Comment on essd-2020-370

Anonymous Referee #3

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.,

https://doi.org/10.5194/essd-2020-370-RC3, 2021

Overview and general recommendation:

The authors developed a new R-factor for Mainland China that requires a huge dataset and work. This study is really beneficial to future studies that requires a representative map of the R-factor for their purposes of application related to sediment transportation. However, there are some places that should be made up before published.

Many studies have developed a better R-factor map for now. So far just developing a R factor map was meaningful as there was a few maps people can employ, but now it is different. The R-factor map at a large scale should be developed based on understanding of application domains (e.g. climate zones, hydrological regimes, and the other characteristics that can affect estimating the R-factor). In this point of view, I think authors can improve the current manuscript more.

Responses to reviewer #3

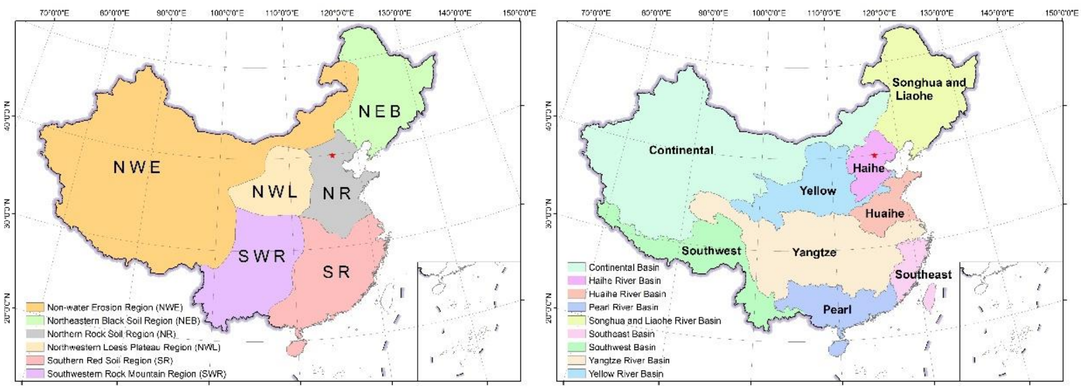
Dear Editors and Reviewer

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:

General comments

Mainland China has a large area consisting of a variety of climate zones and hydrological units (e.g. basins, hydrological regimes, and so on). Providing a map of rainfall erosivity is good motivation to readers and users in the future, but if authors provide the data with meaningful analysis and findings it would be great. You could consider the previous study here (Kim et al., 2020).

Response: We will add an analysis of the spatial interpolation of erosivity maps in the revised version. Considering the application of the erosivity factors, we adopted the soil erosion zoning (Figure 1a; MWR, 2007) and hydrological zoning (Figure 1b). Some statistical characteristics of the erosivity factors are shown in Table 1.



(a) Soil erosion zoning (b) Hydrological zoning

Figure 1 Zoning schemes

Table 1 Statistical characteristics of R-factor and 1-in-10-year EI_{30} in soil erosion and hydrological zonings

Factors	Zones	Mean	Std.	5th-percentile	25th-percentile	50th-percentile	75th-percentile	95th-percentile
R-factor ($MJ\ mm\ ha^{-1}\ h^{-1}\ a^{-1}$)	Mainland China	2200	3147	47	147	645	3503	8208
	NWE	208	192	30	70	144	276	614
	NWL	896	431	263	549	875	1239	1562
	NR	3637	1443	935	2780	3747	4577	5946
	NEB	1483	766	671	1041	1311	1611	3284
	SWR	4226	2079	841	2610	4324	5503	8060
	SR	8294	3370	4918	6140	7311	9141	16544
	Continental	138	130	25	62	92	174	424
	Haihe	2437	1169	719	1218	2717	3489	4042
	Huaihe	4744	948	3197	4062	4653	5466	6310
	SongLiao	1405	765	623	952	1235	1553	3220
	Yellow	920	754	214	402	749	1205	2199
	Yangtze	3933	2535	215	1355	4508	6052	7666
	Southwest	1318	2043	132	265	316	940	5998
	Southeast	7069	1292	4964	6014	7192	7916	9110
	Pearl	10280	3967	4450	7697	9354	12731	17591
1-in-10-year EI_{30} ($MJ\ mm\ ha^{-1}\ h^{-1}$)	Mainland China	1040	1259	99	166	435	1766	3206
	NWE	189	101	84	125	165	220	415
	NWL	635	254	226	438	635	825	1031
	NR	2199	770	556	1860	2422	2717	3123
	NEB	948	449	444	669	867	1044	2055
	SWR	1706	766	439	1098	1689	2308	2952
	SR	3273	1418	1953	2375	2846	3512	6814
	Continental	164	84	80	114	140	193	363
	Haihe	1595	794	459	718	1773	2350	2626
	Huaihe	2706	394	1999	2465	2723	2957	3337
	SongLiao	902	453	422	604	823	1026	1974
	Yellow	627	472	182	293	525	813	1430
	Yangtze	1706	1039	167	711	1959	2551	3194
	Southwest	496	533	184	212	232	389	1701
	Southeast	2814	881	1781	2160	2550	3262	4570
	Pearl	3846	1822	1564	2604	3320	4698	7512

