EGU23-3496, updated on 21 Feb 2024
https://doi.org/10.5194/egusphere-egu23-3496
EGU General Assembly 2023

Space-time modelling of co-seismic and post-seismic landslide hazard via Ensemble Neural Networks.

Ashok Dahal[1], Hakan Tanyas[1], Cees Van Westen[1], Mark Van der Meijde[1], Paul Martin Mai[2], Raphael Huser[3], and Luigi Lombardo[1]

[1]University of Twente, Faculty of Geo-information Science and Earth Observation
[2]Physical Science and Engineering (PSE) Division, King Abdullah University of Science and Technology (KAUST)
[3]Computer, Electrical and Mathematical Sciences and Engineering (CEMSE) Division,King Abdullah University of Science and Technology (KAUST)

Until now, a full numerical description of the spatio-temporal dynamics of a landslide could be achieved only via physics-based models. The part of the geoscientific community developing data-driven model has instead focused on predicting where landslides may occur via susceptibility models. Moreover, they have estimated when landslides may occur via models that belong to the early-warning-system or to the rainfall-threshold themes. In this context, few published researches have explored a joint spatio-temporal model structure. Furthermore, the third element completing the hazard definition, i.e., the landslide size (i.e., areas or volumes), has hardly ever been modeled over space and time. However, technological advancements in data-driven models have reached a level of maturity that allows to model all three components (Where, When and Size). This work takes this direction and proposes for the first time a solution to the assessment of landslide hazard in a given area by jointly modeling landslide occurrences and their associated areal density per mapping unit, in space and time. To achieve this, we used a spatio-temporal landslide database generated for the Nepalese region affected by the Gorkha earthquake. The model relies on a deep-learning architecture trained using an Ensemble Neural Network, where the landslide occurrences and densities are aggregated over a squared mapping unit of 1x1 km and classified/regressed against a nested 30~m lattice. At the nested level, we have expressed predisposing and triggering factors. As for the temporal units, we have used an approximately 6-month resolution. The results are promising as our model performs satisfactorily both in the susceptibility (AUC = 0.93) and density prediction (Pearson r = 0.93) tasks. This model takes a significant distance from the common susceptibility literature, proposing an integrated framework for hazard modeling in a data-driven context.

To promote reproducibility and repeatability of the analyses in this work, we share data and codes in a GitHub repository accessible from this link: https://github.com/ashokdahal/LandslideHazard.