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Coupling numerical approaches for a deeper assessment of karst groundwater vulnerability

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Objective

HydroSciences Montpellier (HSM) laboratory develops various tools for a deeper assessment of karst groundwater resources across a wide range of spatio-temporal scales. The objective is to assess karst groundwater vulnerability (regarding both quantitative and qualitative aspects) in a context of global change.

Hours | Days | Months | Years | Decades

Laboratory

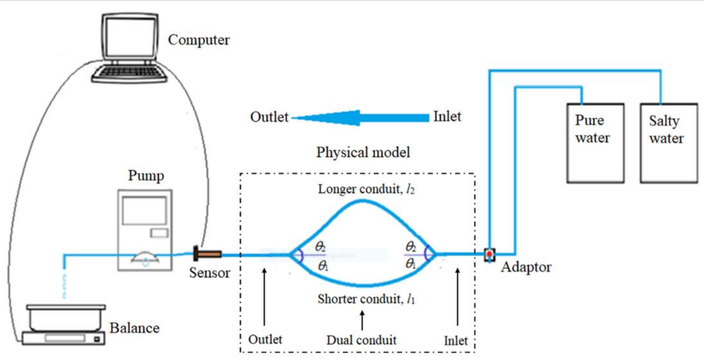
Experimental site

Catchment

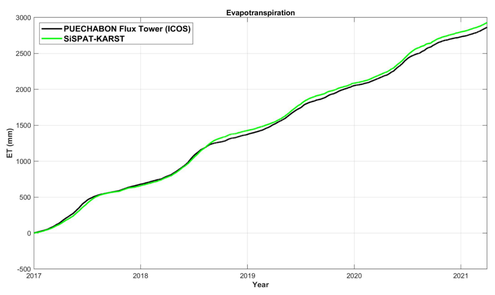
Region

Solute transport | Hydrodynamics | Climate change impacts

Influence of flow geometry on solute transport [1]

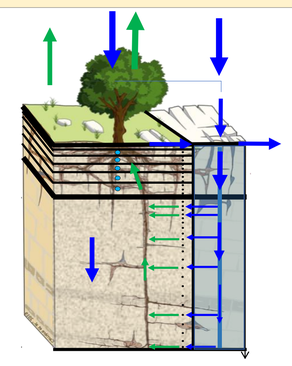


Soil-Vegetation-Atmosphere transfers in karstic environments



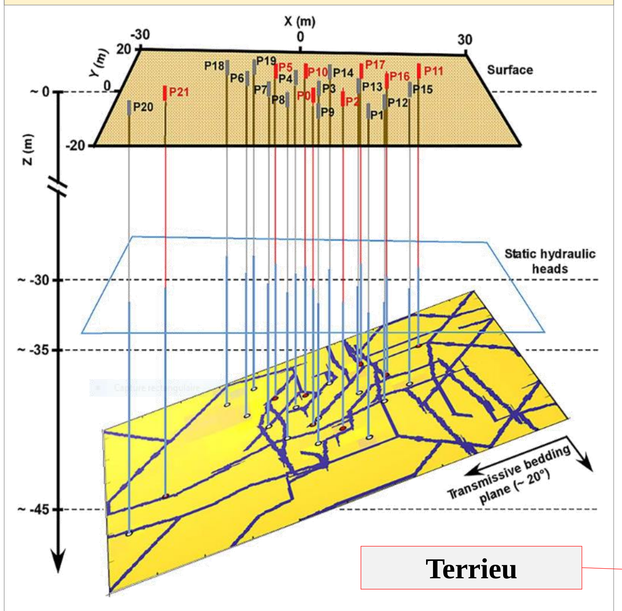
New SiSPAT-KARST Model (in development)

Devoted to energy and water transfers in epikarst (0-20m), including slow and quick infiltration processes, water storage and evapotranspiration



