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Interactive comment on "Multivariate design via Copulas" *by* G. Salvadori et al.

S. Vandenberghe

sander.vandenberghe@ugent.be

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Multivariate extremes are becoming more and more important as there is a tendency to statistically describe natural phenomena (e.g. rainfall or floods) with several variables (e.g. storm duration, storm intensity, peak discharge, flood volume, ...), which can exhibit some kind of (non-linear) dependences. In this context, copulas provide a valuable tool for the construction of multivariate distribution functions.
The first preliminary concept of a copula-based multivariate return period (called the secondary return period in that time) was introduced around 7 years ago, but despite its valuable nature, this concept has only been applied in a very limited number of studies. I believe this might have two reasons. Firstly, the methodology is not yet fully understood and secondly, the power or advantage of a copula-based multivariate return period in (hydrological) applications is a bit underestimated. As a hydrologist, I'm

grateful to the authors for presenting this study, which on the one hand further elaborates the existing methodology and on the other hand clearly states the need for more research on the topic, and more precisely on applications in several branches of science.
This study presents a detailed methodological elaboration of the concept of a multivariate return period and of the selection of representative multivariate design events, addressed both from a mathematical and practical point of view. In a consistent way, the existing concepts for two dimensions have been generalized to the more dimensional case, now called Kendall's return period. Clear remarks and pitfalls for the practitioners are given, with a specific focus on important differences between univariate and multivariate return periods.
The issue of selecting one multivariate design event out of a collection of events which all share the same return period is in fact a challenging one and should clearly be inspired by the application. The authors present two interesting and useful methods for this task, which have not been presented before in hydrology but which are intuitively appealing. The illustration of the over-dimensioning of the dam clearly illustrates the usefulness of such multivariate design events.
Besides selecting just one multivariate design event, the methodology also allows for a more "ensemble" based approach of design by selecting several events with the same return period. In this way, it would be possible to assess to some extent the uncertainty of a specific design. It would be interesting to see a little discussion on this issue in the paper as well, or here in the interactive discussion.
To conclude, I hope this paper triggers other scientists and practitioners to work with and study the copula-based multivariate frequency analysis framework as I believe it is a promising one.

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