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A UNIVERSAL PROBABILITY DISTRIBUTION FOR LANDSLIDE EVENTS

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Landslides are generally associated with a trigger, such as an earthquake, a rapid snowmelt or a large storm. A triggered landslide event can include a few landslides or many thousands. Landslide inventories provide the number-area statistics of the triggered landslides. We examine three recent, well-documented landslide inventories, from Italy, Guatemala and the USA, each with different triggering mechanisms, and find that all three are well approximated by the same 'universal' three-parameter inverse gamma distribution. For small landslides this distribution has an exponential 'roll-over' and for medium and large landslides has a power-law tail, with a slope of 2.40. One implication of this 'universal' landslide distribution is that the mean area of landslides in the distribution is $\bar{A}_L$ = 3,070 m^2, independent of both total number N_{LT} and total area A_{LT} of the event's landslides. We also introduce a landslide-event magnitude scale $M_L = \log N_{LT}$, with N_{LT} the total number of landslides associated with a trigger. If an inventory of triggered landslides is not complete (i.e., only the largest landslides have been compiled), the density of large landslides can be compared with the 'universal' landslide distribution, and the corresponding landslide-event magnitude inferred. One can extend this technique to inventories of historic/geologic landslides, inferring the total number of landslides that occurred over geologic time, and how many of these have been erased from the landscape by erosion, vegetation, and human activity. We have also considered several frequency-volume distributions of rock falls, and find that the distributions are power-law at all scales, but with a much lower exponent than the equivalent landslide frequency-volume distributions.

Even with its obvious limitations, we suggest that our proposed universal landslide distribution and magnitude scale will be very useful in quantifying the severity of a triggered landslide event and the contribution of landslides to total erosion.