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On the role of "internal variability" on soil erosion assessment

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Empirical data demonstrate that soil loss is highly non-unique with respect to meteorological or even runoff forcing and its frequency distributions exhibit heavy tails. However, all current erosion assessments do not describe the large associated uncertainties of temporal erosion variability and make unjustified assumptions by relying on central tendencies. Thus, the predictive skill of prognostic models and reliability of national-scale assessments have been repeatedly questioned. In this study, we attempt to reveal that the high variability in soil losses can be attributed to two sources: (1) 'external variability' referring to the uncertainties originating at macro-scale, such as climate, topography, and land use, which has been extensively studied; (2) 'geomorphic internal variability' referring to the micro-scale variations of pedologic properties (e.g., surface erodibility in soils with multi-sized particles), hydrologic properties (e.g., soil structure and degree of saturation), and hydraulic properties (e.g., surface roughness and surface topography). Using data and a physical hydraulic, hydrologic, and erosion and sediment transport model, we show that the geomorphic internal variability summarized by spatio-temporal variability in surface erodibility properties is a considerable source of uncertainty in erosion estimates and represents an overlooked but vital element of geomorphic response. The conclusion is that predictive frameworks of soil erosion should embed stochastic components together with deterministic assessments, if they do not want to largely underestimate uncertainty.

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