Global estimation of rainfall-runoff model parameters: an empirical experiment

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When setting up global scale hydrological models, parameter estimation is a crucial step. Some modellers assign pre-defined parameter values to physical characteristics (such as soil, land cover, etc.) while others estimate parameter values based on observed hydrological data. In both cases, the regionalisation of parameters is a major challenge since both literature values and observed data are often lacking and assumptions are needed. This work aims at identifying suitable parameter regions to perform a regional calibration of the global model World-Wide HYPE (Arheimer et al., 2020) through empirical tests.

The work is organised in two steps. First we compare different ways of taking soil into account when creating hydrological response units. The soil is either considered uniform, indexed to land use or to a simplified soil map. The best soil representation is selected based on the model performance at a global scale. Based on this best representation, the second step aims at evaluating different ways to regionalise the soil parameters of the hydrological model. Previous classifications of hydrological uniform regions are tested for regionalisation of model parameters: hydrobelts (Meybeck et al., 2013), Köppen climate regions (Kottek et al., 2006), soil capacity index (Wang-Erlandsson et al., 2016) and hydroclimatic regions (Knoben et al., 2018).

For the first step, the results show that the best solution is to represent soil by land use. This counterintuitive result is due to the fact that adding information based on a soil map add another calibration step. To avoid increased equifinality, such an effort increases the need for data, which is often lacking at the global scale. For the second step, the creation of parameter regions contributed with minor improvement in terms of model performances, probably because the choice of regions was not suitable for the model approach. Also, the improvement has shown to be higher when available discharge data for calibration were better distributed over the different regions. This work shows that, when calibrating a model at very large scale, a balance should be found between available data and parameter regions resolution.

References