Extracting hydrological processes with Karhunen-Loève Transform: case study of an alluvial aquifer (Upper Rhine valley)

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When monitoring an environmental system, several physical processes are mixed in the measurements. The aim of this work is to quantify the relative contribution of each physical process from a set of measurements, by combining the Karhunen-Loève Transform (KLT) with the kriging method.

This method was applied to a set of 195 piezometric head time series over a period of 17 years, measured in observation wells within the French and German area of the Rhine valley alluvial groundwater. Piezometric head time series are analyzed thanks to KLT in order to highlight characteristic temporal signals, which are classified from the most energetic (global) to the least energetic (local). The first five signals amount to 80 % of the global variance of the system. They are inferred to represent different hydrological contributions (exchanges with rivers, rainfalls) as well as other contributions such as environmental shaping and impacts of regional development. Kriging is then used to regionalize the signals and build a reconstruction model of the behavior of the whole aquifer. This model contains only filtered information coming from identified source signals.

This method can be considered as a starting point for other studies: initializing hydrodynamical models, quantifying quality of spatial sampling, filtering small scales variations, calculating geodetic effect ...