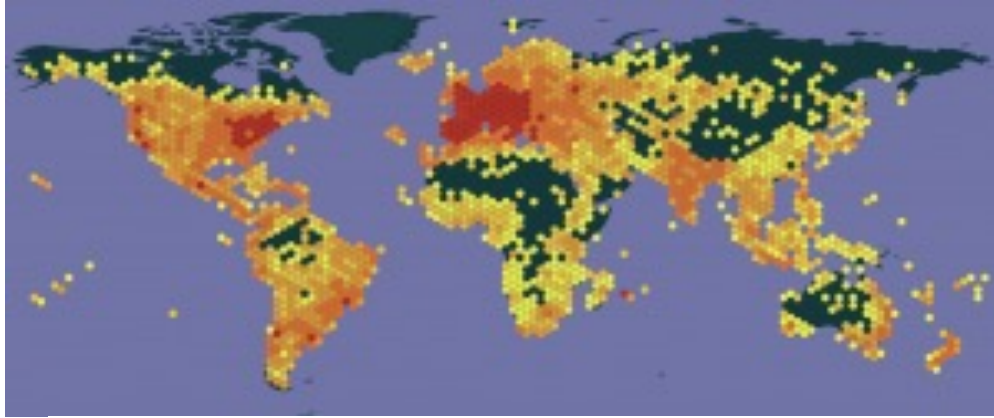


3. Target top of the crown



Tree-Quest: identify tree species (ID)

The GBIF-Global Biodiversity Information Facility Data



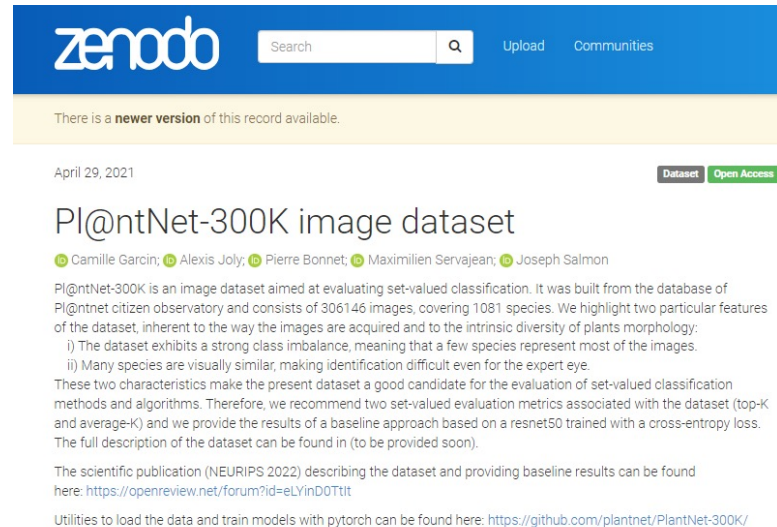
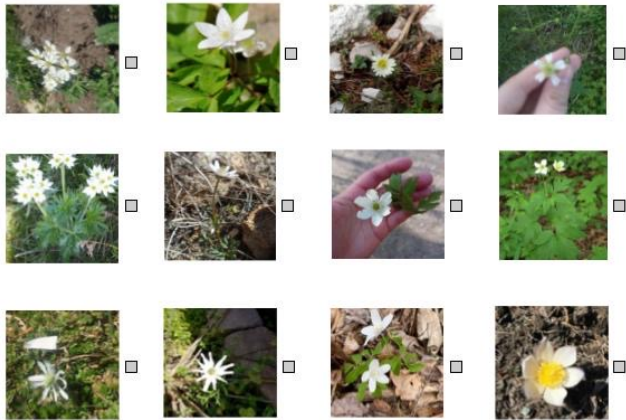
4. Identify the correct tree species

Use the plant identifier to find out the tree species:

Identify plant

Plant identification: a difficult problem

Exercise: link the pictures to the right plant name



zenodo Search Upload Communities

There is a **newer version** of this record available.

April 29, 2021 Dataset Open Access

Pl@ntNet-300K image dataset

Camille Garcin, Alexis Joly, Pierre Bonnet, Maximilien Servajean, Joseph Salmon

Pl@ntNet-300K is an image dataset aimed at evaluating set-valued classification. It was built from the database of Pl@ntnet citizen observatory and consists of 306146 images, covering 1081 species. We highlight two particular features of the dataset, inherent to the way the images are acquired and to the intrinsic diversity of plants morphology:

- i) The dataset exhibits a strong class imbalance, meaning that a few species represent most of the images.
- ii) Many species are visually similar, making identification difficult even for the expert eye.

These two characteristics make the present dataset a good candidate for the evaluation of set-valued classification methods and algorithms. Therefore, we recommend two set-valued evaluation metrics associated with the dataset (top-K and average-K) and we provide the results of a baseline approach based on a resnet50 trained with a cross-entropy loss. The full description of the dataset can be found in (to be provided soon).

The scientific publication (NEURIPS 2022) describing the dataset and providing baseline results can be found here: <https://openreview.net/forum?id=eLYinD0TtI>

Utilities to load the data and train models with pytorch can be found here: <https://github.com/plantnet/PlantNet-300K/>



