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Low-cost river discharge measurements using a transparent velocity-head rod

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The common streamgauging methods (ADCP, current-meter or tracer dilution) generally require expensive equipment, with the notable exception of volumetric gaugings and floats, which are however often difficult to implement and limited to specific conditions. The following work aims at testing and validating a reliable, easy-to-deploy and low-cost gauging method, at a cost typically below 40 € each.

The “velocity-head rod” firstly described by Wilm and Storey (1944), made transparent by Fonstad et al. (2005) and improved by Pike et al. (2016) meets these objectives, for wading gauging with velocities greater than 20 cm/s typically. The 9.85 cm wide clear plastic rod is placed vertically across the stream to identify upstream and downstream water levels using adjustable rulers. The difference in level (or velocity head) makes it possible to calculate the average velocity over the vertical, using a semi-empirical calibration relationship.

Experiments carried out in INRAE’s hydraulic laboratory and in the field have enabled us to find a calibration relationship similar to that proposed by Pike et al. (2016) and confirm the optimal conditions of use. The average deviation to a reference discharge has been found to be close to 5 % except for very slow-flow conditions. The influence of the width of the rod on the velocity-head was studied in the laboratory. The uncertainty of the velocity due to the reading of water levels has been estimated. It increases at low velocity due to decreasing sensitivity, and increases at high velocities due to water level fluctuations that are difficult to average.

Several improvements were tested in order to facilitate and improve the measurement operations, without increasing the cost too much: magnetic ruler, removal of a graduated steel rule (expensive), plastic ruler with water level and velocity graduations, reading the depth with another ruler, spirit level, electrical contact (so the operator has not to bend to the surface of the water). An operational procedure and a spreadsheet for computing discharge are proposed. The method being extremely simple and quick to apply is well suited for rapid estimates of flow (instead of floats), training or demonstrations, citizen science programs or cooperation with services with limited resources.

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