RECLAMATION
Managing Water in the West

U.S. Department of the Interior
Bureau of Reclamation

Research Update

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Bottom Line

This research project examined hydrologic models to determine whether they could predict annual sediment inflow.

Better, Faster, Cheaper

Measuring sediment inflow is critical in addressing potential operation sustainability issues, including:

- **Loss of storage capacity**
- **Burial of outlet works and/or recreational facilities**
- **Downstream erosion**
- **Habitat loss**

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Tracking Sediment Inflow Into Reclamation's Reservoirs

Using a continuous simulation, process-based model to predict sediment inflow

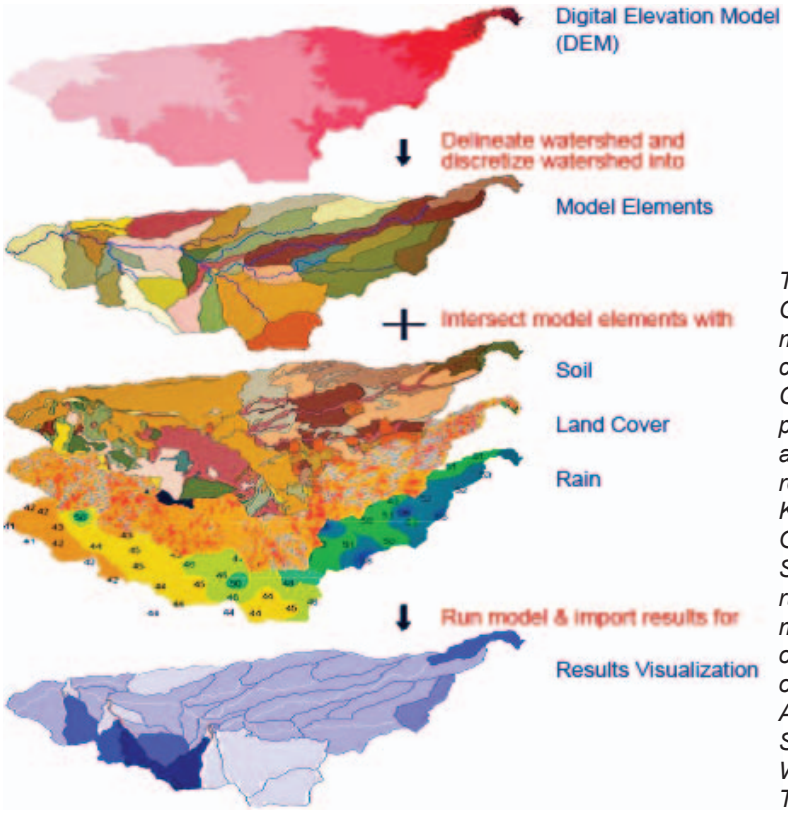
Problem

Reclamation manages over 400 storage facilities, but only 30 percent have had bathymetric surveys conducted since initial filling to determine the amount of sediments entering the reservoirs and what has accumulated over time. As the sediments accumulate in the reservoir, the storage facility gradually loses its ability to store water. Sediment storage rates vary widely, and determining these levels for each storage facility is critical for predicting the efficiency of infrastructure and operations.

Regular surveys provide estimates of annual sediment inflow; however, surveys are labor intensive and expensive undertakings. Hydrologic models might be able to estimate sediment inflows based on watershed size, sediment mobility, and wildfire susceptibility. This would provide a reasonable estimate of sedimentation rates for unsurveyed reservoirs to help develop reservoir sedimentation strategies to keep Reclamation's hydropower and water delivery infrastructure functioning.

Solution

This Reclamation Science and Technology Program research project reviewed two models to determine if they could be used to estimate sediment inflows based on watershed size, sediment mobility, and wildfire susceptibility. Process models calculate sedimentation rates by simulating elevation, land cover, soils, climate, and hydrological processes within a watershed.



The AGWA tool is a GIS-based hydrologic modeling tool that uses commonly available GIS data layers to fully parameterize, execute, and spatially visualize results for the RHEM, KINEROS2, KINEROS-OPUS, SWAT2000, and SWAT2005 watershed runoff and erosion models. Figure courtesy of the U.S. Department of Agriculture, Agricultural Research Service, Southwest Watershed Research, Tucson, Arizona.

