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Stochastic forecasting of SPI

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It is largely recognised that drought, as opposed to other extreme hydrological events such as floods, is a phenomenon whose consequences start to be visible long after its beginning, and further, drought impacts usually span a long period of time. Such features do make possible an effective mitigation, if an accurate monitoring of the phenomenon is available. In the context of drought monitoring systems, forecasting tools can find useful application, since they provide key information for the implementation of appropriate drought mitigation measures.

Among the several drought indices that have been proposed for drought monitoring, the Standardized Precipitation Index (SPI, McKee et al., 1993) has found a widespread use, probably due to its simplicity and the possibility to compare drought conditions across different time scales. In practice, computation of the index requires fitting a probability distribution to cumulative monthly precipitation series, computing the non-exceedence probability corresponding to such cumulative values and assuming the normal standardized quantile corresponding to such probability as the SPI. Different wet and dry conditions can be identified according to a classification of the SPI values. The dimensionless and standardized nature of the index allows for a comparison of droughts among regions with different climates, as well as droughts occurring during different seasons of the year.

In the present work, the problem of forecasting SPI values is addressed by means of stochastic techniques. In particular, an analytical formulation of the autocovariance matrix of SPI time series is derived under the assumption of monthly precipitation normally distributed. Then, capitalizing on the intrinsic normality of the SPI values, Best Linear Predictors and the associated Mean Square Errors can be computed on the basis of the autocovariance matrix. Furthermore, the derived autocovariance is also employed to compute analytically transition probabilities from one drought class

to another. Such application is particularly meaningful, in light of the fact that an accurate estimation of such transition probabilities by means of a frequency approach is generally difficult, due to the limited number of transitions observed in some cases in historical SPI series. A preliminary attempt to include climatological forcing in the forecasting is also presented.

The forecasting procedure is applied to 43 precipitation stations in Sicily, included in the drought monitoring bulletin of the Regional Hydrographic Office. In order to verify the methodology, long synthetic precipitation series are generated and the corresponding SPI series are computed. The comparison of the analytical results with those computed on the generated samples indicates the correctness of the derived expressions.