Ash

Esche (Fraxinus excelsior)
density = 0,64 g/cm³



Maple

Ahorn (Acer spp)
density = 0,6 g/cm³



Oak

Eiche (Quercus spp)
density = 0,8 g/cm³



Walnut

Walnuss (Juglans regia)
density = 0,52 g/cm³

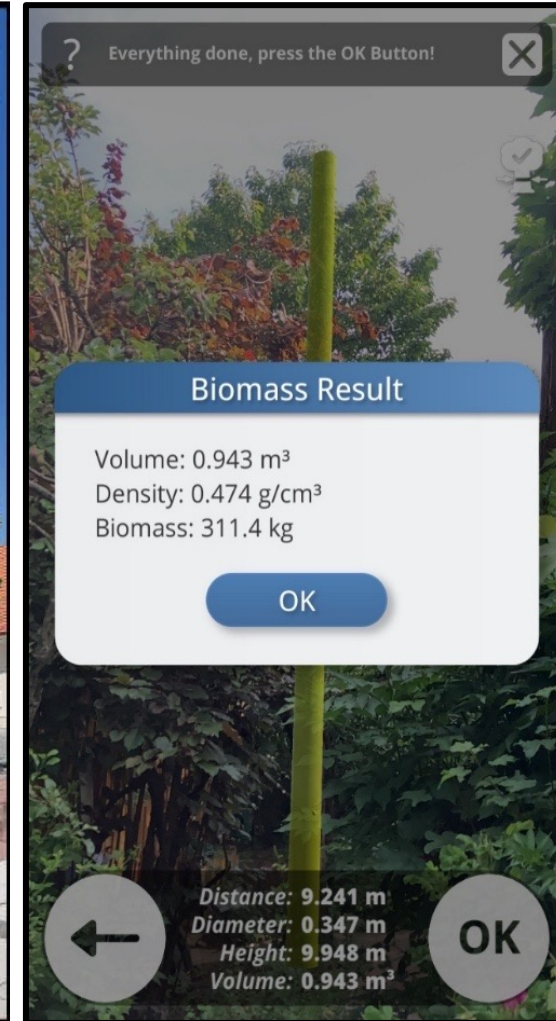
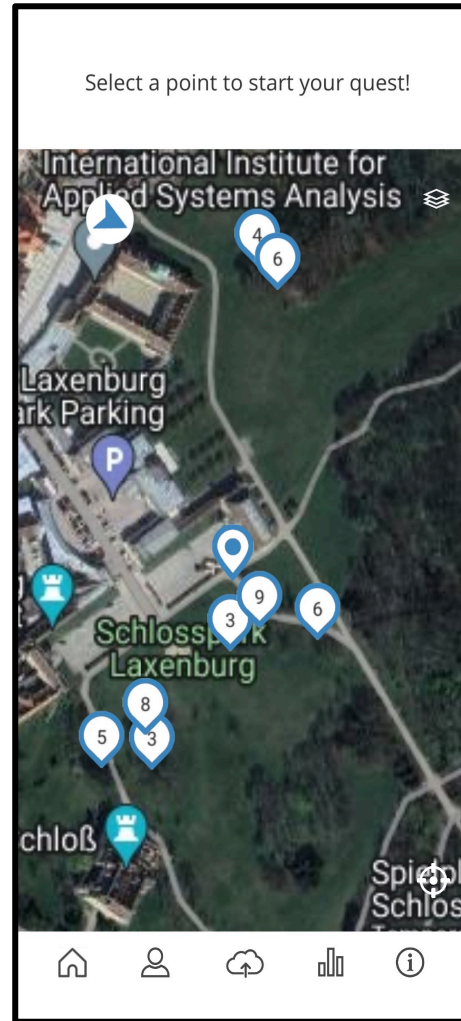
Methods: measurement parameters (TQ)

Measurement parameters:

- Tree Species (ID)
- Tree Diameter (DBH)
- Tree Height (TH)

Application records:

- Tree location
- Image of object
- Tree biomass



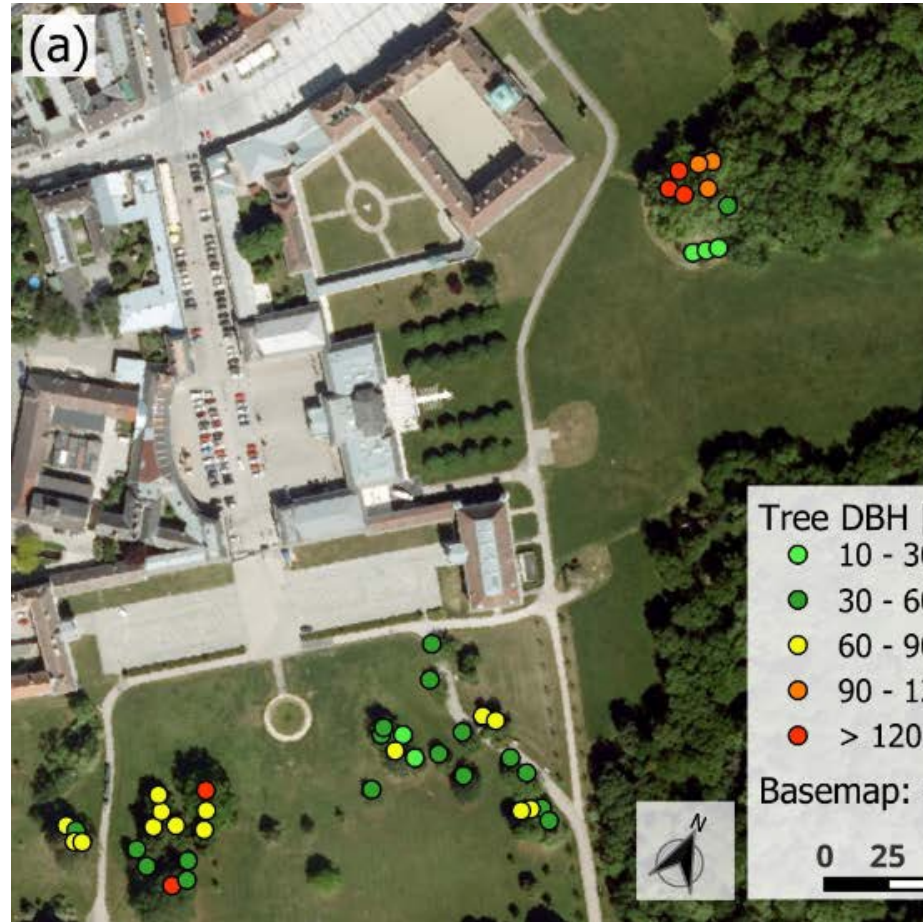
Methods: Case study (urban parks near Vienna)



