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Hydrology and Earth System Sciences Discussions

Interactive comment on "Joint return periods in hydrology: a critical and practical review focusing on synthetic design hydrograph estimation" *by* S. Vandenberghe et al.

Anonymous Referee #1

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Although the copula-based multivariate statistical approach provides more flexibility to the conventional rainfall/flood frequency analysis, the concept of return period becomes non-trivial at the multi-dimensional space. This study provides an important step toward the better understanding of the difference between various JRP methods and offers a general framework that allows the inter-comparison between different JRP estimates. The ensemble-based approach, although not fully demonstrated in this study, is indeed one potential direction for the future hydraulic design practice under the multivariate framework. Given the significant contribution, the reviewer would recommend acceptance of this paper, after all of the following concerns have been addressed in

the revision.

1. [Section 3.2, Eq. 7] The authors should revise how the conditional distribution was applied. The current outputs from Eq. 6 (regression approach) and Eq. 7 (conditional approach) are not comparable. Using the case study as an example, the regression formula (Eq. 6) provided the expected value of volume corresponding to the 100-year peak discharge. Therefore, the result of Eq. 6 should be closer to the conditional expectation of volume given the 100-year peak discharge, instead of the 100-year quantile sought in Eq. 7. In other words, the conditional distribution F_{Y|X} describes the probability of volume for the interested large events (100-year peak discharge), and it will make more sense to compute the expectation or mode from the conditional distribution F_{Y|X}, instead of another 100-year quantile.

2. [Section 3.3, Eq. 8] I would recommend the authors extending Eq. 8 to cover the survival copulas (i.e., computing the joint cumulative exceedance probability). Some recent studies showed that the two different approaches (regular and survival) would result in very different JRP (given their different statistical meaning). It will be of interest to see how the difference will be in this case study.

3. [Section 3.4, lines 19–21] I would suggest the authors refer to Kao and Govindaraju (2010). They utilized the Kendall distribution function on a 12-dimensional copula space (of multiple drought indices) to define a Kendall distribution-based joint drought deficit index.

4. [Section 5.2, line 10] Please note that the statement "As these variables are annual extreme values selected from the 500-year discharge series, the fit of several extreme value distributions is considered." is only true for peak discharge since it is how the annual maximum events were selected. Both volume and duration may be closer to GEV given their high correlation to peak discharge, but it is not a necessity. Therefore, there is no conflict to use non-GEV distributions to characterize volume and duration.

5. [Section 6.3] Since part of the study is targeted for practitioners, additional com-

ments regarding the data limitation should be provided. Although it is appropriate to utilize a great number of synthesized data (500 years) for this case study, the practitioners would still prefer to build their cases on direct observations and hence the data limitation will be one main issue. For instance, one may still need to rely on the conventional univariate approach (if there will be no sufficient data to support the multivariate analysis). Missing values will be another challenge that should be cautioned to the practitioners.

[Reference] Kao, S.-C. and R. S. Govindaraju (2010), A Copula-based Joint Deficit Index for Droughts, Journal of Hydrology, 380, 121-134.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 6781, 2012.