Towards processes-based groundwater vulnerability assessments

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Abstract

Various groundwater vulnerability methods have recently been developed. Considering groundwater quality issues, the most common techniques are based on calculation of an index expressing the protective effect (i.e. in terms of solute contaminant transport) of underground formations overlying the groundwater resource (Gogu & Dassargues, 2000, Gogu *et al.*, 2003)). However, there is a strong need for new methods giving more emphasis on the processes-based calculation of vulnerability indicators.

As a first alternative, a method is proposed based on three factors describing a pollution event (Brouyère et al., 2001): (1) the transit time from the source to the target, (2) the duration of the contamination breakthrough at the target, (3) the ratio between the maximum concentration at the target to the released concentration at the contamination source. The method can feature the impact of surface runoff to preferential infiltration points. Practically, the assessment can then be based on the simulated breakthrough curves at the 'target' corresponding to Dirac-type solicitations (Popescu *et al.*, 2008). Different vulnerability maps can be built according to the relative importance conventionally given to each of the three factors. This concept allows a clear distinction between conventional aspects and processes-based results in the building of a final vulnerability indicator.

A second proposal consists in reframing the groundwater vulnerability assessment in a Pressure-State-Impact causal chain that is familiar to decision makers (Beaujean *et al.*, 2013). The method is here based on the calculation of sensitivity coefficients for a user-defined groundwater state for which several physically-based indicators are proposed. The sensitivity coefficients reflect the easiness with which the groundwater state transmits pressures into impacts. They are converted to vulnerability, using the concept of 'transgressing a given threshold' (Luers *et al.*, 2003). While the methodology is general and can be applied in quantity as quality issues, the choice of causal chains has to be made prior to the calculation. The vulnerability is also related to a damaged state and is related to the 'distance' between the current state and a given threshold. Here also, the method allows a clear distinction between conventional choices (threshold) and scientific work (Dassargues *et al.*, 2009).

Keywords

Vulnerability, sensitivity, DPSIR, groundwater quantity and quality

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