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Calculation of surface roughness of an alpine river reach using Terrestrial Laser Scanning data

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The micro-geomorphology of a river channel, especially the effective surface roughness, has a strong influence on the flow characteristics of the stream. In addition to the form roughness the grain roughness plays an important role. Generally Manning's coefficient [n] is used to describe the total roughness. During former surveys the determination of the surface roughness was based solely on the grain size distribution. In this study we additionally used the Random Field Approach where the basic assumption is that the area of interest is a random field Z (x, y) of bed elevations.

The aim of our research is to calculate the surface roughness in an alpine river reach. The study area is the Reintal Valley in the Bavarian Alps near Garmisch-Partenkirchen, Germany. Six representative test sites were surveyed with high resolution (point spacing $\sim$ 2 mm) using a Terrestrial Laser Scanner. Each test site covers an area of about 1 m^2. The result of the scanning process is a point cloud where each point is described by a coordinate (X, Y, Z). The point cloud is converted into a grid. The cell size of this grid is controlled by the biggest grain size of each sample area.

The standard deviation of the Z value (σZ) is determined within every grid cell. The roughness coefficient is also determined by using the grain size distribution. The b-axis of river bed particles is generally arranged in the flow direction. On the contrary, the c-axis is arranged perpendicular to the river channel. Thus, the c-axis is crucial for roughness determination. The strong correlation between the percentiles of the σZ values and the c-axis confirm this assumption. By multiplying each σZ value by a factor of 2 the effective roughness height (2σZ) is generated. The slope of the regression equation between the percentiles of the effective roughness height and the c-axis is close to unity.

The study has shown that highly resolved surface data (e.g. Terrestrial Laser Scanning) is useful to determine the surface roughness of a river bed with implications for further hydraulic calculations.