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Improving landslide movement forecasting using ASCAT-derived soil moisture data

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Predicting the spatial and temporal occurrence of rainfall triggered landslides represents an important scientific and operational issue due to their high threats to people and goods. However, the prediction of both spatial and temporal occurrence of landslides still remains a complex task. This study investigates the relationship between rainfall, soil moisture conditions and landslide movement by using recorded movements of a rock slope located in central Italy, the Torgiovannetto landslide. This landslide is a very large rock slide located near the famous town of Assisi, threatening county and state roads. Data acquired by a network of extensometers and a meteorological station clearly indicate that the movements of the unstable wedge, firstly detected in 2003, are still proceeding and the alternate phases of quiescence and reactivation are associated with rainfall pattern. By using a statistical approach, the opening of the tension cracks (as recorded by the extensometers network) as a function of rainfall and soil moisture conditions prior the occurrence of rainfall, are predicted in the period 2007-2009. Specifically, soil moisture observations are obtained by the Advanced SCATterometer (ASCAT) sensor on board MetOp (Meteorological Operational) satellite. To estimate the root-zone soil moisture, an exponential filter is applied to the time series of the ASCAT surface soil moisture obtaining the so-called Soil Water Index, SWI. An Antecedent Precipitation Index, API, usually employed for the assessment of the wetness conditions, is also used for comparison. Results indicate that the regression performance (in terms of correlation coefficient, r) significantly enhances if an indicator of the soil moisture conditions is included. Specifically, r is equal to 0.40 when only rainfall is used as predictor variable and increases to r=0.68 and r=0.85 if the API and the SWI are used, respectively. Therefore, notwithstanding the coarse spatial resolution (25 km) of satellite data, the ASCAT SWI is found to be very useful for the prediction of the movement of a local scale landslide. These findings, although valid for a specific area, open new challenges for the effective use of satellite-derived soil moisture estimates to improve landslide forecasting worldwide. A first analysis based on the use of a more advanced physical approach is also carried out.