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Spatial and temporal variability of soil erosion in rangelands of southwest Spain

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The present paper examines spatial and temporal variability of water erosion in semiarid and dry subhumid rangelands of southwest Spain based on a variety of studies carried out since 1990 in Extremadura. The application of the results with regard to sustainable land management is also discussed. Climate is Mediterranean with continental and atlantic influences. Mean annual temperatures are about 16ºC and average annual precipitation ranges from 450 to 800 mm and climate is semiarid to dry subhumid. Rainfall variation is high, both seasonally and interannually. The rangelands are commonly covered by evergreen oak trees (*Quercus rotundifolia, Q. suber*) of varying density, ranging from treeless areas to woodlands with 80 tress per hectare. Besides the layer of herbaceous species, shrubs can also be found in different places. A variety of land uses and management systems exist, being livestock razing (sheep, cattle, pigs, goats) the most important one, besides forest and agricultural exploitation. Erosional and hydrological processes are investigated in experimental watersheds and also in different farms distributed in Extremadura. Sheetwash (interrill erosion) is the dominant process on hillslopes, gully erosion is mainly observed in valley bottoms with an alluvial sediment fill and rilling occurs where the land has been ploughed for cultivation or shrub cleaning.

In the Guadalperalón study catchment (1990-1997) soil losses due to sheetwash were determined using open plots, and gully erosion was monitored by means of a topographic survey. Rainfall and discharge were measured at the outlet of the basin with a time-resolution of 5 minutes. Furthermore, detailed information on ground cover and its temporal development is availabe for a period of two years.

For both processes investigated the variation of erosion was high. In the case of interrill erosion, 133 events were sampled during the study period which registered rainfall amounts in excess of 5.2 mm, the threshold for runoff generation at hillslopes. A proportion of 10% of these events was responsible of nearly 76% of the total amount of soil loss, and only two events caused 50.7% of the total loss. Mean gully erosion amounted to 39.05 m^3 a^{-1} (1.5 t ha^{-1} a^{-1}), varying between +4.92 and –219.20 m^3.

Important differences exist with respect to the relationships between factors and processes for these two erosion phenomena. In the case of sheetwash the variability is mainly related with the characteristics of the rainfall events and the degree of soil cover. Changes in soil cover are related with seasonal and interannual variations of precipitation and with stocking density. Low to moderate livestock densitities may produce degradation of the vegetation cover during prolonged dry periods (droughts), provoking higher soil losses, whereas during normal or humid periods soil losses were low. Antecedent soil moisture conditions and sediment availability are secondary factors.

Gullying is related with high amounts of overland flow generated on the slopes which are characterized by shallow soils with low infiltration capacity. However a close relationship between discharge and gullying does not exist. This is partly due to the complex hydrological response of the catchment. During dry antecedent moisture conditions Hortonian type overland flow dominates, whereas during humid conditions saturation excess overland flow is more important. Temporal rainfall distribution is a crucial factor in two ways. Low frequency, high magnitude events (high intensity rainstorms) generate rapid runoff response with peak discharges, of importance especially during dry soil conditions, whereas continuous rainfall, reaching amounts in access of 250 mm, produces water saturation of the sediment fill in the valley bottom, thereby enhancing greatly runoff production. Highest sediment losses were observed under the latter condition. Of further importance are bank failures which are related with high soil moisture content, as could be shown in the Parapuños experimental catchment, where gully erosion is monitored since 2001.

Soil losses produced by rill erosion of approximately 100 t ha^{-1} were registerd as a consequence of an exceptional rainfall event (recurrence interval 200 years) in a field which had been ploughed recently, values far higher than those observed by gullying or sheetwash.