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Characterising the sources and impacts of rating curve uncertainty across the United Kingdom gauging network

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Knowledge of hydrological systems is largely derived from observed streamflow. Such data is often obtained from multiple different sources and providers that are regionally managed, and equally, all gauges are unique in their characteristics and their resultant uncertainties. Hydrologists are increasingly interrogating and using streamflow time series from ever increasing numbers of gauging stations. Therefore, to ensure that robust conclusions can be drawn from these datasets, it is important to assess their quality and quantify their uncertainties prior to any modelling. This is particularly important as observational data can be subject to significant sources of uncertainty that can vary across the flow range, between gauging stations and have non-stationary properties.

In this study, we contribute to the hydrological community's understanding and awareness of discharge uncertainty by analysing a dataset of rating curves and stage-discharge measurements from 1192 gauging stations in the United Kingdom. The objectives of the study are to, a) demonstrate the different uncertainty sources that impact the modelling of the stage-discharge relationship across the UK, and b) quantify their impact on uncertainty in modelled rating curves and the discharge time series derived from them. To do this, we first reviewed the dataset on a national scale. Different aspects of the stage-discharge relationship were quantified including the number of stage-discharge measurements and historical rating curves, and the amount of time flow is extrapolated at low and high flows. We identified regional differences in the uncertainty sources that affect the modelling of the stage-discharge relationship and were able to draw links between these and differences in the gauging station network, regional hydrometric priorities and catchment characteristics. For the second part of the study, we drew upon a set of case studies where the rating curves and stage-discharge measurements are scrutinised in conjunction with 15 minute water height and discharge time series to highlight the impact of different discharge uncertainties on the constructed streamflow time series. Finally, we discuss the implications for comparative hydrological assessments, our ability to draw accurate conclusions of catchment dynamics and to provide robust hydrological predictions.