EGU21-2443
https://doi.org/10.5194/egusphere-egu21-2443
EGU General Assembly 2021

Landslide size matters: a new spatial predictive paradigm

Luigi Lombardo[1], Hakan Tanyas[1], Raphaël Huser[2], Fausto Guzzetti[3], and Daniela Castro Camilo[4]
[1]University of Twente, Faculty of Geo-Information Science and Earth Observation, Earth System Analysis, Enschede, Netherlands (l.lombardo@utwente.nl)
[2]King Abdullah University of Science and Technology, Thuwal, Saudi Arabia
[3]Presidenza del Consiglio dei Ministri, Dipartimento della Protezione Civile, via Vitorchiano 2, 00189Roma, Italy
[4]School of Mathematics and Statistics, University of Glasgow, Glasgow, G12 8QQ, UK

The standard definition of landslide hazard requires the estimation of where, when (or how frequently) and how large a given landslide event may be. The geomorphological community involved in statistical models has addressed the component pertaining to how large a landslide event may be by introducing the concept of landslide-event magnitude scale. This scale, which depends on the planimetric area of the given population of landslides, in analogy to the earthquake magnitude, has been expressed with a single value per landslide event. As a result, the geographic or spatially-distributed estimation of how large a population of landslide may be when considered at the slope scale, has been disregarded in statistically-based landslide hazard studies. Conversely, the estimation of the landslide extent has been commonly part of physically-based applications, though their implementation is often limited to very small regions.

In this work, we initially present a review of methods developed for landslide hazard assessment since its first conception decades ago. Subsequently, we introduce for the first time a statistically-based model able to estimate the planimetric area of landslides aggregated per slope units. More specifically, we implemented a Bayesian version of a Generalized Additive Model where the maximum landslide sizes per slope unit and the sum of all landslide sizes per slope unit are predicted via a Log-Gaussian model. These "max" and "sum" models capture the spatial distribution of landslide sizes. We tested these models on a global dataset expressing the distribution of co-seismic landslides due to 24 earthquakes across the globe. The two models we present are both evaluated on a suite of performance diagnostics that suggest our models suitably predict the aggregated landslide extent per slope unit. In addition to a complex procedure involving variable selection and a spatial uncertainty estimation, we built our model over slopes where landslides triggered in response to seismic shaking, and simulated the expected failing surface over slopes where the landslides did not occur in the past.

What we achieved is the first statistically-based model in the literature able to provide information about the extent of the failed surface across a given landscape. This information is vital in

landslide hazard studies and should be combined with the estimation of landslide occurrence locations. This could ensure that governmental and territorial agencies have a complete probabilistic overview of how a population of landslides could behave in response to a specific trigger.

The predictive models we present are currently valid only for the 24 cases we tested. Statistically estimating landslide extents is still at its infancy stage. Many more applications should be successfully validated before considering such models in an operational way. For instance, the validity of our models should still be verified at the regional or catchment scale, as much as it needs to be tested for different landslide types and triggers. However, we envision that this new spatial predictive paradigm could be a breakthrough in the literature and, in time, could even become part of official landslide risk assessment protocols.