

Birth and removal of a landslide dam in a controlled tropical river gorge

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Abstract:

Landslide dams extend the reach of landslide hazards by impounding upstream water, setting the stage for catastrophic outburst floods, and disrupting river dynamics, discharge, and sediment transport. Although their geomorphic and societal consequences can be long-lasting, the mechanisms governing their formation and evolution remain poorly constrained. In most settings, rapid river adjustment or extreme triggering events obscure these processes. Located in the Ruzizi Gorge at the DR Congo–Rwanda border, the Lukula landslide dam offers a rare opportunity to isolate landslide–river interactions in a system where hydropower infrastructure imposes strong controls on discharge and sediment transport.

Using a 70-year archive of aerial and satellite imagery, we show that the Lukula landslide, likely initiated within the last $\sim 10,000$ years during gorge incision, experienced decades of slow movement before a two-year acceleration phase led to successive collapses in February and March 2024 — without clear seismic or meteorological triggers. The resulting dam impounded approximately 7 million m³ of water, forming a lake that is now receding as the Ruzizi River incises the deposit. Twelve 3D models from UAS surveys and satellite data reveal post-failure dynamics. Despite $\sim 220,000$ m³ of toe erosion, landslide motion (up to 35 m in one year) remains confined to the upper slope, suggesting weak coupling between fluvial erosion and slope deformation. In contrast, multispectral satellite data show strong coupling between landslide erosion and downstream sediment flux. Lukula provides a rare, well-documented example of the birth and removal of a landslide dam in a hydrologically controlled tropical river gorge.