IN-RIVER RATING CURVES INTERPOLATION FOR A BETTER ASSESSMENT OF STREAM-AQUIFER EXCHANGES IN A REGIONAL DISTRIBUTED HYDRO(GEO)LOGICAL MODEL: APPLICATION TO THE CENTRAL AREA OF THE SEINE BASIN

Firas Saleh, Paris Institute of Technology / MINES ParisTech, 0033164694736, firas.saleh@yahoo.fr

1. Firas Saleh, MINES ParisTech / Geosciences Department
2. Nicolas Flipo, MINES ParisTech / Geosciences Department
3. Chantal de Fouquet, MINES ParisTech / Geosciences Department

An original computational methodology is developed for simulating in-stream water levels and improving the modeling of stream-aquifer exchanges at large-scale. The method links information obtained from field observations and reach-scale hydraulic simulations with a hydrosystem process-based model. The methodology is applied to the central area of the Seine basin (30 000 km2 in Northern France). It allows for better understanding near river water pathways that were difficult to assess at the regional scale.

The work is carried out within the Eau-Dyssée framework, which aims at the integrated modeling of the hydrosystem to manage the various elements involved in the qualitative and quantitative aspects of water resources. In particular, Eau-Dyssée simulates flow in aquifer units with a finite difference pseudo 3D model and river flow with a Muskingum model. Rating curves are used in the regional distributed hydro(geo)logical model to deduce river stage from the routed discharge, which permits to calculate the exchanges between aquifer units and rivers using a Darcy law at the stream-aquifer interface.

This study is an extension of a previous study validated on the Oise basin (4 500 km2, part of the Seine basin) based on an upscaling methodology (Saleh et al., 2011, Modeling the impact of in-stream water level fluctuations on stream-aquifer interactions at the regional scale, Journal of Hydrology 400, 490-500), which purpose is to calculate rating curves. The main rivers are simulated with a 1D Saint-Venant model, from which functional stage-discharge relationships are derived with a 200-m resolution and projected onto each 1-km grid-cell of the regional model. In order to estimate river water levels for larger basins, a second methodology is hereby developed using rating curves calculated with models at lower resolution (> 1 km) that are interpolated on each 1-km grid-cell of the regional model. The interpolation is carried out for each main reach of hydrographic network (9 reaches for the 790 km of the simulated Seine hydrographic network).

The mean linear stream-aquifer exchanged flux assessed by this approach along the main hydrographic network of the central area of the Seine basin are 52 l.s-1.km-1 for aquifer to stream fluxes and 4.7 l.s-1.km-1 for streams to aquifer fluxes, mainly due to storage in aquifer units during storm events. The stream to aquifer fluxes during high flow periods involve a longer transfer time in the aquifer units near to the river network, which corresponds to an increase of the estimated water content of the aquifer system.

This methodology is an efficient way to improve the physics of the stream-aquifer interactions and better assess soil water content at the regional scale, with a limited computational burden owing to the pre-computation of the rating curves.

Keywords: Stream-aquifer interactions, Quantitative Hydrology, Hydrogeology, Regional scale, rating curves interpolation, hydrosystem modeling