Reply to comments on "Rainfall erosivity mapping over mainland China based on high density hourly rainfall records" (ESSD-2020-370)

Dear Editor,

Thank you for your email concerning our manuscript "Rainfall erosivity mapping over mainland China based on high density hourly rainfall records" (ESSD-2020-370). The comments from reviewers were valuable and helpful for revising and improving our paper. We have considered and addressed all the comments carefully. The structure and description of the methods and the discussion sections have been modified. Some descriptive words, such as "good", "true" have been removed where appropriate from the revised manuscript. We have responded to each of the reviewers' comments in blue.

Best regards,

Tianyu Yue

Comments in confidence:

We found that the statement such as '*Renard has developed RUSLE, you have worked on EI30 for USLE*' by the reviewer of the Report #2 seems to suggest a lack of expertise and familiarity with soil erosion prediction models and rainfall erosivity as one of the factors in the commonly used USLE/RUSLE. We found the excessive use of double and sometimes triple exclamation marks '!!' or '!!!' by the reviewer unhelpful, and unprofessional. We would appreciate it if you can take them into consideration when assessing his and her comments.

Topical Editor decision: Reconsider after major revisions

by Min Feng Comments to the author

Dear Authors,

Thank you for submitting the revised manuscript and responses.

The reviewers are positive about the value of the dataset. However, they also provided suggestions on further improving the manuscript.

First, the description of the methodology still has room for improvement. There are thresholds and criteria in the method need to be clarified and justified as the reviewers pointed out in their comments.

Second, the expression can be further improved, especially in the accuracy evaluation and discussion sections. I feel that the explanation of the evaluation caused lots of confusion during the review. After reading the manuscript, I think that the current writing can easily confuse readers on what is compared to what through the evaluation, for example, was the data introduced by the manuscript compared to Yin et al. 2019 or the station-based observations.

Last, the words and terms used in the manuscript need to be carefully checked. For example, try avoiding using subjective words, such as "good". The observation from stations is referred to as "true" value, which could be arguable. Maybe replace it with something like "station-based observation.

-Min

Report #1

General comments:

In the submitted paper authors investigated difference between the rainfall erosivity map prepared based on the high density hourly rainfall records and map prepared by Yin et al. (2019). The paper is probably in the scope of the Earth System Science Data and the investigated topic (i.e. rainfall erosivity) is of general importance for the soil (erosion) science. However, I think that the paper would need to be much better organized in order to be accepted for publication in the ESSD. Thus, often it is very hard to follow the methodological description and discussion of the results. Additionally, I think that authors should clarify what are the "true" rainfall erosivity values and I think that a rainfall erosivity map cannot be regarded as a "true" rainfall erosivity. Please see below comments for further details. Therefore, I think that authors should significantly improve the presentation of their scientific work and after that a better evaluation of the scientific quality would be possible. Some specific comments are provided below.

Please note that these comments correspond to the "clear" version, without track changes and that I have not reviewed this manuscript in the first stage.

Response: Thank you for your 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. The structure and description of the methodology and the discussion sections have been revised. Some descriptive words, such as "good", "true" have been removed from the revised manuscript where appropriate.

Specific comments:

1.1 L98: What was the threshold used to estimate that data is too short? How was the adjustment done?

Response: Due to the interannual variability of rainfall erosivity, stations with less than 22 effective years have be excluded (Wischmeier and Smith, 1978). The methodology of the adjustment is described in Section 2.3.

1.2 L131-132: Please rephrase this sentence and add a reference

Response: The sentence was revised as "The R-factor map shown in the discussion section of this study (Fig. 12) was based on the global rainfall erosivity dataset published by Joint Research Centre - European Soil Data Centre (ESDAC; Panagos et al., 2017)."

