

Multi-Agency Modeling Platform Supporting Long-Term Site Issues

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ABSTRACT

A multi-agency effort is under way to complete the development of a modeling platform that allows for communication between disparate models and databases, which supports site-specific, regional, and national environmental assessments. The Pacific Northwest National Laboratory (PNNL), U.S. Environmental Protection Agency (EPA), and U.S. Department of Energy (DOE) with technical support from the U.S. Department of Defense (DoD) Army Research and Development Center and U.S. Nuclear Regulatory Commission (NRC) are engaged in merging the EPA-sponsored Multimedia, Multi-pathway, Multi-receptor Risk Assessment (3MRA) methodology as applied to the Hazardous Waste Identification Rule (HWIR) with the DOE- and EPA-sponsored Framework for Risk Assessment in Multimedia Environmental Systems (FRAMES). 3MRA-HWIR was designed to perform national risk assessments, while FRAMES was designed to allow analysts to link models and databases to support site-specific assessments. Combining these two systems will allow for the greatest flexibility in analyzing a wide variety of assessment strategies. Both systems have been deployed and are currently available for use. The new merged system could very easily be extended to link site assessments with remediation technologies and strategies, barriers and permeable reactive treatment wall modeling, monitoring and calibration, regulatory and compliance assessments, biological site remediation technology modeling, life-cycle issues, and economic analyses.

SUMMARY

The EPA is charged with developing, implementing, and enforcing regulations concerned with protecting human and ecological health from the myriad of chemical and non-chemical stressors imposed on the environment as a result of man's activities. The DOE, in response to existing and emerging regulatory requirements for environmental protection, has developed a significant program for assessing exposure and risk at its facilities. In pursuing these activities, DOE and EPA share a common need to understand the environmental processes (physical, biological, and chemical) that collectively release, transform and transport contaminants resulting in exposure and finally a probability of deleterious health effects. At both EPA and DOE, computer models are key tools for organizing the knowledge of environmental science for application in the decision-making process, as illustrated by their commitment in developing 3MRA-HWIR and FRAMES.

3MRA-HWIR is a modeling system capable of conducting a national assessment of exposure and risk due to non-radioactive chemical releases from hazardous waste sites. 3MRA-HWIR links 17 different models and five databases, prioritizes data, provides for a two-stage Monte Carlo analysis, and provides visualization of output by allowing the user to investigate the results by chemical, distance, medium, exposure pathway and route, age group, risk measure and type, and percentage of

population protected. 3MRA-HWIR addresses both human and ecological risks.

FRAMES is a software technology system that provides a forum from which various models can interact with each other and facilitate a “plug-and-play” atmosphere to support a wide variety of assessments. The software framework is designed using an “object-oriented design” and, as such, allows for the decoupling of individual modules. This design greatly improves the ability of module developers to “plug” a new model into a full multimedia modeling system without the need to reconfigure the system or invoke major changes to the model itself, if any. Although FRAMES is not limited to a particular assessment domain, its application and attributes currently illustrate the chemical/radionuclide human-health and ecological risk assessment paradigm (i.e., source through transport to exposure to risk/hazard). FRAMES was designed for site-specific applications, allows for connections to disparate databases, contains a universal sensitivity/uncertainty Monte Carlo module, and contains viewers (graphical and tabular) to aid users in inspecting output results. To aid the user in developing a Conceptual Site Model (CSM) of the problem, FRAMES provides a user-interface that allows the user to graphically construct the assessment strategy, using pull-down icons and the connection-lines with arrows to illustrate the information flow between modules (Figure 1).

A number of different government agencies have placed their models into FRAMES, as such FRAMES is model-independent and not model limited. For example, DoD developed the Army Risk Assessment Modeling System (ARAMS), based on the FRAMES technology. DoD needs a system that is compatible and consistent with the other agencies, especially EPA and is cognizant of EPA’s desire to develop a consistent and more universal approach to multimedia modeling. As such, DoD is cooperating with EPA with its development efforts by coordinating its activities with EPA. ARAMS follows protocols for software development that are consistent with the merged system.

FRAMES and 3MRA-HWIR, while conceptually similar, are different in two fundamental ways. First, the manner in which data are managed in HWIR is more advanced relative to FRAMES, using a more advanced Application Programming Interface (API) and Dynamic Link Libraries (DLLs). Second, FRAMES was designed to facilitate site-specific assessments and thus has a user interface for collecting data from the user, which also allows the user to visually construct the CSM, tracking the flow of information between modules. HWIR was designed to facilitate a national assessment and thus does not contain a site-specific user interface.

The merged system will be an integrated plug-and-play software platform, linking models, databases, and frameworks, which allows for integrated source, transport (air, groundwater, surface water, watershed), exposure, and risk/hazard assessments. Several of the more celebrated attributes include the following:

1. Operate on a PC with Microsoft NT or Windows2000 platforms.
2. Allow for disparate databases to be mapped into the system to connect to specific models.
3. Allow for disparate models (analytical and numerical) to be linked both spatially and temporally.
4. Allow for connectivity to outside frameworks (e.g., GMS, WMS, SMS).
5. Consider linkages to different Geographical Information Systems (GISs).
6. Allow databases to link to databases, establishing priority with each data set.

7. Construct the CSM to handle domains other than chemical/radionuclide risk assessments.
8. Allow for graphical and tabular viewers.
9. Allow for web-access, remote-access, and remote-computing.
10. Allow the user to lock the CSM, specific models chosen for the assessment or both.
11. Incorporate security features.

Many DOE installations and EPA hazardous waste sites have data that have been collected specifically for that site, have models developed for and calibrated to site conditions, and use models independently developed by those not associated with the site. In most instances, the analysts cannot directly link the databases to the models or directly link the models to the models, due to data format differences, time and space inconsistencies, or software/hardware incompatibilities. The merged system will allow those models to be linked, and allow databases to be accessed and used by the models to support the decision-making process. Although the first domain associated with the merged system will address chemical/radioactive risk assessment, it could very easily be extended to link site assessments with remediation technologies and strategies, barriers and permeable reactive treatment wall modeling, monitoring and calibration, regulatory and compliance assessments, biological site remediation technology modeling, life-cycle issues, and economic analyses.

