

Flood frequency analysis by using copulas

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Flood frequency analyses are usually univariate and only account for the peak discharge of the hydrograph, as in most cases there is a direct relationship between the river discharge and water level at the point of interest. However, in some cases this direct relationship does not exist, such as the cases of floodplains and dams. Consequently, a multivariate analysis is required to characterise hydrographs by using a set of hydrograph variables, such as peak discharge, hydrograph volume and hydrograph duration. Copulas have shown themselves as being suitable when characterising dependence between such hydrograph variables. Copulas have been applied to solve several problems encountered in flood frequency analysis. Univariate regionalisation techniques are extended to the bivariate case either to improve the at-site estimates of flood peak and hydrograph volume quantiles for a given return period at gauged locations or provide estimates at ungauged sites. They are also used to characterise the dependence between peak discharge and hydrograph volume to establish the design water levels at dams, as well as to assess the dam safety against floods. Bivariate flood trends are studied by analysing how copula dependence varies in time. Finally, an uncertainty analysis to find the minimum number of pairs required to obtain reliable flood quantile estimates is conducted. A set of case studies in Spain and the United Kingdom are used to provide an insight into how copulas have improved the traditional techniques used in flood frequency analysis.