Application and Results

The Water Erosion Prediction Project Model was only suitable for smaller watersheds, under 300 hectacres, while watersheds in the Western United States are usually much larger.

The Soil and Water Assessment Tool (SWAT), using the Automated Geospatial Watershed Assessment (AGWA) tool as an interface, could be an appropriate model for predicting annual sediment inflow in unsurveyed reservoirs. The AGWA tool is a Geographic Information Systems (GIS) interface jointly developed by the U.S. Environmental Protection Agency, the U.S. Department of Agriculture's Agricultural Research Service, and the University of Arizona to automate the parameterization and execution of the hydrologic models, SWAT and KINEROS2 (a kinematic runoff and erosion model). Based on the individual model requirements, watershed model elements are intersected with soils and land cover data layers to derive the requisite model input parameters.

Researchers reviewed documentation, gathered input data, and validated model output using the SWAT/AGWA model for three test dams: Bully Creek, Oregon; Paonia, Colorado; and Nambé Falls Dam, New Mexico. To calculate sediment accumulation and reservoir capacity loss, sediment data and topographic maps (i.e., observed values) were acquired at these dams. Researchers ran the SWAT2005 model and compared model results to observed values. The SWAT2005 model consistently overestimated the observed values by approximately 63 percent. Possible causes for magnification of the model output may include:

- **Data Resolution.** As data resolution increases, model results may improve.
- **Land Cover Change.** Consideration of wildfires or other land cover changes may influence model results.
- **Interpolated Climatic Data.** Some of the precipitation and temperature data were interpolated, which may inflate the estimated sedimentation rates.

Future Plans

Future modeling efforts are needed to effectively model sediment inflow into Reclamation's reservoirs. Actions could include:

- Calibrating the SWAT2005 model using the AGWA tool, which should improve the accuracy of the estimated values.
- Examining the influence of wildfires to SWAT. Many Reclamation reservoirs are in watersheds that experience frequent and extensive wildfires, thus this may be an extremely useful calibration tool.
- Developing a new GIS-based model to predict sediment yield as a function of nine individual drainage basin characteristics: surface geology, soils, climate, runoff, topography, ground cover, land use, upland erosion, and channel erosion.

More information

www.usbr.gov/research/projects/detail.cfm?id=8653

Automated Geospatial Watershed Assessment tool:

www.tucson.ars.ag.gov/agwa

"Sediment capture is the most significant factor in determining the expected lifetimes of reservoirs. Measuring sediment inflow is vital in sustaining storage capacity, preventing infrastructure damage such as burying outlet works and/or recreational facilities, and avoiding downstream erosion and habitat loss. Because most reservoirs have not been surveyed, a model to estimate sediment would be an invaluable aid for Reclamation."

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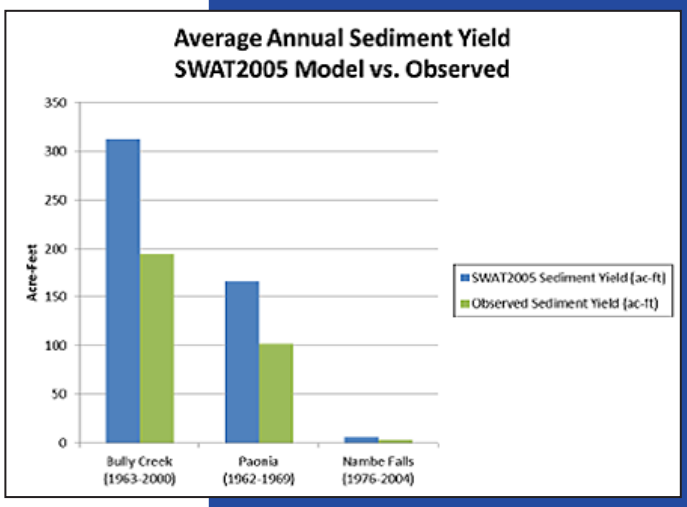

Comparison of modeled and observed average annual sediment yield at three Reclamation reservoirs.

For printable version see: www.usbr.gov/research/docs/updates/2016-05-tracking-sediment.pdf