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Soil erosion modelling nowadays: insights of a young scientist

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Soil erosion models allow mapping and quantifying rates of runoff depth and soil redistribution in a wide variety of environments for different land uses and climatic scenarios. Runoff generation, soil detachment, sediment delivery and river dynamic are non-linear processes that depend on many factors, and thus the development of accurate and broad models has being always a difficult task. Taking in mind this complexity, predicting models have evolved from the first empirical equations (1930's) to the current ambitious and GIS-based models. The first attempts were developed for small areas like the studies of Mockus (1949) and Andrews (1954) that constituted the basis of the runoff Curve Number (SCS-CN). The research of Wischmeier and Smith (1958 and 1978) in plots about the relationship between rainfall energy, soil erodibility and soil loss as well as the development of the Universal Soil Loss Equation became the RUSLE model (Renard et al., 1991) that has been one of the most applied models of rill and interrill erosion. A recent version of RUSLE is the WATEM/SEDEM (Van Rompaey et al., 2001) model that predicts spatially distributed rates of soil loss and deposition at catchment scale and also estimates tillage erosion. Other models simulated not only processes of surface runoff and soil erosion but processes of nutrients, pollutants and sediment delivery, such as CREAMS (Kinsel, 1980) and AGNPS (Young et al., 1987). The assistance of GIS techniques in the 1990's was a milestone that let scientists create advanced models such as the dynamic LISEM (De Roo et al., 1995) and the hydrological STREAM (Cerdan et al., 2002) models. In some cases the current models can be downloaded as executable files: the empirical RUSLE2 (Foster et al., 2000), the process-based WEPP (Adams et al., 2012) and DR2 (López-Vicente and Navas, 2012), the complex river basin SWAT (Arnold et al., 1998) and TETIS (Francés et al., 2007) and the reduced-complexity SedNet (Prosser et al., 2001) models at continuous temporal scale, and also the event-based TOPMODEL (Beven et al., 1995) and EUROSEM (Morgan et al., 1998) models. The development of specific software and its availability in internet since the beginning of the 21st century has been another milestone in soil erosion modelling offering the opportunity to generate hundreds of simulated scenarios in a short period of time. Nowadays, there is coexistence between the different approaches and scientists use both simple empirical and complex physically based models, as well as mass and energy balance equations at any spatial and temporal scales. Even though, landscape evolution models can be found in the literature (SIBERIA; Hancock and Willgoose, 2001). Finally, the current challenges in soil erosion modelling studies are: i) achieve a good linkage between the different types of models related to the processes simulated towards a holistic point of view, ii) include as many calibration techniques as possible within the mathematical operations, iii) use the free data bases available in internet, and iv) introduce specific input factors about the human activities that strongly modify the natural dynamic of soil erosion.