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Adaptive method for quantifying uncertainty in discharge measurements using velocity-area method.

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Streamflow information provided by hydrometric services such as EDF-DTG allow real time monitoring of rivers, streamflow forecasting, paramount hydrological studies and engineering design.

In open channels, the traditional approach to measure flow uses a rating curve, which is an indirect method to estimate the discharge in rivers based on water level and punctual discharge measurements. A large proportion of these discharge measurements are performed using the velocity-area method; it consists in integrating flow velocities and depths through the cross-section [1]. The velocity field is estimated by choosing a number m of verticals, distributed across the river, where vertical velocity profile is sampled by a current-meter at n_i different depths. Uncertainties coming from several sources are related to the measurement process.

To date, the framework for assessing uncertainty in velocity-area discharge measurements is the method presented in the ISO 748 standard [2] which follows the GUM [3] approach. The equation for the combined uncertainty in measured discharge $u(Q)$, at 68% level of confidence, proposed by the ISO 748 standard is expressed as:

$$u^2(Q) = u_s^2 + u_s^2 + \frac{\sum q_i^2[u^2(B_i) + u^2(D_i) + u_p^2(V_i) + \frac{1}{(n_i)} \times [u_c^2(V_i) + u_{exp}^2(V_i)]]}{(\sum q_i)^2}$$

Limitations of this method are well described by Le Coz [4] who proposed an alternative method for computing uncertainty. The major disadvantage of ISO 748 formula comes from the estimation of the uncertainty component (noted u_m) related to the limited number m of verticals. This component is determined by a table and depends only on the number m of verticals without taking into account their spatial distribution, complexity of the riverbed shape and flow distribution. These empirical values are based on non-traceable experiments while most of the computed uncertainty stems from this component. Thus, this method is not applicable given the diversity of river cross-sections.

In this study, we propose a new computation of u_m depending on the riverbed shape and the flow distribution complexity. We used a set of 20 gaugings (each is based on a number of verticals between 33 to 80) at different flow conditions. In order to assess the u_m term, we degraded by subsampling the number of verticals by simulating the behavior of stream gaugers. This method of degradation shows different trends depending on a sampling quality criteria and flow distribution complexity. Streamgaugings with perfectly smooth riverbed lead to a small value of u_m whereas the one with rough shape riverbed lead to a greater value of u_m.

The new method has been applied to a set of 3000 streamgaugings and produces more diversified results compared to the ISO 748 method.

References:

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