Landslide Patterns as Fingerprints of Climate Change and Basin Scale Integrated Risk

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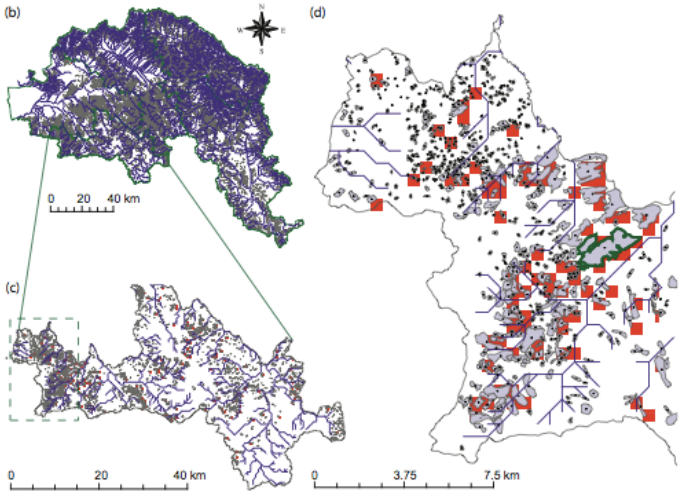
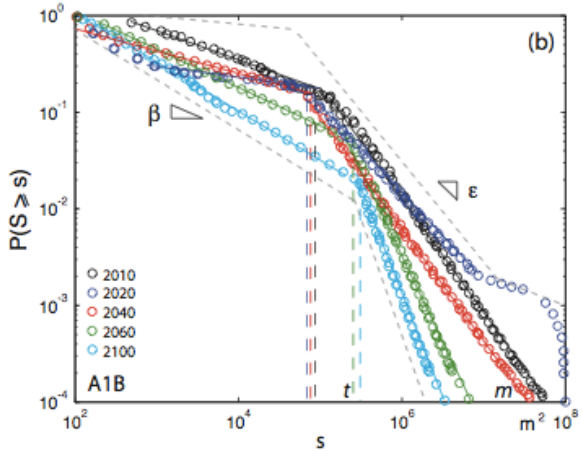
Landslides are extremely important geomorphic events that sculpt river basin ecosystems by eroding hillslopes and providing sediments to coastal areas. However, landslides are also hazardous events for socio-ecological sys- tems causing enormous biodiversity, economic, and life losses in developed and in development countries.



We propose a statistical spatially-explicit model based on a maximum entropy principle model (MaxEnt) for the prediction of precipitation-triggered landslides at the year scale. The model is based on historical landslide oc- currences, precipitation patterns, and environmental covariates at the basin scale. The threshold for the network-extraction, a Lagrangian multiplier, and the threshold on the landslide susceptibility are the only three parameters to be calibrated. The model predicts the size-distribution and location of over 27,500 historical landslides for the Arno basin in Italy which is considered as a case-study of precipitation-triggered landslides. Future landslide pat- terns are predicted for seventeen A1B and A2 precipitation scenarios and for multi-model ensembles from 2000 to 2100.

The potential integrated risk is calculated at the basin scale as a function of the hazard (size and frequency of landslides), and by assuming a damage function proportional to the size of landslides. The potential landslide hazard is strongly correlated with the variation of the 12- and 48-hour precipitation estimates with a return time of 10 years. The potential integrated risk is determined by four parameters of the double-Pareto landslide size distribution: scaling exponents, and truncation points of scaling regimes. Thus, the landslide size distribution is a fingerprint of the geomorphic effectiveness of precipitation. We observe an increase in the integrated risk in the dry period (2040-2100) due to the activation of small landslides in remnant sites of past large landslides .



On average, as the climate gets wetter the probability of large landslides gets higher. For a +20 and -15 mm variation of the 12-hour precipitation in 2020 and 2100 respectively the integrated risk of landslides is predicted 90 and 20 times higher than in 2010. For the Arno, the A1B and A2 precipitation scenarios do not produce relevant differences in the predicted landslide patterns, due to the small scale of the basin with respect to the scale of variability of precipitation.