Lithology-mediated soil erodibility characteristics after vegetation restoration in the karst region of southwest China

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Abstract

Ecological restoration projects have significantly contributed to the global increase in vegetation cover and the reduction of soil erosion. However, the impact of lithology in the karst ecosystem on changes in soil erosion characteristics during vegetation restoration remains unclear. This study aims to investigate the soil erosion characteristics of hillslopes under different vegetation restoration strategies in the fragile karst areas composed of limestone and dolomite. The restoration strategies mainly include arbor forest (AF), orchard (OC), and grassland (GL), with cropland (CR) as the control. Soil physical-chemical properties and soil erodibility factors (K_{EPIC}, K_{NOMO}) were used to evaluate soil erosion characteristics. The results showed that, in comparison to cropland, both limestone and dolomite in restoration strategies exhibited lower soil bulk density (BD) and soil erodibility K values, as well as higher capillary porosity (CP) and soil water-stable aggregates (WSA). However, the K value of limestone (17.9%) was significantly higher compared to dolomite. Additionally, limestone exhibited significant changes ($p < 0.05$) in soil properties, such as BD, organic matter content (OMC), CP, and WSA. Conversely, dolomite did not show significant changes in these soil properties. These findings indicate that vegetation restoration was effective in improving soil structure and erosion resistance, and dolomite exhibit higher stability compared to limestone. Through redundancy analysis, it was observed that soil texture, represented by silt content, was the primary parameter indicating changes in soil erosion characteristics following vegetation modification. The silt content explained 84.4% and 78.2% of the variation in K values for limestone and dolomite, respectively. Moreover, the changes in K values for dolomite were also controlled by OMC, whereas limestone was solely controlled by soil texture. These findings suggest that the interactions between soil properties contribute to the improvement of stability in dolomite. Accordingly, vegetation restoration enhances soil erosion resistance; however, the effectiveness of restoration was controlled by the lithology in the southwestern karst region.

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