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Extracting cross sections and water levels of minor streams and ditches from LiDAR point data

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Quantitative data on the shape and dimensions of location-specific cross-sections is useful for water and floodplain management. In addition, information about the water level is often needed, for example to be used as a boundary condition in hydrological, hydraulic and groundwater models. To detect a water course, let alone the cross section of small streams, the spatial resolution of DEM's derived from LiDAR or other data sources is insufficient. This is not the case for high resolution LiDAR data clouds.

An aerial LiDAR database encompassing on average 16 points per square meter is available for the entire Flanders region. LiDAR elevation point clouds and digital RGB aerial images were collected simultaneously. To extract the right points for determination of the water course's cross-section at a given location, a buffer zone is defined around a predefined cross-section. This is based on the assumption that the cross-section of a channel is invariable over a small distance (0.1-1m). The set of extracted and then projected points was subjected to curve fitting based on shape language modelling (SLM). Based on the modelled cross-sectional profile, characteristics like cross-sectional area, width and water level were extracted. Furthermore, normalized indices combining the RGB and intensity data were used to detect the presence of water and the different characteristics of the points close to the water level and close to the banks.

The study area is located in the alluvial valley of the Dijle, 20 km east of Brussels. It is part of the nature reserve 'de Doode Bemde'. The area of the test site is 10.3 ha and contains a ditch network of approximately three km. The field data, collected during August 2015 with a real time kinematic (RTK) GPS, was used for validation. The measurement result contained 153 cross sections with all the bathymetry data under the water level.

Validation showed that all of the cross-sections modelled with the LiDAR data had a positive mean deviation with an average of 0.14 m with respect to the field-measured elevation data. The presence of water explains the overestimation of elevations in the centre of the ditch, while vegetation explains the (smaller) overestimation on the banks of the ditch. These overestimations of elevations and its spatial distribution within the profile, cause an underestimation of the cross-sectional area. The spatial distribution of the extracted water levels of the cross-sectional profiles were consistent with the hydrologic/hydraulic logic within the study area.