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A cellular automaton for the factor of safety field in landslides modeling

E. Piegari (1), **V. Cataudella** (1), R. Di Maio (2), L. Milano (1) and M. Nicodemi (1)

(1) Dipartimento di Scienze Fisiche, Università di Napoli Federico II, Italy, (2) Dipartimento di Scienze della Terra, Università di Napoli Federico II

The accuracy in the estimation of landslide frequency-size distributions is of fundamental importance in order to determine the hazard of a slope failure. Indeed, large events are more likely to occur if the probability distribution is a power law, than if it is an exponential. Actually, records from several regional inventories of landslides show that the statistical distribution of the area of recorded events, independent of their triggering mechanism, is well described by a power law over a range of decades, with an exponent around 2.5.

To understand these distributions, we consider a cellular automaton that is aimed at modeling the general features of landslides, and is focused on the dynamical evolution of a space and time dependent factor of safety field. The model is able to reproduce the complex structure of the landslide frequency-size distribution, as experimentally reported. In particular, we investigate the role of the rate of change of the system dynamical variables, induced by an external drive, on landslide modeling and its implications on hazard assessment. As the rate is increased, the model has a crossover from a critical regime with power-laws to non power-law behaviors. We find that the detection of patterns of correlated domains in the factor of safety within monitored regions becomes crucial for landslide classification and, consequently, for hazard assessment.