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Hurst's memory for Chaotic, SOI, and Tree-ring series

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The methods of times series analysis have been recognized as important tools for assisting in solving problems related to the management of water resources. Especially, After more than 40 years the so-called Hurst effect remains an open problem in stochastic hydrology. Until now, its existence has been explained by R/S analysis that roots in early work of the British hydrologist H.E. Hurst(1951). Today, the Hurst analysis is mostly used for the hydrological studies for memory and characteristics of time series and many methodologies have been developed for the analysis.

So, there are many different techniques for the estimation of the Hurst exponent(H). However, the techniques can produce different characteristics for the persistence of a time series each other. This study uses several techniques such as adjusted range, rescaled range(RR) analysis, modified rescaled range(MRR) analysis, 1/f power spectral density analysis, Maximum Likelihood Estimation(MLE), detrended fluctuations analysis(DFA), and aggregated variance time(AVT)method for the Hurst exponent estimation. The generated time series from chaos and stochastic systems are analyzed for the comparative study of the techniques. Then, this study discusses the advantages and disadvantages of the techniques and also the limitations of them.

We found that DFA is the most appropriate technique for the Hurst exponent estimation for both the shot term memory and long term memory. We analyze the

SOI(Southern Oscillations Index) and 7 tree-ring series for USA sites by means of DFA and the BDS statistic is used for nonlinearity test of the series. From the results, we found that SOI series is nonlinear time series which has a long term memory of H=0.92. Contrary to earlier work of Rao(1999), all the tree- ring series are not random from our analysis. A certain tree ring series show a long term memory of H=0.97 and nonlinear property. Therefore we can say that the SOI and tree-ring series may show long memory and nonlinearity.

Keywords : Hurst exponent, memory, DFA, SOI, tree-ring, BDS statistic