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Towards real-world application of the RillGrow model, at last? Advantages and disadvantages of modelling soil erosion by water as a self-organizing system

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The RillGrow series of soil erosion models represent an eroding hillslope as a self-organizing system (e.g. Favis-Mortlock, 1998; Favis-Mortlock et al., 2000). Pre-existing hillslope 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.

DEMs of the microtopography of real soil surfaces were, in a series of validation studies, used as inputs to the RillGrow model. Simulated rill networks were then compared with those which developed on these surfaces during laboratory and field experiments; simulated and measured hydrographs and sedigraphs were similarly compared. RillGrow is able to realistically predict the spatial pattern of rills which will develop in response to a given rainfall event. It is also able to replicate several (but not all) characteristics of the flow which creates these rills.

Thus it seems that, in the domain of soil erosion models at least, choice of an appropriate conceptual framework (self-organization) and spatio-temporal scale (microscale) renders it possible to develop an improved geomorphological model which, while physically-oriented, is also simple. However, such simplicity comes at a cost. Because of the need to represent flow and erosion at the microscale, the model's computational requirements are very considerable. Data needs also pose some problems.

For this reason, the model has remained impractical for real-world conservation tasks. Simulations take infeasibly long if the model is run on representations of areas larger than a laboratory flume or a hillslope plot. Development of RillGrow (now at version 3) has continued: representations of other erosional processes, such as splash, infiltration, and rill-wall slumping have been added. These have refined the model's predictive ability; but RillGrow remains solely a research tool.

To overcome this limitation, a version of RillGrow is being developed (in collaboration with Queen's University Computing Services) which is capable of running on highly parallel computing platforms. While this project is still a work in progress, initial results from even a modestly-parallelized version of the model are promising.