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Estimating river discharge uncertainty by applying the Rating Curve Model

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The knowledge of the flow discharge at a river site is necessary for planning and management of water resources as well as for monitoring and real-time forecasting purposes when significant flood events occur. In the hydrological practice, the operational discharge measurement in medium and large rivers is mostly based on indirect approaches by converting the observed stage into discharge values using steady-flow rating curves. However, the stage-discharge relationship can be unknown for hydrometric sections where flow velocity measurements, particularly during high floods, are not available.
To overcome this issue, a simplified approach named Rating Curve Model (RCM) and proposed by Moramarco et al. (Moramarco, T., Barbetta, S., F. Melone, F. & Singh, V.P., Relating local stage and remote discharge with significant lateral inflow, J. Hydrol. Engng ASCE, 10[1], 58[U+F02D]69, 2005) can be conveniently used. RCM turned out able to assess, with a high level of accuracy, the discharge hydrograph at a river site where only the stage is monitored while the flow is recorded at a different section along the river, even when significant lateral flows occur. The simple structure of the model is depending on three parameters of which two can be considered characteristic of the river reach and one of the wave travel time of floods. Considering that RCM well lends itself to predict the stage-discharge relationship at a river site wherein only stages are recorded, an uncertainty analysis on river discharge estimate is of interest for the hydrological practice definitely. To this aim, the uncertainty characterizing the RCM outcomes is addressed in this work by considering two different procedures based on the Monte Carlo approach and the Generalized Likelihood Uncertainty Estimation (GLUE) method, respectively. The statistical distribution of parameters is found and a random re-sampling of parameters is done for assessing the 90% confidence interval (CI) of discharge estimates. In particular, for the latter approach the Nash-Sutcliffe coefficient is used as likelihood measure. Two equipped river reaches of the Upper-Middle Tiber River basin, central Italy, are investigated as case studies. The results provided by the selected methodologies are discussed and compared showing that all the computed CIs are satisfied in term of percentage of included observed discharges with similar percentages characterizing the bands assessed by both Monte Carlo approach and GLUE procedure.