Modeling multivariate extreme rainfall events using different families of copulas

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Fluvial flooding risk assessments require long time series to properly capture extreme behaviours. In places where rainfall time series are not long enough, synthetic precipitation time series generated by stochastic models may be required to properly analyse extreme events (for instance, see Diez-Sierra & del Jesus, 2020; Sun & Stein, 2015). For the synthetic generation of rain events over extensive areas, it is essential to consider the spatial dependence among locations. Recently, some authors proposed the use of multivariate copulas due to the dependence structures (Favre et al., 2018) presents the new family of Fisher copulas by showing that these dependency models are tail asymmetric and allow upper tail dependency; (Brunner et al., 2019) proposed a simulation model for ensembles of stochastic flood events at calibrated and uncalibrated locations, also comparing the performance of different families of copulas.

In this context, our analysis seeks to evaluate different multivariate models applying copulas from different families (Elliptical, Archimedean, Vine, Fisher), to study the copula that best captures the asymmetry of the upper tail and the significant dependence associated with extreme rainfall data. Specifically, we propose a method that allows, through the selected copula, to simulate stochastic events in instrumented and non-instrumented zones, that keeps the spatial dependence of rainfall events.

More specifically, we analyse which measures are adequate to explain the spatial correlation of events at different locations within a network of stations (by elevation or distance); which copula families can optimally capture the spatial structure of dependence within a region; and in which way can the copulas be configured to generate event sets at both instrumented and non-instrumented locations.

These questions are answered by applying the proposed methods to a pilot case, which will be developed in a catchment located in the north of Spain. Multivariate modelling is becoming increasingly relevant in the hydrological field due to its ability to model extreme stochastic events, which are decisive in mitigating the risk and damage caused by floods.

References

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