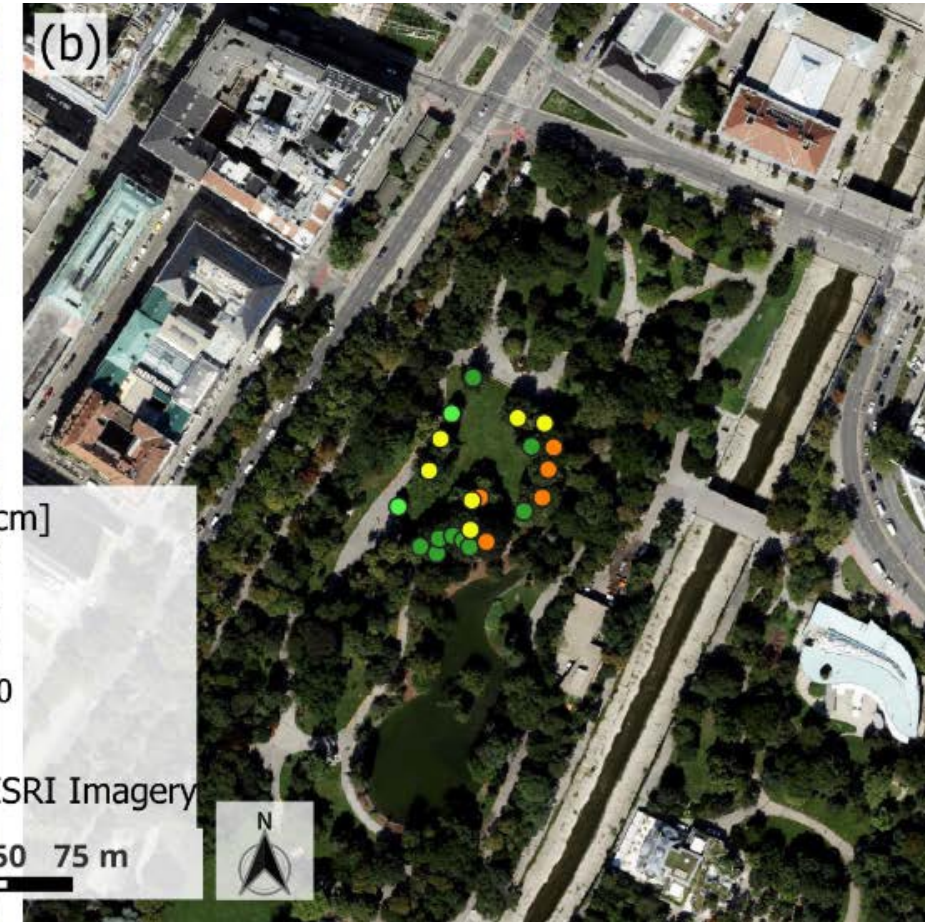
Case study (urban parks):

- Compiled dataset with **700** measurements from **30** volunteers in urban parks near Vienna.
- Collect single-tree attributes, such as tree species (**ID**), tree height (**TH**) and diameter at breast height (**DBH**).
- Compare measurements with traditional forest inventory methods (**FI**) and terrestrial laser scanning (**TLS**).

Laxenburg Park (2024)



Stadt Park Wien (2025)

