Authors’ response to Editor’s decision and comments from Reviewers

The most extreme rainfall erosivity event ever recorded in China:
The “7.20” storm in Henan province

Yuanyuan Xiao, Shuiqing Yin, Bofu Yu, Conghui Fan, Wenting Wang, Yun Xie

We would like to thank the Editor and Reviewers for their comments and suggestions. In the revised version, we have improved the text and figures, considered and addressed all the issues raised by the reviewers. We hope this revision is satisfactory for the further processing of this paper.

Dear Editor,

Thank you very much for your feedback. We revised the manuscript in detail, have answered all reviewers’ questions. We would like to submit the revised version of our paper “The most extreme rainfall erosivity event ever recorded in China: The “7.20” storm in Henan province” by Yuanyuan Xiao, Shuiqing Yin, Bofu Yu, Conghui Fan, Wenting Wang and Yun Xie.

We believe that we followed all the suggestions from the reviewers and we have substantially improved the manuscript and we are looking forward to hearing from you with respect to the review process.

We provide responses to comments from Reviewers below. For clarity, each response is structured as follows: (1) RC# comments from Referees (black), (2) Authors’ response (blue).

Thank you for your time and consideration.

Sincerely,

Yuanyuan Xiao

RC1: 'Comment on hess-2022-351', Anonymous Referee #1, REPLY

The authors have revised the manuscript and addressed many of the reviewers' comments. However, there are still some aspects that need to be improved:

Response: Thank you for your careful review and additional suggestions. We revised the text to address all the weaknesses that you pointed out. Below we are providing our detailed response to your specific comments in blue.

Firstly, I suggest testing and applying several KE-I equations and not just the RUSLE2 equation in order to evaluate the impact of the KE-I equation on the derived extreme rainfall erosivity values. I think that the adopted procedure for the rainfall erosivity estimation should try to cover different uncertainties related to the calculations (and measurements) and derive an estimate of the rainfall erosivity using the confidence intervals. Also, the conversion factor for the I30 is one such elements that greatly depends on the results. Are you sure that 1.489 conversion is also relevant for this specific extreme event? Can you verify this using some half-hourly data for this event? And not just report that event rainfall erosivity was 58,874 (MJ mm)/(ha*h). During your first submission you reported a return period of around 150,000 years, now you are between 10,000 and 23,100 years. Why this huge difference? If you do evaluate the impact of other steps within the rainfall erosivity calculation you should get more reasonable estimates (with the confidence intervals, ranges).

Response: While we appreciate the argument for evaluating the effect of different KE-I relationship, we believe that testing and applying several KE-I equations are unnecessary. It is true that different KE-I relationships were included in different version of the USLE, and yet more empirical localised KR-I relationship for various sites around the world (van Dijk, A. I. J. M., 2002). However, we wanted to use the equation included in RUSLE for consistence and for meaningful comparison to rainfall erosivity values reported elsewhere in China and indeed around the world (Benavidez et al., 2018; Yin et al., 2015).

Secondly, Rainfall erosivity is usually calculated based on long term precipitation records from rain gauges, and depends strongly on the temporal resolution of the precipitation data used. High-temporal resolution data at fixed intervals are increasingly available and they will to improve the estimation of rainfall erosivity, especially the event EI_{30} index in the long run. Such data are still in short supply, short in in length and sparse in spatial coverage. R-factor values decrease with decreasing resolution of the precipitation data because intensity peaks are reduced when precipitation amount is aggregated over longer time intervals (Fischer et al., 2018). Therefore, it is necessary to use conversion factors to adjust the computed EI_{30} value using data of low resolution. Yue et al. (2020) evaluated the impact of the time interval from 1-min to 1-hr on the 1-10-in-year EI_{30} using the 1-min temporal resolution rainfall data from 62 meteorological stations in mainland China. The conversion factor for the 1-in-10-year EI_{30} computed with the 60-min resolution rainfall data is 1.489, which was appropriate for evaluating extreme rainfall erosivity in this paper.

