Geophysical Research Abstracts
Vol. 20, EGU2018-5569, 2018
EGU General Assembly 2018

Sensitivity analysis of pollutant loadings to aquifer properties for the assessment of soil and groundwater pollution potential

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A base case scenario of chemical leak was numerically simulated for four different chemical substances: benzene (light non-aqueous phase liquid (NAPL)), tetrachloroethylene (PCE; dense NAPL), phenol (soluble in water) and pentachlorophenol (PCP; white crystalline solid). The base case scenario assumed that 1 metric ton of chemical substances leaked just above the water table in a typical aquifer in Korea which has the depth to water table of 7.14 m, the hydraulic gradient of 0.00097, the recharge rate of 0.7 mm/day, and the permeability of 2.92×10^{-10} m^2. For comparison, surface spill scenarios were assessed for all four chemical substances. Using the modeling results, point-source pollutant loadings to soil and groundwater were calculated above and below the water table respectively, by multiplying concentrations, impact areas and durations. The pollutant loadings can be combined with the aquifer vulnerability index such as DRASTIC or GOD to assess the pollution potential. However, the components in the pollutant loadings and those in the aquifer vulnerability interact in varying and complex ways, which makes it difficult to combine the two interactive results into a single index of pollution potential. Therefore, we analyzed the sensitivity of pollutant loadings to aquifer properties (depth to water table; recharge rate; porosity; organic carbon content; decay rate; hydraulic gradient; capillary pressure; relative permeability; and permeability), which are also used to define aquifer vulnerability, to understand the interaction between pollutant loadings and aquifer vulnerability. The study result showed that pollutant loadings to groundwater was more sensitive to aquifer properties than pollutant loadings to soil in our base case scenario. In addition, sensitive parameters for each chemical substance was discussed. As a last sept, a method to integrate pollutant loadings and aquifer vulnerability and to provide a single index of pollution potential was suggested based on the sensitivity analysis results. [Acknowledgment] This subject was supported by the Korea Ministry of Environment (MOE) as “Soil and Groundwater Contamination Prevention Technology Development Program (GAIA Project),” and partially supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIP) (No. 2015R1C1A1A01052036).