The challenge of predicting karst water resources in a changing world

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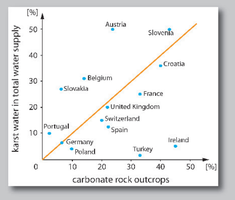
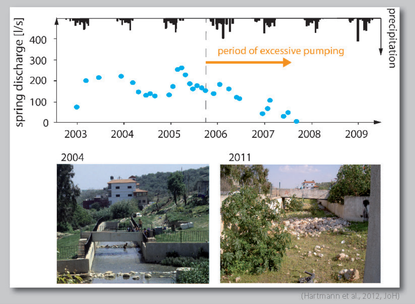
NEED FOR PREDICTIONS

KARST WATER RESOURCES

Around 11% of the earth's ice free land surface is composed of carbonate rock. Its high storage and infiltration capacities make it a preferred domain for groundwater abstractions. Especially in Mediterranean and dry regions with strong rainfall seasonalities karst aquifers are a common source of fresh water. Globally, they contribute around 25% tothe global human drinking water supply.



IMPACT OF WATER CONSUMPTION

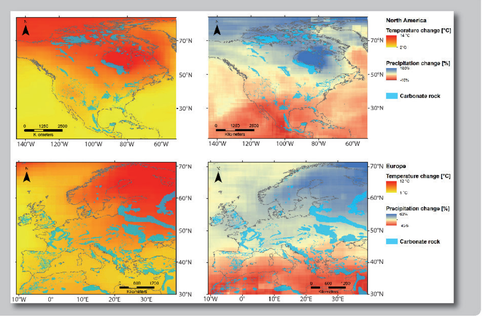


(Hartmann et al., 2012, JoH)

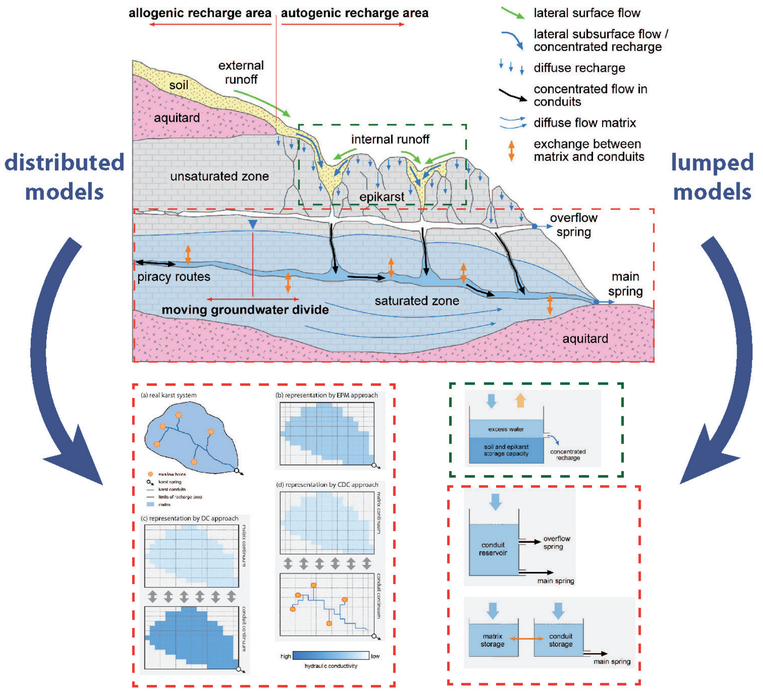
Lately, stress on groundwater resources increased significantly in terms of quantity, due to excessive irrigated agriculture, and in terms of quality, due to pollution by fertilizers. In the future, such problems will get even worse because of the increasing imbalances between freshwater supply, water consumption and population growth.

IMPACT OF CLIMATE CHANGE

Projections of general circulation models suggest that an increase of temperature and a strong decrease in precipitation in most karst regions can be expected. How these changes will affect local or regional water availability in karst regions is still difficult to assess.



CHALLENGE OF SIMULATION



DEFICIENCIES OF PRESENT APPROACHES

Distributed models

In general distributed karst models have a high degree of process representation making them appropriate for reliable predictions. Properly applied they provide the spatial evolution of groundwater levels of a karst aquifer. **However, their high demand of information mostly limits their application to well studied test sites.**

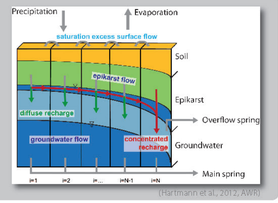
Lumped models

The necessary information to apply lumped models is available more often. Properly applied they provide time series of discharges, usually at the main karst spring. **However, due to their low degree of process representation, lumped karst models have limited prediction skills.**

FUTURE DIRECTIONS

BETTER PREDICTION MODELS

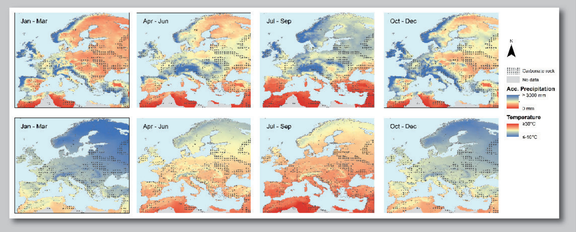
There is a way to reduce the lack of available infromation by adding more information than only discharge to the model calibration. Hydrochemical data is often available because water quality of large karst springs is frequently monitored. Using these observations more process-based karst models can be applied. Due to a better representation of karst processes such models have higher reliability in water resources prediction.



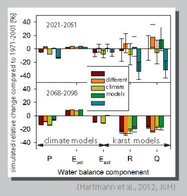
(Hartmann et al., 2012, AWR)

LARGE SCALE SIMULATIONS

The forcings for large scale karst simulation models are readily available. But difficulties in the assessment of model parameters at such scales still prohibit large scale applications. Newly developed regionalization methods including the use of signatures may allow the transition of model parameters to ungauged karst aquifers. However, they require adaptions especially regarding the evolution of the dissolution enlarged karst network and the respective model parameters.



CHALLENGE OF PREDICTION



(Hartmann et al., 2012, JoH)

The coupling of climate simulation models and karst models results in strong uncertainties. Applying karst models backwards may allow to reduce this uncertainty. By defining critical thresholds of water availability, the models can be solved backwards to determine the range of respective climatic or land use conditions. Additionally climate archives in karst caves (speleothems) may be used to understand how the hydrological system reacted on extreme climatic changes in the past and how it may react in the future.

ADDITIONAL INFORMATION is available in *Hartmann A, N Goldscheider, T Wagener, M Weiler: Karst water resources in a changing world. Reviews of Geophysics, status: revise & resubmit until January 2014.* Andreas Hartmann is presently supported by an Early Stage Researcher fellowship of the German Academic Exchange Service.

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