A stochastic framework for the assessment of health risk from groundwater contamination

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We propose a probabilistic framework to estimate the adverse effects on humans of exposure to contaminated groundwater. Our framework is aligned with the standard suggested by the US EPA which is based on the following steps: (i) hazard identification; (ii) exposure assessment; (iii) dose-response assessment; and finally, (iv) risk characterization. The scenario investigated consists of a contaminated aquifer supplying water to a population; a continuous source of contaminant feeds a steady plume which constitutes the hazard source. A stochastic hydrogeological model, particularly suited for NAPL pollutants, underlies the hazard assessment while the exposure and dose response assessments are based on the EPA guidelines. Erratic displacement of the contaminant plume in groundwater, due to the spatial variability of hydraulic conductivity properties, is characterized within the Lagrangian stochastic framework which allows the estimation of complete probabilistic characterization of the contaminant concentration. Following the characterization of flow and transport, we quantify the adverse health effects on human. The dose response assessment involves the estimation the uncertain effects of the exposure to a given contaminant while accounting for the exposed individual's metabolism. Our risk methodology integrates groundwater transport, exposure and human metabolism in a comprehensive probabilistic framework. After employing the definition of risk as a random function, the framework further allows the assessment of uncertainty propagation.