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Soil erosion-vegetation interactions in Mediterranean-dry reclaimed mining slopes

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Mining reclamation in Mediterranean-dry environments represents a complex task. Reclaimed mining slopes are particularly vulnerable to the effects of accelerated soil erosion processes, especially when these processes lead to the formation of rill networks. On the other hand, encouraging early vegetation establishment is perceived as indispensable to reduce the risk of degradation in these man-made ecosystems. This study shows a synthesis of soil erosion-vegetation research conducted in reclaimed mining slopes at El Moral field site (Teruel coalfield, central-east Spain). Our results highlight the role of rill erosion processes in the development of reclaimed ecosystems. Runoff routing is conditioned by the development of rill networks, maximizing the loss of water resources at the slope scale by surface runoff and altering the spatial distribution of soil moisture. As a result, the availability of water resources for plant growth is drastically reduced, affecting vegetation development. Conversely, vegetation exerts a strong effect on soil erosion: erosion rates rapidly decrease with vegetation cover and no significant rill erosion is usually observed after a particular cover threshold is reached. These interactive two-way vegetation-soil erosion relationships are further studied using a novel modeling approach that focuses on stability analysis of water-limited reclaimed slopes. Our framework reproduces two main groups of trends along the temporal evolution of reclaimed slopes: successful trends, characterized by widespread vegetation development and the effective control of rill erosion processes; and gullying trends, characterized by the progressive loss of vegetation and a sharp logistic increase in erosion rates. This stability-analysis also facilitates the determination of threshold values for both vegetation cover and rill erosion that drive the long-term reclamation results, assisting the identification of critical situations that require specific human interventions to ensure the long-term sustainability of the restored ecosystems.