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The impact of the soil surface properties in water erosion seen through LandSoil model sensitivity analysis

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Quantitative models of soil redistribution at the landscape scale are the current tools for understanding space-time processes in soil and landscape evolution. But models use larger and larger numbers of variables and sometimes it becomes difficult to understand their relative importance and model behaviours in critical conditions.

Sensitivity analysis (SA) is widely used to clarify models behaviours, their structure giving fundamental information to ameliorate models their selves. We tested the LandSoil model (LANDscape design for SOIL conservation under soil use and climate change) a model designed for the analysis of agricultural landscape evolution at a fine spatial resolution scale [1-10 meters] and a mid-term temporal scale [10-100 years]. LandSoil is suitable for simulations from parcel to catchment scale. It is spatially distributed, event-based, and considers water and tillage erosion processes that use a dynamic representation of the agricultural landscape through parameters such as a monthly representation of soil surface properties.

Our aim was to identify most significant parameters driving the model and to highlight potential particular/singular behaviours of parameter combinations and relationships.

The approach was to use local sensitivity analysis, also termed "one-factor-at-time" (OAT) which consists of a deterministic, derivative method, inquiring the local response O to a particular input factor *Pi* at a specified point $P0$ within the full input parameter space of the model expressed as:

$\partial O/\partial P = (O_2\text{-}O1)\,/\,(P2\text{-}P1)$

The local sensitivity represents the partial derivatives of O with respect to *Pi* at the point $P0$.

In the SA procedure the topographical entity is represented by a virtual hillslope on which soil loss and sensitivity are calculated. Virtual hillslope is inspired from the virtual catchment framework proposed by Cheviron at al. (2011): a fixed topology consisting of a 3X3 square pixel structure having 150 m length allowing to test different spatial configurations of the properties within the hillslope.

To test the model we identified different parameters. A three-category (P, R, p) sensitivity analysis procedure was therefore found possible and appropriate to control the effects of hydrological factors (P, R) and soil-terrain parameters (p). All the analysis were done with the use of the integration of the ArcGis software structure, on which the LandSoil model is based, and the PEST model (Doherty, 2004). PESTR is an iterative, non-linear parameter analysis software platform based on the Gauss–Marquardt–Levenberg algorithm (Marquardt, 1963).

The results show the relevance of the rainfall amount in simulation and some interesting interactions between parameters such soil roughness – soil crusting and soil cover.