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Deformation and failure dynamics on agricultural dry-stone walls: a novel approach to stability analysis

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Failure of retaining structures in terraced farmlands related to the progressive ceasing of maintenance activities represents a broadly documented issue in several countries across the world. This phenomenon is often the main cause of degradation of terraced landscapes, which in many areas represent a relevant cultural and landscape heritage. Understanding the processes that lead to instability of dry-stone walls in agricultural land is of the utmost importance in order to provide detail information for practitioners and land planners for optimizing restoration and maintenance operations. In this context, a monitoring system was set up on a dry stone wall terrace in Tuscany, central Italy, aiming at measuring pressures acting on the wall and the temporal variation of soil water content at different depths. Two load cells were mounted behind the wall, and a soil moisture probe was installed in the backfill down to a depth of 0.7 m.
A coupled hydrological-geotechnical model was developed for the estimation of destabilizing forces in saturated and unsaturated conditions, also considering the possible occurrence of a water column behind the wall. The destabilizing pressures were estimated for each stone layer composing the dry-stone masonry, considering soil moisture profiles resulting from filed observations and the hydrological and geotechnical modelling. The stabilizing forces acting on each stone layer were also estimated, assuming the possible sliding between the layers. Results showed how stone movements can occur also in unsaturated conditions as a gradual, slow process. The higher instabilities were found for the central layer (between 1/3 and 2/3) of the wall height, showing a bulging profile well fitting to the ones observed in the field.