Research Update

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Bottom Line

This research project developed initial guidelines for formulating reservoir sustainability plans to effectively manage inflowing sediment loads and in-situ deposits.

Better, Faster, Cheaper

Taking a proactive approach in developing a reservoir sedimentation management strategy for Reclamation reservoirs will help avoid loss of project benefits and expensive retirement options. The annual cost to manage inflowing reservoir sediment is much less than the cost to try to recover decades of past reservoir sedimentation.

Principal Investigator

**Kent Collins, P.E.
Hydraulic Engineer
Sedimentation and River Hydraulics Group
Technical Service Center
303-445-2549
kcollins@usbr.gov**

Research Office Contact

**Levi Brekke
Chief, Research and Development
303-445-2494
lbrekke@usbr.gov**

Dealing With the Inevitable: Sediment in Reservoirs

Developing effective guidelines for managing sediment in Reclamation's reservoirs

Problem

As time passes, reservoirs fill with sediment causing storage loss, reducing water supply reliability, and impacting infrastructure, particularly to marinas, boat ramps, outlet works, turbines, and water intakes. Also, reservoir deltas may extend upstream from the full reservoir pool and increase the frequency of flooding. Sedimentation will also reduce the surface area available for recreation. Reservoir sedimentation rates are very site-specific and vary across the world, ranging from an average annual storage loss of 2.3 percent in China to 0.2 percent in North America.

Reclamation's dams and reservoirs were designed to accommodate sedimentation over the first 100 years of operation. With many Reclamation reservoirs at or near their sediment design life, future sediment inflows will further decrease operational capabilities of these facilities along with the reservoir storage capacity. Half of Reclamation's reservoirs are over 60 years old, nearly 20 percent are at least 80 years old, and 7 percent are already older than the sediment design life of 100 years. By the year 2024, 31 (13 percent) of Reclamation reservoirs will be at least 100 years old and that number will increase to 46 (19 percent) by the year 2034. Current and new Reclamation facilities need to be designed, re-operated, and retrofitted for sustainable use to limit the loss of operational benefits and reservoir capacity due to sedimentation.

Solution

This Reclamation Science and Technology Program research project developed a proactive approach to managing sediment. This approach will change the management of reservoirs to provide project benefits indefinitely. A sustainable sediment management strategy would require upfront and continual operation and maintenance costs (including monitoring), but these continual costs can be feasible and less than the final costs associated with dam decommissioning if reservoir sedimentation is not managed.

Methods and alternatives identified by this research help determine the state of reservoir sedimentation in Reclamation facilities and provide Reclamation and other Federal agencies with ideas for taking a proactive planning approach to best manage dams and reservoirs in a sustainable manner.

Results

The preliminary reservoir sustainability guidelines provide the following information:

1. **Determine the magnitude of the sediment problem.** As the saying goes, "one cannot manage what one cannot measure." Direct ways to measure storage loss and the potential of sediment problems in a reservoir are to perform repeat hydrographic surveys of the reservoir and to measure sediment flux upstream and downstream from the reservoir. Determining the magnitude and rate of sedimentation helps predict when key reservoir and dam facilities will be impacted and helps prioritize reservoir sediment management activities.

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2. **Define preliminary sediment management options.** All methods to manage reservoir sedimentation can be placed into three reservoir sediment management categories: reduce sediment delivery, prevent sediment deposition, and remove deposited sediments. A combination of methods may be necessary to maintain reservoir capacity and achieve sustainability.

3. **Define stakeholders and constraints.** Most dams and reservoirs have a unique combination of site-specific constraints. Identifying site constraints and involving all stakeholders that benefit or may be impacted is critical to determine a reservoir's unique and potentially conflicting requirements.

4. **Assess feasibility, economic viability, and environmental considerations of options.** To assess the economic viability of various sediment management methods, a life cycle approach must be developed (either managing the reservoir sustainably or managing the reservoir as an exhaustible resource and funding dam decommissioning and developing new storage to maintain future benefits). Changes in operation to implement various sediment management methods are likely, requiring determination of water quality impacts from reservoir sediments and analysis of any potential contaminants to minimize adverse environmental effects.

5. **Develop and implement a sediment management plan**. Changes involving the dam and reservoir include a reservoir sediment monitoring plan, changes in operational and maintenance procedures, and any new implementation features, such as the possible design and construction of new infrastructure to pass sediments, a periodic dredging plan, and any agreements of funding and coordination with other stakeholders, public and private.

6. **Monitor and revise plan if necessary.** As with managing any resource, continued monitoring of reservoir sediments is necessary to track whether or not the implemented sediment management options are performing as predicted. If implemented options are not performing as predicted, revising the original plan may be necessary to extend the life of a reservoir and achieve reservoir sustainability.

Future Plans

Recommendations based on this research and findings include:

- Coordinate and perform pilot studies at Reclamation facilities to test the competency of the preliminary reservoir sustainability guidelines.

- Develop more detailed guidelines providing decisionmaking tools and key design information for the prediction and implementation of various sediment management methods.

- Develop additional Geographic Information System (GIS) data within Reclamation's DataSpace Console that include the storage capacity, drainage area, mean annual inflow, and mean annual sediment yield for all Reclamation reservoirs. These data would be valuable in further determining the relative impact of reservoir sedimentation in all Reclamation reservoirs, short of a comprehensive reservoir survey program for all Reclamation reservoirs.

- Refine and develop additional reservoir sedimentation distribution tools to estimate the spatial and temporal impacts of reservoir sedimentation to important features.

"This research will help Reclamation and other Federal agencies with methods and tools to best manage dams and reservoirs in a sustainable manner."

Sean Kimbrel
Hydraulic Engineer, Reclamation's Technical Service Center

More information

www.usbr.gov/research/projects/detail.cfm?id=6080

Sediment at Paonia Reservoir, Colorado.

For printable version see: www.usbr.gov/research/docs/updates/2015-03-sediment.pdf