EGU23-9538, updated on 09 Mar 2023
https://doi.org/10.5194/egusphere-egu23-9538
EGU General Assembly 2023
© Author(s) 2023. This work is distributed under
the Creative Commons Attribution 4.0 License.

Functional regression for space-time prediction of precipitation-induced shallow landslides in South Tyrol, Italy

Mateo Moreno[1,2], Stefan Steger[1], Luigi Lombardo[2], Thomas Opitz[3], Alice Crespi[1], Francesco Marra[4,5], Lotte de Vugt[6], Thomas Zieher[6,7], Martin Rutzinger[6], Volkmar Mair[8], Massimiliano Pittore[1], and Cees van Westen[2]

[1]Institute for Earth Observation, Eurac Research, Bolzano, Italy (mateo.morenozapata@eurac.edu)
[2]Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente, Enschede, The Netherlands
[3]Biostatistics and Spatial Processes, INRAE, Avignon, France
[4]Department of Geosciences, University of Padova, Padova, Italy
[5]Institute of Atmospheric Sciences and Climate, National Research Council (CNR-ISAC), Bologna, Italy
[6]Department of Geography, University of Innsbruck, Innsbruck, Austria
[7]Austrian Research Centre for Forests, Innsbruck, Austria
[8]Office for Geology and Building Materials Testing, Autonomous Province of Bolzano-South Tyrol, Cardano, Italy

Shallow landslides are frequently occurring hazards in mountainous landscapes all over the world. These processes are caused by a combination of static (i.e., predisposing factors: topography, material properties) and dynamic controls (i.e., preparatory and triggering factors: heavy rainfall, snow-melt). Data-driven methods have been used to model shallow landslides at regional scales, in which efforts have been taken to separately investigate the spatial component (i.e., landslide susceptibility) and temporally-varying conditions (e.g., rainfall thresholds). However, the joint assessment of shallow landslides in space and time using data-driven methods remains challenging.

In the present work, we aim to predict the occurrence of precipitation-induced shallow landslides in space and time (i.e., the *where* and the *when*) within the Italian province of South Tyrol (7,400 km²). In this context, we test the added value of describing the precipitation leading to landslide occurrence as a functional predictor, in contrast to traditional approaches where precipitation is taken as a scalar predictor. We built upon hourly precipitation data from the Integrated Nowcasting through Comprehensive Analysis system (INCA, provided by Geosphere Austria) and past landslide occurrences from 2000 to 2021, which systematically relate to damage-causing landslide events. The methodical framework comprised filtering the landslide inventory, sampling landslide absences in space and time (i.e., balanced across years and months), extracting static and dynamic environmental factors (e.g., topography, lithology, land cover, and hourly precipitation), and removing trivial areas and time periods. We implemented a Functional Generalized Additive Model (FGAM) to derive statistical relationships between the different static factors as scalar predictors, the hourly precipitation preceding a potential landslide event as a functional predictor, and the occurrence in space and time of shallow landslides. The resulting

predictions were assessed using cross-validation and transferred into space for different precipitation measures in order to hindcast landslide events.

The results from this novel approach are expected to integrate landslide predictions in space and time for large areas by accounting for static and dynamic (i.e., hourly precipitation grids) landslide controls, seasonal effects, and the underlying data limitations (e.g., inventory incompleteness). The findings associated with this research are framed within the PROSLIDE project, which has received funding from the research program Research Südtirol/Alto Adige 2019 of the Autonomous Province of Bozen/Bolzano – Südtirol/Alto Adige.