From dawn till dusk – High-resolution tree shade modelling based on terrestrial laser scanner data

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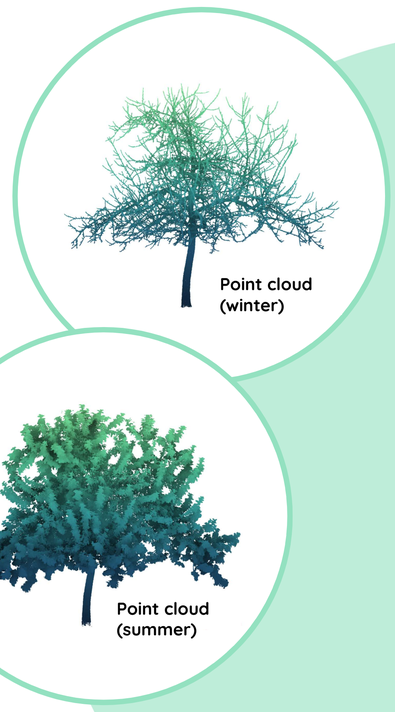
Introduction

- Light quantity, distribution and quality influence **ecosystems**, e.g. regarding
  - Plant growth [1-4]
  - Microclimatic conditions [5]
  - Species diversity & composition [6-8]
- Particularly relevant **where light conditions vary** greatly in space & time
- However, obtaining **areal light measurements** throughout the entire year is extremely laborious
- **Goal: High-resolution shade simulation throughout the year based on a single measurement campaign**



Methodological approach

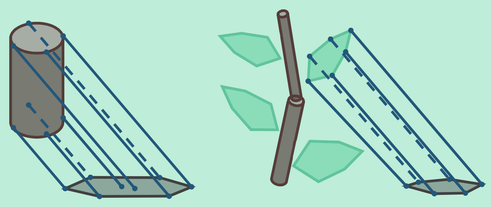
Step 1
Measurement of leaf distribution on branches of several trees

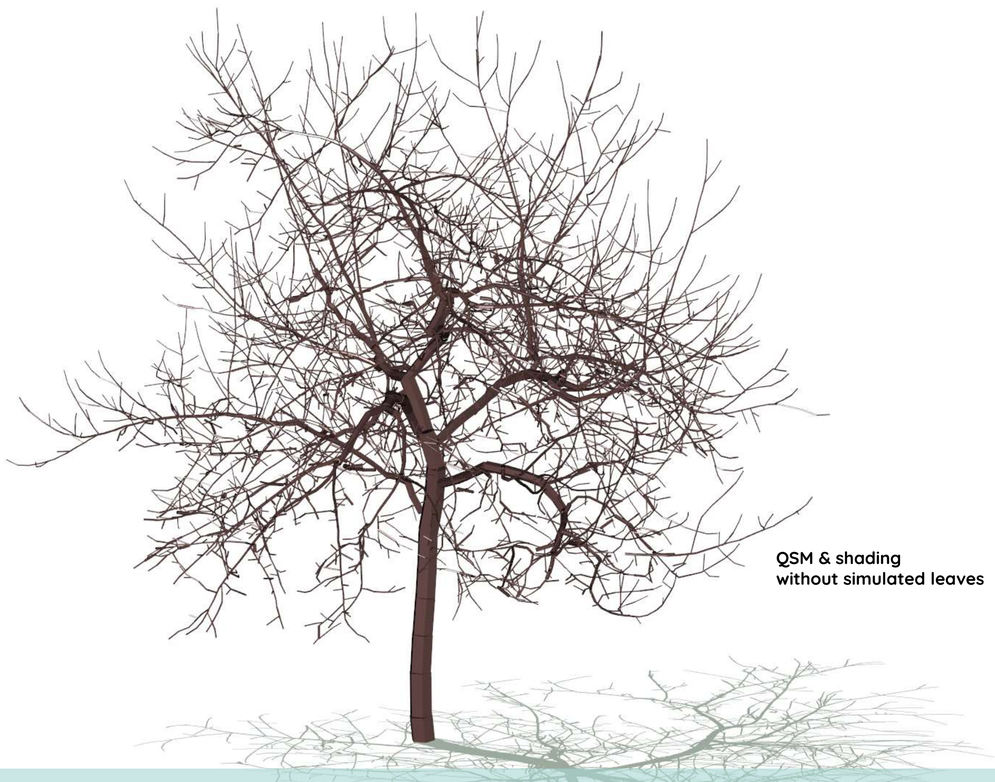
Step 2
Survey of leafless trees in winter using terrestrial laser scanning (TLS)

