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Coping with uncertainty in environmental modeling

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We will present a comprehensive probabilistic risk assessment framework that enables scientists and decision makers to quantify aleatory and epistemic uncertainties associated with characterization and predictions of the fate and transport of contaminants in the subsurface. This framework makes optimal use of existing site characterization data, source material distribution assessments, current physical and biochemical process models, and recent advances in probabilistic and computational techniques. Our uncertainty quantification and risk assessment framework enables analysts, policymakers and other stakeholders to make a variety of decisions, such as to (a) determine the viability of natural attenuation and other alternative remediation strategies, (b) optimize data collection and monitoring campaigns, and (c) recommend and choose between alternative uses of a contaminated site. Finally, the proposed framework provides a flexible and extensible tool to assess subsurface water resource vulnerability. In particular, it readily accommodate new information, including new site data, compounds, process models, and conceptual models. The framework analyzes and links various types and levels of uncertainty that contribute to the overall predictive uncertainty in the fate of contaminants that enter the subsurface environment either through the land surface or from buried waste storage facilities. These uncertainties include physical and biochemical processes, conceptual-mathematical model formulations, flow and transport parameters, forcing terms (initial conditions, boundary conditions, source terms), disparity of scales, and numerical implementation.