Army Risk Assessment Modeling System (ARAMS): Associated Time and Space Scales

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ABSTRACT

ARAMS is a computer-based knowledge delivery and decision support system that integrates multimedia fate/transport, exposure, uptake, and effects of contaminants to assess human and ecological health impacts/risks. The ARAMS is being developed to reduce the time and cost for conducting site-specific health risk assessments; provide more uniform methods for conducting risk assessments with more reliable risk estimates; and reduce the cost of remediation by establishing more appropriate cleanup targets. Contaminant exposure can change with time and space. As a result, there is an increasing need to consider temporal and spatial considerations in health risk assessment. This poster provides an overview of ARAMS version 1.0 released in June 2002 and presents its various temporal and spatial aspects.

INTRODUCTION

ARAMS is based on the risk assessment paradigm of combining exposure and effects assessment to characterize risk. ARAMS uses FRAMES (Framework for Risk Analysis in Multimedia Environmental Systems) to develop conceptual site models and to allow seamless linkages of disparate models and databases. Use of ARAMS is targeted for site-specific risk assessments or specific classes of problems where general risk guidelines are needed with an emphasis on military unique conditions and compounds. Both screening-level (i.e., low-order) and comprehensive (i.e., high-order) models and assessment methods are being incorporated. ARAMS is being fielded in stages with new versions released approximately annually. The present release version (1.0) features only low-order assessment methods. Probabilistic assessments via Monte Carlo simulation are possible. Data extraction tools with linkages to Web-based databases allow use of up-to-date information.

ARAMS Initial Screen

FRAMES conceptual site model

SYSTEM OBJECTS AND ICONS

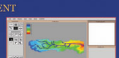
- Databases for chemical properties and toxicity reference values
- Describing source of contamination
- Air fate / transport
- Overland runoff fate / transport
- Surface water fate / transport
- Vadose fate / transport
- Aquifer (groundwater) fate / transport
- Human exposure pathways
- Ecological exposure pathways
- Human receptor intake
- Human health impacts
- Ecological health impacts
- Sensitivity / uncertainty

DEVELOPMENT STRATEGY

Allow for both screening-level (low-order) and focused (i.e., comprehensive or high-order) exposure and effects assessments

EXPOSURE ASSESSMENT

Screening-level exposure: reduced dimensionality; often analytical models



Comprehensive exposure: 3-D; often numerical models

Of course, measured contaminant concentrations can also be entered and used in assessments

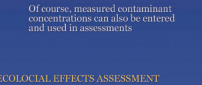
ECOLOCIAL EFFECTS ASSESSMENT

Low Order

$$EHQ = \frac{Dose}{TRV}$$

Applied to an individual without consideration of spatial aspects, e.g., home range, habitat preferences, etc.

High Order



Considers spatial aspects and/or populations risk

TIME SCALES

Hazard index versus time

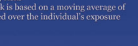
Time scale can be varied, e.g., years to seconds

- With predictive contaminant fate / transport models, one can consider time-varying exposure, thus time-varying (or future) risks
- Time-varying risk is based on a moving average of exposure computed over the individual's exposure duration

SPATIAL SCALES

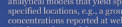
- With predictive contaminant fate / transport models, one can consider spatially varying future exposure, thus spatially varying future risks
- Lower-order models are generally point models or analytical models that yield spatially varying output for specified locations, e.g., a groundwater plume with concentrations reported at well locations
- Higher order models are spatially explicit by design, are enhanced through GIS use, and often have spatially discretized numerical solutions

Numerical model grid for upper Chesapeake Bay



The Spatial scales can vary widely. The metric (feet, meter, kilometer, etc.) can be specified for the analytical models. The metric for the higher order numerical models is determined by the grid or mesh resolution and extent of the model domain.

One present challenge and thrust is to find ways to seamlessly link output from comprehensive, multi-dimensional fate/transport models (e.g., GMS) with other models in ARAMS, e.g., receptor exposure/ uptake models.



Groundwater Modeling System (GMS)

Another challenge and thrust is to add spatially explicit ecological exposure models that can consider temporally and spatially varying contaminant concentrations, along with habitat preferences, population distribution/ densities, and other spatial features. GIS will help facilitate this type of modeling.

A Tier I Terrestrial Wildlife Exposure Model (TWEM) is being incorporated to consider food preferences, but not temporal or spatial variations. Thus, the soil concentration passed to the TWEM model, as shown in the TWEM schematic, is a representative value for a single location, and static assumptions are made.

Terrestrial Wildlife Exposure Model (TWEM)

TT is Terrestrial Toxicity database; BAF is bioaccumulation factors; WEAP is Wildlife Effects Assessment Program

CONCLUSIONS

- Exposure concentrations can change over time and space
- Risk assessment methods should evolve to consider exposure over varying temporal and spatial scales
- Models provide the means to project exposure over time and space
- ARAMS incorporates models to meet this need
- Low-order models have been fielded in ARAMS 1.0
- High-order models will be featured in future versions

ACKNOWLEGEMENT

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