OAK RIDGE NATIONAL LABORATORY

Understanding Reservoir Sedimentation for Smarter Water Management

Hydropower is a key component of a secure and reliable energy grid, but reservoir sedimentation—the steady accumulation of sediment behind dams—poses a serious and growing challenge to water infrastructure across the United States. Sediment buildup reduces reservoir capacity, impairs water availability, degrades water quality, restricts recreational activities, and negatively affects downstream ecosystems.

Sediment accumulation varies dramatically among reservoirs due to differing management practices, land use, and watershed characteristics, so understanding where buildup is most severe—and why—is crucial. Researchers at Oak Ridge National Laboratory (ORNL) are addressing this need by developing a national-scale dataset and advanced computational tools to precisely quantify reservoir sedimentation and inform targeted management strategies.

RESERVOIR SEDIMENTATION BY THE NUMBERS

0-3.6%
Range of reservoir storage capacity lost annually due to sedimentation in select US reservoirs

MORE THAN 2,100
Number of operational US hydroelectric dams, each with a unique sedimentation rate

OVER $10M
Projected costs of prevention and mitigation efforts at Tuttle Creek Reservoir.

Tuttle Creek Reservoir has lost 46% of its original capacity due to sedimentation



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From Watershed to Reservoir: Understanding Sedimentation

Integrated Modeling Framework

The team is developing a coupled modeling framework that integrates sediment transport processes in watersheds and sediment accumulation dynamics in reservoirs. This holistic modeling strategy combines watershed-scale insights provided by the Soil and Water Assessment Tool (SWAT) with a custom reservoir sedimentation and management component developed by ORNL. The resulting framework will enable detailed simulation of sediment movement, accumulation, and removal.

Case Studies to Validate and Inform the Model

The modeling framework is demonstrated using detailed information from two reservoirs with contrasting watershed characteristics and management histories: Tuttle Creek Reservoir in Kansas and Elephant Butte Reservoir in New Mexico. These comparative case studies provide detailed historical data to test model accuracy and identify factors that influence sedimentation rates in each basin.

Dataset Compilation

The ORNL team is compiling the first national-scale reservoir sedimentation dataset focused on mitigation by integrating historical sediment survey data, reservoir storage records, monitoring and discharge permitting information, and documented mitigation actions gathered from federal and state agencies as well as utilities and private reservoir owner/operators.

Remote Sensing Studies

Using remote sensing data products such as optically detected sediment concentrations and historical surface water extent, researchers are quantifying sedimentation rates at spatial and temporal scales not possible through traditional reporting and surveys.

Literature Review

An extensive literature review is being conducted to summarize existing knowledge on sedimentation drivers and highlight areas where targeted research may be needed.

Transforming Reservoir Management Through Targeted Interventions

ORNL's coupled sedimentation modeling framework and robust national dataset will enable reservoir operators to precisely identify sedimentation hotspots, evaluate management and prevention strategies, and aid in allocating resources for effective monitoring and interventions in the future. These data and tools will contribute to greater water and energy security through more proactive management of the nation's water infrastructure.



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