



Soil redistribution in a small Mediterranean agro-ecosystem: modelling predictions calibrated with Cs-137 derived rates

Manuel López-Vicente (1), Teresa López-Montero (1), Leticia Gaspar (2), Javier Machín (1), and Ana Navas (1)

(1) Department of Soil and Water, Estación Experimental de Aula Dei (EEAD-CSIC). Zaragoza 50059, Spain (mvicente@eead.csic.es), (2) Cranfield University, Cranfield Water Sciences Institute. Cranfield, Bedfordshire MK43 0AL, United Kingdom

Hydrological and soil erosion models allow mapping and quantifying rates of runoff depth and soil redistribution for different land uses and climatic scenarios. Mediterranean soils are threatened by marked seasonal changes in the climatic, soil and phenological parameters and thus accurate modelling predictions are difficult to be done. The semi-physically-based Soil Erosion and Redistribution Tool (SERT) model is presented, and also the preliminary results of its application in a small Mediterranean agro-ecosystem (0.73 ha; Central Spanish Pre-Pyrenees). The model is run at high spatial scale (1 x 1 m) and using a detailed database from 266 soil samples. The hydrological module is based on the recently published DR2 (Distributed Rainfall-Runoff) water balance model. The erosion module is built from the Modified Revised Morgan, Morgan and Finney model, and the new Remaining runoff Transport Capacity factor used to estimate the rates of soil loss and deposition. The SERT model predicted an average erosion rate of 15 Mg ha⁻¹ yr⁻¹ for the whole catchment. These values threaten the sustainability of the cultivated areas (42 Mg ha⁻¹ yr⁻¹ on average) and the bare soils (32 Mg ha⁻¹ yr⁻¹) and also medium to high values of soil erosion affect the soils in the Mediterranean and Oak forests (7.0 and 2.8 Mg ha⁻¹ yr⁻¹). These rates exceed the tolerable rate of 1.4 Mg ha⁻¹ yr⁻¹ for European cultivated lands, though are in the same range of magnitude than other values obtained in similar landscapes. Soil erosion was minimum in February (0.15 Mg ha⁻¹ yr⁻¹ on average) and 28 times higher in October. Stable areas, without processes of soil loss neither deposition, are frequent in January (22% of the total surface), February (21%), March (23%), November (11%) and December (24%), whereas for the other seven months the percentage remains below 10%. Predominant processes of soil loss take place between June and September (soil surface affected by net soil loss ranges between 82 and 84%), whereas soil deposition extend over larger areas in April, May, October and November. To perform the calibration procedure 133 control points were established along the whole study area and the Cs-137 activities were measured using a coaxial gamma-ray detector. As the processes of soil loss and deposition are modelled separately with the Cs-137 measurements, the calibration procedure was also split into two parts. The calibrated predictions with Cs-137 got an average Nash–Sutcliffe efficiency of 0.42 and calibrated rates of soil loss (Pearson's $r = 0.746$) and soil deposition ($r = 0.722$) gave a balance of -1.37 Mg yr⁻¹ for the whole study area. These performance values have to be evaluated taking in mind that the analytical precision of the measurements done with Cs-137 is approximately $\pm 5\%$. The sediment balance can be considered as a good estimation as the study area is endorheic and karstic. The new calibrated model is an easy-to-run and low-input-demanding management tool with valuable outputs for hydrological and soil erosion studies in small agricultural catchments.