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Effect of terraces, sinks and scarps in modelling cumulative overland flow and soil erosion at catchment scale

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Distributed erosion models are potential tools for identifying soil sediment sources. However, the uncertainty of model predictions has yet to be resolved. This work presents a new approach to estimate how terraces and geomorphic structures (sinks and scarps) modify overland flow connectivity and thus affects the assessment of soil erosion rates. This target is achieved by using geographic information systems (GIS), detailed maps of topography, geomorphic elements and land-uses in a small mountain catchment (La Coloma, Spanish Pre-Pyrenees). Overland flow per raster cell and soil erosion was estimated with the revised Morgan, Morgan and Finney (RMMF) model. Cumulative runoff was calculated with a combined algorithm of flow accumulation and the trap-efficiencies of human and geomorphic structures were calculated from the basis of the recently published work of Schäuble et al. (2008) [Computers & Geosciences 34: 635–646]. All maps were derived and the models were run at a spatial resolution of 5 x 5 meters. A total of 16 soil samples were collected in order to obtain a database of different soil properties. Results underline the complexity of runoff connectivity in the study area due to the presence of sinks, stone bunds and terraces. These natural and anthropogenic structures are characterized by high values of trap-efficiency and create areas of temporal accumulation of overland flow and eroded particles. Moreover, karstic processes of limestone dissolution explain the presence of clogging soils where no erosion is expected. The highest rates of soil erosion were obtained in cultivated areas at the bottom of the catchment and in areas under low canopy cover. Areas with high values of flow length also present high values of runoff and soil erosion. This work has proved the usefulness of adding information of terraces and geomorphic structures to improve the assessment of overland flow at catchment scale. Moreover, values of spatially distributed soil erosion showed a direct correlation with the presence of sinks and areas of actual runoff accumulation. Results of this research facilitate the better understanding of the dynamic of runoff generation. The information gained can be applied to areas disturbed by humans as well as with complex topography.