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Time series analysis as a tool for karst water management

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Karst hydrosystems are well known for their vulnerability to turbidity due to their complex and unique characteristics which make them very different from other aquifers. Moreover, many parameters can affect their functioning. It makes the characterization of their vulnerability difficult and needs the use of statistical analyses Time series analyses on turbidity, electrical conductivity and water discharge datasets, such as correlation and spectral analyses, have proven to be useful in improving our understanding of karst systems. However, the loss of information on time localization is a major drawback of those Fourier spectral methods; this problem has been overcome by the development of wavelet analysis (continuous or discrete) for hydrosystems offering the possibility to better characterize the complex modalities of variation inherent to non stationary processes.
Nevertheless, from wavelet transform, signal is decomposed on several continuous wavelet signals which cannot be true with local-time processes frequently observed in karst aquifer. More recently, a new approach associating empirical mode decomposition and the Hilbert transform was presented for hydrosystems. It allows an orthogonal decomposition of the signal analyzed and provides a more accurate estimation of changing variability scales across time for highly transient signals.
This study aims to identify the natural and anthropogenic parameters which control turbidity released at a well for drinking water supply. The well is located in the chalk karst aquifer near the Seine river at 40 km of the Seine estuary in western Paris Basin. At this location, tidal variations greatly affect the level of the water in the Seine. Continuous wavelet analysis on turbidity dataset have been used to decompose turbidity release at the well into three components i) the rain event periods, ii) the pumping periods and iii) the tidal range of Seine river. Time-domain reconstruction by inverse wavelet transform allows the assessment of the variance explained by each component. Then, empirical mode decomposition and the Hilbert transform put in evidence the highly transient signal in karst well due to the common effect of pumping and tidal range on turbidity signal. Then, univariate clustering has been used to identify turbidity origins and their periods of occurrence at the scale of the hydrologic year.
These results demonstrate the impact of tidal range on turbidity release at the well and allow a new water resource management for owner.