Use R! for estimating forest parameters based on Airborne Laser Scanner Data

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1 Abstract

Forest parameters such as timber volume, diameter distributions, tree height and tree species are important information for a sustainable forest management and planning issues in the wood-working industry. Additionally, the amount of carbon stocks in woody biomass has become an crucial parameter due to international reporting commitments (e.g., the Kyoto-protocol). Conventionally, these information are surveyed in sample plot inventories.

However, terrestrial sample plot inventories usually cannot provide estimates on the stand-scale[1]. Furthermore, as a result to their high costs, they are repeated in a decennial cycle. Therefore, one aim of the research project MatchWood (`www.matchwood.de`) is to develop methods to regionalize forest parameters based on remotely sensed data. Since many variables of interest are correlated with the structural characteristics of the canopy, airborne laser scanning data were used as auxiliary variable.

Airborne laser scanning (ALS) or light detection and ranging (lidar) is an active remote sensing technique that comprises scanning and navigation units. In an ALS system, a laser pulse is projected on a scanning mirror and sent to the surface. Since the position and orientation of the aircraft is known, the time-of-flight of the laser pulse can be used to determine the position of the reflection on the earth's surface. ALS provides a high resolution 3D representation of the canopy and the terrain surface in one overflight.

R was used to derive height- and density metrics of the lidar-derived vegetation height for inventory plots and to develop statistical models for the response

[1] A usual forest stand in southern Germany has an area of 1-3 ha and comprises of trees with more or less the same species and age.

variables. The presentation will show the application of different R methods and libraries for estimation and regionalizing the above mentioned forest parameters. For example:

- Calling external command-line tools (FUSION) for handling the huge amount (about 500.000 returns km^{-2}) of lidar raw data.
- Mixed-effects models (library nlme) for estimating timber volume and biomass by accounting for the spatial correlation of the inventory plots and heteroscedasticity.
- Generalized additive models for location, scale and shape (library GAMLSS) for estimation of the Weibull distributed response variable diameter.
- RandomForests for non-parametric estimation of timber volume by species.
- Generating maps using the maptools library.