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Calibrating distributed hydrological models with qualitative soil map data related to the soil water regime

T. Doppler (1), U. Zihlmann (2), P. Weisskopf (2), and C. Stamm (1)

(1) Eawag (Swiss Federal Institute of Aquatic Science and Technology), 8600 Dübendorf, Switzerland, (2) ART (Agroscope Reckenholz-Tänikon Research Station), 8046 Zürich, Switzerland

Distributed hydrological models can be used to predict the spatial occurrence of different flow processes like e.g. saturated overland flow. Such predictions are important for the localization of agricultural source areas for diffuse pollution. Spatially distributed, process-based models need to be extensively parameterized and often the parameters needed for modeling carry high uncertainty. For example the parameters describing the hydraulic properties in the subsoil and the underlying geology are poorly known in many cases but important for the prediction of saturated areas generating overland flow. We suggest that this lack of data can partly be overcome by the use of soil maps, since they contain qualitative information on the soil water regime. Soil attributes like soil type, gley horizons or redoximorphic features reflect the long term water regime of a soil. The water regime is also relevant for the short term response of the soil to rain events. By calibrating a short term predictive model with these long term data the prediction uncertainty can possibly be reduced. We present a way to make this information usable for model calibration where two steps are important:

1) Translation of the soil map into a spatial distribution of a quantitative measure of soil water content
2) Calibration of the model with this data in long term runs (several years)

1) With expert knowledge from soil scientists we estimated degrees of water saturation for different soil horizons throughout the year. The estimates are based on texture and the horizons redox features. We confirm these estimates with data from distributed shallow piezometers and water content measurements. We also show that the groundwater level is higher in soils that are classified as gley soils compared to cambisols. A translation of qualitative soil map data into a quantitative estimate is therefore possible.
2) As a proof of principle a hill slope of a small agricultural catchment in the Swiss plateau is modeled with the hydrological model Hydrus 2D. The hill slope is very heterogeneous in soil types ranging from well drained cambisols to gley soils within short distances. Based on the soil map we roughly estimated the depth of the groundwater table. We can show that it is possible to constrain model parameters with the help of qualitative soil map data because many parameterizations predict implausible positions of the water table.
Since soil attributes represent average situations over many years, long term simulations need to be run for the calibration. For automated calibrations a reduction of computation time is therefore important. We show that the seasonal water table fluctuations that are relevant for soil morphology are well captured with monthly input data. This reduces the computation time substantially compared to daily input data.