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Rainfall thresholds for mid-depth landslide triggering: assessment method applied to a translational rock slide in central Italy

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The assessment of landslide triggering rainfall thresholds is a useful technique to predict the occurrence of such phenomena and provide public authorities with the values of the critical rainfall over which it is appropriate to consider the state of alert. In this perspective, I investigated the urban area of San Vito Romano, a 3500 inhabitants), located in the Aniene River basin, about 50 km east of Rome, and heavily affected by landslides.
This area extends over a calcarenitic-marly-arenaceous bedrock of Tortonian age, arranged in a monocline structure dipping 10/15 degrees eastward, in parallel with the slope angle.
Part of the village overlays a 500 m large translational rock slide that has caused damage to many buildings during the last decades. Boreholes, drilled in the landslide area, some of them supplied with piezometers and inclinometers, have provided detailed information on the underlying bedrock (silico-clastic deposits of the Frosinone Formation of upper Tortonian age) and the covering near-surface materials. In particular, borehole data showed the existence of three different sliding surfaces located at different depths (6, 12 and 24 meters).
In order to establish a relationship between landslide events and the triggering rainfall amounts, I have carried out an inventory of all the slope movements that affected the study area in the last few decades on the basis of field survey, stratigraphic analysis, archive research and piezometric/inclinometric data. Then, I calculated and mapped the cumulative rainfall amounts within 3 days, 10 days, 1 month and 3 months before each landslide occurrence. By comparing the landslide distribution with the rainfall maps, I calculated the rainfall thresholds for each event, also considering the depth of the related sliding surface. In this context, I observed that a 3 days pre-event precipitation of 100 mm mobilized the shallow material overlying the upper sliding surface only with at least 170 mm of rain in the last pre-event month. Moreover, I could estimate a rainfall threshold of 80 mm in the 3 pre-event days for the slope mass above the mid-depth sliding surface if the rainfall in the last three months was at least 400 mm. On the contrary, I could not estimate a reliable rainfall threshold for the slope mass overlying the deepest surface.