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A dynamic rating curve approach to indirect discharge measurement

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Abstract. The operational measurement of discharge in medium and large rivers is mostly based on indirect approaches by converting water stages into discharge on the basis of steady-flow rating curves. Unfortunately, under unsteady flow conditions, this approach does not guarantee accurate estimation of the discharge due, on the one hand, to the underlying steady state assumptions and, on the other hand, to the required extrapolation of the rating curve beyond the range of actual measurements used for its derivation.

Historically, several formulae were proposed to correct the steady-state discharge value and to approximate the unsteady-flow stage-discharge relationship. In the majority of these methods, the correction is made on the basis of water level measurements taken at a single cross section where a steady state rating curve is available, while other methods explicitly account for the water surface slope using stage measurements in two reference sections. However, most of the formulae available in literature are either over-simplified or based on approximations that prevent their generalisation. Moreover they have been rarely tested on cases where their use becomes essential, namely under unsteady-flow conditions characterised by wide loop rating curves.

In the present work, an original approach, based on simultaneous stage measurements at two adjacent cross sections, is introduced and compared to the approaches described in the literature. The most relevant feature is that the proposed procedure allows for the application of the full dynamic flow equations without restrictive hypotheses. The comparison has been carried out on channels with constant or spatially variable geometry under a wide range of flood wave and river bed slope conditions. The results clearly show the improvement in the discharge estimation and the reduction of estimation errors obtainable using the proposed approach.

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