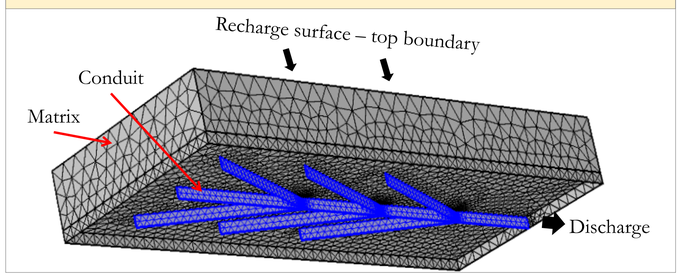
Scale transfer for solute transport modeling

Identifying flow networks [2]



Terrieu

Physically-based modeling

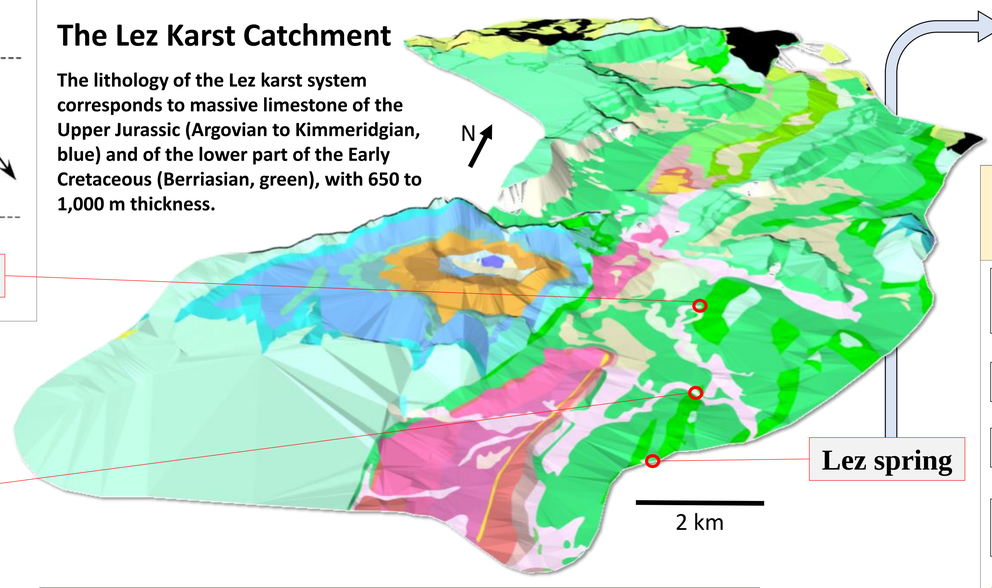


Climate change (CC)
Land cover land use (LCLU)
Vegetation adaptation to CC

Management practices
Lez spring Qpump ~ 1.1 m³/s
250,000 inhabitants

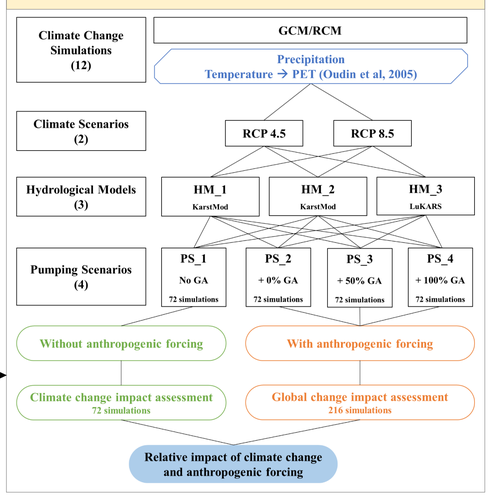
The Lez Karst Catchment

The lithology of the Lez karst system corresponds to massive limestone of the Upper Jurassic (Argovian to Kimmeridgian, blue) and of the lower part of the Early Cretaceous (Berriasian, green), with 650 to 1,000 m thickness.

