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Simulating multi-stage landslide dam breach flooding in a multi-hazard model.

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The 2008 earthquake in the Wenchuan area in Sichuan (China) triggered over 60000 landslides. Some of these deposited in channels and streams leading to landslide dams blocking normal water flow. Although most landslide dams breached within the first months after the earthquake, landslide damming remaining a hazard in the area, due to debrisflow resulting from co-seismic landslide deposits. In 2010, one of these landslide dams was formed in the Minjang River due to large amounts of rainfall and entrainment in the upper catchment. The resulting debris flow deposition blocked major parts of the river, leading to flooding of the nearby Yinxu town. In this presentation, we present the model developments that allowed us to simulate this multi-hazard event. The event consists of three main stages: landslide runout and deposition in the side-channel, entrainment and breaching of the landslide dam, deposition and flooding in the main channel. The event was simulated using the new open source multi-hazard model OpenLISEM. The model uses multi-phase flow equations by Pudasaini (2012), hydrological equations from the original OpenLISEM and entrainment equations from Takahashi et al. (1993). The numerical implementation of the entrainment allows for lateral entrainment and collapse of the side of entrained gullies. Because of this, and the stable numerical scheme for flow, breaching of entrainable barriers can be simulated. The model results show high accuracy in predicting the spatial patterns in deposition, entrainment and flooding in all stages of the simulation. We show that with the current knowledge on dynamic hazardous land surface process it is possible to predict the behavior of multi-hazard events. Particularly, the developed techniques could be used for assessment of hazard and risk under different mitigation scenarios.