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 further processing of this manuscript.

Dear Editor,

Thank you very much for your feedback. We have revised the manuscript in detail, and answered all the 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 have considered and addressed all the suggestions from the reviewers and have substantially improved the manuscript. We look forward to hearing from you with respect to the review process.

Below are our responses to reviewers. 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

Authors have revised the manuscript and addressed most of my comments.

I suggest that authors in all parts of the manuscript (also abstract) state the possible range of erosivity (related to conversion factor), similar as done in L203-204. Also, it would be useful to add at least some details about the additional calculations done in relation to conversion factor (as shown in Figure 1 of the response to the reviewers file).

Response: Thank you for your careful review and additional suggestions. We have included the range of rainfall erosivity in the manuscript based on the range of the conversion factor. For example, for conversion factor 1.489 ± 0.064, the maximum event rainfall erosivity value of the "7.20" storm 58874 $MJ{\cdot}mm{\cdot}ha^{-1}{\cdot}h^{-1}$ is now presented as 58,874 ± 2351 $MJ{\cdot}mm{\cdot}ha^{-1}{\cdot}h^{-1}$. While we could add some details about the conversion factor, the method of calculations of the conversion factor in our response comes from Yue et al. (2020). Therefore, we have explained the range of the conversion factor based on Yue et al. (2020). We have made the following changes in the revised manuscript.

Line 125-130: Yue et al. (2020) used hourly rainfall data to calculate a conversion coefficient of 1.489 for the 1-in-10-year EI_{30}, which is suitable for evaluating extreme rainfall erosivity on average. The conversion factor for individual stations in China ranged from 1.321 to 4.601, and the conversion factor for Zhengzhou Meteorological Station was 2.029, higher than the average, or expected, conversion factor used for this study. We have included the standard error ± 0.064 for the conversion factor to indicate the likely uncertainty associated with this conversion factor.

As for the rain gauge instrument, was the intensity of 4 mm/min exceeded during this extreme event and how many times? Did this have an impact on the measurements and consequently on the calculations (e.g., rainfall erosivity)?

Response: The data we use is hourly rainfall data, and we do not need to calculate how many times the rainfall intensity exceeded 4 mm/min during the "7.20" storm, but we need to ensure that the hourly rainfall data are of good quality. For the rainfall intensity of 201.9 mm/h at Zhengzhou Station, this data was widely questioned when it was first released. However, according to China Daily website, the staff of Zhengzhou Meteorological Observatory use three sensors to record rainfall data, and verify the data every minute using computer calculations and manual proofreading methods to ensure that the data is not false positive and highly authentic. Therefore, we believe that we can fully use hourly rainfall data to calculate rainfall erosivity.

As for testing different KE-I equations, I still think that this would enable authors to better evaluate the possible uncertainty in the estimation of the rainfall erosivity and return periods. At least testing 2-3 more equations would be useful. But it is up to editor to decide if this needs to be included or not.

Response: There is no question that the KE-I relationship is yet another source of uncertainty as far as the total kinetic energy of the storm is concerned. We strongly advocate use of the KE-I relationship as recommended and adopted in the most recent iteration of RUSLE for reasons of standardisation and

comparison. Storm EI30 reported in this manuscript should be used and interpreted in the context of rainfall erosivity and RUSLE. That is why we believe that standard KE-I relationship is quite legitimate and adequate for the manuscript.

I hope that it is clear that most of my comments go in the direction of capturing possible sources of uncertainty in the estimation of the rainfall erosivity and return periods since obviously this event was really extreme and compared to other past events it can be regarded as some kind of outlier. Hence, statistical analysis and estimation of return periods should be done with caution and including uncertainty. Hence, authors could improve this aspect of paper.

Response: We agree with the reviewer. We used the rainfall erosivity values over the past 67 years for Zhengzhou Meteorological Station to fit the extreme value distribution fitting to estimate the return period of "7.20" storm, and the results can be uncertain because the storm was such an outlier and of the large amount of extrapolation.

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

General comment:

Previously mentioned comments have been addressed in this revised draft. However, considering the recent rain episodes in Beijing, - reported in the news as the highest in the past 142 years (as per Associate Press, August 3, 2023) – the title of the paper could be altered to account for it. Though it is beyond the scope of the paper, I would be personally interested to see if this changes any of the results.

Response: The news was misleading. In fact, the heavy rainfall in August 2023 was the largest rainfall amount recorded in Beijing over past 142 years. The heavy rainfall occurred in the Beijing area. According to the People's Government of Beijing Municipal, the maximum rainfall in the city is 744.5 mm, and the maximum hourly rainfall is 111.8 mm/h. The rainfall and rainfall intensity of August rainstorm in Beijing was nowhere as high as the "7.20" storm in Zhengzhou.

Minor comments (line numbers on the tracked changes document):-

Regarding the point made above, the last paragraph of the introduction where "7.20" is emphasised as 'rare' could use some rework to make the paper sound more future-proof. For example, in line 55, 'recent times' can be rephrased to 'till 2022'. I will also limit usages like 'ever'. If you are planning to study recent rain episodes in future, it can be mentioned to substantiate the importance of "7.20" in lines 73-74 etc.

Response: Good point. It is always to add a qualifier such as 'up to 2022'.

On a second reading, probably the sentence in line 36 can be removed to improve readability. For example, it could just be 'However, the long-term average value cannot fully represent….' With Diotdo et. al 2016 and Wang et. al 2022 in references.

Response: We agree with the reviewer. We deleted the sentence from line 36.

In the newly added section from lines 80 to 85, a preposition is missing in line 83. Also, it's to be specific than saying 'certain standards', 'unexpected errors' etc.

Response: We have changed 'The rainfall data acquired from CMA and the data had been quality-controlled by CMA's National Meteorological Information Center' to 'The rainfall data was acquired from CMA and the data had been quality-controlled by CMA's National Meteorological Information Center' in line 81, 'unexpected errors' to 'outlier' in line 83. We deleted the 'to meet certain standards' in line 79.

From line 115, the reasoning provided to the other reviewer on the usage of Kinnell 1981 for KE-I could be stated in the paper. Readers can also be directed to van Dijk 2002 for a review on various relationships and their use cases.

Response: We agree with the reviewer. We made the following changes in the revised manuscript.

Line 112-115:

The most widely accepted kinetic energy-intensity relationship is the exponential model proposed by Kinnell (1981). This equation has the general form:

$$e_r = e_{max} \cdot [1 - a \cdot exp(-b \cdot i_r)] \quad (1)$$

where e_{max}, a, b are empirical constants. Among them, the coefficients a and e_{max} determine the minimum kinetic energy content. On the other hand, the coefficient b defines the general shape of the curve (Kinnell, 1981).

Line 231, I think there are some mistakes in the newly added sentences, on distribution names.

Response: We deleted the redundant word 'and P-III' in line 235.

If my understanding of the recent rain episode is correct, I would recommend mentioning it in conclusions part 3 (lines 324 - 327) since its occurrence illustrates the importance of this study.

Response: Please refer to the reply in the general comment.