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Soil and Nitrogen redistribution in a small Mediterranean cereal field: modelling predictions and field measurements

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Cultivation is one of the main factors triggering soil erosion and the loss of fertile soil accelerates and in some cases causes soil degradation and crop yield reduction. Patterns of erosion, delivery and deposition of soil particles appear to be closely linked to that of soil nutrients. In this study, we assess the rates of soil and nutrient (soil nitrogen) redistribution and budget in a rain-fed cereal experimental plot (0.65 ha; Ebro river basin, NE Spain) caused by water erosion. The study area has a mean slope of 7%, it is classed as a closed-hydrological unit due to the cutting-connectivity effect of the landscape linear elements (LLEs), it has only one outlet and runoff directly reach La Reina gully. Climate is continental Mediterranean with two humid periods (average annual rainfall depth of 556 mm). Rainfall events of high intensity happen in June, July, September and October, with average values of maximum rainfall intensity in 30 min higher than 4 mm h–1 and above 6 mm h–1 in October. Soils are classified as Haplic Calcisols with an average and maximum values of soil organic matter of 1.5% and 2.4% respectively, high carbonate contents (ca. 39%) and texture is silt loam. The field has been cultivated for more than 150 years and consequently the soil is thoroughly mixed in the plough layer (25–30 cm). The cereal field was last harvested in June 2007 and from that date onwards the field has remained fallow for research purposes. Before fallowing the field was managed with minimum tillage during 15 years. Vegetation clearance practices were implemented to prevent scrub growth and so the soil surface has remained almost bare since that date. A total of 222 topsoil (5 cm depth) samples were collected following a regular 5x5 metre grid. Soil nitrogen content (%) was determined by the dry combustion method using a Leco TruSpec carbon and nitrogen analyzer (LECO Corporation, St. Joseph, MI, USA). Soil nitrogen was detected by determining the NO_x gas evolved after oxygen combustion at 950 ºC by a thermal conductivity detector. The average and maximum values of soil nitrogen were 0.11% and 0.37%, respectively. We run the GIS-based SERT-2014 SAGA v1.0 model of soil erosion (more details in DOI:10.1002/hyp.10370). All input maps were generated at 1x1 metre of cell size allowing sound parameterization. Simulation was run at monthly scale with average climatic values. Results of simulated soil erosion, net soil loss and deposition were used to generate the map of soil redistribution. The correlation between the values of soil redistribution and those of soil nitrogen was done at each sampling point. The average annual sediment budget was calculated and the predicted value was analysed in the context of the total nitrogen budget.