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Investigation of direct and indirect measurement techniques for nonuniform bed load transport

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The analysis of bed-load movement is essential to understand morphological processes in alluvial rivers. Better understanding of these mechanisms may help predict changes occurring in the riverbed during flood events, estimate the effect of these events on riverbank ecosystems, and forecast the amount of sediment deposited in reservoirs. Mostly physical based samplers are used to estimate sediment discharge but carrying out reliable measurements can be really challenging. For this reason, indirect techniques have come to the fore. The virtual velocity method based on the bias between the bottom tracking and the GPS based movement of a mounted ADCP is a promising yet unreliable alternative (Conevski et al., 2018). An attempt was made to improve this method.
Field measurements have been carried out on River Drava in the southern part of Hungary, where both physical bed-load sampling and ADCP measurements were performed. The applied sampler was the Károlyi-type sampler mounted with an underwater camera. The results gained with the physical sampling were compared with the filtered ADCP data. The comparison showed that with the increase of the mean grain size the difference between the sampled and the estimated sediment discharge increased exponentially. Because of this the theory of the applied virtual velocity method had been reconsidered. A concept was created, that the ADCP provided virtual velocity does not clearly refer to the velocity of the bed-load movement, but to the mixed layer right above the riverbed. In order to define this layer a lumped parameter had been introduced, and later calibrated based on the physical samples. The improved method was used on a separate dataset and resulted better outcome by a magnitude. Later it was applied in a measurement campaign on the River Danube, and the comparison of the results to historical data showed that the method may be used efficiently, and provided a better estimation than well known bed-load estimating theorems such as Meyer-Peter and Müller (1948) or Einstein and Brown (1950), and was more reliable and more easily applicable than the physical sampler.