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Drag coefficients of large instream wood – mystery or science?

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Drag coefficients convert flow velocity into the force exerted on a body and hydraulic head loss. They spatially integrate all properties of a given configuration into one single parameter. Therefore, drag coefficients are widely used in engineering, including environmental flow applications such as large wood log. However, the scatter in drag coefficients reported from previous studies clearly indicate that universality is no longer given and predictions underlie large uncertainties. Deeper analyses are mostly restricted due to insufficient hydraulic data – which in many studies is simply the discharge and the derived cross-sectionally averaged velocity.

It is obvious, that the 'ideal' drag coefficients from infinite and low-turbulence wind tunnel studies with the iconic $c_D = 1.1$ for the subcritical regime ($10^4 < Re < 10^5$) do not apply anymore. Instead, disturbances play a major role. For large wood, these are typically (i) blockage of the finite river cross-sectional area, (ii) the proximities of the bed below and the free-surface above, (iii) interaction with the free-stream turbulence, (iv) wake interference and (v) 3D-effects such as free ends of the cylindrical or channel aspect ratio.

To search for a more robust predictive scheme, we started flume experiments with horizontal cylinder configurations and measured the flow field in vertical profiles as well as the overall drag. First results shifted our emphasis from drag to velocity coefficients like the ones used in energy and momentum equations to account for non-uniformity. This seems reasonable, both because of the the squared represention of velocity in the drag term and because of the significant non-uniformities in large wood constellations.