Hydrology and Earth System Sciences
Discussions

Hydrol. Earth Syst. Sci. Discuss., author comment AC2
https://doi.org/10.5194/hess-2021-457-AC2, 2021

Reply on RC1

Timo A. Räsänen et al.

Author comment on "High-resolution erosion susceptibility data for agricultural lands of Finland" by Timo A. Räsänen et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-457-AC2, 2021

Dear Referee #1,

Thank you for your thoughtful and constructive comments (RC) – they helped to improve the manuscript. Altogether, the comments from the editor and the two referees prompted major revisions, and we have revised the manuscript. The major revisions are:

- The country scale results on actual erosion and erosion management index were removed from the revised manuscript due to limitations in the used C-factor data, which was pointed out by Pedro Batista (Referee #2). Correction of the C factor data requires considerable research work and decision was made to leave it as future work to be published in another publication.
- The LS factor and consequent erosion data was recalculated to account for field borders.
- The results on RUSLE evaluation, erosion susceptibility and susceptibility near water bodies were slightly restructured to accommodate the changes caused by removal of the two parts in mentioned in the previous point.
- New sensitivity analyses were added that provide estimates on
  - the propagation of uncertainties from RUSLE factors to erosion estimates
  - effects of location specific cropping and management practices and temporal rainfall erosivity distribution on C- factor values and the consequent erosion estimates
- The terms "potential erosion risk" and "actual erosion risk" were replaced by terms, "erosion susceptibility" and "actual erosion" to avoid the misuse of the term "risk".

Thus, the new findings of the revised manuscript are:

- New high-resolution (two-meter) country scale erosion susceptibility data for Finland
- New evaluation of RUSLE and its performance in boreal conditions, which considers also different spatial scales and issues relate to upscaling from field parcel to larger spatial scales
- Improved scientific understanding of agricultural erosion and its spatial distribution

These findings provide new opportunities for research and erosion management. In the following we provide our comments and responses (AC) to the referee comments (RC) point by point.

Comments:

RC1: This is a very interesting paper addressing soil erosion in a Nordic country. The interesting aspects are the modified approaches of a well-known model and the calibration of different factors. This manuscript may help in better spatial planning and better decision making in agricultural sector. There are some issues that can be improved. I would suggest a moderate revision.
AC1: Thank you for your positive comments and encouragement.

RC2: Abstract. L12-13: In terms distances??? Please correct this sentence.
AC2: We have revised the sentence as follows: " The developed data revealed spatially varying erosion patterns, which has implications on erosion management. For example, high erosion rates were found in intensive agricultural areas, and in several areas high erosion rates were concentrated near water bodies, where the eroded soil is more likely to cause negative off-site impacts."

RC3: You have used some abbreviations which are not appropriate in many parts of the manuscript. E.g. L38 Fig.s…., VegeTab.s (l.218).
AC3: We will perform a proof reading of the revised manuscript. Thank you for noting these.

RC4: L41: it is not only the transfer of phosphorus and nutrients but also the transfer of heavy metals. Please add a sentence there with a proper reference.
AC4: We have mentioned heavy metals in the introduction together with appropriate reference (e.g. Shi et al., 2018) in the revised manuscript.

RC5: L70: "was" ? better to put in present. In L72: You can say that the objective of this study is addressed by 1)…………
AC5: Corrected as suggested in the revised manuscript.

RC6: L89-91: Your reference is always the Fig.1. Please put (B, Fig.1).
AC6: The whole section was revised, and this problem does not occur in the revised manuscript.

RC7: L96: The results were analysed spatially (you do not need this sentence). I tis obvious.
AC7: Agreed. The sentence was removed from the revised manuscript.

RC8: For Equations 2 and 3 you refer to the relevant publication. However, please be more specific by providing the reference to the LANDUM model which estimates them.
RC8: The manuscript has been revised regarding the C factor and we use now the original definition from Renard et al. (1997).

