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Impacts of the 2016 outburst flood on the Bhote Koshi River valley, central Nepal

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The central Nepal Himalaya is a region of rapid erosion where fluvial processes are largely driven by the annual Indian Summer Monsoon, which delivers up to several meters of precipitation each year. However, the rivers in this region are also subject to rare catastrophic floods caused by the sudden failure of landslide or moraine dams. Because these floods happen rarely, it has been difficult to isolate their impact on the rivers and adjacent hillslopes, and their importance for the long-term evolution of Himalayan rivers is poorly constrained. On the 5th of July, 2016, the Bhote Koshi River in central Nepal was hit by a glacial lake outburst flood (GLOF). The flood passed through a seismic and hydrological observatory installed along the river in June 2015, and we have used the resulting data to constrain the timing, duration, and bedload transport properties of the outburst flood. The impact of the flood on the river can be further observed with hourly time-lapse photographs, daily measurements of suspended sediment load, repeat lidar surveys, and satellite imagery. Overall, our observatory data span two monsoon seasons, allowing us to evaluate the impacts of the outburst flood relative to the annual monsoon flood.

The outburst flood affected the river on several timescales. In the short term, it transported large amounts of coarse sediment and restructured the river bed during the hours of the flood pulse itself. Over intermediate timescales it resulted in elevated bedload and suspended load transport for several weeks following the flood. Over longer timescales the flood undercut and destabilized the river banks and hillslopes in a number of locations, leading to bank collapses, slumps, and landslides.

We map changes in the channel and associated mass wasting using rapidEye imagery from Oct. 2015 and Oct. 2016. We also use repeat terrestrial lidar scans to quantify the magnitude of change in multiple locations along the river channel and to measure bank erosion and ongoing failures and slumps. The changes to the river bed vary along stream, ranging from up to 10 meters of channel lowering to several meters of deposition. Bank erosion ranges from simple collapses of vertical banks to large scale slumps that extend >200 m up the hillslope. Following the flood, bank and hillslope erosion continued through the monsoon season. These post-flood collapses have caused considerable damage to infrastructure, destroying houses and roads, and are likely to remain active and continue affecting the system for the next years. Our data all indicate that, despite the very short duration of the flood itself, its impact on the river outstripped the monsoon floods of 2015 and 2016.