Geomorphic response to sediment overloading in steep mountain channels triggered by seismic events

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# ABSTRACT

In mountainous terrains, seismic events such as earthquakes can trigger rapid and extensive movement of hillslope materials, leading to a substantial influx of sediment into valley floors. This sudden input of sediment significantly alters the morphology and dynamics of river channels, with the specific response of each channel being influenced by various factors. These factors include the condition of the channel system at the time of the earthquake, the interactions between sediment supply, transportation processes, and flow conditions, as well as the lasting effects of previous events and the subsequent history of disturbances. We present our understanding of the interactions between hillslope and valley floor processes, the patterns and rates at which river channels adapt to these disturbances, and the relationships that influence the downstream movement of sediment. Building upon these insights, we introduce a conceptual model that characterizes the stages of geomorphic adjustment following major earthquake-induced disturbances. Our model emphasizes how the organized input of sediment from landslides modifies the connectivity of sediment in lateral, vertical, and longitudinal dimensions within steep landscapes. We demonstrate how the lasting effects of past events and the conditions present during the earthquake influence the morphological adjustments of river channels and the patterns of sediment deposition and reworking. Our conceptual model is supported with the Hapuku River case study following the 2016 Mw 7.6 Kaikōura Earthquake, in the South Island of New Zealand. The case study portrays the post-earthquake, cascading series of sediment transfer events, giving rise to different erosional and depositional landforms and processes along the channel. Ultimately, we reflect on the lessons learned from historical case studies, considering them in the context of new developments in real-time monitoring and modeling applications. These insights are crucial for informing location-specific management strategies, incorporating an understanding of the range of likely geomorphic responses and the associated risks associated with the adjustments that follow major disturbance events.