EGU21-14033
https://doi.org/10.5194/egusphere-egu21-14033
EGU General Assembly 2021

Do megafloods reset mountain valleys?

Susannah Morey[1], Katharine Huntington[1], David Montgomery[1], Michael Turzewski[2], and Mahathi Mangipudi

[1]University of Washington, Earth and Space Sciences, United States of America (smmorey@uw.edu)

[2]Pacific Lutherean University, Department of Geosciences, United States of America

Quaternary megafloods (10^6 m^3/s) sourced from valley blocking glaciers on the Tibetan Plateau have long been implicated in the evolution of Yarlung-Tsangpo Gorge on the Yarlung-Siang River. However, past estimates of megaflood erosion in this region have relied on back of the envelope estimates of peak discharge and shear stress. This makes it difficult to fully understand how megafloods shape the landscape. Here, we use 2D numerical simulations of megaflood hydraulics over 3D topography to examine the legacy of these massive floods on this confined, sinuous mountain river. First, to assess erosional potential in the Gorge, we calculate flood power and compare it to measurements of annual stream power. We find that the simulated megaflood produces peak flood power up to three orders of magnitude higher than the stream power of the annual river. Compared to stream power, flood power in the Gorge is disproportionately higher than it is downstream of the Gorge. Additionally, in the Gorge, a larger proportion of the inundated valley experiences high flood power and shear stress for long periods of time (5-10 hrs) compared to the valley downstream of the Gorge. These results support previous hypotheses that megafloods can erode more material (both alluvium and bedrock) than the annual monsoon—potentially enough to “reset” the mountain valley by removing most of the sediment and fractured bedrock in the system. However, we hypothesize that this erosional effect is felt primarily in the Gorge region. In contrast to the erosive power in the Gorge, there is an order of magnitude decrease in average peak flood power downstream of the Gorge. We hypothesize that megafloods are predominantly depositional in this downstream domain. Here, we observe few locations that experience sustained (>5 hrs) high (>10 kPa) shear stress and those locations are often isolated and vary through time. At locations that do experience these higher shear stresses, megafloods could move and deposit large (>3 m) boulders, which subsequent annual flows or smaller historical outburst floods would be incapable of moving. These large boulders could then armor the bed and prevent erosion, which could have lasting consequences for the modern river. Most of the shear stress and flood power of the simulated megaflood outside of the modern channel boundaries are much lower, capable of moving gravel to sand sized sediment at most. This is particularly true where we observe significant amounts (>10 km) of megaflood backflow up tributaries. Instead of resetting the system, we predict our megaflood will overwhelm this downstream flood domain with the deposition of coarse- and fine-grained sediment. For the Yarlung-Siang River to incise into the bedrock in a post-megaflood landscape, it must first make its way through these megaflood deposits. Together, our results suggest that the legacy of a

megaflood in the region is both erosional and depositional. We predict wide-spread megaflood erosion in the Gorge, potentially enough to reset the system, but would expect exceptional deposition downstream of it, possibly enough to overwhelm this downstream domain.