1.3 L135: Why not 12.7 mm?

Response: The threshold of 12 mm was based on data analysis in China. Xie et al. (2000) identified the erosive rainfall threshold that storms actually caused erosion were omitted from the calculations, while certain storms that do not cause erosion were included in the calculations in order to balance those omitted. In the study, rainfall and runoff data measured for three plots and a small watershed from 1961 to 1969 at the Zizhou experimental station of the Yellow River Basin in China were used. The erosive rainfall amount threshold proposed by Xie et al. (2000) was 12 mm, which was widely used in rainfall erosivity studies over China. Therefor it was regarded as the most appropriate

threshold in this study.

1.4 L142-143: Please rephrase this description since it is not very clear at the moment.

Response: This part had been revised as follows to make it clearer:

"The R-factor was calculated using Eq. (1-3; USDA-ARS, 2013):

$$R = \frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{m}(EI_{30})_{ij} \quad , \qquad (1)$$

$$E = \sum_{r=1}^{l}(e_r \cdot P_r) \quad , \qquad (2)$$

$$e_r = 0.29[1 - 0.72exp(-0.082i_r)], \qquad (3)$$

where EI_{30} (event rainfall erosivity, MJ mm ha^{-1} h^{-1}) was the product of the total storm energy E (MJ ha^{-1}) and the maximum 30-min intensity I_{30} (mm h^{-1}); i=1, 2, …, N, where N is the number of effective years, and j = 1, 2, …, m means there are m erosive storm events in the i^{th} year. For each storm event, rainfall was divided into l time intervals depending on the temporal resolution of rainfall data. The total storm energy E was the sum of the energy for each time interval r, which was the unit energy e_r (energy per mm of rainfall, MJ ha^{-1} mm^{-1}) multiplied by the rainfall amount P_r (mm) for each time interval. And i_r was the intensity (mm h^{-1}) of the r^{th} interval. I_{30} (mm h^{-1}) was the maximum intensity over 30 consecutive minutes for each storm event. For hourly data, the I_{30} was assumed to be the same as the maximum 1-hour intensity."

1.5 Pages 7 and 8: In general description of the methodology is a bit confused, for example you use Rhour and Rh, you use the term effective years, the formulation of eq. 1 is strange, you have EH60 on both sides of the equation, etc. I suggest that the methodology (and the description) should follow some kind of logical order, for example start with 1-min data, then hourly data and then daily data or vice versa. Now you start with hourly, then you have EI30, then 1-min and then daily. In between, you introduce all sorts of correction factors that come almost out of nowhere. Thus, as a reader you are guessing where the numbers came from. You actually have some results in between. For example, L179 is obviously something that was done and is presented here in the methodology part. Therefore, the methodology should present only data and methods and results should be presented in some other section.

Response: We have revised the method section. Section 2.2 was added to show equations used to calculate the R-factor and 1-in-10-year EI_{30} using 1-min, hourly and daily rainfall data. Some of the equations that may have caused confusion were removed. Although the calibration of Eq. (8) was carried out in this study, it was not the objective of this study. Equation (8) only provided a parameter for adjusting the R-factor from hourly data. Therefore, we included it in the method section.

1.6 L199: "good" this is subjective, please quantify it and I suggest to avoid using such terms.

Response: It had been removed in the revised version.

1.7 L214-215: Yin et al. map was used as a reference, I understand this part, but I cannot understand how were you then able to evaluate the improvement? If you have a reference, then you compare your new map with it but you cannot say that something is better or worse than your reference? From my point of view, what you could compare are station-based values. Thus, as there is mentioned somewhere in the paper, the best estimate of the rainfall erosivity can be obtained using data obtained from the optical disdrometers (speed and drop velocity estimates), then

probably 1-min precipitation data using KE-I equation can yield a reasonable fit. Hourly and daily data should be even less accurate. When you interpolate there is always an additional error due to interpolation. Thus, I am not sure if such approach as mentioned here can be useful? Therefore, I am not sure if you can easily merge maps with station-based data and do a comparison (grid-cell value is not the same as station-based point value)?