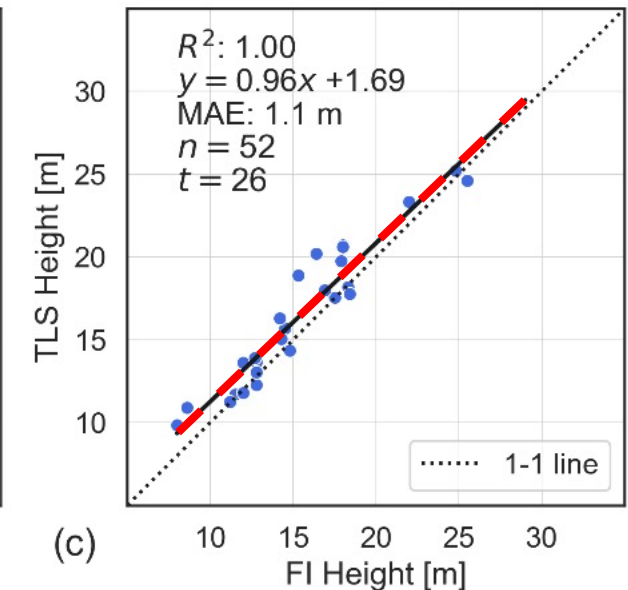
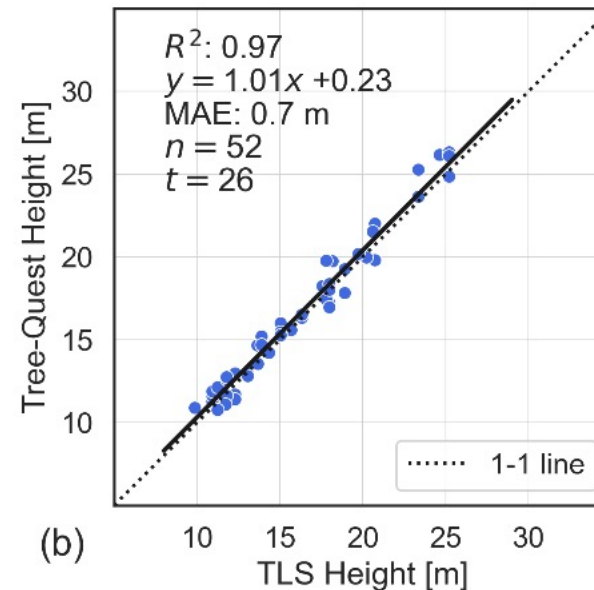
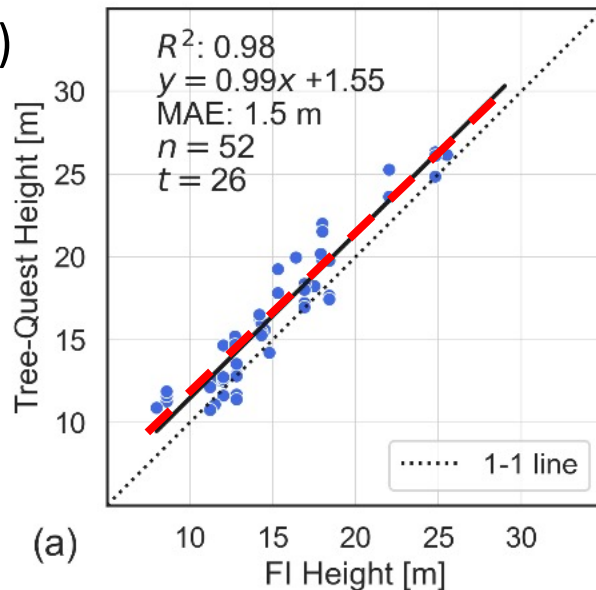
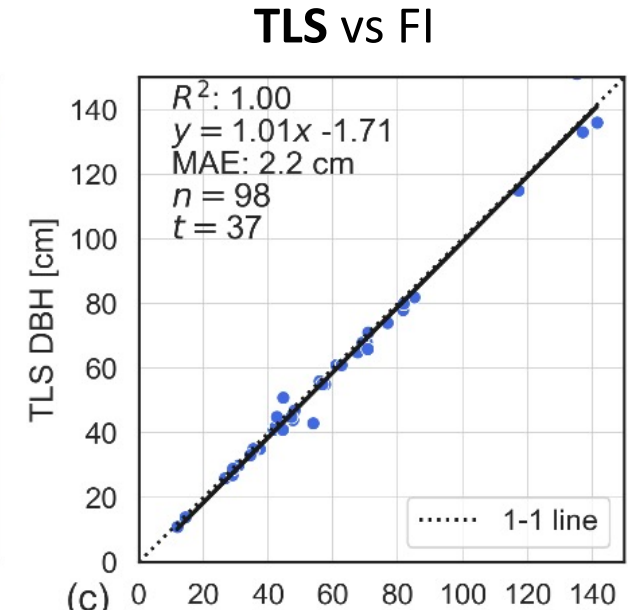
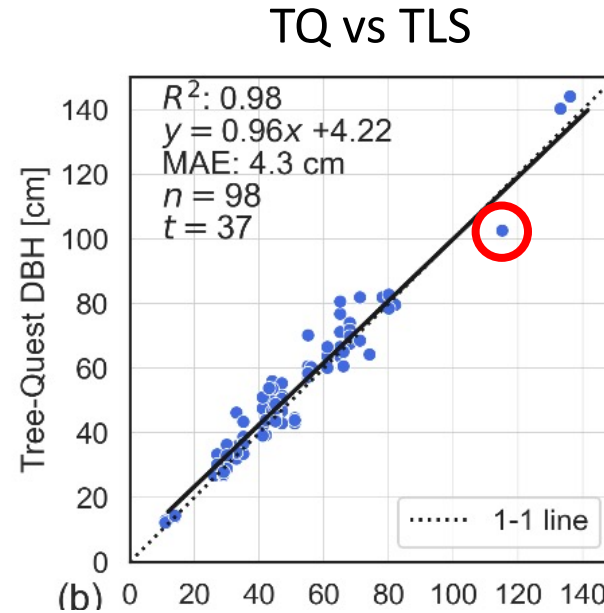
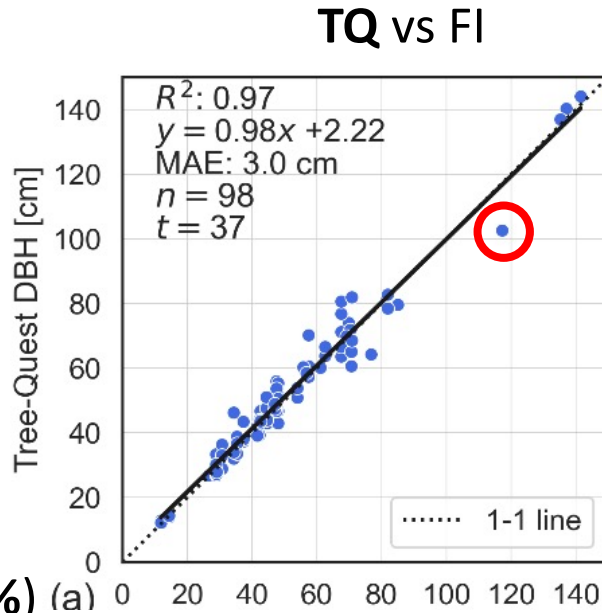


Results: measurement accuracy (errors)

Measurement Accuracy:
mean absolute error (MAE)
3 cm for diameter (DBH)
1.5 m for tree height (TH)

- DBH ($R^2 = 0.97$; rMAE = **6%**)
- TH ($R^2 = 0.97$; rMAE = **11%**)

→ TQ & TLS agree with FI
→ some errors in DBH
→ both overestimate TH



Results: measurement quality (low/med/high)

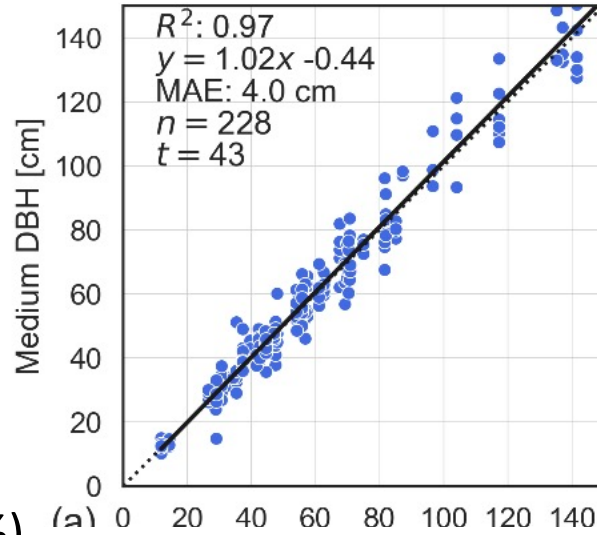


Measurement Accuracy:
mean absolute error (MAE)
3 cm for diameter (DBH)
1.5 m for tree height (TH)

