Using isotopic data for the calibration of a coupled surface water-groundwater model

O. S. SCHILLING[1]*, D. PARTINGTON[2], C. GERBER[3], R. PURTSCHERT[3], R. KIPFER[4], D. HUNKELER[1] AND P. BRUNNER[1]

[1]Centre of Hydrogeology and Geothermics, University of Neuchâtel (UniNE), 2000 Neuchâtel, Switzerland (*correspondence: oliver.schilling@unine.ch).

[2]National Centre for Groundwater Research and Training, Flinders University, Adelaide, SA, 5001, Australia.

[3]Climate and Environmental Physics, University of Bern (UniBE), 3012 Bern, Switzerland.

[4]Water Resources and Drinking Water, EAWAG, 8600 Dübendorf, Switzerland.

A pumping experiment was carried out in a pre-alpine valley to investigate how large-scale groundwater abstraction influences local surface water-groundwater (SW-GW) interactions. During a three-week period the pumping rate of an important drinking water station was lowered by 50%. Changes in residence time distribution and mixing ratios were evaluated using multiple isotopic tracers for different time scales, including the established ^{222}Rn ($T_{1/2}$=3.8d) and ^{3}H/^{3}He ($T_{1/2}$=12.4y), as well as the, in this context, never before employed ^{37}Ar ($T_{1/2}$=35d). The isotopic data were used to calibrate a coupled SW-GW model using the HydroGeoSphere (HGS) [1]. The Hydraulic Mixing Cell method (HMC) was used to integrate isotopic data [2]. The calibration of the model with PEST [3] enables reproducing not only hydraulic heads but also residence time distribution and mixing ratios. The benefit of multiple time scales covering isotopic tracer data to calibrate hydraulic parameters was evaluated. Furthermore, the information content of the different data in terms of data-worth was analyzed.

[1] Therrien, R., McLaren, R.G., Sudicky, E.A. (2010). HydroGeoSphere: A Three- dimensional Numerical Model Describing Fully-integrated Subsurface and Surface Flow and Solute Transport. University of Waterloo, Ontario, Canada.

[2] Partington, D. et al. (2011). A hydraulic mixing-cell method to quantify the groundwater component of streamflow within spatially distributed fully integrated surface water-groundwater flow models. Environ. Model. Softw. 26, 886–898.

[3] Doherty, J., (2015). Calibration and Uncertainty Analysis for Complex Environmental Models. Watermark Numerical Computing, Brisbane, Australia.