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Landscape evolution by soil redistribution in a Mediterranean agricultural context

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Soils and landscapes are frequently subjected to rapid evolutions induced by climate changes and humans disturbances. Early, soil scientists had already sought to identify the dynamic interactions between soils and landscapes. Soil redistribution modelling is an appropriate analyse methodology widely utilized (Kirkby, 1985; Van Oost et al., 2000; Van Rompaey et al., 2001; Minasny and McBratney, 1999; Van Oost et al., 2005; Govers et al., 2006) to understand space time evolution in soil and landscape processes at short and medium term.
The aims of this research is to develop a model able to simulate soil evolution as affected by soil redistribution processes (e.g. water-erosion processes and mechanical erosion) and to use pedological knowledge acquired from a field study coupled with the present research.

The LandSoil model, here proposed, is an event based model, dimensioned for fine spatial [1 m] and medium [10 –100 years] temporal scales, taking into account a detailed representation of the agricultural landscape structure. It is composed of three modules for soil erosion/redistribution: rill erosion (Souchère et al., 2003); interrill erosion (Cerdan et al., 2002); and tillage erosion based on the mechanistic rules developed by Govers et al., 1994. After each rain and tillage event a new topography is evaluated as well as all the geometric landscape parameters.
Specificities of the model are: i) long-term landscape analysis and topography balance after each rainfall; ii) evaluation of water erosion and soil mechanistic redistribution (tillage erosion); iii) taking in consideration of the landscape geometry, especially connectivity, as a significant information in describing the landscape and useful in modelling (Landscape structure management and landscape design); and iv) utilisation of various and different climate scenarios thanks to the event based model. Subsequently we apply this model to study the effect of different scenarios of land management and climate changes on soil cover and landscape evolution.

The model has been tested on a watershed unit (91 ha) located at Roujan (43°30'N – 3°19'E) in the south of France (Hérault, France). Its first justification is to allow the study of global changes affecting hydrosystems in agro-systems located in Mediterranean context. Mediterranean environment is well adapted to study the system vulnerability to anthropic and climatic pressure changes. The pedological dataset is based on the soils map (1/25 000) of the watershed established by Coulouma et al. (2008) refined with data collected during two pedological surveys implementing a 25 m square sampling scheme for soil description.
The simulated soil depth evolution, compared to the present soil cover detailed by the surveying, seems to confirm the observed patterns in terms of soil redistribution and topographic evolution. Land use, cultural practices and agricultural landscape structure are also able to directly influence sediment fluxes, then the related landscape evolution. The present landscape structure, tested under the perspective of climate changing showed a mitigating effect in terms of soil erosion confirming the importance of a detailed representation of the system geometry in modelling practises.