Response: We agree that a comparison with Yin et al. maps is not enough to show that the new maps are better. In this study we calculated the relative error using cross-validation for stations where 1-min data were available, and assessed the two sets of maps based on the relative errors. Since the relative errors in this study were smaller, the newly generated maps were considered to be an improvement over Yin et al. maps. When evaluating the effect of the changes (data temporal resolution, station numbers, interpolation methods), we also compared the changes in relative errors. This study cross-validated the results for individual stations rather than grid cells.

1.8 Figure 3: Where is the 1-minute data here?

Response: One-minute data were mainly used in evaluating the accuracy of the new maps. We have added "(with 1-min data)" in the revised figure.

1.9 L243-244: How is this possible? If Yin et al. map is reference, compared to what you were able to show an improvement?

Response: As mentioned in Response 1.7, reduction in the relative error suggested an improvement. Computed erosivity values using the original 1-min data were taken as the 'true' values for error assessment.

1.10 L245: Underestimated compared to what? Additionally, if I understand correctly, you considered 1-min data as "true" and how did you obtain other values? Why maps are mentioned in Figure 4? I think that you cannot just compare station-based gauge data with corresponding values obtained from the interpolated maps since interpolation has an effect on these values?

Response: As Fig. 4 shows, R-factor in Yin et al. map was smaller where the R-factor value > 10,000 MJ mm ha^{-1} h^{-1} a^{-1} compared to that using the 1-min data. The Y-axis in the figure has been revised using the cross-validation values at the corresponding stations to be able to compare with the station-based values.

1.11 L248: Here again you talk about relative errors of the maps?

Response: We revised the manuscript as "Relative errors of erosivity factors at the stations from the two maps are shown in Fig. 5 (a) and (b)." to make it clearer.

1.12 Section 3.3: Again, you discuss improvement of the map, but since "true" spatial rainfall erosivity is not known I think that this should be rephrased. You can only compare two maps but you cannot say that one of the two is "true" since the interpolation will always introduce some error. From my points of view, "true" erosivity can only be either disdrometer data or perhaps 1-min precipitation data based erosivity estimates. I think that map can be regarded as true erosivity.

Response: We have revised "true value" into "value using 1-min data", which presents the most

accurate value at present. We also rephrased the method section on evaluating the effect of the changes in developing the erosivity maps in Section 2.5 and Section 2.6. In Section 3.3, improvement of the erosivity maps was evaluated in three areas: "To evaluate the effect of the temporal resolution on R-factor and 1-in-10-year EI_{30}, data from the same set of stations were used, and the only difference was that in temporal resolution. To evaluate the effect of station density, maps were compared with the only difference in the number of stations. To evaluate the effect of interpolation methods, maps were compared with the only difference in interpolation methods."

1.13 Figure 10: Here you compare hourly and 1-min data, how exactly is this different from the Figure 4 where you had "R-factor from the map in this study"? As mentioned, there is sometimes hard to follow the results and discussion. Please modify so that it will be easier to follow the results and discussion.

Response: Figure 10 shows a comparison of the R-factor and the 1-in-10-year EI_{30} from hourly or daily data to those using 1-min data of the same period. The results showed the effect of the temporal resolution of the data. While Figure 4 was the comparison between the cross-validated values and those using 1-min data, which shows the accuracy of rainfall erosivity maps. We have modified the results and discussion sections.

Report #2

Dear Editor

Copernicus Publications

Hello

I am thankful to you for allowing me to RE-review the revised version of ESSD manuscript. The revised version has got improvements in different aspects, however, I am not still convinced to advise it for publication. As mentioned earlier, the big issue refers to the rationale of the work.

Some comments have not been addressed or considered properly as annotated in the response letter to the reviewer in the following.

Still, no proper reviewing of literature with further focuses on the main goals of the study (i.e., at national level and countrywide studies) and recent none-Chinese ones has been made.

Still, it has no comprehensive and integrated discussion.

The quality of figures and presentations is very low!

Use histograms for discrete values.

According to the comments mentioned above and some issues appended in the following, I, therefore, suggest submitting a substantially improved MS.

