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"The right answer for the wrong reason" revisited: validation of a spatially-explicit soil erosion model (RillGrow)

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One finding from the GCTE evaluation of soil erosion models (Jetten et al., 1999) is that the models tested were, in general, weak regarding the spatial aspects of erosion. A perfectly adequate simulation of runoff and soil loss at the catchment outlet could be produced even if the model did a poor job of identifying the location of erosion hotspots within that catchment. Spatially, the models could give "the right answer for the wrong reason".

As well as casting doubt on the validity of process representations within such a model, this kind of result is clearly unacceptable when using it to plan or evaluate soil conservation measures within the catchment.

With this as a background, the RillGrow series of soil erosion models were developed. These represent an eroding hillslope area as a self-organizing system (e.g. Favis-Mortlock, 1998; Favis-Mortlock et al., 2000). Microtopography is considered to determine the spatial pattern of overland flow and hence of surface lowering; such lowering modifies the path of subsequent flow. This simple iterative relationship generates rill networks emergently, i.e. as a collective whole-system response to many local interactions. The approach removes a requirement of many erosion models: the need to 'pre-specify' rill characteristics even for an unrilled surface. However, computational constraints currently confine RillGrow to simulation of small, plot-sized, areas.

Even on such small areas however, model validation is not straightforward. In a series of validation studies, DEMs of the microtopography of real soil surfaces (from both laboratory flumes and hillslope plots) were used as inputs to the RillGrow model. Model-simulated rill networks were then compared with those which developed on the real soil surfaces. Other model outputs (e.g. hydrographs and sedigraphs at the outlet; water depths and velocities at points on the surface) were similarly compared.

While conceptually simple, problems with this approach include:

* The difficulty of objectively comparing two rilled soil surfaces. Real and modelled surfaces might appear very similar, but if planwise rill locations differ by even a few mm, then correlation-based measures indicate a poor result. The converse can also be true.

* Flow velocity within rills can vary widely over short distances. However velocity values obtained using e.g. dye tracers have had this small-scale variation smoothed away. How should such values be compared with point-based simulated flow velocity values?

Such ambiguities once again open the possibility of obtaining "the right answer for the wrong reason". Thus this paper highlights these and other issues which can arise when validating a spatially-explicit soil erosion model such as RillGrow.