RECLAMATION
Managing Water in the West

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Framework for Understanding Ground Water Model Uncertainty

A standardized approach for applying statistics and methods to improve model output reliability and use

What Is The Problem?

Increasing demand for limited water supplies has intensified the need for effective information and tools to help water resource managers investigate ground water and surface water interactions. Managing complex surface and subsurface water systems requires efficient application of ground water models to explain how the system behaves and might react to change. Water managers need this information as they plan additional storage, manage water operations and conjunctive use, or assess the impact of climate change and other system stressors.

Uncertainty is inherent in all models, and uncertainty must be understood by both modelers and decisionmakers. Many approaches exist for quantifying model uncertainty, thus choosing the most appropriate approach for a given model and application is difficult. Also, effectively communicating model results to managers has been challenging because uncertainty implies an "error in the results," which is not accurate.

Reclamation does not have a standard for quantifying uncertainty, a standard process, or even tools to communicate ground water model uncertainty. Because of this, deciding whether existing ground water data are adequate to answer water management questions can be difficult. Modelers and managers are often faced with a dilemma: either accept given levels of uncertainty in the analysis or undertake expensive additional well drilling and data collection.

What Is The Solution?

We developed a Framework to apply statistics and methods for quantifying and communicating ground water model uncertainty. The approach guides reducing uncertainty by guiding users to understand the quantity and locations of data that are needed to provide a desired range of certainty and to avoid additional resource expenditures on unnecessary data collection. The Framework is unique in that it serves as a reference and communication tool among modelers, especially within Reclamation, as well as a tool for modelers to effectively communicate uncertainty to managers, resulting in better ground water management decisions.

The Framework document describes the most appropriate methodologies and how best to use them for common problems at the four main points in the modeling process where uncertainty arises: 1) defining the behavior of the system, 2) model inputs (hydrogeology, rainfall, evapotranspiration, irrigation, etc.), 3) calibration (modifying raw data inputs until outputs match observed data), and 4) the model's predictive abilities.

Who Can Benefit?

Ground water modelers and managers can use the Framework to apply a standard, proven approach to defining and characterizing uncertainty that, in turn facilitates communication between technical and managerial staff and reduces the costs of ground water studies.

Where Have We Applied This Solution?

We applied the Framework in the Minidoka Dam Raise Study, simulating the region surrounding and beneath Lake Walcott. We may also apply the Framework during the Henry's Fork Special Study in the Upper Snake River Basin and the Treasure Valley Ground Water Model for the Boise River Basin (both in Idaho).

Minidoka Dam and Lake Walcott.

Future Development Plans

As new techniques emerge, they will be investigated and incorporated into the Framework document. We intend to continue discussing uncertainty with management to improve the Framework as a communication tool.

More Information

A copy of the Framework document is available at: http://www.usbr.gov/research/docs/GroundwaterModelUncertainty_2010.pdf.

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Collaborators

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