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Stability analysis of Mt Toc slope in the years up to the 1963 Vajont catastrophic slide: the critical role of a confined aquifer

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Water-soil interaction is known to play a fundamental role in the equilibrium conditions of slopes. Limit Equilibrium Methods (LEMs) include groundwater contribution in the Mohr-Coulomb criterion, as a term decreasing the shear strength and hence reducing the safety factor value. In our work, we investigate the effect of a confined aquifer, located just below the gliding surface of a mass. We model the related water pressure as an external load acting on the gliding surface and incorporate it in the Minimum Lithostatic Deviation (MLD) method (Tinti and Manucci, 2006; Tinti and Manucci, 2008), which is one of the variants of the LEM.

We test the validity of the modified model on the Vajont case which is examined for a period a few-year long until the crucial instant of the catastrophic landslide. The hypothesis is that water infiltrations from the reservoir and rainfalls, fed phreatic and artesian aquifers, and that this latter induced a destabilizing overpressure in the clay layer at the basis of the slide that led first to the deformation and then to the detachment of the mass.

We have identified ten milestone profiles in the landslide pre-history depending on rainfall and reservoir filling data. We calculate the variation of the safety factor with time and demonstrate that the timeline of the main events of the Vajont case can be reproduced satisfactorily only by taking into account the action of the confined aquifer. Our analysis shows therefore that the combination of both phreatic and confined aquifers, in addition with the lowering of the reservoir level, were key factors for the destabilization of the Mt Toc flank and the consequent occurrence of the disastrous landslide.