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Rescaled Range Analysis of Seismic Time-Series: Example of the Recent Seismic Crisis of Alhoceima

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Abstract : Persistency, long-term memory and randomness are intrinsic properties of time-series of earthquakes. The Rescaled Range Analysis (RS-Analysis) was introduced by Hurst in 1956 and modified by Mandelbrot and Wallis in 1964. This method represents a simple and elegant analysis which determines the range of variation of one natural property (the seismic energy released in this case) in a time interval. Despite the simplicity, there is complexity inherent in the property measured. The cumulative curve of the energy released in time is the well-known fractal geometry of a devil's staircase. This geometry is used for determining the maximum and minimum value of the range, which is normalized by the standard deviation. The rescaled range obtained obeys a power-law with the time, and the exponent is the Hurst value. Depending on this value, time-series can be classified in long-term or short-term memory. Hence, an algorithm has been developed for compiling the RS-Analysis for time series of earthquakes by days. Completeness time distribution and locally stationarity of the time series are required. The interest of this analysis is their application for a complex seismic crisis where different earthquakes take place in clusters in a short period. Therefore, the Hurst exponent has been obtained for the seismic crisis of Alhoceima (Mediterranean Sea) of January-March, 2016, where at least five medium-sized earthquakes were triggered. According to the values obtained from the Hurst exponent for each cluster, a different mechanical origin can be detected, corroborated by the focal mechanisms calculated by the official institutions. Therefore, this type of analysis not only allows an approach to a greater understanding of a seismic series but also makes possible to discern different types of seismic origins.

Keywords : Alhoceima crisis, earthquake time series, Hurst exponent, rescaled range analysis
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