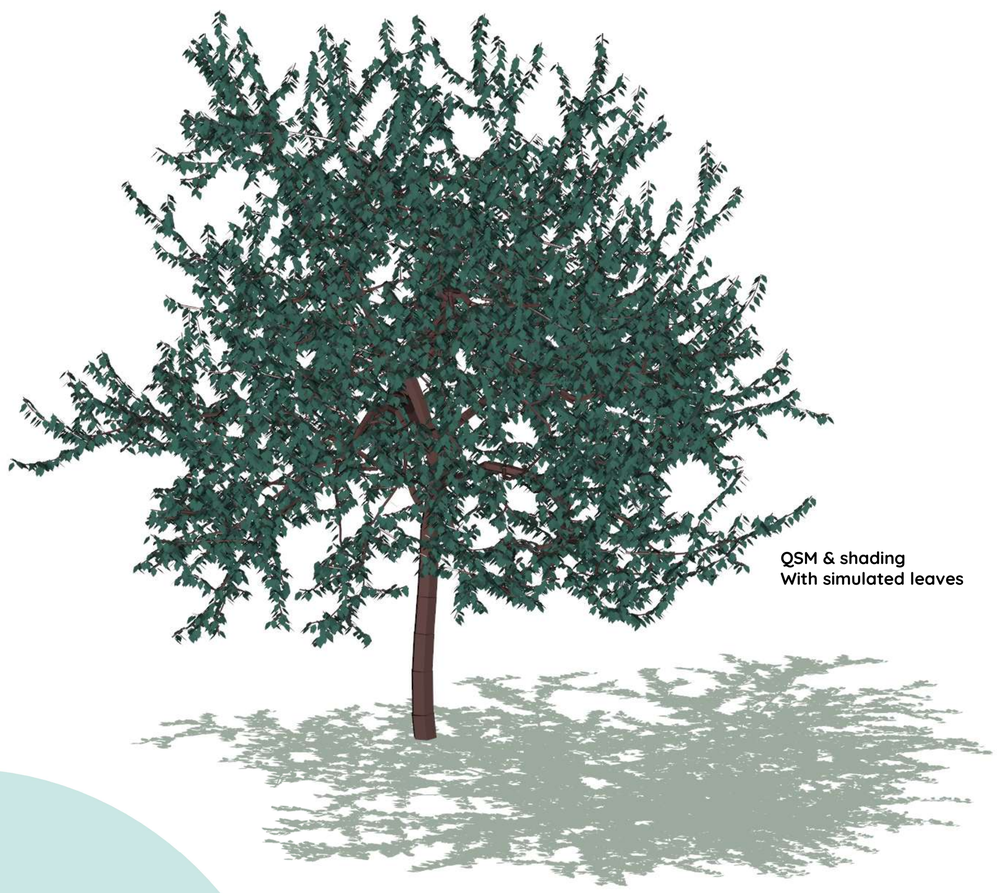
Step 3
Reconstruction of quantitative structural models (QSMs) from the TLS point clouds [9]

Step 4
Simulation of individual leaves onto QSMs based on measured leaf distribution

Step 5
Calculation of shading by projecting of the QSM cylinders & leaves

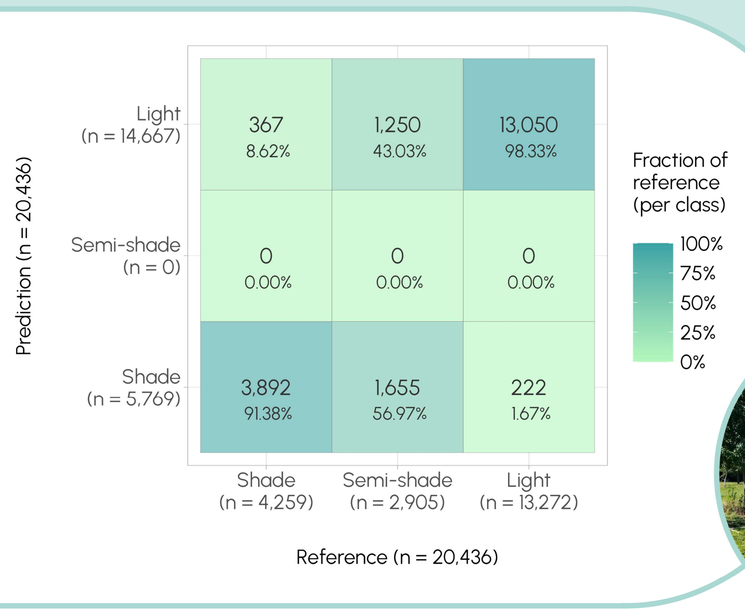






Validation

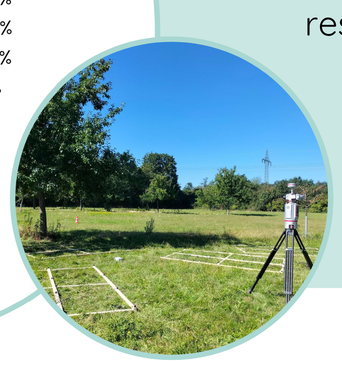
Approach: Comparison of measured radiation with simulated light and shadow under a solitary tree



Measurements: 60 quantum sensors beneath an apple tree on a cloudless summer day, measurements 1 x per min (n = 20,436)

Simulation: spatial & temporal resolution of 1 cm & 1 min

Result: measurements and simulation highly correlated (r = 0.84)



Discussion

- Enhanced **functionality** and improved **computational efficiency** compared to previous algorithms [10,11]
- Recording TLS data only once reduces both the required **time & costs**
- Possible applications in **forestry, urban forestry & agroforestry research** (e.g. for biodiversity / microclimate assessments)

References

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Related Paper:
Schindler *et al.* (2024) From dawn to dusk: High-resolution tree shading model based on terrestrial LiDAR data. *Remote Sensing, 16(12)*, 2189.

Related R Package:
qsm2shade

qsm2shade

GitHub

Paper

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