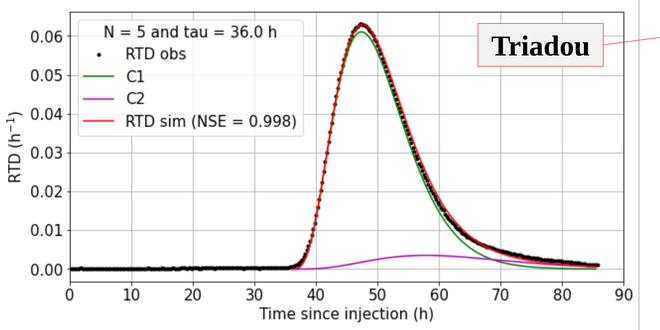


Lez spring

Workflow for assessment of global change impacts on groundwater [3]

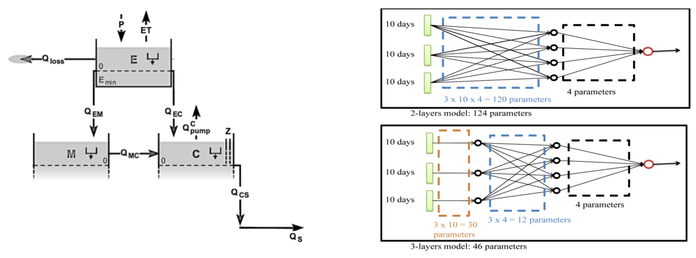


Artificial tracer tests



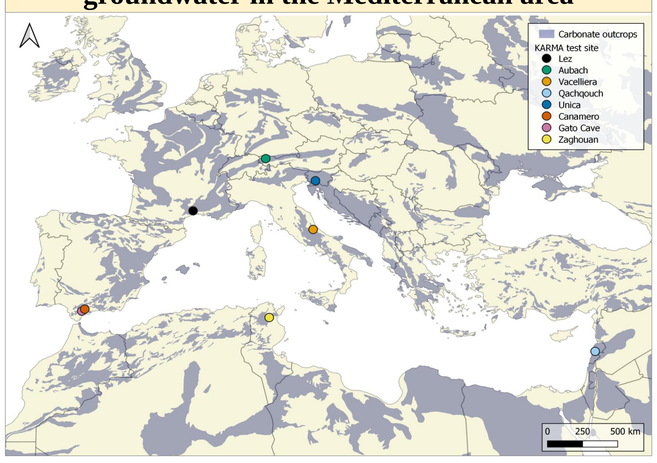
Triadou

Lumped Parameter (LP) [4] and Artificial Neural Network (ANN) [5] modeling



Hydrochemical monitoring at the Lez spring from 2008 - MEDYCYSS

Climate change impacts on karst groundwater in the Mediterranean area



References:
[1] Wang, C., Wang, X., Majdalani, S., Guinot, V. & Jourde, H. Influence of dual conduit structure on solute transport in karst tracer tests: An experimental laboratory study. Journal of Hydrology 590, 125255 (2020).
[2] Fischer, P. et al. Harmonic pumping tomography applied to image the hydraulic properties and interpret the connectivity of a karstic and fractured aquifer (Lez aquifer, France). Advances in Water Resources 119, 227–244 (2018).
[3] Sivelle, V., Jourde, H., Bittner, D., Mazzilli, N. & Tramblay, Y. Assessment of the relative impacts of climate changes and anthropogenic forcing on spring discharge of a Mediterranean karst system. Journal of Hydrology 598, 126396 (2021).
[4] Cousquer, Y., & Jourde, H. Reducing Uncertainty of Karst Aquifer Modeling with Complementary Hydrological Observations for the Suitable Management of Groundwater Resources.
[5] Siou, L. K. A., Johannet, A., Borrell, V. & Pistre, S. Complexity selection of a neural network model for karst flood forecasting: The case of the Lez Basin (southern France). Journal of Hydrology 403, 367–380 (2011).

Perspectives

The proposed approaches mainly consist in the development of innovative methods for the interpretation of artificial tracer tests. In addition, natural tracers as well as electrical conductivity or dissolved gas provide insight about flow processes within the karst aquifers, and constitutes relevant data for hydrological modelling. Tools for the analysis of non-reactive solute transport with potential application to reactive transport are also developed, with potential perspectives for the simulation of pollutogramme and development of Early-Warning System (EWS).