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Looking high and low: comparing a UAV-based and a ground-based methodology for the detection of vineyard terrace failures

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Agricultural terraces are known to be related to complex hillslope hydrology, characterized by surface and sub-surface water flows. Locally high fluxes or accumulation of water can be responsible for terrace wall failures, such as collapse and piping. There is a need for both scientific research and applied sustainable viticulture to better understand these processes. A key challenge is to find a suitable balance between highly integrated but local field measurements, and a more approximate but widespread approach such as remote sensing. In this study, two distinctive methodologies were applied in order to locate and explain terrace wall failure observed in a north-Italian vineyard: a field-based vs. a remote sensing approach. The field-based approach was based on spatially distributed measurements of topsoil soil moisture content using Time Domain Reflectometry (TDR) instrument. This survey revealed high relative soil water concentration at the damaged terraces, in both wet and dry conditions. Furthermore, a unique cross-sectional saturation profile was found above the damaged walls, with the highest values found near the edges. The remote sensing approach was based on a photogrammetric survey and subsequent high-resolution digital terrain analysis and modeling using the Topographic Wetness Index (TWI) and SIMulated Water Erosion model (SIMWE). Results showed how the formation of surface water flow patterns explains the location of damaged walls. These findings show both the opportunities and limitations of the two approaches. Field measurements provided more conclusive information about the location of walls at risk (high predictive potential), but this approach is relatively labour-intensive (low upscaling potential) as compared to a remote sensing approach. The latter can be a powerful tool for acquiring fully distributed estimations of wall failure over larger non-instrumented areas.