Exploring how rivers and their deposits distort estimates of aquifer recharge using numerical simulations

Guillaume Rongier[1], Luk Peeters [2]
[1] *CSIRO Deep Earth Imaging FSP – Data61, Kensington, WA, Australia*
[2] *CSIRO Deep Earth Imaging FSP – Mineral Resources, Glen Osmond, SA, Australia*
guillaume.rongier@csiro.au
ORCID: orcid.org/0000-0002-5910-6868

Deposits from meandering rivers contribute to the heterogeneity of the subsurface by channeling or diverting groundwater flow. We propose to analyze how the evolution of a river affects this relationship and distort estimates of recharge rates in aquifers. We use the fluvial and stratigraphic modules of the Channel-Hillslope Integrated Landscape Development Model (CHILD) [1] to simulate the evolution and deposits of a meandering river using simplified physical models and rules. Then, we use the fractional packing model [2] to compute porosity and permeability from the resulting unconsolidated sediments. Finally, we use PFLOTRAN [3] to simulate subsurface flow and groundwater age based on a homogeneous recharge from the top. Groundwater age is a key concept to estimate recharge rates using analytical models. Varying aggradation and incision rates of the river lead to a heterogeneous channel belt with varying distributions of coarse deposits. If the channel belt itself funnels the flow, its heterogeneities lead to heterogeneous groundwater ages, even at short distances. This results in varying estimates of recharge rate over the domain (figure 1) and a significant bias even when sampling the subsurface with many wells.

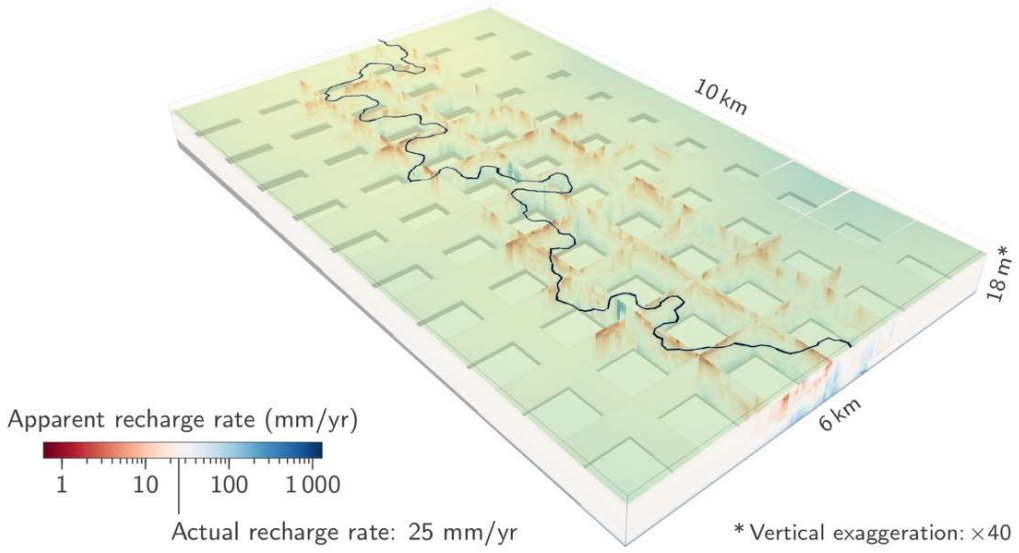

Figure 1. Estimation of the recharge rate in a synthetic aquifer made of fluvial deposits.

References
Clevis, Q., G. E. Tucker, S. T. Lancaster, A. Desitter, N. Gasparini, and G. Lock, 2006, A simple algorithm for the mapping of TIN data onto a static grid: Applied to the stratigraphic simulation of river meander deposits: Computers & Geosciences, 32(6), 749-766.
Koltermann, C. E., and S. M. Gorelick, 1995, Fractional packing model for hydraulic conductivity derived from sediment mixtures: Water Resources Research, 31(12), 3283-3297.
Hammond, G. E., P. C. Lichtner, C. Lu, and R. T. Mills, 2011, PFLOTRAN: Reactive Flow & Transport Code for Use on Laptops to Leadership-Class Supercomputers, in F. Zhang, G. T. G. Yeh, and J. C. Parker, eds., Ground Water Reactive Transport Models: Bentham Science Publishers, 141-159