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Mean transit time estimation of the Luxembourg Sandstone aquifer using high-accuracy tritium data analysis

Gourdol Laurent (1), Stewart Michael K. (2), Morgenstern Uwe (2), and Pfister Laurent (1)

(1) LIST, Catchment and Eco-hydrology Research Group, Belvaux, Luxembourg (laurent.gourdol@list.lu), (2) GNS Science, Lower Hutt, New Zealand

The Luxembourg Sandstone hosts the most important groundwater resource of Luxembourg (North-Western Central Europe). Understanding its hydrogeological functioning is considered a national priority. Here, we rely on tritium data to better understand groundwater transit times inside this aquifer. Tritium (3H) is a radioactive isotope of the water molecule and is one of the most valuable tracers that can inform on water transit times in the range of years to decades. In the Northern Hemisphere, we require tritium time-series as well as high-quality tritium measurements in order to achieve accurate water dating estimations. To this end, a high-accuracy tritium survey of 36 springs draining the Luxembourg Sandstone aquifer is carried out every second year since 2013. Here, we present the first dating results obtained from this dataset using simple lumped-parameter models. Due to the rather short length of the tritium time-series, model parameters (including mean transit time, MTT) were investigated using a Monte Carlo sampling routine in a generalised likelihood uncertainty estimation (GLUE) framework (Gallart et al. 2016) instead of using “a best-fit” calibration. The approach also considers the uncertainties inherent to tritium measurement errors. Our results show that unambiguous MTT estimations are not possible at this stage as several ranges of MTT appear theoretically possible. More tritium analyses are required in a few years if we aim at discriminating the different age solutions, solely based on tritium data. Nonetheless, we demonstrate that it is possible to considerably reduce the possible MTT solutions and to tend towards MTTs consistent with the overall hydro-geological context of our area of interest when using supplementary data (e.g. lithological and structural context, discharge time series analysis, water chemical analysis, and stable isotopes of the water molecule).

Gallart, F., Roig-Planasdemunt, M., Stewart M.K., Llorens, P., Morgenstern, U., Stichler, W., Pfister, P., Latron, J. (2016) A GLUE-based uncertainty assessment framework for tritium-inferred transit time estimations under baseflow conditions. Hydrological Processes 30: 4741-4760.