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LANDSLIDE SIZE DISTRIBUTIONS AND THE STRUCTURE OF MOUNTAIN LANDSCAPES

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Landslides triggered by rainfall, earthquake strong ground motion, and snowpack ablation, exhibit similar power-law size distributions. We present a model of landslide propagation and analysis of topographic and landslide data that suggest that the size distribution is determined by the self-similarity of ridges and valleys in the landscape. In the model, landslide rupture is driven and resisted by shear stresses encountered at the rupture perimeter. Besides the material properties of the soil and rock, the shear stresses are largely set by the steepness and orientation of the hillslopes, which in turn are set by the geometry and scale of the ridges and valleys. Topographic analysis of mountain landscapes shows that the mean size of the ridges and valleys is a linear function of measurement scale, implying that model fluctuations in net shear stress grow linearly as the landslide propagates. A good way to describe these growing fluctuations is to write the rupture model as a stochastic differential equation, whose solution for rupture arrest gives the model landslide size distribution. The solution is remarkably consistent with the best available landslide data.