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Functionning of a karstic aquifer: from rainfall-discharge series analysis to modelling

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Karst aquifers are complex systems characterized by a high heterogeneity and non-linearities. Our approach consists in analyzing rainfall-discharge time series to characterize the functioning of karst aquifer in order to develop a conceptual rainfall-discharge model to simulate spring discharge at the daily step. The proposed methodology follows a two step approach. First rainfall-discharge time series analyses are analyzed in order to identify the behaviour of the karstic system second a conceptual model is designed on the basis of this analysis.
The analyses of time series allows identifying key hydrodynamic properties of the system: storage capacity, water residence time and discharge threshold. These analyses rely on classic statistical tools probability density functions of discharges, correlograms, recession curve analyses, wavelets ... applied on rainfall and/or discharge time series.
The model allows estimating spring flows and relative volumes of water stored in the different reservoirs of the karstic system. The model is based on a production function and a transfer function. Production function calculates the effective rainfall. The simulation of effective rainfall is essential in the representation of the karstic system functioning given their specificities: existence of an épikarst, development of a soil cover and concentrated infiltration points. Concerning the transfer function the model uses generally two reservoirs to calculate the discharge. One reservoir with a slow discharge to represent the low flow and a reservoir with a quick discharge representing the high flow and floods.
We applied this methodology to a well known small mountain karstic system. Le Baget located in the Pyrenees Mountains. This system has a very long discharge data record period ($\sim$40 years) and was already extensively studied for discharge time series analysis. We propose the first model for this system.
This work shows that analysing rainfall-discharge data can be seen as a preliminary step to design the structure and parameters of any model representing the global functioning of complex system such as karstic springs. Ongoing research will focus on the generalisation of this approach to other karstic systems.