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Experimenting on simple and flexible top-down approaches for hydrological modelling

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Nowadays, a plethora of modelling software on rainfall-runoff and groundwater dynamics are available. Considering the complexity and heterogeneity of natural processes governing the water cycle, many of those models involve physically-based formulations. Inevitably, a large amount of data is also required. However, the available data are often insufficient, while their quality questionable. At the same time, an increasing model complexity also gives rise to high computational requirements. In order to mitigate some of the aforementioned issues, during the past years a simple and flexible top-down approach for distributed rainfall-runoff modelling has been developed (Tran et al., 2018). Essentially, the distributed rainfall-runoff model is built starting from a simple lumped model, whose parameters are then spatially disaggregated. Disaggregation is carried out using conceptual links between model parameters and natural catchment characteristics.

We now test an extended version of this methodology involving disaggregation relationships for more model parameters. Moreover, we evaluate modelling performance for 2 different configurations. The first starts from the parameters of a lumped conceptual model and is essentially the original approach. The second one starts from the parameters of a uniform distributed conceptual model. The motivation behind the new approach is that it allows a better-integrated routing scheme with less model parameters. In turn, this can further reduce equifinality (denoting the “phenomenon” that largely different parameter-sets can often result to largely similar model outcomes). The two approaches are inter-compared and evaluated against flow observations.

With the disaggregated models as basis, we also experiment on the potential of simple methods for modelling groundwater levels. We approach this challenge by trying to identify links between a) the variations and b) the reference levels of the modelled groundwater storages and observed groundwater levels. For example, we hypothesize that modelled storages can be scaled to the actual level variations via the specific yield, which expresses the amount of interconnected pores in the soil. The modelling methodology is evaluated against groundwater level measurements.

Tran, Q.Q., De Niel, J., Willems, P., 2018. Spatially Distributed Conceptual Hydrological Model Building: A Generic Top-Down Approach Starting From Lumped Models. Water Resour. Res. 54, 8064–8085.