Synergy between isotope tracers and numerical modelling: Is it useful?

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Isotope tracers are powerful tools in addressing hydrological cycle in various scales in time and space, although it sometimes assumes simple conditions (e.g., steady-state, a few sources mixing) and lacks physical ground. On the other hand, numerical modelling is based on physical mechanisms and capable of considering more complicated conditions, while it often projects virtual, that is, not always real world. Therefore, one can expect complementary use of the two approaches is a promising way. However, there are objections. For instance, incorporating isotopic data into numerical models will not always improve them because the number of unknown parameters increases and new uncertainties inherent in tracer simulations are introduced. Is synergy between isotope tracers and numerical modelling useful? The answer for this question is “yes”, I think. In the present study, I’d like to demonstrate the usefulness by means of introducing some case studies concerning groundwater flow, runoff, and ecohydrology. In groundwater studies, isotopic tracers can be additional calibration targets for numerical modelling, if appropriate input data are available. Once numerical models were calibrated using isotopic data, they are more reliable than those calibrated with hydrometric data alone, then the models can provide more detailed information than sole use of isotopic tracers. Similarly, in runoff studies, models calibrated with isotope data are more reliable, especially in estimating water storage. Wave propagation affecting hydraulic gradient and thus water flux does not always relate to whole water storage, but tracer concentration does. This is the reason why isotope tracers should be incorporated into models, in particular, to estimate residence time. In addition, there is a possibility that calibration of runoff models with isotope tracers are useful way for basins where rating curve (or called H-Q curve) is highly variable. In ecohydrological applications, isotope tracers provide information that improve soil-vegetation-atmosphere transfer (SVAT) models. Probably, isotope tracers provide us the most reliable information concerning the root water uptake profile (RWUP). Even if water balance does not depend on RWUP consequently, such information is important, for instance, in investigating water use strategy of plants, which may affect long-term hydrological response. In conclusion, I’d like to emphasize that further studies with integrated use of isotope tracers and numerical models will improve our understanding and provide new insight into hydrological cycle more than now.

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