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An exercise in hydrological modeling: does expert knowledge improve model results?

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In hydrological modeling the use of detailed soil data is sometimes troublesome since often these data are hard to obtain and, if available at all, difficult to interpret or process in a way that makes them meaningful for the model at hand. In this study a labor-intensive methodology to assess dominant runoff processes (DRP), which occur after prolonged rainfall events, is simplified and applied at a meso-scale basin in order to be used in rainfall runoff modeling. Intuitively the understanding and mapping of dominant runoff processes shows high potential for improving hydrological models, but there is an ongoing debate on ways to integrate this information in models. In this study a two step approach is suggested. First, dominant runoff processes are mapped using three characteristics: the permeability of the substratum, land-use information and slope. During a field campaign the processes are validated and for each DRP assumptions are made concerning their water storage capacity. The latter is done by combining soil data obtained during the field campaign with soil data obtained from the literature. Second, a parsimoniously parameterized hydrological model is set-up for each dominant runoff process and is parameterized a priori by means of expert knowledge. The overall catchment response is computed based on the area-weighted contribution from each process unit. The proposed methodology is tested in a case study in the Attert river basin located in the Grand Duchy of Luxembourg. For this purpose two models have been developed and applied: a so-called benchmark model in which the soil is represented as one lumped parameter and a second model in which the soil is represented by the mapped dominant runoff processes. The main goal of this study is to investigate whether the integration of dominant runoff process maps with hydrological models yields improvement of simulation results. The proposed maps and methodology could thus enhance hydrological predictions in basins where conventional soil data (i.e soil maps) are lacking and furthermore, the maps could be used for the evaluation of model concepts.