RC9: Section 2.2. what is the difference between your high resolution LS factor (2m) and the European one (at 25m)?
AC9: We assume that you refer to the 25 meter resolution EU DEM, and to the European LS data calculated from the EU DEM by Panagos et al. (2015). We used a national a two-meter resolution LiDAR-based DEM (National Land Survey of Finland, 2020) and used the same calculation tool (Conrad, 2013) and method (Desmet and Govers, 1996) as Panagos et al. (2015). It is known that the resolution of the DEM influences the calculation of the LS and the erosion estimates (e.g. Chen et al., 2018; Beeson et al., 2014). For example, coarser resolution DEMs can result in larger estimates of L values and finer DEM's on larger estimates of S values (Fu et al., 2015). To our knowledge there are no guidelines on how to account for the effect of DEM resolution, which consequently adds uncertainty in RUSLE estimates. We are considering to add the following sentence to the discussion section of the revised manuscript: " According to an analysis conducted in Finland (Lilja et al. 2017b), the use of two-meter resolution DEM with a modified LS calculation method of Desmet and Govers (1996) resulted in 37-43% larger erosion estimates compared to the

use of 25 m resolution DEM, but it is not clear how the modification of the LS calculation method affected these estimates compared to the original approach (Desmet and Govers, 1996) and whether the field parcels were considered hydrologically isolated in the calculation of the LS factor. This comparison is, however, available only in Finnish language, and it is not published in a peer-reviewed publication.

RC10: In table 1, please add a column with the Spatial resolution of each dataset.
AC10: The Tab. 1 was removed from the revised manuscript due to major revisions resulting from Pedro Batista's (Referee #2) comments. In the revised manuscript the summary of C and P factor data are not needed, and therefore, the need for data summary table is also reduced.

RC11: Somewhere in section 2, please provide a map with the Agricultural land of Finland, with a zoom also in the location of the seven monitoring sites, etc. Maybe can you include also the boarders of the 14 selected basins?
AC11: A new map is provided in the revised manuscript that shows agricultural areas, the seven field sites, the small catchments, and large river basins.

References

Beeson, P.C., Sadeghi, A.M., Lang, M.W., Tomer, M.D., Daughtry, C.S.T., 2014. Sediment Delivery Estimates in Water Quality Models Altered by Resolution and Source of Topographic Data. Journal of Environmental Quality 43, 26–36. https://doi.org/10.2134/jeq2012.0148

Chen, W., Li, D.-H., Yang, K.-J., Tsai, F., Seeboonruang, U., 2018. Identifying and comparing relatively high soil erosion sites with four DEMs. Ecological Engineering 120, 449–463. https://doi.org/10.1016/j.ecoleng.2018.06.025

Conrad, O., 2013. Module LS-Factor, Field Based [WWW Document]. SAGA-GIS Module Library Documentation (v2.1.4). URL http://www.saga-gis.org/saga_tool_doc/2.1.4/ta_hydrology_25.html (accessed 5.29.20).

Desmet, P.J.J., Govers, G., 1996. A GIS procedure for automatically calculating the USLE LS factor on topographically complex landscape units. Journal of Soil and Water Conservation 51, 427–433.

Fu, S., Cao, L., Liu, B., Wu, Z., Savabi, M.R., 2015. Effects of DEM grid size on predicting soil loss from small watersheds in China. Environ Earth Sci 73, 2141–2151. https://doi.org/10.1007/s12665-014-3564-3

Lilja, H., Puustinen, M., Turtola, E., Hyväluoma, J., 2017. Suomen peltojen karttapohjainen eroosioluokitus (Map-based classificication of erosion in agricultural lands of Finland). Natural Resources Institute Finland (Luke) 36.

National Land Survey of Finland, 2020. Elevation model 2 m [WWW Document]. URL https://www.maanmittauslaitos.fi/en/maps-and-spatial-data/expert-users/product-descriptions/elevation-model-2-m (accessed 5.29.20).

Panagos, P., Borrelli, P., Meusburger, K., 2015. A New European Slope Length and Steepness Factor (LS-Factor) for Modeling Soil Erosion by Water. Geosciences 5, 117–126. https://doi.org/10.3390/geosciences5020117

Renard, K.G., Foster, G.R., Weesies, G.A., McCool, D.K., Yoder, D.C., 1997. Predicting Soil

Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE). Agricultural Handbook 703. US Department of Agriculture, Washington, DC, pp. 404.

Shi, T., Ma, J., Wu, X., Ju, T., Lin, X., Zhang, Y., Li, X., Gong, Y., Hou, H., Zhao, L., Wu, F., 2018. Inventories of heavy metal inputs and outputs to and from agricultural soils: A review. Ecotoxicology and Environmental Safety 164, 118–124. https://doi.org/10.1016/j.ecoenv.2018.08.016