Thunderslide - from rainfall to preliminary landslide mapping: an automated open-data workflow for regional authorities

Stefano Crema¹, Alessandro Sarretta¹, Donato Maio², Francesco Marra³, Giorgia Macchi¹, Velio Coviello¹, Marco Borga⁴, Lorenzo Marchi¹, and Marco Cavalli¹

¹CNR - IRPI National Research Council - Research Institute for Geo-Hydrological Protection, Corso Stati Uniti 4, 35127, Padova, Italy (stefano.crema@irpi.cnr.it)
²CNR - IMAA National Research Council - National Research Council - Institute of Methodologies for Environmental Analysis, C.da S. Loja, 85050 Tito Scalo, Potenza, Italy
³CNR - ISAC National Research Council – National Research Council - Institute of Atmospheric Sciences and Climate, via Piero Gobetti, 101, 40129, Bologna, Italy
⁴Department of Land, Environment, Agriculture and Forestry, University of Padova, Viale dell' Università 16, 35020, Legnaro, Padova, Italy

Gathering systematic information on the effects of extreme weather events (e.g., floods, landslides and debris flows, windthrows) is a fundamental prerequisite to establishing rapid-response strategies and putting into practice management policies. However, the collection of field data requires significant economic and human efforts by local authorities. Furthermore, events occurring in remote areas are rarely detected and mapped accurately as they have a low chance of intersecting human infrastructures. These missed detections lead to incorrect assumptions in relation to both the extreme events’ spatial distribution and, especially, the real occurrence probability. This work proposes a framework for obtaining the automatic identification of severe weather events that may have caused important erosion processes or vegetation damage, combined with a rapid preliminary change detection mapping over the identified areas. The proposed approach leverages the free availability of both high-resolution global scale radar rainfall products and Sentinel-2 multi-spectral images to identify the areas to be analyzed and to carry out change detection algorithms, respectively. Radar rainfall data are analyzed and the areas where high-intensity rainfall and/or very important cumulative precipitation has occurred, are used as a mask for restricting the subsequent analysis, which, in turn, is based on a multi-spectral change detection algorithm. The whole procedure feeds a geodatabase (storing identified events, retrieved data and computed changes) for proper data management and subsequent analyses.

The testing phase of the proposed methodology has provided encouraging results: applications to selected mountain catchments hit by intense events in northeastern Italy were capable of recognizing flooded areas, debris-flow and shallow landslide activations, and windthrows. The described approach can serve as a preliminary step toward detailed post-event surveys, but also as a preliminary “quick and dirty” mapping framework for local authorities especially when resources for ad hoc field surveys are not available, or in the case of an event that triggers changes in remote areas. Such a systematic potential change identification can help for a more homogeneous and systematic detection and census of the events and their effects. The workflow
herein presented is intended as a starting point on top of which more modules can be added (e.g., radar climatology, SAR change detection for near real-time, other severe sources such as lightning, earthquakes or wildfires, machine learning algorithms for image classification, land use and morphological filtering of the results). Future improvements of the described procedure could be finally devised for allowing a continuous operational activity and for maintaining an open-source software implementation.