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Spurious trends out of nothing? Taking the Hurst phenomenon seriously

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Trend analysis is widely used to check for effects of climate change on hydrological systems. Often inconsistent patterns are found that are usually ascribed to local, mostly anthropogenic effects. On the other hand apparently inconsistent trends might be due to long-term persistence (Hurst phenomenon). Therefore, apparent linear trends can result from low-frequency oscillations that are inherent to natural systems irrespective of human impacts.
This study aimed at subtracting local effects from time series of lake water level and groundwater head observations that exhibited inconsistent trends during a 28 years period in Northeast Germany and then checking the residuals for trends to be compared with those of precipitation and potential evapotranspiration. We found numerous significant trends for lake water level and groundwater head, although with opposing signs, depending on the degree of damping of the input signal. In contrast, there were no consistent trends for the respective meteorological variables.
Trends of the former were primarily due to low-pass filtering of the groundwater recharge signal: The more high-frequency oscillations were attenuated during seepage flux in the vadose zone, the more minor long-term oscillations in the input signal became visible, resulting in apparent linear trends. These empirical results nicely confirm the findings of a numerical experiment by Koutsoyiannis (2006). Thus caution is advised when trend analysis is applied in a naïve way.