Numerical simulation of long-term pumping in a heterogeneous sandstone aquifer

Polina Abdrakhimova, Laurence R Bentley & Masaki Hayashi
Department of Geoscience – University of Calgary, Calgary, Alberta, Canada

ABSTRACT
Sustainable groundwater management practices are essential for ensuring future adequacy of water supplies and minimizing detrimental effects on aquatic ecosystems. One of the concepts for defining sustainable groundwater development is the safe aquifer yield, the pumping rate that does not create an excessive negative impact on the groundwater system on multi-decadal scale. Conventional methods for determining a safe yield often rely on idealized aquifer theory. The ideal aquifer assumptions are not valid in heterogeneous aquifers, such as the Paskapoo Formation, which is a source of groundwater for a number of rural communities in Alberta. The heterogeneity and internal boundary effects associated with an aquifer structure consisting of sandstone channels embedded in lower permeability mudstone and siltstone make the estimation of safe aquifer yield particularly challenging.
This work assesses the ability of conventional methods to evaluate safe aquifer yield in a heterogeneous channel in an overbank aquifer system by comparing the expected drawdown with that predicted using a numerical model. Two models with different levels of complexity are used for the evaluation, a synthetic bounded aquifer and the model of a real aquifer site close to Innisfail, Alberta. The aquifer belongs to the Paskapoo Formation. The numerical model was calibrated using 48-hour pumping test data and information from slug tests, a surface electrical resistivity tomography survey, gamma ray logging, lithological logs (core and cuttings description) and water-level time series. The results show that increased heterogeneity influences the ability of different methods to reliably predict aquifer response to long-term pumping and that the incorporation of various aquifer characterization techniques can greatly improve model predictions.