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Modelling runoff depth and connectivity in commercial vineyards (DO Somontano, Huesca, NE Spain)

Dr. Manuel López-Vicente and Dr. Ana Navas
EEAD-CSIC, Department of Soil and Water, Zaragoza, Spain (mvicente@eead.csic.es)

Surface runoff, soil redistribution and sediment delivery are non-linear processes that depend on many parameters, and thus, numerical simulation of overland flow, sediments and other solutes connectivity is a complex and non-solved task. Additionally, man-made landscape linear elements (LLEs: unpaved and paved trails, roads, land levelling, irrigation ditches, stone walls, dams, etc.) modify the natural patterns of connectivity. Mediterranean soils have been cultivated for hundreds and thousands of years and landscapes appear intensively modified. Vineyards are one of the most ancient crops in Mediterranean countries and recently in other countries around the World. In this study, we run the IC model of connectivity (Borselli et al., 2008, doi:10.1016/j.catena.2008.07.006) and the water balance DR2-2013© SAGA v1.1 model (López-Vicente et al., 2014, doi:10.1016/j.envsoft.2014.08.025; software freely downloaded at http://digital.csic.es/handle/10261/93543) in a vineyard (26.4 ha) composed by four fields (6.2 ha) and their upslope drainage area. These commercial fields belong to a winery included in the Somontano certificate of origin. All input maps are generated at 5 x 5 m of cell size and the digital elevation model is based on LIDAR technology. The map of connectivity showed the typical spatial pattern of overland flow though values of connectivity varied along the whole map. The average value was –2.65 (sd = –0.62) and within the four vineyards was –2.46 (sd = –0.65). High connectivity appeared in bare soil areas, in the unpaved trail and within some sections of the main pathways. The lowest connectivity appeared in the forest and in small areas within the vineyards. The effective rainfall (ER) that reaches the soils, was 88% on average (384 mm) from the total rainfall depth (436 mm yr–1) and the average initial runoff, before overland flow processes, was 382 mm yr–1 (sd = 31 mm). The ER within the vineyards was 81%. The effective runoff (CQeff) ranged from 0.5 until 985.5 mm yr–1 with an average value of 51.4 mm and 52.4 mm within the vineyards. The corresponding map showed numerous disruptions along the hillslope due to the presence of LLEs and topographic changes. The total depth of annual runoff corresponds to only 28.3% of the total effective rainfall (TER) and 24.9% of the total rainfall depth (TR). Within the vineyards these percentages were of 21.6 and 17.5%. The remaining water associated with the runoff and rainfall events (Waa) meant 71.7% and 63.2% of the TER and TR, respectively, and 78.4 and 63.2% within the vineyards. The average values of Waa were 130 and 189 mm for the whole study area and within the vineyards. The map of the Waa presented a different spatial pattern where the land uses play a more important role than the processes of cumulative overland flow. The highest values of CQeff appeared in April, September, October and November. The joint analysis of the results and the correlation between the predicted values with the IC and DR2 models adds valuable information about the processes of surface water dynamics in hillslopes with cultivated and forested soils.