Simulation of karst spring discharge using deep learning

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Karst springs discharge time series are strongly nonlinear and nonstationary and contain multiple frequency subsequences, which make it difficult to obtain satisfactory prediction results. For improving the prediction accuracy of karst springs discharge, this study first applied the time-frequency analysis methods including Singular Spectrum Analysis (SSA) and Ensemble Empirical Mode Decomposition (EEMD) to extract frequency and trend feature of Niangziguan Springs discharge. Then the Long Short-Term Memory (LSTM) was used to simulate each frequency subsequence. Subsequently, the prediction of spring discharge was completed by a combination of the simulated results. Finally, the performances of LSTM, SSA-LSTM, and EEMD-LSTM under different inputs were compared. The results show that the performance of SSA-LSTM and EEMD-LSTM are better than LSTM, and the EEMD-LSTM model achieved the best prediction performance.

Keywords: Karst spring discharge, Nonlinear and nonstationary time series, Singular spectrum analysis (SSA), Ensemble empirical mode decomposition (EEMD), Long short-term memory (LSTM), Deep learning