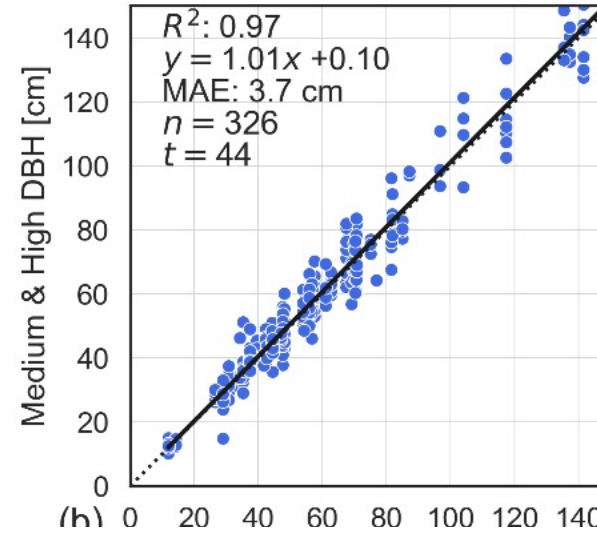
- DBH ($R^2 = 0.95$; rMAE = **6%**)
- TH ($R^2 = 0.90$; rMAE = **11%**)

→ **quality** of measurement
→ spreads with **size (DBH)**
→ **difference among users ?**

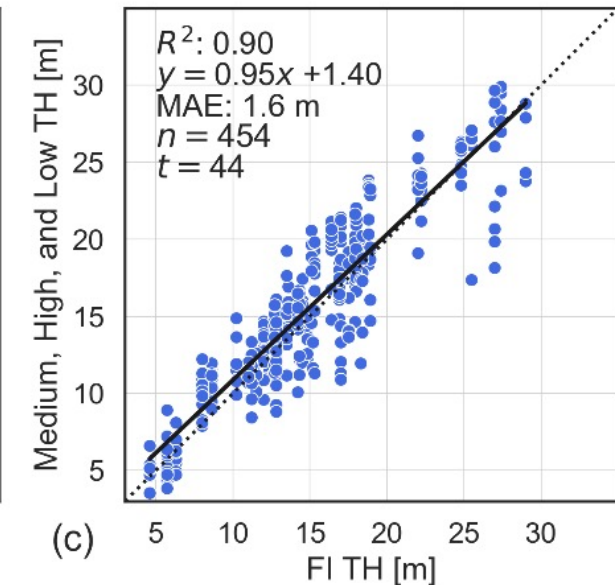
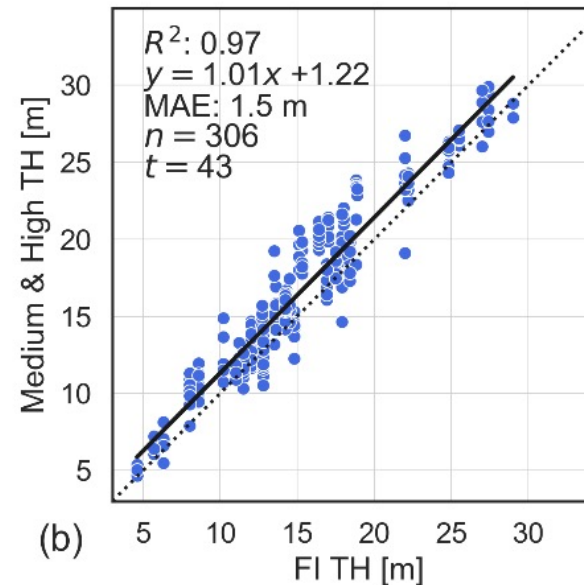
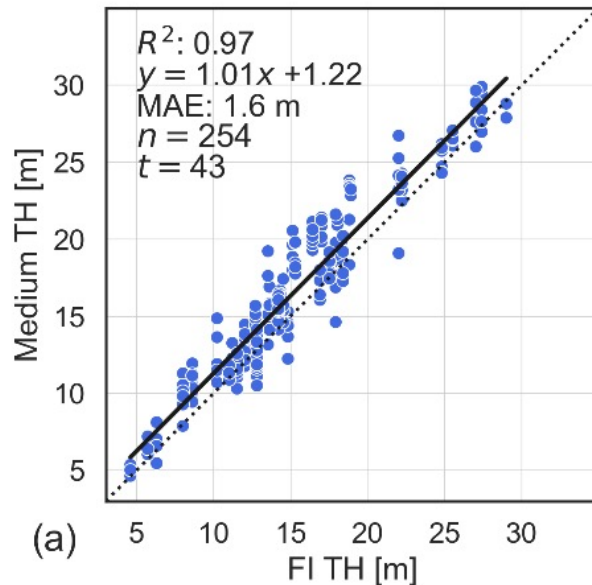
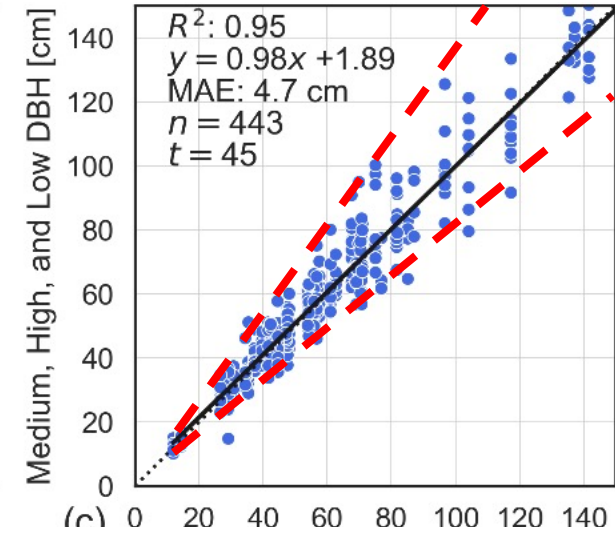
High Quality