To allay the reviewer's concerned, we collected 1-min temporal resolution rainfall data from Zhengzhou Meteorological Station from 2005 to 2016, and calculated the 1-in-10-year EI_{30} value to be 4054 MJ, and the ratio of 1-in-10-year EI_{30} value to the 60-min temporal resolution rainfall data is 2.029. But the conversion factor for individual stations in China ranges from 1.321 to 4.601 (Fig. 1). As the equivalent 'conversion factor' for Zhengzhou is much higher than the 'average' conversion factor we used for this study, it is worthwhile to compute the standard error (± 0.064) for the conversion factor (Yue et al., 2020).

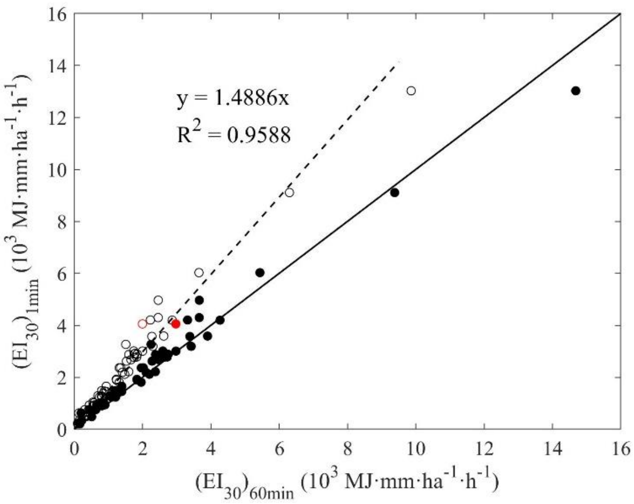

Figure 1. A comparison of 1-in-10-year EI30 values estimated with 1-min versus 60-min data. The dashed line represents the best fit using a linear model through the origin. Open circles are 1-in-10-year EI30 values estimated 60-min data without conversions, and solid circles are values adjusted with a conversion factor of 1.489 for the 62 meteorological stations in China. The open and solid circles in red refer to the Zhengzhou meteorological station. (Yue et al., 2020)

Finally, the significant difference in estimated value of the return period is related to the frequency distribution we assumed and not related to rainfall erosivity values per se. When using the LP-III, we first performed logarithmic transformation on the samples, which effectively narrowed the data range with better fit with observations. Your suggestion is valuable, it is worthwhile comparing estimates of the return period using different probability distribution explained below.

Secondly, in terms of measuring devices, for such extreme rainfall, this is import, tipping buckets have a notable decrease in accuracy with the increase of the rainfall rate. Therefore, for very extreme events, the accuracy can be a problem. Please add the specific instrument that was used, at least for the stations that was used to derive the rainfall erosivity return period. Try to include measuring device accuracy in the uncertainty estimation.

Response: The instrument used by China Meteorological Administration is SL3-1 tipping bucket rain sensors, and precipitation was measured according to the operation manual to meet certain standards at all stations. Tipping bucket rain gauges have a rainfall bearing diameter of 200 mm, and its resolution is 0.1 mm. The maximum allowable rainfall intensity is 4 mm·min^{-1}, and the maximum allowable rainfall error is ± 4 mm for every 100 mm. The details of the data have been added to the paper.

Thirdly, you should test if the LP-III distribution fits well to the data using some statistical test and not just say that it fits well. Moreover, as you already noted, the estimated return period greatly depends on the selected distribution function. I think that you should do the estimation using several distributions and select the one that fits the data the best.

Response: Generalized extreme value distribution model (GEV), P-III, and LP-III were used to fit the maximum event rainfall erosivity, calculated the correlation coefficient, and performed Kolmogorov-Smirnov test. The results showed that the LP-III distribution function was more suitable for this study. Please refer to the supplement for details.

There are several typos in the manuscript that should be corrected. Also, the English should be double-checked. Moreover, you should be less subjective and try to avoid statements like “so rare and freakish”.

Response: We have carefully proof-read and revised the paper.

Specific comments:

L125: You need to provide more information about the IDW method applied.

Response: We have explained this in the revised version. (line 129-134)

Eq. 6 and Eq. 7, you should define the f(x) and F(x). It is not clear how confidence intervals were estimated.

Response: We have defined the probability density function and cumulative distribution function of the P-III distribution in the article, but we have not given a detailed calculation process of the confidence interval. The calculation process of the confidence interval is relatively complex. We use the approximate square difference using the Kite's (1975) method for parameter estimation and for evaluating the confidence interval, and we have included a reference to the method in the paper.

Figure 3: Caption should be improved.

