Spatial hazard assessment of sediment delivery using statistical perturbation and physical models

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ABSTRACT

There exists a growing move towards the use of physically-based models of various environmental processes to make quantitative assessments of the risks posed by various land-use practices. Risk, in this context, is defined as the likelihood that an inherent hazard will be realized. The ways in which land-use alters the propensity for change, compared to the inherent hazard, provide the set of options available between which land managers can choose.

Here, we take an approach of dividing a given region into management units; these will often be the paddock structure but may be otherwise defined. For hazard assessment, we are interested in the integrated response of the region to a change in a particular management unit (or set of them). The approach adopted is to model the behaviour of the region as a whole by assuming all units have the same properties. The contribution of each unit to the integrated output is then quantified by altering the response of that unit and examining the change in the integrated output.

Our example is delivery of sediment through a catchment. The management units are individual fields; a buffer along channels is also recognised. We assume that the climate (rainfall) is fixed and that land-use principally alters soil erodibility. Two constant cases are defined: sediment supply unlimited and a minimum erodible state offered by near-complete groundcover.

Rather than simply change the erodibility across an entire field in a constant fashion, a perturbation is imposed by defining the mean and standard deviation of a statistical distribution function. We examine further the case in which the perturbation is conditioned on a secondary attribute; in this case slope position.

We quantified the hazard each field poses to the integrated catchment output and thereby identified the portions of the catchment for which risk analysis should be undertaken to guide management.