

Spectral analysis of hydrological time series of a river basin in southern Spain

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Spectral analysis has been applied with the aim to determine the presence and statistical significance of climate cycles in data series from different rainfall, piezometric and gauging stations located in upper Genil River Basin. This river starts in Sierra Nevada Range at 3,480 m a.s.l. and is one of the most important rivers of this region. The study area has more than 2,500 km², with large topographic differences. For this previous study, we have used more than 30 rain data series, 4 piezometric data series and 3 data series from gauging stations. Considering a monthly temporal unit, the studied period range from 1951 to 2015 but most of the data series have some lacks. Spectral analysis is a methodology widely used to discover cyclic components in time series. The time series is assumed to be a linear combination of sinusoidal functions of known periods but of unknown amplitude and phase. The amplitude is related with the variance of the time series, explained by the oscillation at each frequency (Blackman and Tukey, 1958, Bras and Rodríguez-Iturbe, 1985, Chatfield, 1991, Jenkins and Watts, 1968, among others). The signal component represents the structured part of the time series, made up of a small number of embedded periodicities. Then, we take into account the known result for the one-sided confidence band of the power spectrum estimator. For this study, we established confidence levels of <90%, 90%, 95%, and 99%. Different climate signals have been identified: ENSO, QBO, NAO, Sun Spot cycles, as well as others related to sun activity, but the most powerful signals correspond to the annual cycle, followed by the 6 month and NAO cycles. Nevertheless, significant differences between rain data series and piezometric/flow data series have been pointed out. In piezometric data series and flow data series, ENSO and NAO signals could be stronger than others with high frequencies. The climatic peaks in lower frequencies in rain data are smaller and the confidence level too. On the other hand, the most important influence on groundwater resources and river flows are NAO, Sun Spot, ENSO and annual cycle.

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