SYSTEM-LEVEL MODELING TO SUPPORT DECISION MAKING WITH UNCERTAINTY IN RADIOLOGICAL PERFORMANCE ASSESSMENT

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The disposal of radioactive waste requires analysis of environmental transport and human exposure effects, in the face of uncertainty in many forms. Environmental, physiological, and behavioral systems are complex, and uncertainties are present in conceptual models, physical and mathematical representations, and input parameters. Despite these complexities, decisions about siting, operating, and permitting radioactive waste disposal facilities must be made. Decision makers are often uncomfortable with inherent uncertainties, and are appreciative of tools and methods that allow them to effectively regulate complex issues like radioactive waste management. Key to supporting these decisions is the ability to identify which uncertainties are the most significant for a particular situation. This is the role of sensitivity analysis. Examples are presented of system models developed to support decisions concerning radioactive waste disposal with full consideration of uncertainty.

Characterization and representation of uncertainties must be performed at many scales, from individual human behaviors to regional climate. Time scales of interest may span hundreds to millions of years. The myriad systems that are inherent to radiological performance assessment (PA) are highly non-linear, and must be integrated so that their relative significance may be understood. System-level models are capable of such integration. Probabilistic models can accept uncertainty, and can be used for sensitivity analysis so that the relative significance of different sources of uncertainty can be evaluated. With this information, overall uncertainties can be reduced by focusing the gathering of information on sensitive parameters, and ignoring those that do not have an influence on model results or decision making. This approach has the added benefit of optimizing limited funding and resources, thereby efficiently reducing uncertainty and improving the quality of decision making.

The decision analysis process implied by this approach follows the basic tenets of Bayesian methods, the scientific method, and the radiological community's as low as reasonably achievable (ALARA) goals, and allows PA maintenance programs to become operational and measurable. Technical nuances in this type of PA modeling such as uncertainty and sensitivity analysis methods that can be applied to such complex, dynamic, nonlinear, non-monotonic models, and issues associated with proper model scaling are also presented. Specific examples are presented from performance assessment modeling conducted at several radioactive waste disposal facilities in the United States.