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Comment on hess-2022-118

Paweł Licznar (Referee)

Referee comment on "Regionalisation of rainfall depth–duration–frequency curves with different data types in Germany" by Bora Shehu et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2022-118-RC2>, 2022

Dear Authors,

my name is Paweł Licznar and I am currently a professor at the Wrocław University of Science and Technology, Poland. At the beginning, I would like to inform you, that I was selected by the Editor to be one of the anonymous reviewers of your manuscript. Despite that, I have decided to submit this review as non-anonymous person because of the reasons described below.

I believe I was proposed to be reviewer of your manuscript because of two reasons.

First, it was my former research concerning multiplicative cascade models implementation for the sake of rainfall disaggregation. Below listed are my most important communications in this particular field. Some of them were published at the HESS Journal:

- Licznar P., Ćwikłomowski J., Rupp D. E.: Random cascade driven rainfall disaggregation for urban hydrology: An evaluation of six models and a new generator. *Atmospheric Research* 99, 2011, s. 563-578.
- Rupp D. E., P. Licznar, W. Adamowski, and M. Leńniewski (2012): Multiplicative cascade models for fine spatial downscaling of rainfall: parameterization with rain gauge data. *Hydrol. Earth Syst. Sci.*, 16, 671–684, 2012 ([doi:10.5194/hess-16-671-2012](https://doi.org/10.5194/hess-16-671-2012)).
- Licznar P., Schmitt T. G., Rupp D. E. (2011): Distributions of microcanonical cascade weights of rainfall at small timescales. *Acta Geophysica* DOI: 10.2478/s11600-011-0014-4
- Licznar, P., De Michele, C., and Adamowski, W.: Precipitation variability within an urban monitoring network via microcanonical cascade generators, *Hydrol. Earth Syst. Sci.*, 19, 485-506, [doi:10.5194/hess-19-485-2015](https://doi.org/10.5194/hess-19-485-2015), 2015.

From the above mentioned list I would like to focus your attention on paper from 2011 which was prepared with collaboration of Prof. Theo Schmitt (TU Kaiserslautern) and based on German gauges series, most probably incorporated also in your database.

Second, probably the more important reason of my person selection for reviewer was my scientific collaboration with the Editor of your submission. He knows more about my activity than it could be retrieved from published communication. In years 2016-2020 I was involved in development of the Polish Atlas of Rainfalls Intensities (PANDa). It is to some extent solution similar to German KOSTRA Atlas however established for Poland. As I suppose you have not heard about it before since the communication in English about some preliminary project phase is only to be found at:

Burszta-Adamiak E., Licznar P., Zaleski J., 2019: Criteria for identifying maximum rainfalls determined by the peaks-over-threshold (POT) method under the Polish Atlas of Rainfalls Intensities (PANDa) project. *Meteorology Hydrology and Water Management. Research and Operational Applications* 2019, vol. 7, No. 1, doi: <https://doi.org/10.26491/mhwm/93595>

Just to cover the most important PANDa project elements: We were forced to prepare a database from 100 gauges (30 years each). About half of it was prepared based on paper strips digitalization. All records were verified and stored at 1-min. resolution. Maxima series were selected by POT and modelled by Generalized Pareto Distribution. Kriging techniques were used for final maps development. At the end a completely digital Atlas was developed. The whole territory of Poland was divided into about 13 thousand pixels. Surprisingly the pixel size is as in your case 5 km by 5 km! For each pixel a unique DDF model was established. All the data could be accessed only by Internet at: <https://atlaspanda.pl/o-projekcie/>. The access to the data is commercial as the project was co-funded from EU funds for small startup companies. Since two years PANDa is used in practice by Polish engineers. This project serves for amelioration of Polish practice of drainage systems design. An important part of the project was to educate Polish engineers and to make them change old habits, i.e. using unrealistic empirical IDF equations. You can learn more about it from the following paper:

Zbigniew Kundzewicz, Paweł Licznar: Climate change adjustments in engineering design standards : European perspective. *Water Policy*. 2021, vol. 23, nr S1, s. 85-105.

Considering the need for local education, the methodology of PANDa project was published in the form of monograph in Polish language and is accessible on public (<https://www.imgw.pl/sites/default/files/2020-06/metodyka-opracowania-polskiego-atlasu-natezenia-deszczow-panda.pdf>). To my best knowledge most of information about KOSTRA first versions was also prepared for local engineers in Germany and was accessible in German.

Returning to the evaluation of your manuscript, I am fully aware of its scientific and practical valor.

I see and I can imagine how much work you have done. My recommendation is to publish it with only minor corrections. From my experience I know that in such scale project their authors have to take a number of decision and many of them could be questioned from scientific perspective. Please, find below my questions and recommendations. All of them are just my suggestions. If some of them are impossible to be incorporated into the corrected manuscript I will not change my positive opinion.

