



## **Study of influences of air temperature and relative humidity on discharge from karst spring by means of partial spectral analysis**

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Hydrological time series comprise the influences of numerous processes involved in the transfer of water in hydrological cycle. It implies that an ambiguity with respect to the processes encoded in spectral and cross-spectral density functions exists. The ambiguity can be resolved by applying a novel approach based on the spectral representation of partial correlation. Mathematical background for partial spectral density, partial amplitude and partial phase functions is presented. These functions yield the estimates of spectral density, amplitude and phase that are not affected by a controlling process. For example, if an input-output relation is the subject of interest, antecedent and subsequent influences of the controlling process can be distinguished considering the input event as a referent point. The method is used for analyzing discharge time series in order to obtain information about processes, other than rainfall, involved in groundwater transfer in karst aquifers. It allows separating out the part plaid by some parameters which modify the input and output signal by their variations before and after each input event. This is especially the case for air temperature and relative humidity which partially control the water consumption by evapotranspiration. This work focuses on the indirect influences of these two parameters on the rainfall-discharge relationship.

Time series are collected in the catchment of the Jadro Spring located in the Dinaric karst area of Croatia. The antecedent and subsequent influences of the air temperature and relative humidity on the Jadro spring discharge are analyzed. The results show that air temperature and relative humidity affect slightly the quick-flow component, whereas the effects on the slow-flow component are more evident. The subsequent influences on the discharge are more important than the antecedent influences on the form of spring response. The mean residence time of the slow-flow component depends on air temperature. A linear relation between the relative humidity one day before rainfall and the form of spring response after 5 days can be noted.

Although the air temperature and relative humidity influence the karst spring response and they have subsequent influences on the discharge from karst spring, it can be concluded generally that the relative importance of the influences of these two parameters on the discharge from the Jadro Spring is low. The discharge from this spring is mainly generated by other unobserved processes occurring in the karst underground including intercatchment groundwater flows. However, the air temperature and relative humidity affect the groundwater balance at seasonal level so their influences are mainly concentrated at low frequencies.

The presented results of practical application on the Jadro Spring show that the partial spectral analysis can give additional information which cannot be obtained by using classical methods in frequency domain including the wavelet transform. For example, the spectral representation of partial correlation can be used for: recognition of processes affecting signal in frequency domain, recognition of processes affecting system response, determination of contribution and relative importance of each process, identification of antecedent and subsequent influences of each process, estimation of relative importance of observed and unobserved processes, etc.