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Modeling discharge and microorganism transport in a karst aquifer

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A sequence of three box models with increasing complexity has been used to describe discharge and particle transport in a karst spring in Northwestern Switzerland. The simulated parameters were discharge rate, *E. coli* concentration, enterococci concentration and turbidity as well as uranine recovered from two artificial tracer tests. To quantify parameter identifiability, sensitivity of model results to parameters and the collinearity index of parameter subsets were analysed. Discharge could be separated into slow (∼120 d), intermediate (11-43 d) and fast (∼0.4 d) flow components, which could be attributed to different geologic formations. An important feature of the water flow regime was an overflow accounting for the hydraulic connectivity between the soil and epikarst zone with the spring that diffuses head pulses through the saturated zone; this is mainly responsible for peak flow. Fast flow through the channel network contributes marginally to total discharge, however, microorganisms and turbid matter are transported via this flow path. Flow velocity of contaminants transported in the channel system is strongly influenced by total discharge from the slow and intermediate flow system. The main mechanism controlling particle transport in the karst aquifer studied was advective transport by water flow. The flow velocity of the uranine was retarded with respect to the particulate matter, an effect that is due to low water input during artificial tracer tests rather than matrix diffusion of the solute tracer. The box models further revealed the surface dimensions of the catchment areas for fast and slow water flow. The model parameters were identifiable for two of the three model structures. This emphasises the importance of performing sensitivity analysis

and parameter identifiability to solely use models that have not only a physical and hydrogeological meaning but also make sense from a modelling perspective. The simulations performed have potential for practical hydrological applications such as the delineation of groundwater protection zones and water management.