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Abstract

Resilience of Heterogeneous Aquifers Evaluated from Different Dose-Response Models of Bisphenol A †

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Abstract: With the growing concerns over emerging contaminants in indirect potable reuse (IPR) applications, we investigate the impact on human health risk of emerging contaminants introduced into groundwater. Some emerging contaminants have potential endocrine-related health effects at a specific exposure range that is much lower than current guidelines. We start by analyzing Bisphenol A (BPA), which is one of the frequently detected emerging contaminants in groundwater. The objective of this study is to understand how the non-trivial toxicity of BPA affects the estimation of human health risks and, consequentially, aquifer resilience. Based on our results, we aim to provide indications on how to improve water resources management in BPA contaminated sites. We use numerical methods to model BPA contamination of a three-dimensional aquifer, and human health risks and aquifer resilience are estimated at a control plane representing an environmentally sensitive target. A Monte Carlo simulation is conducted to compute uncertainty associated with two levels of heterogeneity. In order to evaluate health risks due to BPA, two types of Dose-Response (DR) models are considered: the monotonic DR model for general exposure and the non-monotonic DR model for prenatal/postnatal exposure. The aquifer resilience is defined as the capacity to recover the state where groundwater is considered potable (i.e., negligible health risks due to BPA). When using the non-monotonic DR model, computational results indicate that the aquifer resilience reduces and its uncertainty increases as the aquifer heterogeneity increases. On the other hand, the aquifer resilience considering the monotonic DR model enhances, and its uncertainty increases relatively smaller than the one considering the non-monotonic DR model. In addition, the variability of the aquifer resilience is controlled by the residence time of the BPA plumes at the control plane, which is related to the volumetric flow rate at the front side of the contamination source. Finally, the decision-making strategy for BPA contaminated sites should be established in accordance with the heterogeneous structure of aquifer and land uses that determines which DR model of BPA is more important in estimating the aquifer resilience.

Keywords: human health risk; resilience; heterogeneous aquifer; non-monotonic toxicity; Bisphenol A