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Landscape response to the Wenchuan earthquake: sediment, topography, and carbon

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In tectonically active mountains, large earthquakes are a major driver of landscape change. Earthquakes cause surface deformation and create topography, but also trigger landslides that generate large volumes of clastic sediment and erode topography. The 2008 Mw7.9 Wenchuan earthquake offers a particular opportunity to understand the perturbation of landscapes from an event that is rare in the observational record. Looking at the research that has been done over the ten years since this event, this presentation will summarize what we have learned from this case study about the effects of large earthquakes on sediment (flux and grain size), topography, and the carbon cycle. Hydrological gauging data allows us to quantify catchment-scale erosion rates from before and after the Wenchuan earthquake, and to evaluate controls on post-earthquake erosion rates. Grain size data of landslide deposits and riverbed sediments will be presented to show how landslide supply to rivers affects fluvial sediment grain size. The Wenchuan event-triggered landslides enhanced post-earthquake sediment flux, demonstrating the erosive power of large earthquakes. Notably, the volume of the Wenchuan-triggered landslides is comparable to the co-seismically uplifted volume, raising the fundamental question of earthquake volume balance between seismic rock uplift and landslide erosion. A generalized modeling framework of earthquake volume balance is developed and applied to the Wenchuan case, with more consideration of the role of erosion-induced isostasy and post-seismic relaxation. Chemical analyses of water and sediment samples help to quantify chemical weathering rates and organic carbon fluxes following the Wenchuan event, and to explore the driving mechanisms. Combining seismic landslide volume models and regional seismicity data, we show that earthquake-triggered landslides are a major contributor to mountain erosion over geological timescales in our study area. This approach provides a promising way to project the long-term effect of such rare events over multiple earthquake cycles from short-term observations.