Supplementary Material

In this supplementary material section, visual representations of the pairs sampled from the continuous time series of flow discharges recorded at the Bomporto river gauge station are reported, in order to provide an additional insight on the analysed theoretical copulas obtained for a threshold flow discharge of 240 m^3/s and an interevent time definition of 24 h (Lang *et al.*, 1999). In Figure SM.1, observations are plotted. It can be noticed that extreme floods feature a great variability: for instance, the maximum peak flow discharge corresponds to a flood duration less than 40 h, whereas the maximum flood duration is greater than 70 h. Further, the maximum flood duration is associated with the fourth largest peak flow discharge.

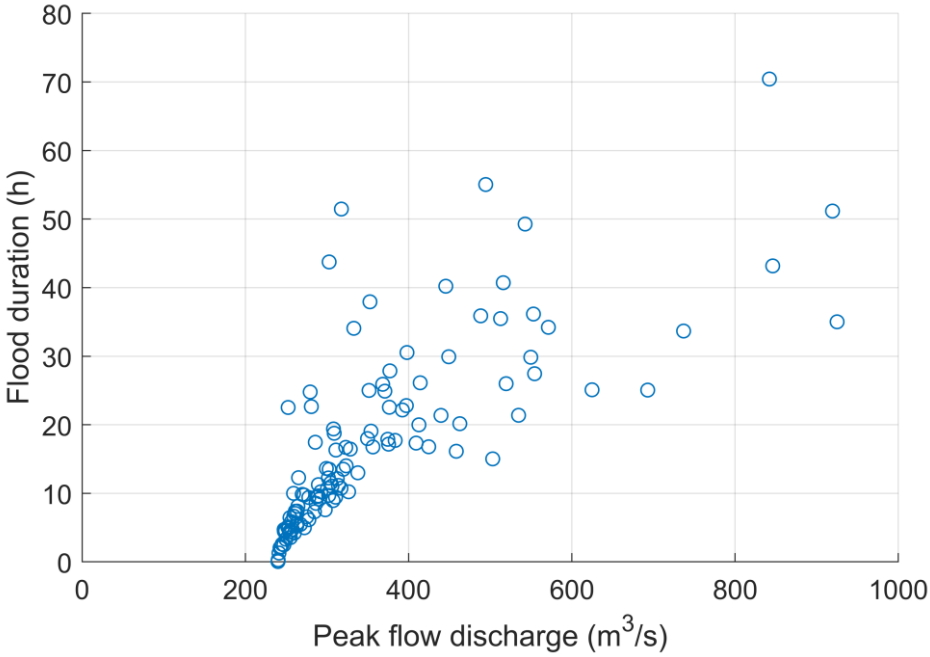

Figure SM.1: Scatter plot of the observations sampled from the continuous time series by using a 240 m^3/s threshold flow discharge and a 24 h interevent time definition.

The corresponding pseudo-observations are plotted in Figures SM.2–SM.4, where the contour lines of the empirical copula are compared to those obtained for the fitted theoretical copulas. The Clayton, Student, and Gumbel copulas are analysed in Figure SM.2, SM.3, and SM.4, respectively (details can be found in Joe, 1997; Nelsen, 2006; Salvadori *et al.*, 2007). All models provide a good agreement with the empirical copula. The best fitting capability displayed by the Clayton copula, as

highlighted by the likelihood value ranking reported in in Table 2 of the manuscript, appears to be related to the great dispersion of the extreme events and the concentration of the lowest ones on the bisector.

