STOCHASTIC APPROACH TO HYDRAULIC BARRIER DESIGN: AN EXAMPLE IN NORTHEASTERN ITALY

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Starting from 2004, a progressively increase of volatile organic compounds (VOCs) in the public water supply wells located in a pre-alpine valley at northeast of Verona (Italy), reveals an extensive groundwater contamination by tetrachloroethylene (PCE) and trichloroethylene (TCE). The contamination involves a multi-layered aquifer system consisting of three main gravel aquifers intercalated by discontinuous clay layers and hydraulically connected by multiscreened wells. The first aquifer is between 48 and 60 m below ground level (m b.g.l.), the second ranges from 75 to 105 m b.g.l. and the third from 118 to 130 m b.g.l. The results of a preliminary characterization indicate that the source of the groundwater pollution is located in the middle part of the valley and it is related to the activity of a graphic industry. At the end of 2013, a plume of PCE/TCE was identified at the center of the valley between the source area and the northern outskirts of Verona, about 4000 m downstream. The plume is about 500 m wide and its concentrations in PCE and TCE respectively range from 731 to 0.07 µg/l and from 0.6 to 0.06 µg/l.

Currently, a new phase of investigation and monitoring has started. The aims of this phase are: (i) the upgrade of the conceptual hydrogeological model of the area, (ii) the realization of pumping tests for hydraulic conductivity estimation, (iii) the evaluation of the spatial and temporal evolution of the contaminant plume and (iv) the design of a hydraulic barrier involving all contaminated aquifers.

In particular, a three-dimensional numerical model of groundwater flow and advective transport is developed to design a hydraulic barrier. Steady-state saturated flow is simulated with MODFLOW-NWT (Niswonger et al., 2011), while MODPATH (Pollock, 1994) is used for particle tracking analysis. The approach used for dealing with uncertainty associated to the model implementation is stochastic simulation based on multiple equally plausible candidates of the site heterogeneity. Random Sampling (RS) and Latin Hypercube Sampling (LHS) are the two methods tested to generate different realizations of the hydraulic conductivity (K) zonation. Preliminary results of numerical simulation show that discharge rates ranging from 1.0 to 3.0 L/s are required to prevent further migration of contaminant downstream.

References

Pollock D.W. (1994). User's guide for MODPATH/MODPATH-PLOT, Version 3: A particle tracking postprocessing package for MODFLOW, the U.S. Geological Survey finite-difference ground-water flow model. U.S. Geological Survey, Open File Report 94-464.