Factors controlling erosion dynamics in Mediterranean vertisols: the case of the Kamech catchment in Tunisia.

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ABSTRACT

A better understanding of sediment dynamics is essential for conserving soil and water resources, as well as mitigating environmental risks. This study aims to identify the main factors governing sediment transport in vertisol-dominated areas, where knowledge of erosion factors and processes is limited due to a lack of long-term data. To this end, we analysed an 18-year dataset comprising rainfall, runoff and erosion time series, which was acquired at the 175-hectare GBV station in the Kamech Observatory. The catchment area is located in the semi-arid north of Tunisia. Land use is dominated by cereals and leguminous crops. The soil mainly consists of highly expansive clays, which are responsible for active shrinkage and swelling processes across more than two-thirds of the study area. The study area is characterised by a semi-arid Mediterranean climate, with a mean annual rainfall and runoff of 620 mm and 105 mm, respectively. Flow regime is ephemeral, occurring in a limited number of runoff and erosive events. In this study, we examined the influence of 18 potential factors on suspended sediment concentration (SSC) or specific sediment flux (M_spec) by applying linear and power-law regression models at event scale. For each model, the final set of significant factors was determined using an AIC-based stepwise upward selection procedure, followed by a pruning procedure mainly based on multicollinearity estimated via VIF and statistical significance such as p-value. The findings demonstrated that the multiple linear model outperformed the power-law model in terms of predicting SCC, while the power-law model exhibited superiority in predicting M-Spec. For both target variables, the most influential factors are the peak discharge and the percentage of vegetation cover, followed, to a lesser extent, by runoff volume and rainfall intensity. As expected, it is easier to predict M-Spec than SCC. Variables related to runoff also proved to be key factors in predicting both target variables. The key role of vegetation cover in limiting sediment transport has also been highlighted. Finally, we have identified a significant time lag between the peak in SCC, which occurs in early autumn, and the peak in sediment export, which occurs around December. This can be explained by the major role played by the swelling-shrinkage dynamics of the cracks, which are largely opened by the end of the dry summer. These cracks severely restrict autumn runoff due to the 'bypass effect', thereby limiting the export of suspended sediment during this season despite high values of SCC.

Keywords: Erosion, Factors, Sediment exports, Vertisols, Tunisia.