Coarse Bedload — A Threat to the Viability of the Three Gorges Project

Concerns are still being raised by the engineering and scientific community regarding this significant large dam project.

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Professor Huang Wanli expressed a major technical concern about the Three Gorges Dam currently being constructed on the Yangtze River in China — namely, that bedload, especially coarse bedload, would deposit in the first backwater of the reservoir and create real problems near Chongqing.[1] There are no proven, efficient measures for sluicing this coarse material on downstream in a way that would prevent continuing damage to projected electric power generation, flood control and navigation benefits. Since some more realistic estimates of bedload quantity and particle size are greater than the official estimates, the travel distances of coarse particles by sluicing will be less successful than projected.[1-3] Although the dredging and stockpiling of this coarse material may provide some relief if the quantities of bedload turn out to be equal to some of these current estimates, long-term dredging would not be cost effective.

Sluicing Sediment Through Dams

Where reservoir sedimentation threatens the long-term viability of a dam project, it is common practice to design into the project provisions for sluicing sediment through or around the dam.[2] The sediment must be near the dam at the downstream end of the reservoir in order to be in position to be sluiced. It is very likely that most of the sand and smaller material (less than 2 millimeters in diameter) can be transported through the reservoir to this position. However, even though the Three Gorges Dam Project operating policy includes drawing down the reservoir to enhance the transport of coarse sediment through the reservoir, the extreme length of the reservoir will prevent this coarse sediment from reaching the dam; instead, a coarse-sediment delta will form near the upstream end of the reservoir.

With time, this delta will extend further and further into the reservoir, but imperfect sediment continuity in the downstream delta extension will result in progressive aggradation in the initial backwater area. Channel slope will decrease in the aggrading reach and, thus, reduce the stream power necessary to transport sediment downstream.

Current understanding of the stream power and sediment transport along a flattening (aggrading) reach of a channel at the upstream end of a reservoir, though imperfect, strongly suggests the inevitable, progressive deposition of coarse sediment.[4] The consequent rise in the channel bed elevation will result in a higher water-surface elevation where the river enters the reservoir. At the proposed final stage normal pool level (175 meters),[2] Chongqing Harbor will sooner or later be submerged. Measures such as lower operating pool levels, costly dredging and extensive levees could, of course, postpone that result indefinitely, but their costs might exceed their benefits.

A Similar Problem

The U.S. Army Corps of Engineers opened the Columbia and Snake rivers to ocean navigation as far inland as Lewiston, Idaho, via a series of dams and locks. The uppermost dam is Lower Granite Dam, a short distance downstream from Lewiston. To have turn-around depths for the Port of Lewiston, the reservoir level dictated levees for Lewiston. The height of the levees depended on the incoming bedload size and quantity, deposition of the bedload in the upper reservoir area, the new equilibrium profile of the riverbed in the deposition area, the depth of the standard project flood on top of the bed profile and a levee height to contain the project flood.

In a then-novel departure from previous levee designs, bedload on the Snake and Clearwater rivers was measured and computations were made for riverbed and water-surface elevations to determine the required dredging needs and levee heights.[5] Subsequent river surveys have confirmed the calculated predictions.

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