Uncertainty Analysis of the Standardized Precipitation Index in The Presence of Trend

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Abstract. The Standardized Precipitation Index (SPI) is a widely used index for drought monitoring purposes that requires the preliminary fitting of a probability distribution to monthly precipitation aggregated at different time scales. Regardless of the parametric distribution adopted, as a consequence of the procedure of parameter estimation, the SPI will exhibit sampling variability, namely its value for a given year and a given month will depend on the sample of observed precipitation adopted for its estimation and in particular on the sample size. This implies a potential limitation when comparing index values based on sample series of different length. Furthermore, the presence of trend in the underlying precipitation will affect adversely the estimation of parameters, and therefore the computation of SPI.
Objective of the present paper is to investigate the variability of the SPI with respect to the size of the sample used for estimating its parameters, either in the case of stationary or non stationary precipitation series. In particular, sampling properties of SPI, such as bias and mean square error (MSE), are analytically derived assuming the underlying precipitation series without trend and normally distributed. Such results related to the normal case can find aplication also in the case of other distributions, namely when sample data can be transformed into normal values by a Box-Cox transformation (i.e. lognormal or cube root normal distributed data). Furthermore, sampling properties when precipitation is affected by trend are investigated by means of Monte Carlo simulation.
Results indicate that SPI values are significantly affected by the size of the sample adopted for its estimation. In particular, while for the case of underlying stationary series MSE tends asymptotically to zero as sample size increases as expected, in the presence of a linear trend a minimum MSE value can be determined corresponding to a specific sample size. This suggests that an optimal sample size (in MSE sense) can be determined, when the underlying series is affected by trend.

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