Again, as the domain is considerable, there is a question mark to using one energy equation for entire Mainland China. Also, please describe more about using the conversion factor, 1.871, as a representative value for entire domain.

Response: Calculation of the kinetic energy requires raindrop disdrometer observation data which are very limited at a national scale. Empirical formulations have been developed for KE-I relationships (Eq. 1-3; Wischmeier and Smith, 1978; Renard et al., 1997; USDA–ARS, 2013). Yin et al. (2017) compared the R-factor calculated by different energy equations (Eq. 1-3) using rainfall data at 1-min interval from 18 stations across the central and eastern regions of China. The results showed that the behavior of the Eq. (3) (RUSLE2; USDA–ARS, 2013) which was used in this study was very similar to that of the Eq. (1) (USLE; Wischmeier and Smith, 1978). While the results from Eq. (2) (RUSLE; Renard et al., 1997) was underestimated by about 9.3%. Therefore, Eq. (3) was used for entire Mainland China, although there must be the uncertainty of the energy equation, which would be discussed in the revised version.

$$e_r = 0.119 + 0.0873\log(i_r),\ i \leq 76\ \ mm\ \ h^{-1} \tag{1a}$$

$$e_r = 0.283,\ i_r > 76\ \ mm\ \ h^{-1} \tag{1b}$$

$$e_r = 0.29[1 - 0.72\exp(-0.05 i_r)] \tag{2}$$

$$e_r = 0.29[1 - 0.72\exp(-0.082 i_r)] \tag{3}$$

where e_r is the unit rainfall kinetic energy (energy per mm of rainfall, MJ ha^{-1} mm^{-1}), i_r is the intensity (mm h^{-1}).

We agree that applying the same conversion factor for the entire mainland China may result in some uncertainty. The conversion factor, 1.871, for the R-factor was developed using 1-min observation rainfall data from 62 stations over Mainland China by Yue et al. (2020). It was reported in Yue et al. (2020) independent dataset for the validation showed that the symmetric mean absolute percentage error (sMAPE) was about 6.7% (ranging from 0.2% to 37.0%) after applying the conversion factor of 1.871. We will add more discussion on the uncertainty in the revision.

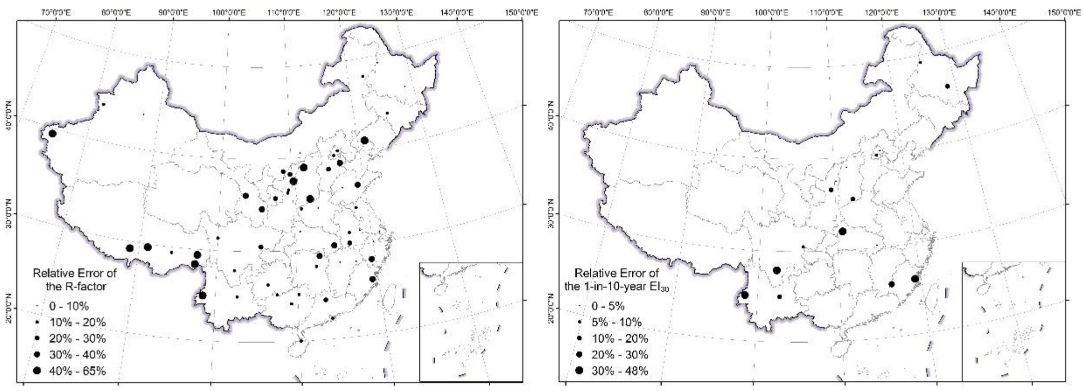
Using a conversion factor to correct the hourly data is good for estimating the 1-in10-year EI_{30} but it is concerned that whether the factor, 1.489, could be employed uniformly for entire Mainland China. I suggest authors provide some more details that can describe the uncertainty and its variability so readers can pre-understand its reliability before employing the newly developed map to their own applications.

