



Topographic status of the central Longmen Shan region——the role of the 2008 Mw 7.9 Wenchuan earthquake

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Landscape evolution in active orogenic regions is inevitably affected by the repeated strong earthquakes triggered by the corresponding active faults. However, the lack of adequate methods for the documentation and monitoring of mountain-building processes has resulted in a shortage of quantitative estimates of orogenic and eroded volumes. A strong earthquake and its associated co-seismic landslides represent a sudden pulse in landscape evolution in tectonically active areas. The 2008 Mw 7.9 Wenchuan earthquake dramatically modified the topography of the Longmen Shan region. Based on topographic data before the earthquake and stereo pairs of post-earthquake remote sensing imagery, we derived pre- and post-earthquake DEMs (digital elevation models) of the three regions along the Longmen Shan Thrust Belt. By comparing the geomorphic features before and after the earthquake, we find that the Wenchuan earthquake smoothed the steep relief and caused a co-seismic uplift of the Longmen Shan region. The medium-relief regions increased; however, the high-relief regions decreased, indicating that the local relief is controlled by repeated strong earthquakes. The changed slope aspect indicates that the formation and modification of the east- and west-facing slopes are controlled by tectonic events in the Longmen Shan region, which might be associated with the regional stress field. However, the unchanged aspects of other slopes might be controlled by long-term erosion rather than tectonic events. The topographic changes, landslide volume and co-seismic uplift indicate that the greatest seismically induced denudation occurred in association with a thrust faulting mechanism and low-angle fault geometry. Our findings reveal that the local relief has been shaped by the localized, seismically induced high rate of denudation within the plateau margins, and that the formation of local relief is also related to tectonic events, especially the events that have occurred on low-angle faults. The Wenchuan earthquake and associated co-seismic landslide erosion is the most recent expression of the rapid deformation and erosion in the eastern Tibetan Plateau. Here we quantify the Wenchuan earthquake induced erosion rate based on the differential DEM method. The results show that the average erosion rate is comparable with the rate of uplift in the Longmen Shan region. The erosion rate varies through time during the earthquake recurrence interval. Erosion associated with co-seismic landslides causes the biggest spike in erosion rate, erosion associated with rain or storm induced landslides are smaller spikes. This non-linear coupling between erosion, mean slope and local relief in the study area also reveals that the local relief growth of the middle Longmen Shan region may be already close to the upper limit.