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Analysis of soil losses caused by concentrated flow for the improvement of management strategies in an olive orchard microcatchment in Spain

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Soil losses caused by rills, ephemeral gullies and gullies represent one of the major processes of land degradation in agricultural areas such as olive orchards, where the interaction of steep slopes, frequent erosive rainfall events, low soil cover and inappropriate managements contribute to their development. The identification of dominant erosive phenomena in agricultural fields are essential for the design and implementation of suitable management strategies.

This work presents the analysis of the contribution of concentrated flow (rills and ephemeral gullies) to soil losses in an olive orchard microcatchment where tillage operations were applied for a period of three years (2009-March-2012). morphological patterns of (shape, depth, width, length and location) rill and ephemeral gullies formed during inter-tillage periods were measured and analyzed. Rainfall characteristics, runoff and sediment load were also monitored at the catchment outlet for the same period. In an attempt to fill data gaps caused by equipment failure, e.g. during high erosive events, the LISEM model (De Roo and Offermans, 1995) previously was calibrated and applied for singular events.

During the study period, the cumulative rainfall between tillage operations and measurement dates was 786.2 mm (generated in 30 events during 2009-2010), 209.5 mm (10 events; 2011) and 27.72 mm (1 event; 2012); whereas the erosivity values reached 1154.8, 618.9 and 42.8 MJ.mm.ha-1.h-1 for each period. The maximum intensity in 30 minutes (I30) was 29.6 mm h-1, corresponding to an event occurred in 2011, with a return period to 1.2 years. The approximate soil losses in the catchment were 11.8 t.ha-1, 23.6 t.ha-1 and 0.16 t.ha-1, for the periods 2009-2010, 2011 and 2012, respectively.

Although different networks of rills and ephemeral gullies were observed during each campaign, the volume of erosion associated to concentrated flow was equal or quite larger than soil losses measured in the outlet. This illustrates the dominance of rill and ephemeral gully erosion processes in the field and the need of its control. Spatial analysis allowed to concentrate the effort on the hillslope where most rills were located. The main proposed measure was the establishment of cover crop strips. A cost analysis allowed to justify its application.

References

De Roo, A.P.J., Offermans, R. J. E., 1995. LISEM: a physically-based hydrological and soil erosion model for basin-scale water and sediment management. In: Modelling and Management of Sustainable Basin-scale Water Resource Systems (Proceedings of a Boulder Symposium, July 1995). IAHS Publ. no. 231, 1995. 399