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A systematic assessment of uncertainties in large scale soil loss estimation from different representations of USLE input factors – A case study for Kenya and Uganda

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The Universal Soil Loss Equation (USLE) is a standard model to assess soil erosion by water. The model equation quantifies long-term average annual soil loss as a product of the rainfall erosivity R, soil erodibility K, slope length and slope steepness LS, the soil cover C and support measures P. Several methods exist to derive each of the model inputs from readily available data. The estimated values of a model input, however, can strongly differ depending on the method that was applied. The multiplication of the input factors with the USLE eventually results in large uncertainties for the soil loss estimates. A comparison of the estimated soil loss to observation data can potentially reduce the uncertainties. Yet, for large scale soil loss estimations, in-field observations are rare and their comparability to long-term soil estimates is limited. This work puts a focus on uncertainty and sensitivity analysis in large scale soil loss estimation employing the USLE with different realizations of the USLE input factors.

In a systematic analysis we developed different representations of the USLE inputs for the study domain of Kenya and Uganda with a spatial resolution of 90 m. All combinations of the generated USLE inputs resulted in 756 USLE model setups. We assessed the resulting distributions in soil loss, both spatially distributed and on district level for Kenya and Uganda. In a sensitivity analysis we analyzed the contributions of the USLE model inputs to the ranges in soil loss and analyzed their spatial patterns. We compared the calculated USLE ensemble soil estimates to available in-field data and other study results and addressed possibilities and limitations of the USLE model evaluation.

The USLE model ensemble resulted in wide ranges of estimated soil loss, exceeding the mean soil loss by over an order of magnitude particularly in hilly topographies. The study implies that a soil loss assessment with the USLE is highly uncertain and strongly depends on the realizations of the model input factors. The employed sensitivity analysis enabled us to identify spatial patterns in the importance of the USLE input factors. The C and K factors showed large scale patterns of

importance in the densely vegetated part of Uganda and the dry north of Kenya, respectively. The LS factor estimates were mostly relevant in small scale heterogeneous patterns. Major challenges for the evaluation of the estimated soil losses with in-field data were due to spatial and temporal limitations of the observation data, but also due to measured soil losses describing processes that are different to the ones that are represented by the USLE.

Reference: Schürz, C., Mehdi, B., Kiesel, J., Schulz, K., and Herrnegger, M.: A systematic assessment of uncertainties in large scale soil loss estimation from different representations of USLE input factors – A case study for Kenya and Uganda, Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2019-602, in review, 2019.