Response: We have improved the caption, replaced the old one: 'Figure 3. Distribution of total rainfall over the study area, and rainfall mass curves for three stations with the largest rainfall totals.', with the new one 'Figure 3. A map of total rainfall over the study area, and rainfall mass curves for three stations with the largest rainfall totals.'.

Figure 4: The same for this one.

Response: We have improved the caption, replaced the old one: 'Figure 4. Spatial pattern of daily rainfall in the study area.', with the new one 'Figure 4. Spatial distribution of daily rainfall in the study area.'

Figure 6: The captions say that this is empirically fitted, you mean LP-III?

Response: The caption of Figure 6 is revised to read 'Figure 6. The logarithm of observed daily (a) and event (b) rainfall erosivity as a function of the return period assuming LP-III for Zhengzhou meteorological station'.

L225-226: I do not understand this sentence, please rephrase. Why this return period is so low, compared to others?

Response: Here we are translating the Zhengzhou meteorological station to the upper limit of the confidence interval, and found that within the range of the confidence interval, the minimum values of daily and event rainfall erosivity return periods at the Zhengzhou meteorological station are at least 785 and 516 years, respectively.

Figure 7: Confidence intervals are very wide. I am not sure how did you obtain that the estimate is between 10,000 and 23,100 years? I would expect something like: "The return period of the event was estimated to be XYX years with the 95% confidence intervals of +-YXYX years".

Response: We agree with you on this. We have explained this in the revised version.

Figure 8: Caption says this is return period, but legend is showing erosivity?

Response: We have changed the erosivity in the legend to the return period.

Figure 9: As indicated in the previous round, I do not fully understand this, you have one extreme event (point 6) and you are drawing some envelopes. You could draw several different ones.

Response: Yes, you are right. When we draw the envelopes, we do not use any equation or model, just connect the outermost points. Our goal is to emphasize that the value of rainfall erosivity for the extreme event is the highest in mid-latitude around 35 °N, which indicates the likely location of the maximum rainfall erosivity.

References

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RC2: 'Comment on hess-2022-351', Anonymous Referee #3, REPLY

General comment:

The revised manuscript has incorporated the comments suggested in previous draft. The analysis has been changed from GEV to LP-III, with corresponding changes in results. Authors have improved information on devices, data, estimation of erosivity, storm classification criteria, and in summarizing the results. Some of the uncertainties are now addressed, notably the confidence of estimated return period.

Minor comments (line no. as per latest draft):

The language of the manuscript can be improved in some areas. For example, in line 25 ‘is’ instead of ‘as’.

Response: We have changed ‘as’ to ‘is’ in line 25, and have carefully proof-read and revised the paper.

In line 36, maybe adding ‘itself’ at the end of sentence could stress the idea that a very few studies have focused erositivity during event.

Response: Added.

In line 56, Zhang. et.al feels like a repetition of the more detailed descritpion in line 61.

Response: Yes, you are right. In line 56, Zhang et al. proposed several weather systems that lead to “7.20” storm, and explained this process in detail later in line 59-64.

In line 80, were some corrections applied based on cross checking with daily observation with rain gauges? It would be worth mentioning.

Response: During quality control, some corrections have been made based on cross checking with daily observations with rain gauges.

Descriptions of model parameters and equations can be in present tense, I believe. For example, in line 98 ‘is’ instead of ‘was’. Similar in lines 115, 116, 120, 133, 142 etc.

Response: We have changed ‘was’ to ‘is’ in line 101, 118, 119, 123, 141, 151.

Since inverse distance weighing (IDW, in line 121) is used here to map rainfall erosivity distribution, the references on them could be retained (some references were there in the deleted part in introduction regarding spatial and temporal variability, line 45 in tracked changes document).

Response: We agree with you on this. We have provided additional information on IDW in Section 2.2.2 and have cited these references according to your suggestions. (line 129-134)

Figure 7 caption: it should be ‘performed’ in brackets, I think.

Response: We have changed ‘Perform’ to ‘Performed’ in Fig. 7.

Line 239, 240: repetition of ‘by fitting the LPIII.

Response: Deleted.

Line 295: re frame the last sentence, ‘following’ is repeated.

Response: We have changed ‘The following conclusions can be drawn as follows’ to ‘The following conclusions can be drawn as a result of this research’.