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Estimating floodplain roughness parameters for surface water modelling using airborne laser scanning data

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Two-dimensional hydraulic models are an essential tool for describing hydrodynamic processes of streams, estuaries and floodplains. Numerical hydraulic models simulate the flow regime, water depths, water table elevations and flow velocities, thereby providing further aid for the analysis of inundated areas. These simulation results find a variety of applications for many problems ranging from river management measures to understanding ecological processes.

The quality of hydraulic models depends on input data (topography, roughness) quality and on the assumptions which are made during the model setup and calibration. Riverbed and Earth surface roughness play a decisive role in the distribution of the flow regime with regards to quantity and direction. Conventionally, floodplain roughness is determined from vegetation- and land use maps that are conventionally derived from aerial photographs and field measurements. The presented study shows two alternative approaches to derive such floodplain surface roughness parameters for hydrodynamic models from airborne laser scanning data (ALS).

Based on the highly accurate topographic data from ALS, which contain information about the Earth surface as well as above-ground objects, different roughness maps can be derived. Two roughness delineation approaches, based on the ALS point cloud, will be tested for the usage in such a hydrodynamic model. First, the surface roughness will be derived by using the standard deviation of the elevation information in a fix distance of each point. With this method a 2D or a 3D roughness can be derived. The 2D roughness is the standard deviation of all points within a cylinder and contains all points in the searching radius. Such a 3D surface roughness is the standard deviation of points which belong to a sphere in a specific diameter around the search point. The advantage of the 3D standard deviation is, if only ground points are used as searching points the influence of points which belong to tree canopies are minimised. The second approach is to derive single trees, to count the number of trees in a specific area and build homogeneous segments. For non-forested areas (shrubs and bare Earth) the elevation difference between ground and top reflections in a given area are calculated and segmented. For both approaches, classes of homogeneous roughness areas can be computed. After computing the roughness classes the corresponding roughness values of the used hydrodynamic model can be added.

The hydrodynamic model results of the two different floodplain roughness delineation approaches are compared with those from conventional roughness parameters. Our first results show that there is no obvious benefit from using the ALS data. We argue that this is not due to the quality of the data themselves, but due to a lack of theoretical understanding of how roughness should be defined and used in hydrodynamic models.