

Development of new and innovative tools for the characterization, modelling and forecasting of karst aquifers hydrogeological behavior in response to climatic and anthropogenic changes.

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As a result of erosion due to infiltration and circulation of acidic waters, karst systems have a particular geomorphological structure which generally consists of a substantial and structured heterogeneity conditioned by past flow conditions. Understanding the functioning of flow and storage processes in karst aquifers thus represents a major challenge – especially since these resources provide drinking water to approximately 9% of the global population. This thesis aims to develop and improve hydrological methods and modelling for characterising the functioning of karst systems in response to climatic and anthropogenic changes.

A classification of karst systems hydrological functioning is first proposed. Based on the analysis of recession curves, the method allows to categorise a karst system into 6 groups with different characteristics in terms of storage capacity, draining dynamic and hydrological variability. In parallel, a software – KarstID – is developed to perform various discharge analyses as well as the aforementioned classification.

Another aspect of the thesis is dedicated to the evaluation and improvement of rainfall-runoff models. Benefiting from the framework of the KARMA European project, the accessible data facilitates large-scale and extensive research based on multiple karst systems in the Mediterranean region. Firstly, a comparative study of the performance of two different modelling approaches – artificial neural networks and reservoir models – is carried out. The objective is to identify the advantages and disadvantages of each approach, depending on the available data and the objectives of a study. Secondly, the impact of climate change on karst spring discharge in the Mediterranean area is studied using reservoir models. The goal is to characterise medium- to long-term trends, as well as potential changes in duration and intensity of extreme events (droughts, floods). Finally, the counterbalancing error mechanism on the Kling-Gupta Efficiency and its variants is extensively studied: when calibrating or evaluating a model, counterbalancing errors can artificially lead to a higher criterion score that is not associated with an increase in model relevance. Further work is also focused on the development of new functionalities (related to input data and performance criteria) for KarstMod, a software dedicated to rainfall-runoff modelling for karst systems.