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Joint application of the ModRMMF and IC models of soil erosion and sediment connectivity: improvement of modelling predictions

Manuel López-Vicente (1), Laura Quijano (1), Leticia Palazón (1), Javier Machín (1), Leticia Gaspar (2), and Ana Navas (1)

(1) Estación Experimental de Aula Dei - CSIC, Department of Soil and Water, Zaragoza, Spain (mvicente@eead.csic.es), (2) Cranfield University, Cranfield Water Sciences Institute, Cranfield, Bedfordshire MK43 0AL, United Kingdom

Soil detachment, sediment delivery and redistribution are non-linear processes that depend on many factors and their values change as a function of the different temporal and spatial scales. Therefore the development of accurate and broad models is a difficult task and most approaches cover a limited number of processes. In this study we seek to boost the predictive ability of two models by their joint application in a Mediterranean agricultural system (42º 26' 12"N; 1º 13' 10" W; NE Spain). Firstly, we run the Modified Revised Morgan, Morgan and Finney (ModRMMF) model of soil erosion and the Index of sediment Connectivity (IC) in a small agricultural system (Site-Plot) at very high spatial scale (1 x 1 m of cell size) and results are analysis in order to identify those areas with net soil loss and deposition. Then, the calibrated IC model is run in the La Reina gully catchment (Site-Catch) where the Site-Plot is included at high spatial scale (5 x 5 m) and potential soil redistribution is mapped. This study area presents numerous man-made infrastructures (paved and unpaved trails, drainage ditches, stone walls and barriers, buffer strips) that modify the runoff pathways and the effect of these landscape linear elements (LLEs) is included in the IC model. Climate is continental Mediterranean and the average annual rainfall was 514 mm in the latest 25 years (1987-2011). A total of 613 soil samples were collected in the Site-Plot and all input and output maps were generated with ArcMapTM 10.0. The map of cumulative runoff, calculated with a multiple flow algorithm, allowed identifying those areas with predominant rill soil erosion of that with main interrill erosion. In the Site-Plot the average soil erosion was 1.84 Mg / ha yr and the corresponding map shows a high spatial variability (s.d. = 15.5 Mg / ha yr). The map of sediment connectivity mirrors the spatial pattern of soil erosion obtained with the ModRMMF model though the values of IC (between -10.5 and -0.5) present a higher spatial variability, especially in those areas where the soil erosion model predicts both very low and very high rates. Although sediment connectivity is high in the unpaved trails and those areas with concentrated overland flow, the IC model let us identify pixels and small patches with low connectivity and thus sedimentation within these areas with predominant processes of soil loss. The scatterplot diagram of the values of the two models at each sampling point shows the presence of two populations with an inflexion point in the value IC=-4.2. Lower values indicate predominant processes of soil deposition whereas higher values indicate net soil loss. The inflexion point value was then used to identify the stable, sedimentation and erosion prone areas in the map of sediment connectivity of the La Reina gully catchment. Thus, the combined used of two different models makes more valuable the results obtained with each model lonely and helps researchers obtain a better interpretation of the generated maps.