Comment on essd-2020-370

Anonymous Referee #2

Referee comment on "Rainfall erosivity mapping over mainland China based on high density hourly rainfall records" by Tianyu Yue et al., Earth Syst. Sci. Data Discuss.,

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Dear editor,

Thanks for the review invitation. The USLE model is used in many regions over the world. It is a general method by several indicators. The R factor, i.e., rainfall erosivity, has significant effects on the modeling results. This study maps the rainfall erosivity over mainland China by using high density hourly rainfall records. The data sources are presented well and the results would be useful for related soil-erosion research. The manuscript should be improved in several aspects before it is considered for the publication.

Responses to reviewer #2

Dear Editors and Reviewer

Thank you for your letter and the reviewer's comments concerning our manuscript "Rainfall erosivity mapping over mainland China based on high density hourly rainfall records" (ESSD-2020-370). The comments are valuable and helpful for revising and improving our paper. We have considered and addressed all the comments carefully. We have responded to each of the reviewer's comments in blue:

The new development of USLE, especially the rainfall erosivity, should be presented and discussed in the introduction section. The meaning and rational of the study is not exhibited well.

Response: In the original version of the USLE, 181 stations with breakpoint data plus 1700 stations with annul averaged precipitation, 2-yr, 1-h amount and 2-yr, 24-h amount for eastern part of the US were used to generate the erosivity maps (Wischmeier and Smith, 1965). In the successor of the USLE (Wischmeier and Smith, 1978), erosivity maps for the western part of the US were added based on 2-yr, 6-h rainfall amount data (P) using the equation of $R=27.38P^{2.17}$. In Revised USLE (RUSLE), Renard et al. (1997) released erosivity maps using same data as Wischmeier and Smith (1965) for eastern part, and 60-min rainfall data at 790 stations for the western part in the US. In RUSLE2, monthly erosivity maps based on 15-min data from 3700 stations were generated (USDA–ARS, 2013). We will add more details on the new development of the USLE model, especially the generation of rainfall erosivity maps in revised versions of USLE.

Rainfall erosivity maps can be meaningful in various fields such as soil erosion, sediment yield, environment and ecology. Current R-factor and extreme event erosivity maps over China were usually based on daily rainfall data, which demonstrated limited accuracy. Yin et al. (2015) reported the accuracy of rainfall erosivity estimation increased with the temporal resolution of rainfall data and the use of hourly precipitation data can improve the estimation of rainfall erosivities, especially those for the extreme events. Hourly precipitation data from 2381 stations were obtained to improve the current rainfall erosivity maps. In addition, the uncertainty in the generation of rainfall erosivity maps mainly comes from (1) the temporal resolution of precipitation data, (2) the distribution and density of stations and (3) interpolation methods. Therefore, objectives of this study are: (1) to develop high-precision maps of the R factor and 1-in-10-year EI_{30} over the mainland China; (b) to quantify the improvement of the new erosivity maps in higher temporal resolution and station density and better interpolation method compared to current maps. The meaning and rationale of the study is to: (1) present and share high-precision maps of the R factor and 1-in-10-year EI_{30} over the mainland China with related earth system science communities, which leads us submitting the manuscript to ESSD; (2) provide some insights in the improvement of rainfall erosivity maps for other regions over the world. We will clarify the meaning and rationale of the study in the revised version.

How can the re-calculation of R factor help to reveal the mechanism of rainfall erosivity? I suggest the authors to add a flowchart for the study.

Response: Strictly speaking, this is beyond the scope of the paper. This paper is about a data product for the application of USLE/RUSLE in China. The flowchart of the data and the methods is as follows (Figure 1), and we will add it in the revised version.

We may understand the connection of the re-calculation of R factor in this study and the mechanism of rainfall erosivity as follows:

Rainfall erosivity is an index describing the combined effects of raindrop splashing and runoff scouring on soil, which are quantified by the product of kinetic energy (E) and maximum 30-min intensity (I_{30}), EI_{30} in USLE models. Kinetic energy generated by raindrops can be calculated based on raindrop disdrometer data and estimated based on breakpoint or hyetograph data via KE-I equations, while I_{30} is expected to be prepared using breakpoint or hyetograph data with an observed interval $\leq$ 30 min. However, these data were usually in shortage not only in the length but also in the spatial coverage, which challenge the generation of rainfall erosivity maps. Statistical models have been developed to use more commonly available data, such as daily data to estimate R factor. The aggregation of temporal resolution of precipitation data results in large information loss due to the high temporal variation of precipitation, especially for extreme events. Hourly data was believed to reflect the variation of precipitation intensity better than daily data, which can be used to improve the estimation of at-site rainfall erosvity with precipitation observations. In addition, the increase of station density for the interpolation can better describe the spatial variation of rainfall erosivity and improve the estimation of rainfall erosivity for areas without observations together with the improvement of interpolation models and procedures.