Medium quality



Low quality



Results: user groups (expert, citizen, student)

Measurement Accuracy:
mean absolute error (MAE)

3 cm for diameter (DBH)

1.5 m for tree height (TH)

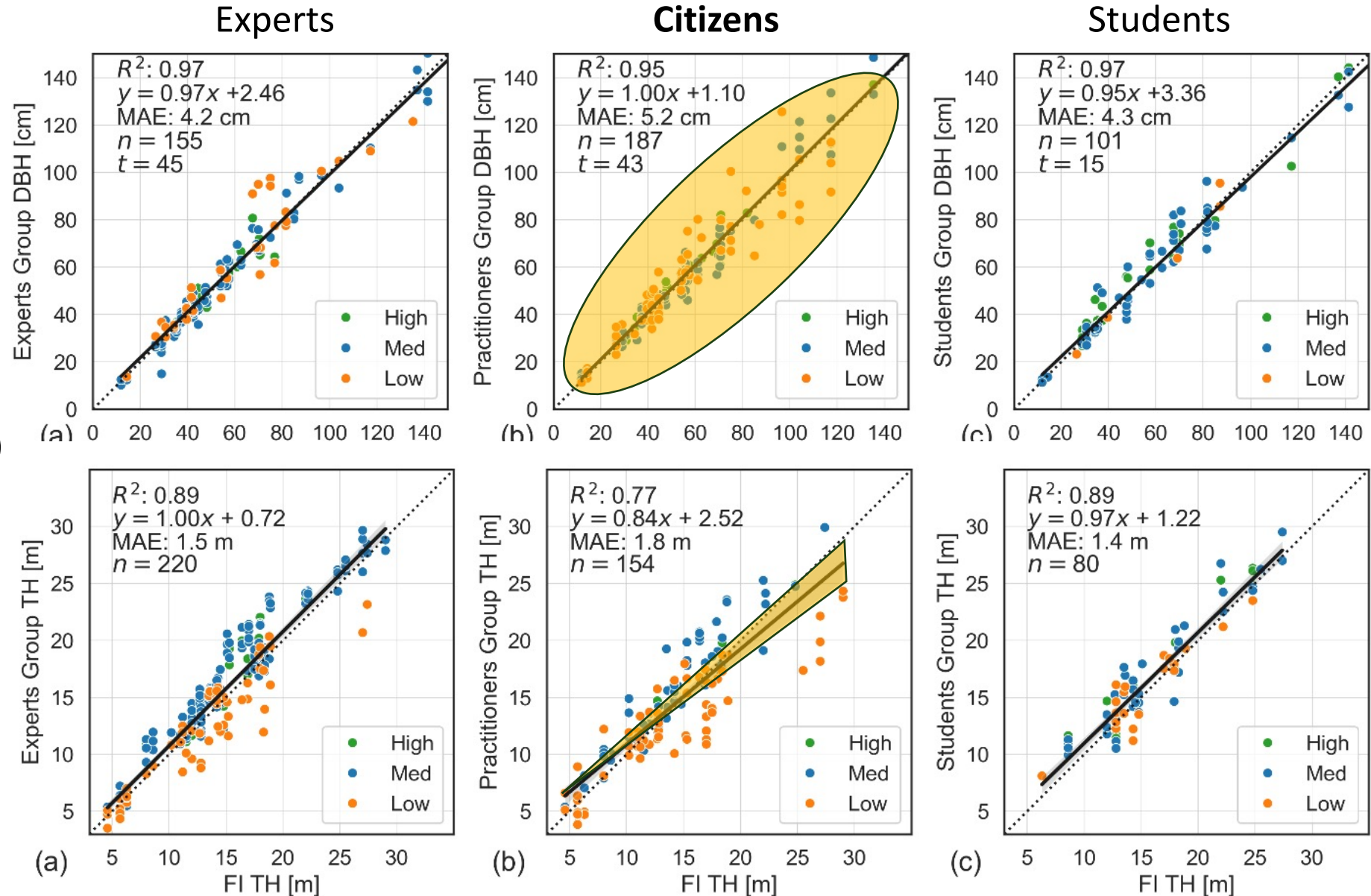
- DBH ($R^2 = 0.95$; rMAE = **6%**)

- TH ($R^2 = 0.77$; rMAE = **11%**)

→ differs among users (DBH)

→ over/under estimate (TH)

→ user group / tree size !



Results: mobile apps (TQ, GL, WT)

Compare different mobile applications:

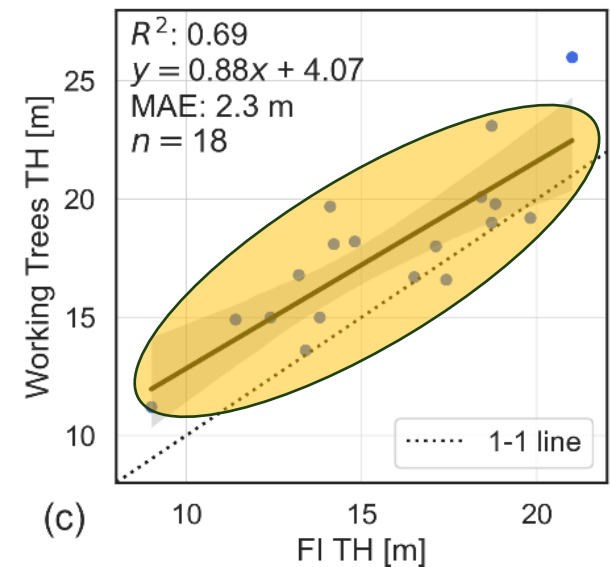
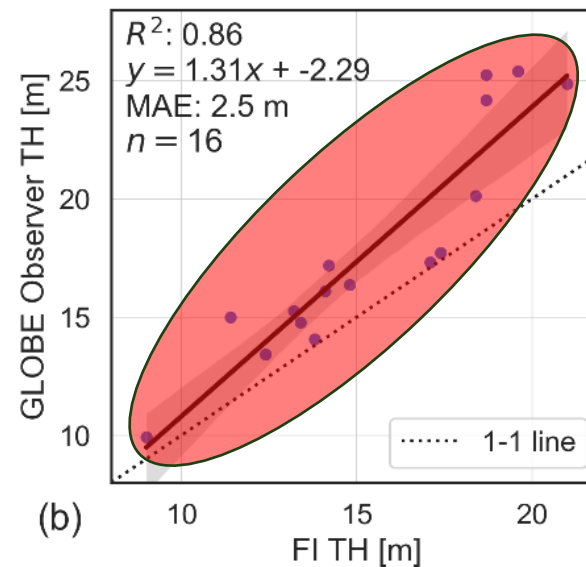
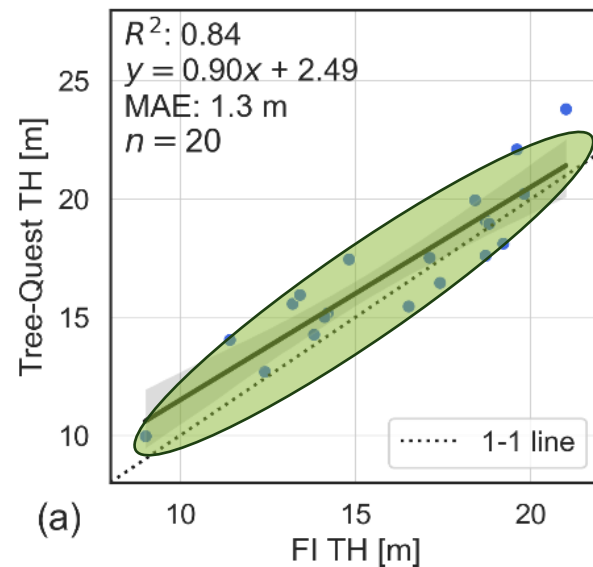
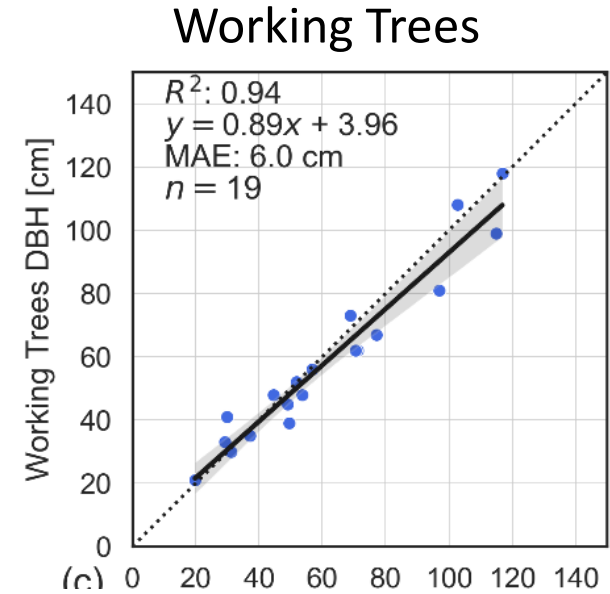
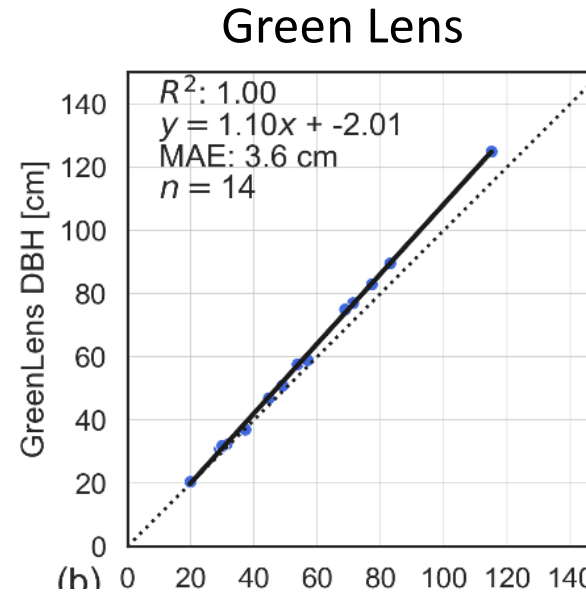
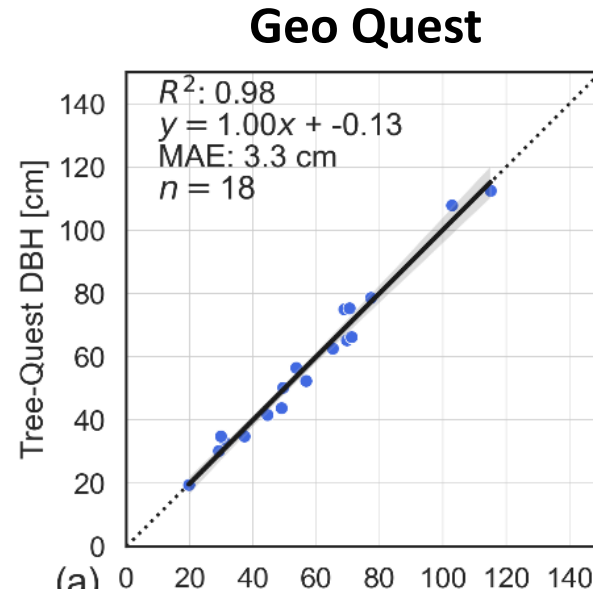
- Geo Quest



- Green Lens



- Working Trees



Conclusion: comparing methods (FI, TLS, TQ)



	Operationally in use	Single tree information	Stand characteristic acquired	Statistically planned sampling	Expert knowledge required	Costs
Forest Inventory (FI)	Yes	Directly measured	Yes	Yes	Yes	High
Terrestrial laser scanning (TLS)	No	Indirectly derived from point clouds	Yes	Yes	Yes ¹	High
Terrestrial Photogrammetry	No	Indirectly derived from point clouds	Yes	Yes	Yes ¹	Medium ²
Citizen-Science with Mobile Phones	No	Directly measured in the app	No	No	No	Low

