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Karstmod - a rainfall discharge modelling tool for education and research

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Karst has been defined as 'the medium where heterogeneity reaches is paroxysm'. These contrasts result in a duality of infiltration (either diffuse or concentrated) and of flow regimes (either laminar or turbulent). The karstification process itself, the rapid evolution of karst conduits, and the self-organization of karst which impacts their hydraulic connections result in highly non-linear hydrodynamic behavior and global functioning of karst aquifers.
With the increasing demand for water, karst aquifers have grown more important as a resource. Modelling the rainfall - discharge relationship is an essential step in estimating the sustainable yield of karst aquifers but also in predicting the impacts of climatic or anthropogenic forcing on groundwater resources in the long term. Even so, the characterization and modelling of karst aquifers remains a challenging task.

Among the different modelling approaches, lumped modelling is recognized as a major tool for analyzing hydrological processes and for managing water resource. These models are based on physically sound structures and equations selected by the modeler as representative of the main processes involved, together with semi-empirical processes. This approach is particularly well suited to karst environments where knowledge of system geometry is usually difficult to gather. The parameters of lumped models cannot be determined directly from physical catchment characteristics, and thus parameter values must be estimated by calibration against observed data. The structure of compartment models is thus a trade-off between adaptability (the model must be able to represent a large variety of hydrological conditions) and parsimony (parameters must be identifiable and over-fitting must be prevented). Effective model development practices include careful sensitivity analysis and uncertainty assessment, to assess model performance and also model uncertainty and physical realism. .

Within the framework of the KARST observatory network initiative from the INSU/CNRS, one the observatory networks from the OZCAR Research Infrastructure, we propose a generic and modular/adjustable modelling platform (KARSTMOD) for both the spring discharge simulation at karst outlets and the hydrodynamic analysis of the compartments considered in the model. KARSTMOD provides a modular, user-friendly modelling environment for educational, research and operational purposes. It can reproduce the structure of conceptual lumped models of karst systems in the literature. The modularity of the platform allows a comparison of different hydrosystems through a single methodological approach.
To promote valid modelling practices, the platform provides a variety of graphs and tools that facilitate the understanding and gives insight into the hydrodynamic behavior of the models, which allow detecting possible flaws in structure and parameterization.