Geophysical Research Abstracts
Vol. 19, EGU2017-2660, 2017
EGU General Assembly 2017
© Author(s) 2017. CC Attribution 3.0 License.

Transient flow conditions change how we should think about WHPA delineation: a joint frequency and probability analysis

Abelardo Rodriguez Pretelin (1) and Wolfgang Nowak (1)

(1) Institute for Modelling Hydraulic and Environmental Systems (IWS), University of Stuttgart, Stuttgart, Germany (Abelardo.Pretelin@iws.uni-stuttgart.de)

Well head protection areas (WHPAs) are frequently used as safety measures for drinking water wells, preventing them from being polluted by restricting land use activities in their proximities. Two sources of uncertainty are involved during delineation: 1) uncertainty in aquifer parameters and 2) time-varying groundwater flow scenarios and their own inherent uncertainties. The former has been studied by Enzenhoefer et al (2012 [1] and 2014 [2]) as probabilistic risk version of WHPA delineation. The latter is frequently neglected and replaced by steady-state assumptions; thereby ignoring time-variant flow conditions triggered either by anthropogenic causes or climatic conditions.

In this study we analyze the influence of transient flow considerations in WHPA delineation, following annual seasonality behavior; with transiency represented by four transient conditions: (I) regional groundwater flow direction, (II) strength of the regional hydraulic gradient, (III) natural recharge to the groundwater and (IV) pumping rate.

Addressing WHPA delineation in transient flow scenarios is computationally expensive. Thus, we develop an efficient method using a dynamic superposition of steady-state flow solutions coupled with a reversed formulation of advective-dispersive transport based on a Lagrangian particle tracking with continuous injection. This analysis results in a time-frequency map of pixel-wise membership to the well catchment. Additional to transient flow conditions, we recognize two sources of uncertainty, inexact knowledge of transient drivers and parameters. The uncertainties are accommodated through Monte Carlo simulation.

With the help of a global sensitivity analysis, we investigate the impact of transiency in WHPA solutions. In particular, we evaluate: (1) Among all considered transients, which ones are the most influential. (2) How influential in WHPA delineation is the transience-related uncertainty compared to aquifer parameter uncertainty.

Literature

[1] R. Enzenhoefer, W. Nowak, and R. Helmig. Probabilistic exposure risk assessment with advective-dispersive well vulnerability criteria. Advances in Water Resources, 36:121–132, 2012.

[2] R. Enzenhoefer, T. Bunk, and W. Nowak. Nine steps to risk-informed wellhead protection and management: a case study. Ground water, 52:161–174, 2014.