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Exploring the potential of soil moisture reanalysis data for improving the identification of regional landslide triggering thresholds

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Landslide triggering thresholds provide the rainfall conditions that are likely to trigger landslides, therefore their derivation is key for prediction purposes. Different variables can be considered for the identification of thresholds, which commonly are in the form of a power-law relationship linking rainfall event duration and intensity or cumulated event rainfall. The assessment of such rainfall thresholds generally neglects initial soil moisture conditions at each rainfall event, which are indeed a predisposing factor that can be crucial for the proper definition of the triggering scenario. Thus, more studies are needed to understand whether and the extent to which the integration of the initial soil moisture conditions with rainfall thresholds could improve the conventional precipitation-based approach. Although soil moisture data availability has hindered such type of studies, yet now this information is increasingly becoming available at the large scale, for instance as an output of meteorological reanalysis initiatives. In particular, in this study, we focus on the use of the ERA5-Land reanalysis soil moisture dataset. Climate reanalysis combines past observations with models in order to generate consistent time series and the ERA5-Land data actually provides the volume of water in soil layer at different depths and at global scale. Era5-Land project is, indeed, a global dataset at 9 km horizontal resolution in which atmospheric data are at an hourly scale from 1981 to present. Volumetric soil water data are available at four depths ranging from the surface level to 289 cm, namely 0-7 cm, 7-28 cm, 28-100 cm, and 100-289 cm. After collecting the rainfall and soil moisture data at the desired spatio-temporal resolution, together with the target data discriminating landslide and no-landslide events, we develop automatic triggering/non-triggering classifiers and test their performances via confusion matrix statistics. In particular, we compare the performances associated with the following set of precursors: a) event rainfall duration and depth (traditional approach), b) initial soil moisture at several soil depths, and c) event rainfall duration and depth and initial soil moisture at different depths. The approach is applied to the Oltrepò Pavese region (northern Italy), for which the historical observed landslides have been provided by the IFFI project (Italian landslides inventory). Results show that soil moisture may allow an improvement in the performances of the classifier, but that the quality of the landslide inventory is crucial.