WAVELET DECOMPOSITION FOR DETECTION OF CHAOTIC CHARACTERISTICS OF MONTHLY PRECIPITATION AT MOKPO, KOREA

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Understanding the dynamics of hydrological variables such as precipitation constitutes one of the most important problems in hydrology, hydro-meteorology, and soil science, with obvious relevance for the water resources management. Better understanding of precipitation dynamics is important not only to manage extreme events such as floods and droughts but also to predict future water availability that can be derived from the dynamics.

In the present study, we apply deterministic chaos theory to investigate nonlinear dynamics of monthly precipitation at Mokpo, Korea, using wavelet decomposition. The wavelet transform is used not only for removal of the noise component but also for extraction of low and high frequency signals in the data, representing the dynamics. In order to determine an appropriate decomposition level for the wavelet transform, a correlation dimension analysis is applied for the respective low and high frequency signals derived from the successive decomposition. According to the result from the analysis, the wavelet decomposition is performed up to the 5th-level with orthogonal and compactly supported wavelets (Fig. 1). Accordingly, long-term approximation (low frequency) and a detailed (high frequency) time series of the monthly precipitation obtained after the 5th-level decomposition are investigated in terms of deterministic chaos theory. The data sets with low/high frequency components filtered by the wavelet transform are used for three-dimensional phase space analysis with a delay time of three months estimated from the auto-correlation function, respectively, as seen in Fig. 2.

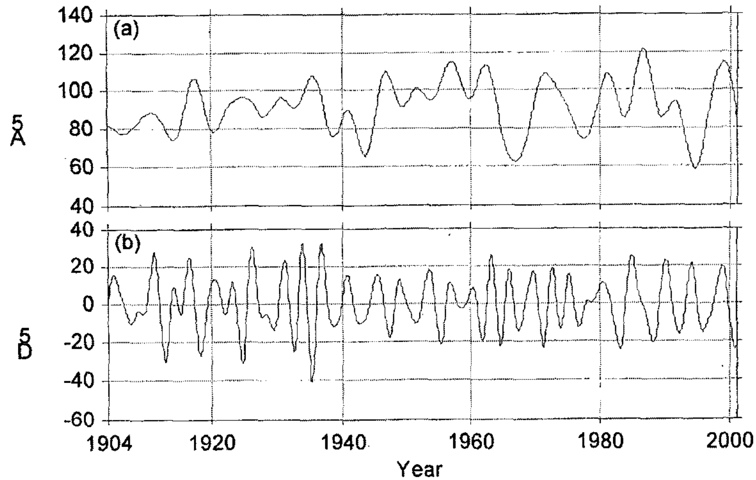

Fig. 1 Time series plots of long-term approximation and short-term details for monthly precipitation from 5th-level wavelet decomposition

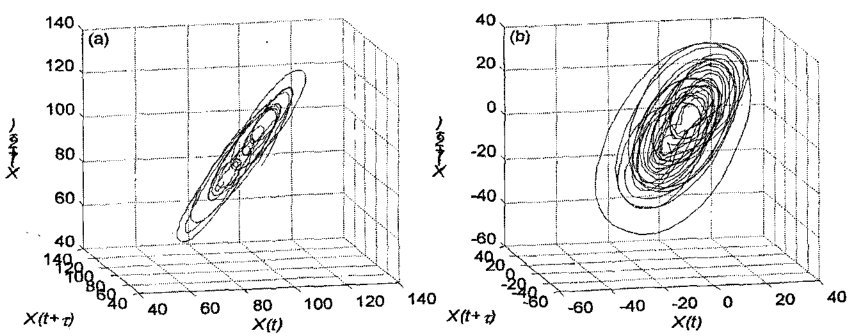

Fig. 2 Three dimensional phase plots of (a) the long-term approximation and (b) the short-term detail with delay time of three-months

The results show that the long-term and short-term approximations from the 5th-level wavelet decomposition indicate chaos based on a correlation dimension analysis. The low-dimensional chaotic behavior shown in the three-dimensional phase space reveals the dynamical evolution of the monthly precipitation in the study area based on different frequencies. The outlined method may be used to extract meaningful information about the low-dimensional dynamics and, therefore, to be used for prediction using the different frequency bases.