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Hydrology and Earth System Sciences Discussions

Interactive comment on "Assessing the sources of uncertainty associated with the calculation of rainfall kinetic energy and the erosivity $\vec{R}$ factor. Application to the Upper Llobregat Basin, NE Spain" *by* G. Catari et al.

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Answers to Referee #1

We want to thank the anonymous referee #1 for the comments and questions that will certainly be helpful to improve the quality of the manuscript. Below, we provide the answers to the questions (shown between quotation marks) and we also addressed

the comments given by referee # 1.

"P. 3454, line 10: Rainfall erosivity maps were estimated from the stations values using Thiessen polygons. The choice of such spatial interpolation should be motivated. How the interpolation differs if we consider the inverse distance or the squared of the inverse distance for estimating distribution of the spatial rainfall erosivity ?"

We used the Thiessen Polygons because it is the simplest among the existing interpolation methods and it does not imply any modification of the original data. The contribution of every station to rainfall erosivity and its uncertainty is fixed and easy to calculate. We did not try other interpolation methods because we deemed that this would make the paper too intricate, whereas there are other published works on the uncertainty related to areal interpolation of variables. Nevertheless, we will try to pay more attention to this subject and make the test suggested for the revised manuscript.

"P. 3455, line 12: The R factor is derived from I30 and the total kinetic energy of the storm. In this study which criteria is considered to define and to separate rain events?"

The events were defined as those having a precipitation depth of 12.5 mm or higher, as following the RUSLE guidelines. The criterion to separate rainfall events was on the daily basis, because of the daily resolution of the dataset provided by INM.

"P. 3457, lines 23-25: The location of the Vallcebre station is such that during winter, solid precipitation (snow, hail) would be observed. How such events are considered in your analysis ? Is the typing bucket rain gauge equipped with a heating system to accelerate the melting of the snow?"

The used pluviometers were not equipped with any heating system. However, better measurements of actual snowfall intensity would not be helpful because of the negligible fall velocity of flocks, so kinetic energy would be overestimated. We did not pay attention to the snow precipitation because winter is the season with the least precipitation in the study area.

"P. 3459, lines 1-2. Possible and relevant errors on the daily precipitation provided by the INM stations are mentioned but not taken into account. For a complete uncertainty approach, it is needed that those errors are considered or at least estimated."

Indeed, this may be a source of error, but we do not have adequate data to analyse it in sufficient depth. Sevruk (1987) states that systematic errors in rain measurements by standard totalising rain gauges may be up to 15%, mainly due to the role of wind and evaporation but it can decrease down to about 5% during heavy rainfalls with large drop diameters; we are using this kind information for a first estimation of the role of network precipitation errors in the revision of the paper.

"P. 3459, line 25. It is not clear to me the meaning of this sentence : " Diverse published graphs of the relationships observed between Ekd and intensity, from diverse sites around the world, were examined." Which kind of examination did you perform ? You should develop on this point. Hence, do the sites (location, climate, level, . . .) cited in table 2 are close to the conditions in the llobregat basin ?"

The original graphs were digitized and the data were used to derive the scatter of observations around the means. Our purpose was not to find observations from areas with characteristics comparable to those of the Llobregat basin, but representative of the diverse types of rain that may occur across the world.

"P. 3460, line 9. The assumption of log-normal distribution of the point measurement of kinetic energy has to be justified."

This distribution was selected because most of the graphs of the observed specific kinetic energy showed a clear asymmetry of the values around the mean, and this type of distribution is physically reasonable for 'size' variables when the low values are limited to 0.

"P. 3463, line 19. The value of 519 mm/h for the rain intensity seems unrealistic. From table 2, the range of observed intensities does not exceed 228.6 mm/h. Attend to

extrapolate to higher intensity is quite "risky"."

We wanted just to show that equation (5) gives reasonable values within the expected range of intensities; indeed, 519 mm/h is an unrealistic value but much far from the used range of values. We will rewrite the sentence to avoid misunderstandings.

"P. 3463, line 21. "relative dispersion is minimal for high-intensity . . .". This is the consequence of equation (3); Ekd is approaching an asymptote, emax, at high intensities. If one considers the various relationshiphs between Ke and I from the literature, the dispersion is not minimal at high intensities (e.g. Salles et al., fig 2a)."

We did not work with equations but with observations. All the graphs on measured specific kinetic energy against intensity of short rainfall intervals we could obtain from the literature showed a decrease of dispersion (standard deviation of the log-transformed variable or variation coefficient of the physical variable) with increasing rainfall intensity. This is indeed shown in Figure 1a in Salles et al (2002): max. observed values of KEmm are similar for intensities from 1 to about 30 mm/h, whereas min. values clearly increase for the same range. Figure 1b of the same work shows a similar behaviour in the log scale of KEtime.

On the other hand, Fig. 2a in Salles et al (2002) represents not observations but simulations using diverse equations; at a first glance, it demonstrates that equations must be used only within the range of calibration, because four equations give negative values of specific kinetic energy for intensities of 1 mm/hour. High intensity observations are usually rarer than low intensity ones, so we can expect that the diverse fitted curves will show higher dispersion for increasing intensity.

"P. 3465, line 6. The fitted relationships between daily rainfall depth and daily rainfall erosivity (eqs. (6) and (7))were obtained from the scatterplot reported figs. 5a and 5b. The daily rainfall erosivity is known with a given uncertainty as this is the daily values of storm erosivity. Does this uncertainty is taken into account for the dertermiantion of eqs. (6) and (7) parameters . If not, how the uncertainties on the daily rainfall erosivity

could be taken into account?"

We used fixed parameters for the equations (6) and (7) and derived the uncertainty of the estimates using the dispersion of the residuals. The uncertainty of the rainfall erosivity obtained from sub-hourly data was analysed separately, as shown in the table 4 (“instrument” and “kinetic energy” columns).

References:

Sevruk, B. (1987) point precipitation measurements: why are they not corrected?. in: water for the Future, IAHS Publ. n° 164: 477-486.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 3453, 2010.