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Above Ground Biomass References for Urban Trees from Terrestrial Laser Scanning Data

Daniel Kükenbrink[1,2], Oliver Gardi[3], Felix Morsdorf[2], Esther Thürig[1], Andreas Schellenberger[4], and Lukas Mathys[5]

[1]Swiss Federal Institute for Forest, Snow and Landscape Research WSL , Land Change Science, Remote Sensing, Switzerland (daniel.kuekenbrink@wsl.ch)

[2]Remote Sensing Laboratories, University of Zurich, Winterthurerstrasse 190, CH-8045 Zurich, Switzerland

[3]School of Agricultural, Forest and Food Sciences HAFL, Länggasse 85, CH-3052 Zollikofen, Switzerland

[4]Federal Office for the Environment FOEN, CH-3003 Bern, Switzerland

[5]Nategra LLC, Nydeggstalden 30, CH-3011 Bern, Switzerland

Trees supply a multitude of ecosystem services (e.g. carbon storage, suppression of air pollution, oxygen, shade, recreation etc.) not only in forested areas but also in urban landscapes. Many of these services are positively correlated with tree size and structure. The assessment of carbon storage potential via the quantification of above ground biomass (AGB) is of special importance. However, quantification of AGB is difficult and applied allometries are often based on forest trees, which are subject to very different growing conditions, competition and form compared to urban trees. In this contribution, we highlight the potential of terrestrial laser scanning (TLS) techniques to extract high detailed information on tree structure and AGB with a focus on urban trees.

A total of 55 urban trees distributed over eight cities in Switzerland were measured using TLS and traditional forest inventory techniques before they were felled and weighted. Tree structure, volumes and AGB from the TLS point clouds were extracted using Quantitative Structure Modelling (QSM). TLS derived AGB estimates were compared to allometric estimates dependent on diameter at breast height only. The allometric models were established within the Swiss National Forest Inventory and are therefore optimised for forest trees.

TLS derived AGB estimates showed good performance when compared to destructively harvested references with an R^2 of 0.954 (RMSE = 556 kg), compared to an R^2 of 0.837 (RMSE = 1159 kg) for allometrically derived AGB estimates. A correlation analysis showed that different TLS derived wood volume estimates as well as trunk diameters and tree crown metrics show high correlation in describing total wood AGB.

The presented results show that TLS based wood volume estimates show high potential to estimate tree AGB independent of tree species, size and form. This allows us to retrieve highly accurate, non-destructive AGB estimates that could be used to establish new allometric equations without the need of extensive destructive harvest.