A global relation between surface uplift and erosion caused by large, compressional earthquakes

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Large earthquakes deform Earth's surface and drive topographic growth in the frontal zones of mountain belts. They also induce widespread mass wasting, reducing relief. Previous work has found strong contrasts in the relative importance of erosion by landsliding in the mass balance of two well-studied earthquakes. To determine the main controls on the trade-off between surface uplift and erosion caused by seismicity, we have estimated the net topographic effect of 12 earthquakes with a compressional component, ranging from Mw 5.9 to Mw 8.6. This was done by comparing the volume of seismically induced landslides, determined by comprehensive landslide mapping, with the volume change due to co-seismic surface uplift computed with Okada's deformation theory. Combining our new data with older, updated information, we have determined a global, empirical relationship between triggered landslide volume and earthquake moment, accounting for seismic wave attenuation and landscape sensitivity. Comparing this relationship with theoretical coseismic uplift, we show that there is a critical magnitude above which thrust earthquakes have a negative mass balance, with net destruction of topography. This critical magnitude is controlled primarilly by seismic wave attenuation and landscape sensitivity, rather than by earthquake mechanism, and can be as low as Mw~6.