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Tree Species Maps from Multispectral Airborne Laser Scanning Data

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Classification of tree species is still a challenge for remote sensing-based forest inventory. Estimates of forest variables such as tree height and stem volume can be derived with high accuracy from Airborne Laser Scanning (ALS). Passive multispectral optical sensors provide additional information about tree species, but have the disadvantage that the recorded spectral values depend on the light conditions and shadowing. Active sensors such as ALS are more independent of light conditions since the sensor itself emits the light for which the reflection is measured and have the advantage that data from the tree canopy and the ground can be separated to avoid mixed signals.
Most ALS systems that are commercially available for terrestrial mapping use only one wavelength of light (i.e. one color) and the sensors are not designed to measure spectral values. New multispectral ALS systems have recently become operational, such as the Optech Titan system with wavelengths 1550 nm, 1064 nm, and 532 nm, which has been used for tree species classification of individual trees with promising results. However, individual tree methods require positions of reference trees as training data.
Operational use of ALS data for prediction of forest variables has this far been dominated by area-based methods, which require less dense ALS data than individual tree methods. Until now, classification of tree species has not been successfully done with an area-based method from ALS data only, since the features that have been derived from the ALS data are related to structure and height distribution that are not distinctly different for different tree species. Additionally, a mix of tree species can complicate the species classification.
This study presents a new type of area-based method using small raster cells for classification of tree species from multispectral ALS data, from hereon called the mini raster cell method. The features used for the tree species classification are derived from the intensity of the different wavelengths in small raster cells using a moving window average approach to allow for a heterogeneous tree species composition. Classification has been done for pine, spruce, deciduous forest and mixed forest in a study area located in hemi-boreal forest in the southwest of Sweden. Preliminary results for tree species classification of individual trees in the same area are also presented.
The classification with the mini raster cell method was slightly more accurate (74% overall accuracy) than classification with a conventional area-based method (67% overall accuracy). The results were good for spruce and pine and slightly worse for deciduous forest and mixed forest. Earlier studies using spectral data for tree species classification have shown lower accuracy for separation between pine and spruce. Visual comparison gave by hand that the raster maps were consistent with maps of forest stands and tree species composition from manual interpretation of aerial images. The small raster cells can be aggregated to arbitrary areas, for example forest stands or area units corresponding to field plots.