Geophysical Research Abstracts
Vol. 20, EGU2018-11167, 2018
EGU General Assembly 2018

Uncertainties of tritium streamflow transit times: Experiments with single and double lumped parameter models

Michael Stewart (1), Uwe Morgenstern (1), Mike Toews (1), Rob van der Raaij (1), and Maksym Gusyev (2)
(1) GNS Science, Lower Hutt, New Zealand, (2) ICHARM, PWRI, Tsukuba, Japan

Tritium-based transit time uncertainties due to measurement errors and model parameter choices were investigated using Monte Carlo sampling in a generalised likelihood uncertainty estimation (GLUE) framework (Gallart et al., 2016) by means of a program written in R. The method was applied to a variety of single lumped parameter models, including the exponential piston flow (EPM), dispersion (DM) and gamma (GM) models), which represent catchments as homogeneous. Double versions of the models were also considered, allowing for extreme heterogeneity (e.g. two distinctive parts) in a catchment. The ranges of the model shape parameters examined were limited to those that can apply to homogeneous systems. This required eliminating L-shaped transit time distributions (i.e. those with dispersion parameters greater than 1.36 for the DM, and alphas less than 1.0 for the GM; Bardsley, 2017). The modified ranges allowed relatively consistent MTTs to be obtained with the different models.
The method was applied to tritium series data from the Waikoropupu Main Spring (data from 1966 to 2006) and the Kuratau River (1964-2017), both in New Zealand. The spring has two sources, as previously shown by a mass-balance model (Stewart and Thomas, 2008), and the two source waters had MTTs of 1.3 years and 13 years respectively. Comparison of results from the single and double models showed a moderate difference in overall ages (6.3 ± 1.8 to 11 ± 1 years). Kuratau River had a greater difference between overall ages from the single and double models (2.4 to 12.4 years) representing a more extreme aggregation effect (Stewart et al., 2017). The two component waters identified by the double models had ages of 0.7 years and 24 years respectively, resulting from drainage from two very different rock types in the Kuratau catchment.
This method should improve confidence in tritium-based MTTs especially in combination with other dating methods.

Bardsley E. 2017. Transit time distributions are not L-shaped. Hydrology and Earth System Sciences Discussions, https://doi.org/10.5194/hess-2017-497.
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.
Stewart, M.K., Morgenstern, U., Gusyev, M.A., Maloszewski, P. 2017: Aggregation effects on tritium-based mean transit times and young water fractions in spatially heterogeneous catchments and groundwater systems. Hydrology and Earth System Sciences 21, 4615-4627.
Stewart, M.K., Thomas, J.T. 2008: A conceptual model of flow to the Waikoropupu Springs, NW Nelson, New Zealand, based on hydrometric and tracer (18O, Cl, 3H and CFC) evidence. Hydrology and Earth System Sciences 12(1), 1-19.