Surface-water/groundwater relationships using long time series statistical analysis

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The water resource management needs a detailed hydrogeological framework definition, in order to explain the relationships between groundwater and both rainfall and riverine recharge influencing its hydrodynamic.

In this research, univariate and bivariate statistical methods have been applied on rainfall, river and piezometric level data, which are generally used to understand the precipitation inflow effect on rivers and springs discharge in karst aquifers. On the other hand, hydraulic head response in porous aquifer are still under study to date.

For this reason, long time series (24 years) of rainfall, river and piezometric level data have been analysed. These data have been collected since 1986 in a rain gauge, a hydrometer and in 3 wells, all located along low Pescara river valley (Abruzzo, Italy) where an important alluvial aquifer is present.

To better understand the hydraulic conditions and to make statistical results coherent, photo-interpretation analyses and GPS surveys have been made.

Based on this information, Auto-Correlation Function has allowed the evaluation of "memory effect" in each considered time series, that represents a self-coherency indicator. This results higher in both wells and river level than in rainfall. The interdependency between different hydrological parameters, that has been found by mean of Cross-Correlation Function (CCF), highlights a strong groundwater/surface water relationship between Pescara river and 2 of the wells, while the other shows a clear correlation with local rainfall. The CCF has been applied to residual data, after seasonal cycle and trend removal. This analysis underlines in one of the measured wells a strong pressure transfer from river to groundwater during flooding events.

At last, univariate (Fast Fourier Transform) and bivariate (Cross-Amplitude Function) spectral analyses indicate a predominant annual cycle (12 months), linked to seasonal fluctuation, and multi-year cycles (72 and 144 months), related with climatic factors.