Patterns in time-dependent parameters reveal deficits of a catchment-scale herbicide transport model

Lorenz Ammann\textsuperscript{1}, Fabrizio Fenicia\textsuperscript{1}, Tobias Doppler\textsuperscript{2}, Christian Stamm\textsuperscript{1}, and Peter Reichert\textsuperscript{1}

\textsuperscript{1}Eawag: Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, Switzerland (lorenz.ammann@eawag.ch)
\textsuperscript{2}VSA, Swiss Water Association, Glattbugg, Switzerland

Many hydrological systems have a stochastic behavior at the spatiotemporal scales we observe them. The reasons are insufficient quantity or quality of input observations, and model structural errors, the effects of which vary over time. Assuming model parameters as time-dependent, stochastic processes can account for such effects. This approach differs from using deterministic models in combination with a stochastic error term on output and or input. We start from an existing deterministic conceptual bucket model, which was developed and calibrated to jointly predict streamflow and herbicide pollution observed in a small stream with an agricultural catchment in the Swiss midlands. The model considers sorption and degradation of herbicides, as well as fast transport processes such as overland flow to shortcuts and macropore flow to tile drains. Subsequently, the model is made stochastic by replacing selected constant parameter values by time-varying stochastic processes. We perform parameter inference according to the Bayesian approach using a Gibbs-sampler to combine Metropolis sampling of the remaining constant parameters with sampling from an Ornstein-Uhlenbeck process for the time-dependent parameter. A preliminary analysis of the resulting time series of the parameters reveals, for example, model deficits w.r.t. baseflow, in particular during dry conditions. We show that the resulting patterns can inspire model improvements by providing information that can be interpreted by the modeler. These findings indicate that stochastic models with time-dependent parameters are a promising tool for uncertainty quantification of water quality models and for facilitating the scientific learning process, which may ultimately lead to better predictions.