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Topography-based modeling of large rock avalanches and application to hazard assessment

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Similarly to earthquakes, wildfires, and regolith landslides, the sizes of rock avalanches follow a power-law distribution covering an enormous range of sizes. So all these processes have been viewed in the context of self-organized criticality (SOC). While a relationship of earthquakes and wildfires to SOC is well established (although still in discussion), and there have been some modeling approaches to link regolith landslides to SOC, there seems to be no model to explain the power-law distribution of rock avalanches quantitatively and to relate this process to SOC so far. In this contribution, the presumably first modeling approach that explains this power-law distribution quantitatively is presented. Applied to the European Alps, the Himalayas and the Rocky Mountains, the model suggests that a power-law exponent of 1.35 is a universal property of rock avalanches. Beyond reproducing and explaining existing statistical data, the model allows an estimate on size and frequency of the largest possible rock avalanches in a region, which cannot be derived from available rock avalanche inventories so far. Furthermore, the model predicts a power-law relation between area and volume with an exponent of $\frac{4}{3}$.