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Predicting the impact of vineyard management changes on landslide susceptibility by incorporating probabilistic parameterization into the landscape evolution model LAPSUS

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Rainfall-induced shallow landslides, which mobilize the first few meters of soil cover (usually <2m) following significant rainfall events, can severely impact human life. They most frequently damage human activities as they often dam rivers, invade roads, destroy crops and occasionally cause the loss of human lives.

Such landslides can develop in vineyards, as they are commonly grown on hillslopes, causing farmers to lose revenue. However, not all vineyards are managed the same way: standard management techniques include (1) Tillage and Total Tillage (T/TT), which is the tillage of the soil between rows up to 6 times a year; (2) Permanent Grass Cover (PGC), in which grass is allowed to grow between rows and (3) ALTernating tillage-grass (ALT), the practice of tilling every other row.

Since land use has been proven to impact landslide susceptibility, the present work aims to investigate how landslide susceptibility would be affected by vineyard management changes.

To do so, a probabilistic version of the physically based landscape evolution model Lapsus-LS was adopted.

Created as a physically based model, LAPSUS simulates soil movement downslope by calculating the critical rainfall needed for triggering landsliding. After calibrating the critical rainfall threshold, the model calculates a slide trajectory and accumulation lobe with a double multiple flow routine.

The model requires as inputs the Digital Terrain Model (DTM) of the area, range values for geotechnical parameters, and a land use map of the site. Associated with the latter are values of root cohesion, which vary among different vineyard management practices: root cohesion is lower in T and TT vineyards and is higher in PGC and ALT vineyards.

In its probabilistic version, the model selects each input from a range of acceptable values and runs its course 100 times to compile a map illustrating which cells are more commonly predicted

as unstable. Cells calculated as unstable in more than 50% of the iterations are classified as such.

The model was applied in the basin of Rio Vergomberra (municipality of Canneto Pavese, PV), a hilly area of 0.54 km^2, in the Oltrepò Pavese (located in the southern-west sector of the region of Lombardy, in Italy) where shallow landslides triggered by rainfall are expected. Vineyards in the area are managed through T and TT techniques in the southeast sector, where most of the landslides have occurred, and through PGC and ALT in the northwest sector, where no landslides have occurred.

It was therefore evaluated how the predicted landslide susceptibility would be affected if vineyards currently cultivated with T and TT management techniques were to be managed through PGC.

The result was a lowering of the predicted susceptibility in previously unstable T and TT vineyards, despite the steep slope angles.

The result is also supported by the generally lower number of landslides in PGC vineyards compared to T and TT vineyards in the Oltrepò Pavese. In the presented study area alone, all five past landslides that occurred in vineyards were located in tilled vineyards.