Landcover classification: Does Airborne LiDAR Alone Capable of Producing Good Quality of Landcover Map?

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Abstract: This paper discusses landcover classification using high density airborne LiDAR data and multispectral imagery, in which both datasets are obtained from the same airborne LiDAR system. The study area is the Duursche Waarden floodplain in the Netherlands and surrounding areas. This area can be divided into several landcover classes i.e. buildings, tilled land, herbaceous vegetation, grassland, forest or trees, and paved road. The airborne LiDAR dataset was acquired by the FLI-MAP 400 system during the leaf-off season. The point density of this system is between 50 and 100 points per m^2. Other than height and intensity, the FLI-MAP 400 system also measures spectral information (Red, Green, and Blue) embedded in each laser return. The resulting dataset was used to generate several statistical features from the height and intensity data and so-called multispectral images from the spectral data. The methodology is divided into three main parts; 1) data pre-processing and derivation of several features from airborne LiDAR data for landcover classification, 2) landcover classification, and 3) evaluation of results. In the first part, the ground points are extracted from the LiDAR data to generate the DTM of the study area. The elevation value of each laser return is then normalized to the DTM by subtracting the DTM from the elevation value. After that, all the components of the dataset (height, Intensity, Red, Green, and Blue) are converted to a raster form at the same spatial resolution. In this step, several features are created for height, intensity, Red, Green, and Blue. The landcover classification process is divided into two major parts which deal with the Support Vector Machine (SVM) and Maximum Likelihood (ML) classifiers. Each classifier is used on three different datasets: 1) FLI-MAP 400-generated multispectral images, 2) LiDAR-derived features, and 3) a combination of the multispectral images and the LiDAR-derived features. The results show that the SVM method produces better classification results than the ML method. In addition, the landcover classification based on the combination of LiDAR-derived features and multispectral images produces better results than classification based on either dataset only. The accuracy of the landcover classification using the SVM method on the combined dataset is sufficient for the subsequent process to estimate hydrodynamic roughness for each landcover class. By employing all the input features, good classification accuracy can be achieved even with a relatively low polynomial order of SVM. Generally, both classification methods agree that the LiDAR-derived features require the multispectral images to improve the classification results, especially for grassland, tilled land, and paved road. The landcover classification using only the LiDAR-derived data tends to produce lower overall classification accuracy than the classification based on just the multispectral images. For classification of the multispectral images by the SVM method, the LiDAR-derived features improve the classification results, especially for buildings, tilled land, paved road, forest or trees. For classification of the multispectral images by the ML method, the LiDAR-derived features improve the classification results, especially for buildings, paved road, herbaceous vegetation, and forest or trees.

Keyword: Landcover, support vector machine, airborne LiDAR.