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Influence of rating-curve uncertainty on discharge signatures for 43 UK basins

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Understanding rating-curve uncertainty is fundamental to understanding the information content of discharge data for hydrological analyses and modelling. Many studies have investigated discharge uncertainty and its effects at individual sites, but there is a need to estimate and compare uncertainty magnitudes across larger sets of catchments. This would enable a better understanding of the factors that control the discharge uncertainty magnitudes. In this study we investigated how rating-curve uncertainties propagate to uncertainty in hydrological signatures (derived as index values from the discharge time series) across a UK dataset. Such signature indices are used for a wide variety of purposes including model calibration, regionalisation, change detection, and eco-hydrological studies.

The study was made using a diverse dataset of 43 catchments in the UK, incorporating gauging (stage-discharge) data and water level time series data from all the discharge stations. The signature uncertainties were assessed within a Monte Carlo framework, where rating-curve uncertainty was estimated using the "Voting Point" likelihood method that incorporated aleatory gauging uncertainty as well as epistemic uncertainty in the rating-curve approximation of the true stage-discharge relation.

The rating-curve uncertainty estimation method worked well across the whole range of gauging stations in the dataset, incorporating different causes of epistemic uncertainty (e.g. weed growth, backwater) and different numbers of sections in the power-law rating curves. The discharge uncertainty was found to have a highly place-specific variability with flow range that propagated to the signature uncertainties. The signature uncertainty resulted from the conditions at the gauging station in combination with the flow series variability. The results show that discharge signature uncertainty can be large, with different factors controlling the uncertainty in different signatures, and that place-specific rating curve uncertainties need to be estimated to obtain reliable results.