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Seismically induced erosion and the mass balance of a large earthquake

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Large earthquakes deform Earth's surface, and help build the topography of tectonically active areas. They can also induce widespread mass wasting, reducing relief and contributing significantly to societal losses. Earthquakes trigger slope failure, often in proportion to their strength, and increase substrate erodibility through shattering of rock mass and coalescence of cracks. Intense mass wasting has been reported from the epicenters of many large earthquakes, and a link between earthquakes and increased fluvial sediment transport has been demonstrated. After an earthquake, enhanced erosion persists, and its intensity and decay determine the net topographic effect of the earthquake. We have calculated the mass balance and topographic effect of the MW7.6 Chi-Chi earthquake in west Taiwan. Rates of mass wasting in the Chi-Chi epicentral area increased fivefold due to the earthquake, and since then have decayed systematically to background values. The sediment concentration in the epicentral Choshui River has closely tracked hillslope mass wasting, and from the excess sediment load of typhoon floods following the earthquake, we estimate that about half of the co- and post seismic surface elevation has been removed by seismically-induced erosion. Further erosion at background rates will annul the remaining earthquake topography faster than the return time of large earthquakes in this area. For other large earthquakes, erosion and associated damage and risk may evolve in similar, predictable ways.