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. 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.
<u>Could the reanalysis soil moisture data improve the identification of the landslide triggering thresholds?</u>

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Climate reanalysis combines past observations with models in order to generate consistent time series. The ERA5-Land data provides the volume of water in soil layer at different depths and at global scale.

It is 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.
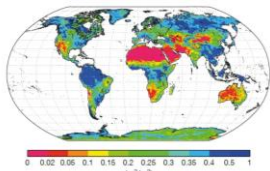

Figure 1 ERA5-Land soil moisture data. The chart shows mean soil moisture for May 2018 from ERA5-Land.
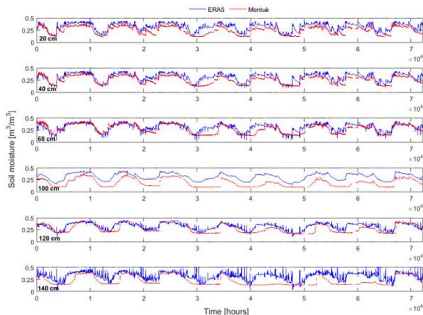

Figure 2 Comparison between reanalysis soil moisture data and measured data at different depths for the selected study area (Oltrpò Pavese Region, Northern Italy)

Intensity – Duration thresholds (I – D)

Landslide thresholds, are commonly in the form of a <u>power-law</u> relationship linking rainfall event duration and intensity or cumulated event rainfall.
The optimization of the I - D power law threshold gives back a TSS = 0.4 corresponding to the red point in the FPR-TPR plane (Figure 5)
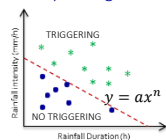

$$y = ax^n$$
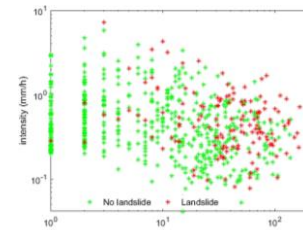**Figure 3** Examples of intensity (I)–duration (D) triggering thresholds

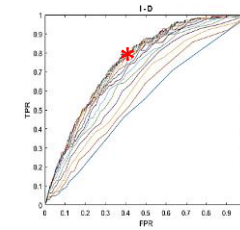**Figure 4** Intensity –Duration values for each landslide / no landslide event within the study area

Figure 5 ROC curves for different a and n values. The red star rapresents the best obtained performance with FPR=0.4 and TPR=0.8

Cumulated rainfall – Soil moisture thresholds (H – S)

For each of the four available layers, different thresholds taking the form presented in Figure 6 have been assessed. An increase of the resulting TSS value is observed ranging from 0.6 to 0.7 depending on the considered layer (Figure 8) together with a TPR = 0.8 and FPR = 0.15
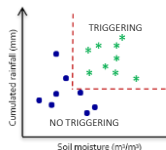

Figure 6 Examples of the adopted cumulated rainfall (H) – Soil moisture (S) landslide triggering thresholds
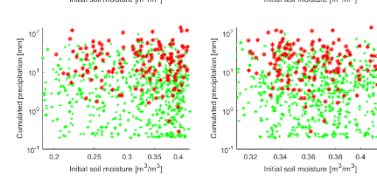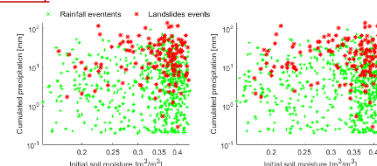

Figure 7 Cumulated rainfall – Soil moisture values for each landslide / no landslide event within the study area
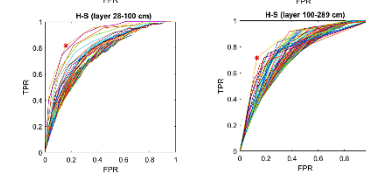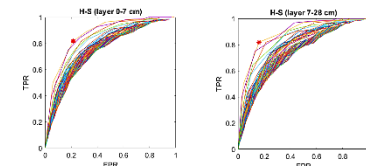

Figure 8 ROC curves for different H and S htreshold values. The red star rapresents the best obtained performance

THE TAKE-HOME MESSAGE

Preliminary results suggest that soil moisture may allow an improvement in the performances since an increase of the TSS value was found out but that the quality of the landslide inventory is crucial.

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SESSION NH3.1 Space and time forecasting landslides