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Protracted fluvial recovery from medieval earthquakes, Pokhara, Nepal

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River response to strong earthquake shaking in mountainous terrain often entails the flushing of sediments delivered by widespread co-seismic landsliding. Detailed mass-balance studies following major earthquakes in China, Taiwan, and New Zealand suggest fluvial recovery times ranging from several years to decades. We report a detailed chronology of earthquake-induced valley fills in the Pokhara region of western-central Nepal, and demonstrate that rivers continue to adjust to several large medieval earthquakes to the present day, thus challenging the notion of transient fluvial response to seismic disturbance. The Pokhara valley features one of the largest and most extensively dated sedimentary records of earthquake-triggered sedimentation in the Himalayas, and independently augments paleo-seismological archives obtained mainly from fault trenches and historic documents.

New radiocarbon dates from the catastrophically deposited Pokhara Formation document multiple phases of extremely high geomorphic activity between ~700 and ~1700 AD, preserved in thick sequences of alternating fluvial conglomerates, massive mud and silt beds, and cohesive debris-flow deposits. These dated fan-marginal slackwater sediments indicate pronounced sediment pulses in the wake of at least three large medieval earthquakes in ~1100, 1255, and 1344 AD. We combine these dates with digital elevation models, geological maps, differential GPS data, and sediment logs to estimate the extent of these three pulses that are characterized by sedimentation rates of ~200 mm yr^{-1} and peak rates as high as 1,000 mm yr^{-1}. Some 5.5 to 9 km^3 of material infilled the pre-existing topography, and is now prone to ongoing fluvial dissection along major canyons. Contemporary river incision into the Pokhara Formation is rapid (120-170 mm yr^{-1}), triggering widespread bank erosion, channel changes, and very high sediment yields of the order of 10^3 to 10^5 t km^{-2} yr^{-1}, that by far outweigh bedrock denudation rates inferred from cosmogenic ^{10}Be inventories in river sands. The rapid infill of about a dozen tributary valleys displaced river channels, and caused them to re-incise into bedrock along steep epigenetic gorges. We conclude that the Pokhara Formation offers a unique archive of medieval earthquakes as well as the associated protracted fluvial response that may have been ongoing for up to 900 years.