A simple contaminant fate and transport modelling tool for management and risk assessment of groundwater pollution from contaminated sites

Contaminated sites pose a significant threat to groundwater resources. The resources that can be allocated by water regulators for site investigation and cleanup are limited compared to the large number of contaminated sites. Numerical transport models of individual sites require large amounts of data and are labor intensive to set up, and thus they are likely to be too expensive to be useful in the management of thousands of contaminated sites. Therefore, simple tools based on analytical solutions of contaminant transport models are widely used to assess (at an early stage) whether a site might pose a threat to groundwater. We present a tool consisting of five different models, representing common geological settings, contaminant pathways, and transport processes. The tool employs a simplified approach for preliminary, conservative, fast and inexpensive estimation of the contamination levels of aquifers. This is useful for risk assessment applications or to select and prioritize the sites, which should be targeted for further investigation. The tool is based on steady-state semi-analytical models simulating different contaminant transport scenarios from the source to downstream groundwater, and includes both unsaturated and saturated transport processes. The models combine existing analytical solutions from the literature for vertical (from the source to the top of the aquifer) and horizontal (within the aquifer) transport. The effect of net recharge causing a downward migration and an increase of vertical dispersion and dilution of the plume is also considered. Finally, we illustrate the application of the tool for a preliminary assessment of two contaminated sites in Denmark and compare the model results with field data. The comparison shows that a first preliminary assessment with conservative, and often non-site specific parameter selection, is qualitatively consistent with broad trends in observations and provides a conservative estimate of contamination.