We will add some information addressed here in the revision.

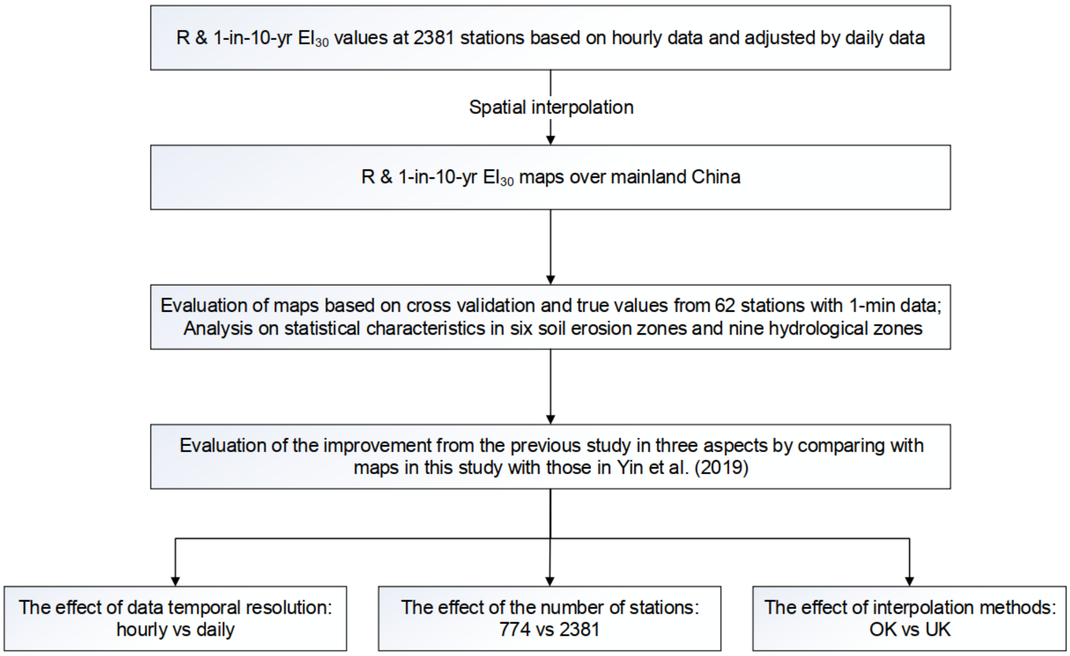

Figure 1 Framework of this study

The validation of the results is conducted mainly by comparing with Yin's results. If the authors provide more findings from field observation, the validation would be more meaningful.

Response: The validation of the results was conducted based on true rainfall erosivity values calculated by 1-min rainfall data from 62 stations (Fig.2) using equation (10-11). Yin's results were only used for the comparison to evaluate the improvement from present studies. We will emphasize it in the revised version.

The uncertainty of the results and methods should be added by more details in the discussion.

Response: Thanks for your constructive suggestion. We will add the analysis of the uncertainty of the results and methods into the discussion. The uncertainty of the results from this study mainly comes from the following aspects: (a) KE-I model for estimating Kinetic Energy (KE) from the instant precipitation Intensity (I). KE-I model used in this study is from RUSLE2 (USDA-ARS, 2013) and raindrop disdrometer observation data need to be collected to calibrate the KE-I model. (b) The estimation of the erosivity factors from hourly data (equation 5). The conversion factors were developed based on 1-min rainfall data from 62 stations (Fig. 2). Hourly data brings information loss in the estimation of instant precipitation intensity comparing with breakpoint data. (c) The adjustment of the R factor from the stations with less effective years (equation 8). This is based on a power function (equation 9) of the mean annual precipitation and rainfall erosivity using 1-min and daily rainfall data of 35 stations; The degree of uncertainty mainly depends on the annual variation of rainfall erosivity. (d) Station distribution and density. In western China, the stations were sparse and unevenly distributed, which affect the interpolation accuracy. (e) Spatial interpolation model (Universal Kriging in this study) and the interpolation procedures (the division of regions before the interpolation and the mergence of regions after the interpolation). We will add more details in the discussion.

Reference

USDA-ARS: Science documentation: Revised Universal Soil Loss Equation Version 2 (RUSLE2), USDA-Agricultural Research Service, Washington, D.C., 2013

Yin, S., Xie, Y., Liu, B. and Nearing, M. A.: Rainfall erosivity estimation based on rainfall data collected over a range of temporal resolutions, Hydrol. Earth Syst. Sci. Discuss., 19(10), 4113–4126, doi:10.5194/hess-19-4113-2015, 2015.