A grand comparison of soil & water conservation in 50 vineyards under 5 different terracing systems

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Steep-slope agricultural landscapes often show a mosaic of diverse terraced and non-terraced hillslope configurations. The use and specific design of Soil and Water Conservation (SWC) measures such as earth bank or dry-stone wall terraces is often the result of agro-landscape evolution, and is shaped by various factors such as culture-historical values (e.g. traditional cultivation methods), agronomic development (e.g. mechanisation), site-specific conditions (e.g. local rainfall regime and construction materials), as well as environmental concerns (e.g. runoff and erosion control). Concerning the latter, the effectiveness of SWC measures is becoming increasingly urgent in the face of climate change expressed as extreme rainfall interspersed with drought periods, as commonly found in Mediterranean Europe.

While past research has provided unique insights in the impact of several terracing practices on runoff and erosion control (doi.org/10.1016/j.catena.2020.104604), this mostly focussed on descriptive analysis of detailed soil degradation patterns in a limited number of study areas. In this study, we expand this research by a comprehensive and massive evaluation of 50 vineyards cultivated by 5 different terracing and non-terracing techniques in the cultural landscape of Soave, northern Italy. This provides a grand comparison of SWC impacts based on a systematic workflow of high-resolution topographic analysis, physical erosion modelling, and statistical evaluation. Analysis is performed on a preselected set of 50 representative vineyards (10 sites for each practice) with homogeneous soil type and properties, geometric shape and size, slope positioning and steepness (calculated from 1-m LiDAR data). A set of SWC indicators is determined (e.g. average rates of soil erosion, deposition, and runoff), and are computed for each vineyard using spatially-distributed physical simulations by the Simulated Water Erosion (SIMWE) model. Simulated processes are quantified by zonal statistics, while differentiating between potential detachment and deposition hotspots (i.e. pre-determined uphill and downhill zones inside each vineyard). This allows a first indication of SWC impacts by the different hillslope configurations. Furthermore, we provide a comparison of the actual cultivated study sites and an assumed “natural scenario” (i.e. smoothed terrain, natural vegetation), in order to quantify the impacts of the 5 different terrace configurations on SWC.

Our findings provide relevant insights in the SWC effectiveness of terraced and non-terraced cultivation practices commonly found in the steep-slope agricultural landscapes of Italy. The
unique experimental scale of our systematic comparison offers reliable and novel findings, which support sustainable landscape planning and management, e.g. as in our case by rural development plan Solution System “Innovative solutions for soil erosion risk mitigation and better management of vineyards in hilly and mountain landscapes” (www.soilutionsystem.com). Future research along the same lines are encouraged in order to improve the general understanding of SWC in steep cultivation systems across diverse geographical settings.