

Comments on the Manuscript "Return periods of erosive rain in Germany"

by Karl Auerswald and co-workers

Summary: This study proposes an interesting approach to estimate the return period of rainfall erosivity across Germany by comparing rain gauge and weather radar over a period of 17 years. Defining the rainfall erosivity factor R as sum of the Erosion Intensities over all erosive rain events in a year, the authors conjecture that event (erosion) characteristics and the number of events are statistically independent. Secondly, they conjecture that spatial and temporal changes in rainfall erosivity results mainly from frequency changes while Erosion Intensities can be treated as largely invariant. The authors use general extreme values statistics to estimate the distribution of Erosion Intensity based on the two different types of rainfall observations. They then define the return period of rainfall erosivity as inverse of the exceedance probability times the expected value of events of this strength. Using their methodology the authors relate the number of erosive rainfall events to the rainfall erosivity using weather radar data, and compare the respective mean of the Erosion Intensity against to the corresponding value derived from 115 rain gauges. The authors compare, furthermore, the distribution functions of Erosion Intensities, revealing differences rain gauge and weather radar estimates for less impact full events. They finally provide a relation between rainfall erosivity and Erosion Intensity for return periods starting from 10 up to 500y.

Evaluation: The proposed study is technically sound, the findings are interesting and of high practical relevance. So, the manuscript deserves without doubt publication in Hess. Yet I find made a few observations that require careful attention in a round of major revision.

Major points

- The polynomial relating the number of events N to the erosivity R is interesting (Eq 5.). Yet I ask how much of this relation is spurious, because R is not independent of N ! Let us assume that EI is constant for each event of the year. This implies $R = N \times EI$ where N is the number of the events. In this case the linear regression of N with R would be perfect, with $1/EI$ being the slope, correct? Does the fact that the linear regression is so strong, suggest that the variation of EI is small? In this case the relation would be largely spurious. You could also estimate an upper and lower bound of R using the maximum or minimum of EI . Do I miss something? I would be happy to be proven wrong.
- While Figure 3 is a key finding of this study, I must admit that I do not fully understand, whether this refers to a single station, a radar pixel or the entire of Germany? If the latter is the case, it needs more explanation. KOSTRA extreme value statistics reflects the climatic and orographic setting (as reflected in the underlying data). So, I would naively expect that extreme values or rainfall erosivity are not spatially homogeneous in a statistical sense. At least for me there is a need for further clarification.
- Kinetic energy of rainfall depends on the drop size distribution and scales the 7th power of the drop radius (when using Stoke law to characterize rain drop velocity). How is kinetic energy in the rain events estimated without using distrometer data?
- While I have the highest respect for the main author, I regret to say that the presentation quality is not appropriate for a top journal. The study would benefit from a concise presentation of the main objectives and the underlying hypotheses. The hypotheses are currently presented on page 5 in the method section (I had to search for them). The objectives are presented in a diluted manner, instead of a clear and concise statement. I also quickly lost track when reading the abstract, which is puzzling with the acronyms R , RR , RG , RP and EI .

- The study would for sure reach a wider audience, if key concepts like rainfall erosivity were shortly explained in the introduction (This is also key for stating the hypotheses at the end). While I am doing active research on erosion, I am not in the USLE user group, but work with concepts like shear stress, physical work and stream power. I appreciate that the author states that kinetic energy of rainfall determines its erosional impact. However, I finally learned that rainfall erosivity equals the sum of the Erosion Intensity of all erosive rain events in a year. Erosion Intensity is in turn the production of kinetic energy and rainfall intensity, right? In physical terms this is power, i.e. the kinetic energy flux of the rain. This makes much sense, when recalling Bagnolds formula relating stream power and shear stress. But it would be helpful for a reader outside of the USLE user group, e.g. from hydromechanics, to have this explanation earlier.

Technical points.

- I don't see that the definition of the exceedance probability relates to a time period. This comes in when estimating it from time series. Maybe I am wrong?
- EI has the dimension force over time. On a first note, I found this irritating because you can only have a flux of an additive/extensive quantity (energy, entropy, momentum, mass). Force is, however, not extensive variable. Power has the dimension force times velocity. So is EI defined as power over length (W/m)?
- I like the definition of the RP. But it essentially relies on the idea that N and EI are independent, correct?
- The Nash Sutcliffe Efficiency and the RMSE are not independent. The NSE is basically the MSE normalized with the variance of the observations. So what is the benefit of using both?
- Please provide confidence limit for all expected values of EI and also for the parameters of the GEV.
- While I don't know all the details underlying RadKlim, I assume that the product is not totally independent from rain gauge data? So, what do we learn from the difference in the expected values of EI. Is a difference of 1.2 N h^{-1} ? Recalling that critical shear stress for diffusive erosion is of order 1 N/m^2 , the difference appears remarkable to me.

Best regards,

Erwin Zehe