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Improving predictions in ungauged basins through combination of several regionalization methods

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To provide reliable simulations, rainfall-runoff models usually require parameter calibration against observed discharge data. However, these are limited and most of the catchments remain ungauged: none streamflow time series is available or at least sufficient to calibrate the model. Therefore, alternative methods are necessary to estimate the parameters. This issue, refered to as prediction in ungauged basins, has been at the heart of much scientific work in the last decade. If no consensus emerged, three methods can be distinguished: (i) transposition, (ii) prescription and (iii) constraint.

This work presents a combination of these three methods for a spatially distributed rainfall-runoff model, named MORDOR-TS (Rouhier et al, 2017). The study is conducted over the French Loire catchment at Gien (35 707 km^2) discretised into 387 hydrological meshes. Within this one, 106 streamflow time series are available between 1980 and 2012. According to a spatial split-sample test scheme, the data is split into two similar parts: a calibration and a validation sample with 53 gauges each.

Firstly, the 12 model parameters are spatialised by upstream-downstream and physio-climatic transposition. The catchment is divided into sub-basins and as many parameter sets are calibrated as there are calibration stations. Secondly, some of the parameters are no longer submitted to calibration. They are prescribed uniformly or by hydrological mesh, partly according to a priori based on physio-climatic descriptors. Finally, physio-climatic catchment descriptors are used to estimate the seasonal runoff, which is then used as a proxy data to re-calibrate some parameters at the scale of the validation stations' sub-basins.

Regarding the validation sample, the transposition method improves the performance in terms of daily runoff, daily regime and flood. On the contrary, the prescription method does not enhance the simulations but reduces the number of degrees of freedom without any loss of performance. As for the constraint method, it improves the modelling of the least well simulated validation stations.

Rouhier, L., Le Lay, M., Garavaglia, F., Le Moine, N., Hendrickx, F., Monteil, C., & Ribstein, P. (2017). Impact of mesoscale spatial variability of climatic inputs and parameters on the hydrological response. Journal of Hydrology, 553, 13-25