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A proposal to reduce streamflow predictive uncertainty in ungauged basins

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One of the main goals of the PUB Science Plan is to reduce uncertainty in hydrological predictions. Prediction in ungauged basins is, however, a complex task mainly because the hydrologic processes occurring within a basin take place over a wide range of spatio-temporal scales for which no agreed upon general hydrological theory is still available. For these reasons, various techniques are required to guaranty the transferability of information from donor basins to an ungauged locations. These techniques aim 1) to find an appropriate dissimilarity measure based on discharge time series. 2) to relate a dissimilarity measure with various basin descriptors. 3) to develop a multiscale parameter regionalization (MPR) technique that is able to relate model parameters with basin characteristics through transfers functions and upscaling operators. And, 4) to develop a multi-structure hydrologic model to represent various dominant hydrologic process. As shown in Samaniego et al., 2010a, 2010b[1] [2], the combination of first three techniques within a Monte Carlo framework have contributed to reduce the predictive uncertainty in a number of crossvalidation experiments in Germany. Additionally, the MPR technique ensures the transferability across modelling scales.

In this study, we propose a method that further reduces the streamflow predictive uncertainty at ungauged locations by selecting only those transfer function parameters (from donor basins) which are able to reproduce discharge simulations in an ungauged location whose seasonal runoff characteristics are closer to those obtained with regionalized input-output models (Samaniego and Bárdossy, 2005)[3]. Runoff characteristics such as total drought duration, magnitude and frequency of high flows, among others, can be used for this purpose.

To illustrate the application of this technique, 34 southern German basins ranging from 70 to 4200 km^2 were selected. For each donor basin a number of catchment descriptors were quantified for the regionalization of the runoff characteristics, e.g. mean slope, aspect, shape factor, mean elevation, and several climatic indices such as the antecedent precipitation index and mean monthly temperature. Daily streamflow time series for the donor basins correspond to the period from 1961 to 2000. Results showed that this procedure lead to a reduction up to 20% of the streamflow predictive uncertainty if compared with unconstrained selection of transfer function parameters from the nearest donor basins.

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[2] Samaniego, L., R. Kumar, and S. Attinger (2010b), Multiscale parameter regionalization of a grid-based hydrologic model at the mesoscale, Water Resour. Res., doi:10.1029/2008WR007327, in press.

[3] Samaniego L., Bárdossy A., (2004). Robust Parametric Models of Runoff Characteristics at the Mesoscale. Journal of Hydrology. doi: 10.1016/j.jhydrol.2004.08.022