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Parameterisation of rainfall-runoff models for forecasting low and average flows, I: Conceptual modelling

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In the calibration procedure of continuously-simulating models, the hydrologist has to choose which part of the observed hydrograph is most important to fit, either implicitly, through the visual agreement in manual calibration, or explicitly, through the choice of the objective function(s). Changing the objective functions it is in fact possible to emphasise different kind of errors, giving them more weight in the calibration phase. The objective functions used for calibrating hydrological models are generally of the quadratic type (mean squared error, correlation coefficient, coefficient of determination, etc) and are therefore oversensitive to high and extreme error values, that typically correspond to high and extreme streamflow values. This is appropriate when, like in the majority of streamflow forecasting applications, the focus is on the ability to reproduce potentially dangerous flood events; on the contrary, if the aim of the modelling is the reproduction of low and average flows, as it is the case in water resource management problems, this may result in a deterioration of the forecasting performance.
This contribution presents the results of a series of automatic calibration experiments of a continuously-simulating rainfall-runoff model applied over several real-world case-studies, where the objective function is chosen so to highlight the fit of average and low flows. In this work a simple conceptual model will be used, of the lumped type, with a relatively low number of parameters to be calibrated. The experiments will be carried out for a set of case-study watersheds in Central Italy, covering an extremely wide range of geo-morphologic conditions and for whom at least five years of contemporary daily series of streamflow, precipitation and evapotranspiration estimates are available. Different objective functions will be tested in calibration and the results will be compared, over validation data, against those obtained with traditional squared functions.
A companion work presents the results, over the same case-study watersheds and observation periods, of a system-theoretic model, again calibrated for reproducing average and low streamflows.