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Outburst floods control the fluvial landscape evolution in Himalayan Tsangpo Gorge

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It has been debated whether gradual, persistent river flows or infrequent outburst floods play more important roles shaping the rugged mountain landscape, partially tied to insufficient evidence based on reliable retrievals of erosion and sediment fluxes from historical outburst floods. The Himalayan Tsangpo Gorge, exhibiting rapid exhumation and outburst floods, provides a perfect avenue to shed light on this debate. Here we report the quantitative erosion and transport capacity of a recent catastrophic outburst flood in Himalayan which occurred in June 2000 by landslide-dam failure with a peak discharge of $10^5 \text{ m}^3/\text{s}$. The flood lasted for only ~ 10 hours, but equivalent to the cumulative effect of 10^3 years of continuously gradual fluvial transport and erosion. The valley widened three times, triggering a large number of landslides, and extensive boulder bars were formed in the channel. These boulder bars protected the channel bed from incision but promoted extensive lateral erosion through increased roughness, resulting in widespread bank erosion and concurrent landslides, which will continue to do so until the next catastrophic flood remobilizes them. We provide direct evidence that highlights the dominance of recurrent outburst floods on drastic exhumation, deep gorge formation and long-term landscape evolution over rapidly uplifting mountains.