PROCESS BASED METHOD FOR GROUNDWATER RESOURCE VULNERABILITY MAPPING WITH REGARDS TO SOLUTE CONTAMINATION AT THE SURFACE

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Abstract

Numerous groundwater vulnerability methods have been developed taking into consideration a variable number of factors. The most common techniques are based on calculation of an index expressing the protective effect of underground formations overlying the groundwater resource. However, it has been shown that different overlay and index methods applied to the same system can yield dramatically dissimilar results (among others, Gogu et al., 2003). The limitation of most of these methods is related to their use of a qualitative definition of groundwater vulnerability, as opposed to a definition based on a quantitative description of contaminant migration. A process-based point of view is proposed and 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 assessment can then be based on the impulse response at the 'target' to a Dirac-type solicitation (point, unit mass, instantaneous source of pollution), considering only physical hydrodispersive processes for intrinsic vulnerability and both physical and biochemical processes for specific vulnerability. The breakthrough curve obtained after a vertical transfer through the overlying layers can be computed pixel by pixel. Automatically processing the columns with identical characteristics, 1D partially saturated flow and solute transport computations are performed. Different maps are obtained for the three above mentioned factors. On the basis of these results, different vulnerability maps can be built according to the weighting coefficients agreed by the local community or decision makers. This concept allows a clear distinction between conventional aspects and process-based results in the building of a final vulnerability indicator.

This methodology has the further advantage to consider the possible impact of runoff conditions occurring at the land surface and possibly leading to lateral contamination of groundwater through downstream preferential infiltration features. To solve this problem, Popescu et al. (2004 & 2008) and Dassargues *et al*. (2009) proposed a method for quantifying a lateral "dangerosity" coefficient using runoff coefficients based on land use, slopes, and soil properties. A test application is illustrated on a case-study located in a limestone basin in Belgium.

Keywords

groundwater resource vulnerability; contaminant migration; modelling; preferential infiltration; unsaturated zone; groundwater protection

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