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Connectivity of runoff and sediments in reclaimed Mediterranean-dry slopes: controlling factors and long-term ecological implications

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Hydrological connectivity has emerged in recent years as a critical factor for understanding the transference of runoff, sediments and nutrients across scales. Here we examine its relevance for the successful reclamation of water-limited environments in which vegetation stability largely depends on optimal redistribution of water and soil resources for plant production. We studied the connectivity of runoff and sediments across plot to slope scales in three Mediterranean-dry reclaimed slopes that were restored about 25 years ago and have developed different levels of vegetation cover (24-51%) and rill density (0.5-0.0 m m-2), along a gradient of overland flow (slope-scale runoff coefficient 11.2%-0.5%). Event-based connectivity of runoff and sediments was controlled by the spatial organization of vegetation and rills, and at the same time was modulated by storm intensity. In absence of rill networks, both runoff and sediment yield per unit area decreased from patch to slope scales due to internal redistribution of both water and sediment fluxes. However, the connectivity of the slopes increased with rainfall intensity. Additionally, the presence of rills largely increased the connectivity of runoff and sediments, leading to increases in sediment yield across scales due to active rilling under high intensity storm conditions. Further simulations using an eco-geomorphic modelling approach showed that the development of rill networks structurally enhances the hydrological connectivity in these systems, providing persistent pathways for the routing of water and soil resources out of the slopes that can compromise the development and long-term stability of reclaimed vegetation. Overall, our results confirm the relevance and efficiency of using a surface connectivity analysis for understanding the spatial and temporal dynamics of water-limited eco-geomorphic systems, and call for its application in order to achieve a successful restoration of Mediterranean slopes.