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Using the USLE: Chances, challenges and limitations of soil erosion modelling

To give soils and soil degradation, which are among the most crucial threats to ecosystem stability, social and political visibility, small and large scale modelling and mapping of soil erosion is inevitable. The most widely used approaches during an 80year history of erosion modelling are Universal Soil Loss Equation (USLE)-type based algorithms which have been applied in 109 countries. Addressing soil erosion by water (excluding gully erosion and land sliding), we start this review with a statistical evaluation of nearly 2,000 publications). We discuss model developments which use USLE-type equations as basis or side modules, but we also address recent development of the single USLE parameters (R, K, LS, C, P). Importance, aim and limitations of model validation as well as a comparison of USLE-type models with other erosion assessment tools are discussed. Model comparisons demonstrate that the application of process-based physical models (e.g., WEPP or PESERA) does not necessarily result in lower uncertainties compared to more simple structured empirical models such as USLE-type algorithms. We identified four key areas for future research: (i) overcoming the principally different nature of modelled (gross) versus measured (net) erosion rates, in coupling on-site erosion risk to runoff patterns, and depositional regime, (ii) using the recent increase in spatial resolution of remote sensing data to develop process based models for large scale applications, (iii) strengthen and extend measurement and monitoring programs to build up validation data sets, and (iv) rigorous uncertainty assessment and the application of objective evaluation criteria to soil erosion modelling.