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An appraisal of the Burr distribution for hydrological applications

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The extended three-parameter Burr XII is a probability distribution function rarely used in hydrology, while this distribution is more popular in other disciplines. The aim of this contribution is (i) to define the scope of this distribution in hydrological applications, (ii) to describe a simplified method to estimate the distribution parameters based on the sample L-moments, and (iii) to discuss an application aimed at representing the Flow Duration Curve (FDC) with the Burr distribution.
Compared to other three-parameter distributions, the Burr is particularly appealing because its range covers positive values only, which of course is convenient when modeling streamflows; moreover, the distribution has two shape parameters, which allows it to be quite flexible and to adapt well to many different shapes of the frequency curves and FDC. The third parameter of the distribution is a scale factor.
Despite in the literature the most important methods for parameter estimation have been already discussed, current approaches still require numerical solution of two joint non-linear equations to evaluate the shape parameters of the distribution. This can hamper the use of the Burr distribution in practical applications due to the difficulties in implementing and controlling the estimation procedure. These difficulties are particularly relevant in extensive applications, such as the mapping of the FDCs in many section of a river network, or when professionals without expertise in numerical computation are involved.
In this work we develop a simplified, although accurate, set of explicit equations to compute the two shape parameters starting from the L-CV and the L-skewness coefficients. This goal is achieved by properly weighting a set of simple base functions over the domain of the Burr distribution in the L-CV vs L-skewness space. The Burr distribution has been applied to represent the FDC of an extensive set of data including about 120 time series from stations located in Northwestern Italy. The obtained results are very encouraging in terms of quality of the representation (smaller errors compared to other distributions) and capacity to represent the FDC also in the low-flows range; in fact, other three-parameter distributions have the problem that the lower bound can be either larger than the minimum observed value, which is inconsistent with the observations, or lower than zero, which implies non-null probability of having negative streamflows.