- Page 7, lines 197-200. Why do you mention about 4-hour dry duration period between following maxima if you are deriving annual maximum series (AMS)? Don't you derive just only one maxima for each single calendar year? You have most probably months gaps between following maxima values in your series?

- Page 6, lines 185-186. Why only 30 realizations of disaggregation were made? In most multiplicative random cascades applications, cascades generators are run 100 times.

- Page 6, lines 181-183. Daily rainfall is disaggregated up to 15 min time scale. If this is true, why in Fig. 3 you present the relative error results only to 1 h time scale? The evolution of error seen in Fig 3 shows visible underprediction of extreme rainfall for shorter time durations. Since this is cascading process most probably the magnitude of underprediction for sub-hourly durations of 30-min and 15-min must be much bigger. Most probably such problem could be explained by errors of cascade generator parametrization (for a detailed discussion of this please refer to:

for urban hydrology: An evaluation of six models and a new generator. Atmospheric Research 99, 2011, s. 563-578).

- Page 12, lines 342-343 "Based on a k clustering approach (Ward, 1963) 9 homogeneous regions were identified and are shown in Figure 8". This is unclear since usually you must enter the k-means algorithm with already known (assumed) number of clusters. How did you select k=9? Was there any objective approach to estimate the optimal clusters number? Addition of some dendrogram might help here. I believe most probably you should explain your selection of clusters number by analyzing how values of the Caliński and Harabasz Index (the CHIndex) and total within sum of squares (wss), depend on the adopted number of clusters k. Examples of such approach could be found at:

Karol Mikołajewski, Marek Ruman, Klaudia Kosek, Marcin Glixelli, Paulina Dzimińska, Piotr Zięta, Paweł Licznar: Development of cluster analysis methodology for identification of model rainfall hyetographs and its application at an urban precipitation field scale. Science of the Total Environment. 2022, vol. 829, art. 154588, s. 1-20

- Page 313, lines 306-307. In your manuscript you are only declaring selection and application of some semivariogram model. It is simple spherical model. Did you measured the goodness of spherical model fit? It is of value to have at least a single example illustrating empirical semivariogram and fitted theoretical spherical model. I am raising this question since here you might encounter two problems. First, high (singular) extreme values like ones reported for event in Münster destroy the regular picture of empirical variance dependance vs. stations distance. Second, usually to model the complicated picture of spatial distribution of extremes (or their distributions parameters) one needs to implement more advanced semivariogram model, being a superposition of two or three simple models (eg. double spherical plus nugget). It is explained by the influence of different scale process on local rainfall maxima (from large scale forcing up to local turbulence scale). For example, the rainfall maxima field in Poland is usually the sum of the outcomes of three types of processes operating at various spatial scales. The spatial scales are probably connected with a convective/orographic, a frontal and a 'climatological' genesis of high precipitation. It is explained in details in monograph (https://repozytorium.amu.edu.pl/bitstream/10593/3938/1/Stach_analiza.pdf). Once more it is in Polish but with English summary.

- What I am missing in all your manuscript is the proposal or clear discussion on how your method could contribute to confidence intervals estimation to be provided for designers at the new KOSTRA. To my best knowledge at the current KOSTRA Atlas they are imposed subjectively and calculated as a certain percentage of maxima. This approach is in general against the physics of rainfall maxima in nature. Rainfall series are multifractals and rainfall maxima are singularities. The more rare (higher frequency) maxima the higher order singularity it is and it becomes more uncertain. With increasing frequency and decreasing time duration confidence intervals should expand.

- It is worth to explain or at least discuss why you have selected new 5 km by 5 km spatial resolution for the new KOSTRA. This resolution is different than in old KOSTRA (71 km²). Here I would advise to refer to the paper: Hengl T., 2006, Finding the right pixel size, *Computers and Geosciences*, 32 (9), 1283-1298, DOI: 10.1016/j.cageo.2005.11.008.

- Page 8, lines 221-222. I would say that another possible reason could be a "step response error" typical for electronic gauges. It is real problem not only in case of simple tipping-bucket gauges series but also for series recorded by the first generation of weighing type gauges. This issue is discussed at: Licznar, P., De Michele, C., and Adamowski, W.: Precipitation variability within an urban monitoring network via microcanonical cascade generators, *Hydrol. Earth Syst. Sci.*, 19, 485-506, doi:10.5194/hess-19-485-2015, 2015.

At the end, once more I would like to underline the fact that I can imagine the extend of research done by you. Your contribution deserves to be published at the HESS Journal.