Hydrology and Earth System Sciences Discussions

Hydrol. Earth Syst. Sci. Discuss., referee comment RC1
https://doi.org/10.5194/hess-2022-233-RC1, 2022

Comment on hess-2022-233

Anonymous Referee #1

Referee comment on "A principal component based strategy for regionalisation of precipitation intensity-duration-frequency (IDF) statistics" by Kajsa Maria Parding et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-233-RC1, 2022

This study proposes an empirical statistical modelling approach to estimate the precipitation intensity-duration-frequency (IDF) statistics from 74 stations in Norway. Principal Component Analysis (PCA) was first used to reduce the dimensions and complexity of the IDF of all stations into two sets of principal components (PCs) through the Singular Value Decomposition (SVD). The PCs were then regressed against climatological and geographical information using Bayesian linear regression.

General Comments:

This manuscript is well-written with a good structure, and the proposed methodology is mathematically sound and well-established, which provides a good contribution in statistical inference methods of the IDF curves. Having said that, there are several issues needed to be addressed to better discuss the uncertainty and to enhance the applicability of the method.

The nature and probabilistic behaviour of extreme climate phenomena is known to be influenced by anthropogenic climate change over time, which challenges the fundamental stationary risk concepts in calculating the IDF curves. As a result, the static stationary-based IDF curves may underestimate the occurrence probability of extreme precipitation. I wonder how the proposed methodology address the non-stationary issue (e.g. historical trends in the probability of heavy rainfall) and incorporate the influence of non-stationary conditions on IDF curves?

The Benestad et al, (2021) simple approximate formula that used to compare and assess the proposed methodology in this study is only one of many approaches in estimating the return values and predicting the IDF curves, and it is based on some assumptions (e.g. deliberate choice of using L=24) and is calibrated only from Oslo and validated at some independent sites in Norway. The formula has not been, to my knowledge, vigorously tested worldwide, and thus, remains regional specific. To ensure the robustness of the proposed methodology and increase its applicability, I suggest the authors evaluate the proposed methodology with several more commonly used statistical inference methods (e.g. parametric formulation of IDF relationships based on Koutsoyiannis et al. (1998) framework, distribution fitting using L-moments/probability weighted moments estimation, and regionalization methods such as the Index Flood method). In this way, the readers will have better ideas on how the proposed methodology performs against those widely used methods.

- Koutsoyiannis, D., Kozonis, D., & Manetas, A. (1998). A mathematical framework for studying rainfall intensity-duration-frequency relationships. *Journal of Hydrology*, 206(1-2), 118-135. https://doi.org/10.1016/S0022-1694(98)00097-3.

As the authors correctly stated, the accuracy of IDF curves depends on the quality of input data and the statistical inference methods. While this study focuses on the latter, the former should not be neglected and a better discussion in this regard could be done. Since considerable amount of research (e.g. Eldardiry et al., 2015; Marra et al., 2017; Degaetano & Castellano, 2017) have been done on investigating the use of alternative sources of rainfall measurements (e.g. radar, satellite-based precipitation, downscaled global/regional climate models' precipitation simulations, and reanalysis products) in constructing the IDF curves, I wonder how these alternative sources of information could potentially be used and supplement with the ground stations in the study region?

- Eldardiry, H., Habib, E., & Zhang, Y. (2015). On the use of radar-based quantitative precipitation estimates for precipitation frequency analysis. *Journal of Hydrology*,531, 441–453. https://doi.org/10.1016/j.jhydrol.2015.05.016.
- Marra, F., Morin, E., Peleg, N., Mei, Y., & Anagnostou, E. N.: Intensity–duration–frequency curves from remote sensing rainfall estimates: comparing satellite and weather radar over the eastern Mediterranean, *Hydrol. Earth Syst. Sci.*, 21, 2389–2404, https://doi.org/10.5194/hess-21-2389-2017, 2017.
- DeGaetano, A. T., & Castellano, C. M. (2017). Future projections of extreme precipitation intensity-duration-frequency curves for climate adaptation planning in New York State.Climate Services,5,23–35. https://doi.org/10.1016/j.cliser.2017.03.003.

Specific Comments:

L34-35: Certainly building the relationship between IDF curves and some climatological and geographical factors is one way to regionalize the IDF curves, but there are also other ways to estimate the IDF curves such as using radar and remote sensing data (e.g. Eldardiry et al., 2015; Marra et al., 2017; Ombadi et al., 2018; Sun et al., 2019). It would be appreciated if the authors could add some discussions in this regard.

- Ombadi, M., Nguyen, P., Sorooshian, S., & Hsu, K. L. (2018). Developing intensity-duration-frequency (IDF) curves from satellite-based precipitation: Methodology and evaluation. *Water Resources Research*, 54(10), 7752-7766. https://doi.org/10.1029/2018WR022929.
- Sun, Y., Wendi, D., Kim, D. E., & Liong, S. Y. (2019). Deriving intensity–duration–frequency (IDF) curves using downscaled in situ rainfall assimilated with remote sensing data. *Geoscience Letters*, 6(1), 1-12. https://doi.org/10.1186/s40562-019-0147-x.

L40-41: It is not clear that why calculating IDF curves for each grid is impractical and computationally expensive as research has been done at the global scale, i.e. Courty et al., 2019. Please clarify.

- Courty, L. G., Wilby, R. L., Hillier, J. K., & Slater, L. J. (2019). Intensity-duration-frequency curves at the global scale. *Environmental Research Letters*, 14(8), 084045.

L73-74: It seems to me that there are no analysis done on using the proposed statistical modelling in combination with future projections of meteorological quantities. I could have missed the material, please correct me if I am wrong. If not, please show the results or the objective is over-stated otherwise.

L88-90: Can the authors comment on the quality of the data (e.g. % of missing values) please?

L90-92: Is it possible to have the same station with temperature data assigned to two different IDF stations, given the sparse spatial coverage of the network?

L196-205: The sensitivity of the IDF curves on the predictors were examined by holding one variable constant at a time. I wonder how the combined effect of the predictors influences on the shape and level of the IDF curves? It would be appreciated if the authors could do a more in-depth analysis here.

Remarks:

Figure 2: the IDF curves for all return periods for eight stations (Figure S4) could be shown here alongside with the geographical locations of the stations, i.e. combining Figure S4 and Figure 2