Integrated modelling and uncertainty analysis for assessment of climate change effects on groundwater resource

P. Goderniaux[1], S. Wildemeersch[2], A. Dassargues[2]

[1]*Hydrogeology, Applied Geology, University of Mons, Mons, Belgium*
[2]*Group of Hydrogeology and Environmental Geology – Aquapôle, University of Liège, Liège, Belgium*

Climate change will bring new pressure on surface and groundwater resources (e.g. Allen et al., 2004; Goderniaux et al., 2009; Van Roosmalen et al., 2009) in many parts of the world. Additional work is required to help water managers to plan for future changes. For example, most of studies provide projections for a stationary climate representative of the end of the century, although information is demanded for the near-future.
A sophisticated transient weather generator (WG) in combination with an integrated surface-subsurface hydrological model (HydroGeoSphere) are used for producing a stochastic generation of large numbers of equiprobable climatic time series, representing transient climate change, and assess impacts on groundwater resources in a probabilistic way. This new methodology is applied for the unconfined chalky aquifer of Hesbaye (Geer basin in Belgium). The following uncertainty sources are studied : (1) the uncertainty linked to the calibration of the hydrological model, using 'UCODE_2005' (Poeter et al., 2005); (2) the uncertainty linked to the global and regional climatic models (GCMs and RCMs), by using a multi-model ensemble; (3) the uncertainty linked to the natural variability of the weather, by using stochastic climate change scenarios. 30 equiprobable climate change scenarios from 2010 to 2085 have been generated for each of 6 different RCMs. Results show that although the 95% confidence intervals calculated around projected groundwater levels remain large, the climate change signal becomes stronger than that of natural climate variability by 2085.
Additionally, the WG ability to simulate transient climate change enabled the assessment of the likely timescale and associated uncertainty of a specific impact. This methodology constitutes a real improvement in the field of groundwater projections under climate change conditions as it enables water managers to analyse risks and take decisions with full knowledge of projected impact and their degree of confidence.

References

Allen, D. M., D. C. Mackie, and M. Wei, (2004, Groundwater and climate change: A sensitivity analysis for the Grand Forks aquifer, southern British Columbia, Canada, *Hydrogeology Journal*,12(3), 270 - 290.

Dassargues A., Radu J.P., Charlier R., 1988, Finite elements modelling of a large water table aquifer in transient conditions, *Advances in Water Resources*, 11(2), 58-66.

Goderniaux, P., Brouyère, S., Fowler, H.J., Blenkinsop, S., Therrien, R. Orban, Ph. and Dassargues, A., 2009, Large scale surface – subsurface hydrological model to assess climate change impacts on groundwater reserves, *Journal of Hydrology*, 373, 122-138.

Goderniaux, P., Brouyère, S., Blenkinsop, S., Burton, A., Fowler, H.J., Orban, P. and Dassargues, A., 2011, Modelling climate change impacts on groundwater resources using transient stochastic climatic scenarios, *Water Resources Research*, 47(12), W12516

Rojas, R., Feyen, L., Batelaan, O. and Dassargues A., 2010, On the value of conditioning data to reduce conceptual model uncertainty in groundwater modelling, *Water Resources Research*, 46, 8, W08520.

Rojas, R., Kahundeb S., Peeters L., Batelaan, O. and Dassargues A., 2010, Application of a multi-model approach to account for conceptual model and scenario uncertainties in groundwater modelling, *Journal of Hydrology*, 394, 416–435.

Van Roosmalen L., T. O. Sonnenborg, and K. H. Jensen, 2009, Impact of climate and land use change on the hydrology of a large-scale agricultural catchment, *Water Resources Research*, 45, W00A15.