Response: We are grateful for your constructive suggestions. As explained in the response above, the conversion factor 1.489 for 1-in-10-year EI_{30} was developed based on 1-min rainfall data from 54 stations over Mainland China by Yue et al. (2020). Independent dataset for the validation showed the symmetric mean absolute percentage error (sMAPE) was about 15.5% (ranging from 0.4% to 48.4%) applying the conversion factor of 1.489. It is hoped that more data at high temporal resolution (e.g. 1-min, breakpoint) could be available in future studies to develop conversion factors for different regions. We will add more details about the uncertainty of this study in the discussion as follows:

"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 in the manuscript). The conversion factors were developed based on 1-min rainfall data from 62 stations (Fig. 2 in the manuscript). 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 in the manuscript). This is based on a power function (equation 9 in the manuscript) of the mean annual precipitation and rainfall erosivity using 1-min and daily rainfall data of 35 stations (Fig. 2 in the manuscript); 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)."

In the verification part, suggest authors show the error on the map. This is to present the spatial distributed error and accuracy of the developed map. Also, it would be nice if authors describe errors varying in different density of gauge network.

Response: The distribution of relative error was shown on the following figure, which was evaluated using 1-min rainfall data from 62 (for R-factor) and 18 (for 1-in-10-year EI_{30}) stations. And the variation of the errors in different density of gauge network was shown in Fig. 8 and Table 6 in the original manuscript.



(a) R-factor (b) 1-in-10-year EI_{30}

Figure 2 Spatial distribution of the relative error from 62 stations for R-factor (a) and 18 stations for 1-in-10-year EI_{30} (b) with 1-min observation data.

Reference

Kim et al., 2020. Use of a high-resolution-satellite-based precipitation product in mapping continental-scale rainfall erosivity: A case study of the United States, Catena.

Specific comments

[Page 1 line 10] are indispensable for soil erosion assessment -> are necessary for sediment transportation estimation based on the ~

Response: We will rewrite the sentence as: 'Maps of rainfall erosivity are necessary for soil erosion assessment and sediment transportation estimation based on the Universal Soil Loss Equation (USLE) and its successors.'.

Recommend using a consistent word, for example, erosivity, rainfall erosivity, rainfall erosivity factor, erosivity factor, or R factor and erosivity map or R factor map. In addition, most studies use the 'R-factor' instead of 'R factor'.

Response: We will replace the 'R factor' with the 'R-factor' in the revised version.

[Page 1 line 12-13] not a good place to provide data-source where the data is available. Please put the information somewhere in the introduction or data section.
Response: Thank you for your suggestion. We will revise it.

Please mark the thousand commas into all of the values that over a thousand.
Response: Thank you for the suggestion. And we will revise it.

[Table 1] Please re-write the title.
Response: We will revise it as 'Studies on the mapping of R factor for or involving China'.

[Introduction] please re-write the first paragraph and it is too long as one paragraph.
Response: We will rewrite the paragraph to make it more concise and logical.

[Figure 6] Instead of saying 'changes', please find other words to express that. The developed map can be compared with the previous work, but the previous work having lower accuracy cannot be employed to analyze the changes.
Response: We will use 'differences' instead of 'changes'.

References

Ministry of Water Resources of the People's Republic of China. 2007. *Standards for classification and gradation of soil erosion*. Beijing: China Water and Power Press, 3-7.