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On the Appropriate Application of Standardized Precipitation Index for Assessing Drought Characteristics in the Arid Environment of Iran

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The standardized precipitation index (SPI) is widely used to assess drought characteristics (intensity, frequency, extent and duration) around the world. To be applicable for different climatic zones, the SPI is principally normalized utilizing a univariate probability distribution. Selecting an inappropriate probability distribution function can impart bias to the SPI values, increasing or decreasing the severity level of droughts. In general, two-parameter gamma model has been the first choice in most previous studies focusing on droughts in both low and high precipitation environments. This distribution statistically fits individual precipitation better than the total number of precipitation events in short periods. In arid climatic regimes with common zero precipitation cases, hence, gamma distribution function may result in lower bounded SPI values at short time scales, and hereby failing to identify drought events. To remove such effects, it is suggested to estimate the SPI values by excluding the zero precipitations. This study aims at providing the most proper probability distribution for estimating SPI values in the arid environment of Iran. Accordingly, four common precipitation data modifications (SCI package, BoxCox approach, empirical method, and inverse normal functions) for normalizing 1,2, . . . , 12 and 24 months SPI values were applied for monthly precipitation time series at 53 stations evenly scattered over Iran. Five different probability distribution functions were also used to calculate the SPI values. The normality of SPI values was tested based on Shapiro-Wilk, Anderson- Darling, and Kolmogorov- Smirnov statistics. The SCI package determined the Weibull distribution as the best distribution function for calculating SPI values on 1-month time step, while the gamma model for the longer than 1-month time steps. The inverse normal functions represented similar results to the SCI package. Besides, the SCI package was performed much better than the BoxCox approach in normalizing the SPI values at all time scales in Iran. From a mathematical point of view, the BoxCox approach generally resulted in reliable SPI values by largely influencing the nature of precipitation time series. In this study, the empirical method showed the best performance for estimating the SPI values in Iran at both short (1 month) and long (> 2months) time scales. In conclusion, this study recommends to apply the empirical method for removing the effects of zero precipitation and calculation of SPI values in the arid environments, particularly Iran.