¹ Particularly for the data post-processing and information extraction phases

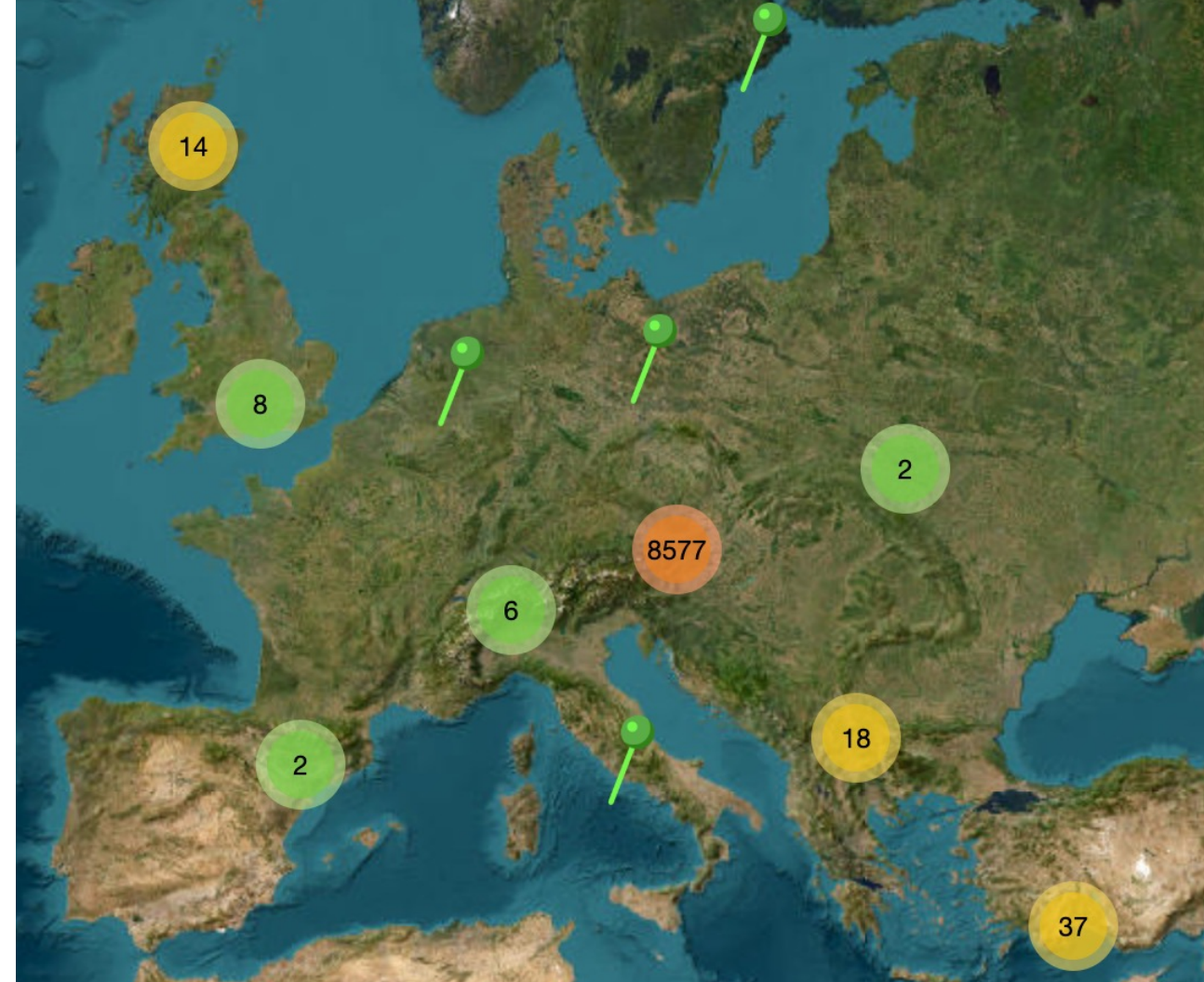
² The costs of the equipment are low, but the software and postprocessing costs can be medium to high

Conclusion: spatial coverage & user location



Number of user downloads & measurement locations:

- In **total 331 users** visited **9635 locations** and uploaded **70001 images** in Geo-Guest
- iOS: 1186 downloads (**881 from Austria**, 74 from Germany, 43 from USA, 24 from China, 21 from France, 18 from UK)
- Android: 635 installs (**425 from Austria**, 25 from Germany, 15 from Zambia, 11 from USA, 9 from UK)



Let's go: download the App with the QR-Code



Thank you for your attention! Questions?

Online
Dashboard



Download on the
App Store



GET IT ON
Google Play



Collaboration partners:



<https://c4cweb.main.geo-wiki.org/>

Conclusion: aboveground biomass (AGB)

Species	Equation	Source	DBH [cm]	TH [m]	P [g/cm ³]	AGB Error [%]
Quercus robur	$\ln(AGB) = a + b \cdot \ln(DBH)$	(Zianis et al. 2005)	139.3	24.8	0.66	5.77
Quercus robur	$AGB = a \cdot (\rho \cdot TH \cdot DBH^2)^b$	(Chave et al. 2014)	139.3	24.8	0.66	9.08
Fagus sylvatica	$\ln(AGB) = a + b \cdot \ln(DBH) + c \cdot \ln(TH)$	(Zianis et al. 2005)	54.2	12.7	0.56	15.52
Fagus sylvatica	$AGB = a \cdot (\rho \cdot TH \cdot DBH^2)^b$	(Chave et al. 2014)	54.2	12.7	0.56	19.8
Pinus nigra	$AGB = a + b \cdot TH \cdot DBH^2 + c \cdot DBH^2$	(Muukkonen and Mäkipää 2006)	75.45	20.4	0.41	12.48
Pinus nigra	$AGB = a \cdot (\rho \cdot TH \cdot DBH^2)^b$	(Chave et al. 2014)	75.45	20.4	0.41	13.25