Response: Thank you for your comments concerning our manuscript "Rainfall erosivity mapping over mainland China based on high density hourly rainfall records" (ESSD-2020-370). Your comments are all about our responses on the referee comments #1 of the first review process. The comments are valuable and helpful for revising and improving our paper. We have considered and addressed all the comments carefully, listed each of the comments below and responded to them in blue:

2.1 Response 1.1: Use the same expression. I am not convinced. Meanwhile, other return periods

up to some 50 years are beneficial for soil and water conservation projects!! It has to be added to new version.

Response: "1-in-10-year" is a common expression and we had added "(also called "10-yr EI" in Renard et al. (1997))" into the first sentence where the term was mentioned. This study focused on the R-factor and 1-in-10-year EI_{30} which are needed in the USLE and RUSLE model. Other factors, such as those for return periods, are not needed for soil loss prediction in the USLE/RULSE framework.

2.2 Response 1.2: Renard has developed RUSLE, you have worked on EI30 for USLE. It is not acceptable.

Response: The term "USLE-type model" refers to the USLE, RUSLE, RUSLE2 and CSLE model. EI_{30} is used in all these models.

2.3 Response 1.3: "average". Use "mean" throughout the context instead.

Response: We have revised accordingly.

2.4 Response 1.4: I am not convinced!! How could you assess the soundness of previous study??

Response: Station-based values using observed 1-min precipitation data were taken as the most accurate and were used to assess the maps from the previous study as well as those from this study.

2.5 Response 1.5: How important this minor difference is?? In reality there is no that much difference between 19 and 16%??

Response: We had revised this part into "(2) the new R-factor map generated in this study had a median absolute relative error of 16% for the western region, compared to 162% for old maps, and 18% for the rest of China. And the new 1-in-10-year EI_{30} map had a median absolute relative error of 14% for the central and eastern regions of China, excluding the western region due to data limitations, compared to 21% for old maps;". We emphasized the message which is more valuable——for the R-factor, in the western region, the map from this study reduced the median absolute relative error from 162% to 16% comparing with the previous one.

2.6 Response 1.11: Please be persistent what version of the USLE model you are dealing with?? Original EI30 for USLE or the revised R factor for RULSE. Clarify it and follow it up throughout the context.

Response: We are dealing with the erosivity factors (R-factor and 1-in-10-year EI_{30}) from the latest version of the USLE-type models——RUSLE2 (USDA-ARS, 2013). The methods for calculating EI_{30} in different versions of the USLE have been compared in Yin et al. (2017). They all serve the same purpose but used different kinetic energy-intensity equations, precipitation threshold, and the time interval to define erosive storms. We used the K-I equation and the threshold of the minimum inter-event time interval for the RUSLE2, and the threshold of the erosive storms of 12 mm we used in this study were developed locally (Xie et al., 2000).

2.7 Response 1.12: 10% frequency cannot be supposed as extreme value!! I am not convinced!!

Response: 1-in-10-year EI_{30} values were considered in the study simply because they are required to apply the USLE/RUSLE for soil loss prediction. No more no less.

2.8 Response 1.16: “Therefore, breakpoint data and 1-min data are the best datasets for deriving precipitation intensity and estimating rainfall erosivity given the absence of raindrop sizes observations.” It is just repetition of what already asked!!

Response: For 1-min interval data are the finest resolution data measured by automatic tipping bucket rain gauges we can obtain up to now, they are now one of the best datasets for deriving precipitation intensity and estimating rainfall erosivity.

2.9 Response 1.18: It is not certain. R is only one factor out of six factors.

Response: In soil loss assessment, a more accurate estimation of the R-factor can obtain a more accurate estimate of soil loss when other factors had been determined.

2.10 Response 1.19: “into “Ordinary Kriging”. It is still doubtful!!

Response: The methods the authors used were just quoted here. We will not discuss them.

2.11 Response 1.20: So it is better to clearly point out rain erosivity!!!

Response: When we write about rainfall erosivity, we are clearly referring to rain.

