Characterization of droughts using Copulas: frequency analysis and spatial patterns in Guangdong, China

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Droughts have repeatedly occurred over the past decades and have inflicted significant damage to human society and ecological environment. Therefore, it is of great significance to have a better understanding of the occurrence frequency and spatial patterns of droughts. This study carried out the univariate and bivariate frequency analysis of drought duration and severity using Copulas and investigated the spatial distributions of droughts based on the joint probability distribution in Guangdong province. The quartiles descriptive statistical approach and spatial interpolation was used to map the spatial frequency distribution for the marginal distribution and joint occurrence probability of drought duration and severity; Cluster analysis was employed to characterize the spatial pattern. Results show that drought properties in water rich regions have their own unique features so there might not be a best copula for a region but a best copula for a site; further analysis demonstrated that the Gumbel Copula outperformed marginally than Frank Copula in the relatively dry regions of Guangdong Province and may serve as a reference for Copulas selection for droughts in other humid regions; the quartiles descriptive statistical approach enables the comparisons of the risk of drought properties among the meteorological stations and allows recognition of the spatial distributions of droughts in a multi-scale way. Spatial patterns based on cluster analysis indicate that total precipitation is not the only factor that influences the drought occurrence for a certain region, the temporal uneven distribution of precipitation also plays an important role, which may provide valuable information for site selection for water conservancy projects.