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VERTICAL VEGETATION STRUCTURE ANALYSIS AND HYDRAULIC ROUGHNESS DETERMINATION USING DENSE ALS POINT CLOUD DATA - A VOXEL BASED APPROACH

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Abstract. In this contribution the complexity of the vertical vegetation structure, based on dense airborne laser scanning (ALS) point cloud data (25 echoes/m^2), is analyzed to calculate vegetation roughness for hydraulic applications. Using the original 3D ALS point cloud, three levels of abstractions are derived (cells, voxels and connections) to analyze ALS data based on a 1 × 1 m^2 raster over the whole data set. A voxel structure is used to count the echoes in predefined detrended height levels within each cell. In general, it is assumed that the number of voxels containing echoes is an indicator for elevated objects and consequently for increased roughness. Neighboring voxels containing at least one data point are merged together to connections. An additional height threshold is applied to connect vertical neighboring voxels with a certain distance in between. Thus, the connections indicate continuous vegetation structures. The height of the surface near or lowest connection is an indicator for hydrodynamic roughness coefficients. For cells, voxels and connections the laser echoes are counted within the structure and various statistical measures are calculated. Based on these derived statistical parameters a rule-based classification is developed by applying a decision tree to assess vegetation types. Roughness coefficient values such as Manning's *n* are estimated, which are used as input for 2D hydrodynamic-numerical modeling. The estimated Manning ' s values from the ALS point cloud are compared with a traditional Manning's map. Finally, the effect of these two different Manning's *n* maps as input on the 2D hydraulics are quantified by calculating a height difference model of the inundated depth maps. The results show the large potential of using the entire vertical vegetation structure for hydraulic roughness estimation.

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