2.12 Response 1.23: This criterion has to be adjusted for the study region!!

Response: The criterion is the same as that applied by Xie et al. (2000) to determine the threshold of erosive storm of 12 mm using rainfall data from China. In practice, this criterion should be estimated in different regions with local rainfall and soil loss data. However, due to the limitation of the data, this study can only use one threshold for the whole region.

2.13 Response 1.24: Can this criterion be used for the entire China??

Response: As mentioned above, in practice, this criterion should be estimated in different regions with local rainfall and soil loss data. However, due to the limitation of the data, this study can only use one threshold for the whole region.

2.14 Response 1.25: This criterion has to be adjusted for the study region??

Response: In China, Wang et al. (1995) analyzed the relationship between soil loss and different rainfall indexes using data from 10 fallow plots over China. The results showed that EI_{30} is suitable for obtain rainfall erosivity for the whole country.

2.15 Response 1.26: This criterion has to be adjusted for the study region??

Response: The conversion factor for the R-factor from hourly data to the 1-min data were obtained using 1-min data from 62 stations over China (Yue et al., 2020). The study also noted that there were no significant differences in the conversion factors in different regions. Therefore, the same conversion factor was used for the whole country.

2.16 Response 1.28: On which basis??

Response: For hourly data, the record length in terms of the number of effective years was short for some of the stations (as shown in Figure 1 in the manuscript). Therefore, when the effective years of hourly data were not less than those of daily data for 871 out of 2,381 station, no adjustment of

the R-factor was made. For the remaining 1,510 stations, the R-factor from hourly data was then adjusted by a relationship between the mean annual rainfall and the R-factor computed with hourly data as follows (Zhu and Yu, 2015)

2.17 Response 1.31: Definition is wrong!! Redefine it.

Response: Accuracy can be defined in two different ways: (1) More commonly, accuracy is a description of systematic errors, a measure of statistical bias; low accuracy causes a difference between a result and a "true" value. ISO calls this trueness, which was adopted in this manuscript. (2) Alternatively, ISO defines accuracy as describing a combination of both types of observational error above (random and systematic), so high accuracy requires both high precision and high trueness.

2.18 Response 1.40: Conclusion has to be changed not abstract!!

Response: In the conclusion part, we have included some 'take-home messages in three areas: (1) the accuracy of the new maps generated in this study (with relative error of ~15%) and their improvements compared to current maps (obviously improved in western China); (2) the ranges and the changes of the values in the new erosivity maps; (3) the effect of the changes (data temporal resolution, numbers of the stations, interpolation method) for improving the maps. The conclusion matches the objectives of this study: "(a) to develop high-quality 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 using precipitation data in a higher temporal resolution and from more weather stations, and better interpolation techniques compared to those used to generate erosivity maps that are currently available (Yin et al. 2019)."

Report #3

I am very happy to notice that the authors have made careful and deep revision, and I just have few suggestions on the revised manuscript.

Response: Thank you for your 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 and responded to them in blue:

3.1 Page 1, lines 18-19, "and the 1-in-10-year EI30 map had median absolute relative error of 14%, except for the western region for which no evaluation was made because of data limitation", should be "had a median absolute error" ?

Response: We have corrected this accordingly.

3.2 Page 3, lines 85-86, "The study of (Yin et al., 2019) was chosen to represent the latest data had set to estimate the R-factor and 1-in-10-year EI30 and related maps. " The sentence is hard to understand

Response: The sentences had been revised as "Therefore more than 2,000 stations of hourly and daily data were collected, together with the 62 stations of 1-min data: (a) to develop high-quality

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 using precipitation data in a higher temporal resolution and from more weather stations, and better interpolation techniques compared to those used to generate erosivity maps that are currently available (Yin et al. 2019).".

3.3 The resolution of Figure 9 seems to be lower than that of Figure 8. What is the reason? Please improve the resolution of Figure 9, if possible.

Response: We have improved the resolution of Figure 9(b).

References

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