Ecological Risk Assessment Modeling Tools

EVS has developed a number of modeling tools for evaluating potential risks to ecological receptors from environmental contamination. RESRAD-ECORISK estimates the movement of contaminants through the terrestrial food webs of wildlife receptors, predicts doses and risks to them, and derives preliminary cleanup goals for site remediation. An aquatic bioenergetics model predicts fish growth and biomass production under different environmental and exposure scenarios.

PROBLEM/OPPORTUNITY

Ecological risk assessments are mandated regulatory activities at contaminated sites owned by federal agencies. Site remediation managers must assess how contaminants could affect ecological resources. Because ecological systems are extremely complex, potential risks to them are more complicated to assess than risks to human health. Any tools that can make the assessments quicker and more cost-effective, precise, and comprehensive could result in faster decision making and safer and more effective remedies, thereby lowering overall project costs.

APPROACH

For terrestrial systems, EVS developed the RESRAD-ECORISK computer code to estimate contaminant doses to wildlife. It employs environmental fate and transport models and food-web uptake models. The exposure pathways considered by the model are shown in the figure. Resultant dose estimates can be used to predict risks to ecological receptors and to calculate preliminary remediation goals for reducing risks to acceptable levels.

Features of this PC-based tool include a menu-driven interface through which the user can easily access input screens, modify and save data, view results in graphical and tabular format, and print reports. The model includes default databases for soil-to-plant uptake factors, insect bioaccumulation factors, chemical parameters of 151 organic and inorganic chemicals, and species- and contaminant-specific screening values. These databases can be readily modified to incorporate new information.

RESRAD-ECORISK evaluates five wildlife receptors: American robin, mallard, white-tailed deer, eastern cottontail, and deer mouse. For each species, it contains data on factors that could affect exposure to and uptake of site contaminants; the factors include home range, body weight, food and water ingestion rates, and diet. It allows the user to analyze receptors and exposure routes individually and in combination. The code may be used as a screening tool to determine if site conditions warrant a more detailed baseline risk assessment. It can also be used for detailed risk assessments if site-specific data are available. Both applications of the code comply with current U.S. Environmental Protection Agency guidance on, and requirements for, assessing Superfund sites. Moreover, the model can help in developing preliminary soil guidelines to reduce risks and in evaluating the risk-reduction effectiveness of proposed remediation alternatives.

For aquatic systems, EVS is designing a bioenergetics-based risk assessment tool to evaluate the potential effects of sublethal contaminant exposure on fish growth and biomass production. The model now addresses seven species: alewife, dace, yellow perch, channel catfish, bluegill, largemouth bass, and northern pike. It can help in assessing risks from site contamination, evaluating remediation alternatives, and monitoring.

The tool takes a systems approach. It includes submodels for predicting food consumption, egestion and excretion, and respiration rates. The user selects the receptor species to be evaluated; selects run time and sensitivity analysis preferences; and inputs environmental, physiological, and ecotoxicological data. The model then predicts fish growth and biomass production under the selected environmental conditions. A dose-response input module under development will allow data on the effects of specific contaminants on physiological parameters (particularly temperature and oxygen) to be directly incorporated in the bioenergetics model. The result will be predictions of contaminant effects on growth and production.

The PC-based model includes an interface that lets the user set values for site-specific contaminant and environmental input parameters, identify sensitivity analysis parameters, and graphically view selected input data distributions.

RESULTS

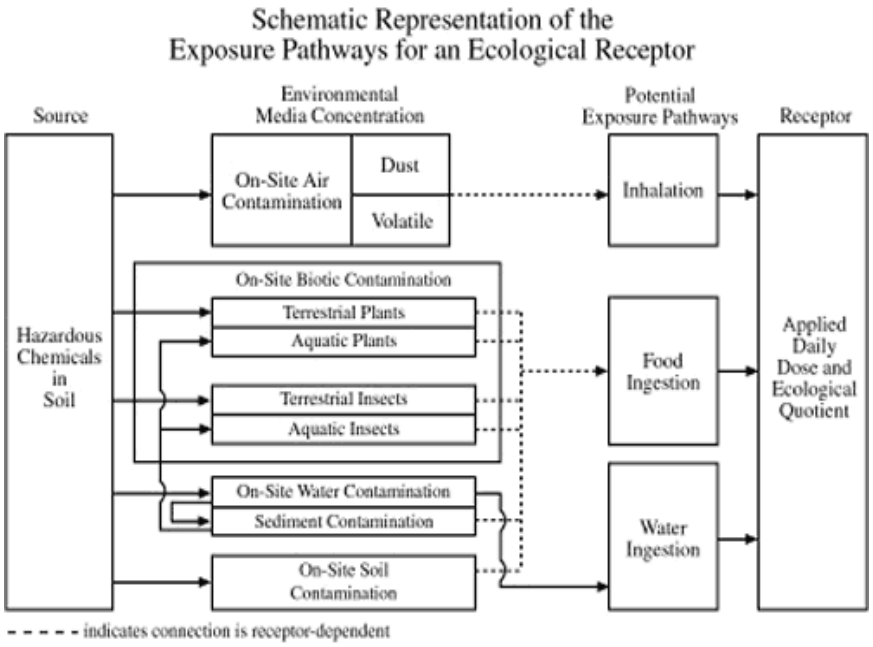
EVS has been involved in ecological risk assessments for a number of years. It has supported the U.S. Department

of Energy (DOE) at the Weldon Spring Site in Missouri, Argonne National Laboratory in Illinois, and Los Alamos National Laboratory in New Mexico. It has supported the U.S. Department of Defense at Aberdeen Proving Ground in Maryland and Yuma Proving Ground in Arizona. This work, which has involved risk assessments and modeling, field investigations, and remedy evaluations, served as the basis for developing the modeling tools. EVS staff are currently assisting the Chief of Naval Operations, the U.S. Army Corps of Engineers, and DOE in the area of ecological risk assessment, and continues to develop modeling tools for ecological risk assessment.

COMMUNICATION OF RESULTS

EVS staff have led workshops on conducting ecological risk assessments for DOE headquarters and the U.S. Department of the Navy and workshops on probabilistic modeling for the Society of Environmental Toxicology and Chemistry (SETAC) and Society of Risk Analysis. The results of EVS ecological risk assessments have also been presented at SETAC annual meetings.

The staff have also presented information on RESRAD-ECORISK at a number of conferences and workshops, including the 1995 DOE Environmental Restoration Conference, 1997 DOE Environmental Safety and Health Conference, 1997 DOD Tri-Services Conference on Risk Assessment, and 1996 SETAC meeting. Information on the bioenergetics model will be presented at the 1999 American Fisheries Society meeting.



Schematic representation of contaminant transport, fate, and uptake as evaluated by RESRAD-ECORISK