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Validation and application of Acoustic Mapping Velocimetry

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The goal of this paper is to introduce a novel methodology to estimate bedload transport in rivers based on an improved bedform tracking procedure. The measurement technique combines components and processing protocols from two contemporary nonintrusive instruments: acoustic and image-based. The bedform mapping is conducted with acoustic surveys while the estimation of the velocity of the bedforms is obtained with processing techniques pertaining to image-based velocimetry. The technique is therefore called Acoustic Mapping Velocimetry (AMV). The implementation of this technique produces a whole-field velocity map associated with the multi-directional bedform movement. Based on the calculated two-dimensional bedform migration velocity field, the bedload transport estimation is done using the Exner equation.

A proof-of-concept experiment was performed to validate the AMV based bedload estimation in a laboratory flume at IIHR-Hydroscience & Engineering (IIHR). The bedform migration was analysed at three different flow discharges. Repeated bed geometry mapping, using a multiple transducer array (MTA), provided acoustic maps, which were post-processed with a particle image velocimetry (PIV) method. Bedload transport rates were calculated along longitudinal sections using the streamwise components of the bedform velocity vectors and the measured bedform heights. The bulk transport rates were compared with the results from concurrent direct physical samplings and acceptable agreement was found.

As a first field implementation of the AMV an attempt was made to estimate bedload transport for a section of the Ohio river in the United States, where bed geometry maps, resulted by repeated multibeam echo sounder (MBES) surveys, served as input data. Cross-sectional distributions of bedload transport rates from the AMV based method were compared with the ones obtained from another non-intrusive technique (due to the lack of direct samplings), ISSDOTv2, developed by the US Army Corps of Engineers. The good agreement between the results from the two different methods is encouraging and suggests further field tests in varying hydro-morphological situations.