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Linking water surface roughness to velocity patterns using terrestrial laser scanning and acoustic doppler velocimetry

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There are well established links between water surface characteristics and hydraulics. Biotope identification is currently an important part of the River Habitat Survey in England and Wales. Their differentiation is based upon recognition of a family of flow features exhibited on the water surface. Variability in this water surface 'roughness' is dependent upon the interaction of flow with boundary roughness and flow depth. Past research that has attempted to differentiate biotopes based upon differences in Froude number (Fr) and Reynolds number (Re), however this linkage has only been limited to local analysis between flow velocity, depth and roughness. Milan et al. (2010) have recently demonstrated that terrestrial laser scanning (TLS) can be applied to produce fully quantitative maps of hydraulic habitat, based upon defined water surface roughness delimeters. However the nature of the linkages between water surface roughness, flow velocity and depth are still poorly understood, particularly at the reach-scale. This study attempts to provide a full spatial picture of the links between water surface roughness, flow depth and velocity. A Sontek Acoustic Doppler Velocity Profiler (ADVP) was used to provide detailed information on vertical velocity and water depth for a 300 m reach of the gravel-bed River Wharfe, Yorkshire, UK. Simultaneous to the ADVP measurements, a Riegl LMS-Z210 TLS was used to take a series of first return scans of the water surface. Categorisation of the point cloud elevation data for the water surface was achieved through the allocation of moving window standard deviation values to a regular grid, thus defining water surface roughness. The ADVP data demonstrate gross reach-scale variation in velocity and depth linked to bedforms, and more localised spatial and temporal variation within biotope units. The ADVP data was used to produce reach-scale maps of Fr and Re. The extent to which water surface roughness defined biotopes mapped onto these Fr and Re maps was then explored. The maps produced demonstrate a hydraulic picture that is far more complex than previously reported. It is concluded that a re-evaluation of the definition and use of biotopes to map instream river habitat is required.

Reference

Milan, D.J., Heritage, G.L., Large, A.R.G., Entwistle, N. 2010. Identification of hydraulic biotopes using terrestrial laser scan data of water surface properties. Earth Surface Processes & Landforms, 35, in press.