RECLAMATION
Managing Water in the West

U.S. Department of the Interior
Bureau of Reclamation

Reservoir Sustainability – Sediment Flushing

A pilot study on Black Canyon Reservoir

Research Bulletin
Science and Technology Program

S&T Project 8235

Black Canyon Reservoir has lost approximately 64% of its capacity due to sedimentation. This study assesses how pressure and drawdown flushing can remove sediments to extent the reservoir's useful life.

Mission Issue

Sedimentation within Black Canyon Dam has decreased capacity and compromises the functionality and safe operation of the facility. Developing reservoir sediment management options will prolong the viability of the facility.

Principal Investigator

Caroline Ubing, P.E., M.S.
Hydraulic Engineer
Water, Environmental, and Ecosystems Division
Sedimentation and River Hydraulics Group
Technical Service Center
cubing@usbr.gov

Research Office Contact

Jennifer Bountry
Science and Technology Environmental Issues for Water Delivery and Management Coordinator
jbountry@usbr.gov

Problem

Reservoir sedimentation is impacting all Reclamation (and other public and private) facilities to various extents, some being more extreme. The urgency of mitigating the impacts of sedimentation on reservoir storage and dam operations is often stifled by the hidden nature of the problem. Taking a proactive approach to developing a reservoir sedimentation management strategy for Reclamation reservoirs will help minimize the loss of project benefits and expensive retirement options. Failure to measure or estimate sediment inflow or deposition rates can result in severe future impacts including the loss of reservoir storage capacity, power generation down-time, burial of outlet works, burial of recreational facilities, downstream erosion, and habitat loss in the reservoir and in downstream rivers. The annual cost to manage inflowing reservoir sediment is much less than the cost of trying to recover decades of past reservoir sedimentation. A proper, proactive, and sustainable approach to reservoir sediment management would mean that a reservoir would be able to provide project benefits indefinitely.

This research provides a pilot study of reservoir sediment management at Black Canyon Dam, located in western Idaho on the Payette River. As of 1983, Black Canyon Reservoir has lost approximately 40% of its original storage capacity. The sediment reduces its ability to be a reliable water source for irrigation and local municipalities. Sediments are likely to impact operations and accelerate degradation of key structures, such as penstocks and turbines within decades. The outlet works already pass measurable amounts of sediments which increases wear on dam components.

Solution

A sustainable sediment management strategy requires upfront and continual operational and maintenance costs (including monitoring), but these continual costs can be feasible and are much less than the total costs associated with dam decommissioning. Furthermore, we must measure the amount of sediment accumulation to determine the risk to infrastructure and appropriate sediment management strategy. Sediment management options can be largely classified into three approaches: 1) reduce sediment yield from the watershed, 2) minimize sediment deposition, and 3) increase or recover reservoir capacity (Kondolf, et al., 2014). The preferred sediment management technique(s) for a given reservoir is determined predominantly by reservoir size, reservoir shape, sediment volume, sediment characteristics, and water volume (Sumi, 2008; Annandale, 2013; Kondolf, et al., 2014).

Black Canyon Reservoir, looking upstream at sediment depositing within the river delta.

"Taking a proactive approach to developing a reservoir sedimentation management strategy for Reclamation reservoirs will help minimize the loss of project benefits and expensive retirement options."

Sean Kimbrel
Umatilla Field Office Manager
Bureau of Reclamation

Collaborators

Snake River Area Office
Bureau of Reclamation

Pacific Northwest Regional Office
Bureau of Reclamation

More Information

https://www.usbr.gov/research/projects/detail.cfm?id=8235

Application and Results

Black Canyon reservoir was surveyed in 2016 as part of this research effort. Results show that 64% of the reservoir has been lost the sedimentation. Further analysis shows that maintaining current reservoir operations will bury crucial infrastructure within the next 30 to 50 years. Empirical data and previous studies suggest that either drawdown (lowering the reservoir pool) or pressure (maintaining the reservoir pool) flushing is the most suitable sediment management option at Black Canyon Reservoir. These actions could restore reservoir capacity and extend its useful life. Analysis shows that drawdown flushing is the most effective means of removing deposited sediments and restoring reservoir capacity. However, drawdown flushing is limited by the undersized low-level gates and risks the health of the downstream ecosystem. Pressure flushing will extend the reservoir's useful life, but the annual sediment load is greater than the volume removed; thus, the reservoir will eventually fill.

To prevent the loss of reservoir storage and loss of hydropower generation, the current low-level outlet at Black Canyon dam can be opened to move deposited sediments. However, the capacity of the low-level gates and impacts to downstream fisheries limit the ability to erode reservoir sediments. The low-level outlet gates can pass about half of the annual peak flow, limiting the flushing/sluicing time to the low flow season. Flushing during the low flow season puts the downstream community at risk as sediment loads are high in comparison to water volume. If additional gates were installed, the timing of a drawdown flush could be moved to March which would more closely mimic the natural sediment regime. Higher flows would limit the duration of the high turbidity impact, decreasing the risk to the downstream ecosystem.

Future Plans

Further investigation of both pressure and drawdown flushing can refine the timing, duration, and frequency of the operations. Studies could apply mobile-bed numerical modeling and physical modeling as well as a field test. Ideally, all three are completed before a sediment management plan can be implemented. The mobile-bed numerical and physical models will complement each other, while the field test is the best tool to predict results.

If dam management operations include pressure or drawdown flushing operations, additional monitoring is recommended. Ideally, repeat reservoir surveys before and after the flush would inform sediment volume removed. Basic operations data should be collected to include the flushing flow rate, gate opening height during the operation, length of time of the operation, and rate of refill for drawdown flushing events. Further, the downstream river health is a priority, and surveys of river health before and after the flush should be conducted to better estimate tolerances of the ecological community to elevated sediment loads. This information should be documented in a post sluicing/flushing report or memo.