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Computation of the coefficient relating depth-averaged velocities to surface velocity over a large sample of French cross-sections gauged with a current meter

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Whether we talk about safety reasons, energy production or regulation, water resources management is one of EDF's (French hydropower company) main concerns. To meet these needs, since the fifties EDF-DTG operates a hydrometric network including around 300 hydrometric stations. The data collected allow real time monitoring of rivers (hydro meteorological forecasts at points of interests), as well as hydrological studies and the sizing of structures: ensuring the quality of stream flow data is one of its priorities.

For those reasons, the knowledge of river discharge during extreme flood is of prime importance. However, measuring high discharge during flood events is complicated for safety reasons and without damaging the measuring equipment. For this purpose, non intrusive methods such as velocity radar (SVR) and images analysis like Large Scale Particle Image Velocimetry (LSPIV) are emerging to measure surface velocities. Then, to compute discharge with non intrusive methods, the shape of the vertical distribution of velocities and the value of the coefficient relating depth-averaged velocity to surface velocity (called α) must be known.

This study performs a review of in situ measurements over a large sample of rivers. 3598 discharge measurements realized by EDF-DTG with a current meter are used to compute vertical distribution of velocities and the coefficient α. It is worth noting that gaugings with current meters are systematically realized with an important number of velocity measurement points per vertical including a velocity measurement of the free surface at EDF-DTG, so that a fine description of the velocity profile is obtained. Treated gaugings were realized at 175 different sites located close to EDF-DTG's hydrometric stations. The measurements cover a large range of discharges (0.01 to 863 m^3/s), river sizes (width ranges from 0.5 to 90m, hydraulic radius ranges from 0.05 to 5.36m) and morphologies (from mountain rivers with gravel bed to sandy plain rivers and concrete channels). For each gauging, verticals realized close to the river banks were removed to avoid edges effects and measurements' depths and velocities were normalized respectively with the depth and the averaged velocity of the considered vertical.

For each gauging, three different methods are used to compute α :

1. The average of the normalized velocities measured close to the free surface equals $1/\alpha$.
2. A power-law is fitted over the normalized measurements with a statistical adjustment of the hydraulic roughness and the bed-shear velocity.
3. A log-law is fitted over the normalized measurements with a statistical adjustment of the hydraulic roughness.

The computed average value of α is about 0.8, with few differences between the methods used and with a small standard deviation (about 10%) for all the tested methods. This study gives a large range of the α coefficient for different types of river bed (concrete channel, sand, pebbles and boulders). The results of this work can be used to compute discharge with non intrusive methods for worldwide similar type of rivers.