Controls of boundary conditions on accelerating turbidity currents in a reservoir: Case study of Xiaolangdi Reservoir on the Yellow River, China

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Turbidity currents are a major way to transport sediment along reservoir, lake and sea beds. They are not fully understood yet due to the difficulty of accessibility. Theoretical criteria have been established for the conditions that generate accelerating turbidity currents, which can produce strong erosion of channel beds, transmit over long distances and thus have important significance for reservoir and sea bed morphology. However, the current theoretical criterion only utilizes local factors of hydraulic, morphology and grain size, which do not necessarily depend on the up- and down-stream boundary conditions. Here, we conducted field surveys on turbidity currents and bed morphology of the Xiaolangdi reservoir on the Yellow River, China. The survey results show clear evidence of accelerating turbidity currents. We identify two types of accelerating turbidity currents: one locates closely to the upstream plunging point where fluvial sediment-laden flow collapses to a stratified turbidity current, concentrating momentum and producing acceleration locally, and the other is located downstream and shows dependence on the enhancement of local slope and potentially on downstream boundary (flushing condition at flow outlets of the dam). So both ends of the boundaries may work together to produce long run-out turbidity currents that transmit through the entire reservoir. Although preliminary, our dataset indicates that the conditions for accelerating turbidity currents are not only controlled by local morphology and grain size, but also by both upstream and downstream conditions. A comprehensive understanding of the boundary conditions so as to determine conditions for the generation of accelerating turbidity currents will help enhance the sustainability of the dam and reservoir system.

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