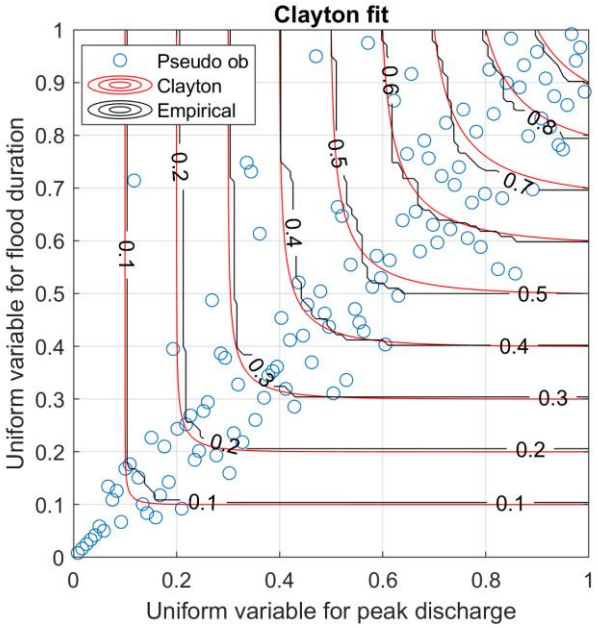

Figure SM.2: Scatter plot of the pseudo-observations and comparison between the contour lines of the Clayton copula and the empirical copula.

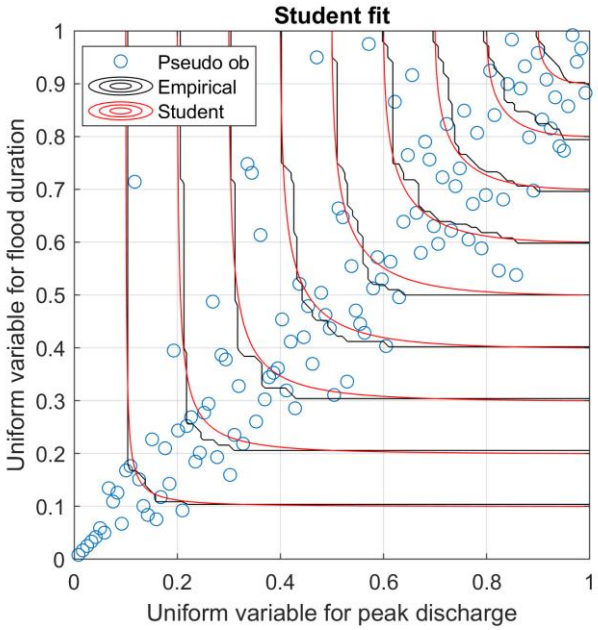

Figure SM.3: Scatter plot of the pseudo-observations and comparison between the contour lines of the Student copula and the empirical copula.

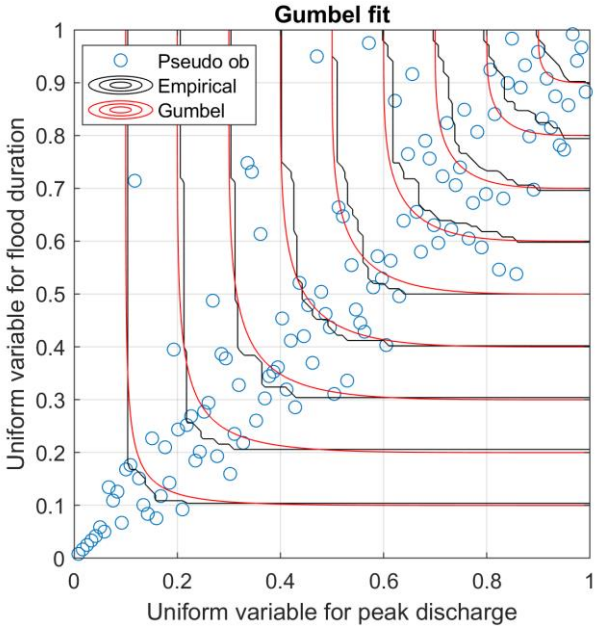

Figure SM.4: Scatter plot of the pseudo-observations and comparison between the contour lines of the Gumbel copula and the empirical copula.

References

Joe, H., 1997. Multivariate models and dependence concepts. Chapman & Hall, London, UK.

Lang, M., Ouarda, T.B.M.J., Bobée, B., 1999. Towards operational guidelines for over-threshold modeling. J. Hydrol. 225 (3-4), 103-117. https://doi.org/10.1016/S0022-1694(99)00167-5.

Nelsen, R.B., 2006. An introduction to copulas, (second ed.). Springer, New York, NY.

Salvadori, G., De Michele, C., Kottegoda, N.T., Rosso, R., 2007. Extremes in nature: an approach using copulas. Springer, Dordrecht, NL.