Isotope supported recession analysis to assess hydraulic properties of karst aquifers across Austria

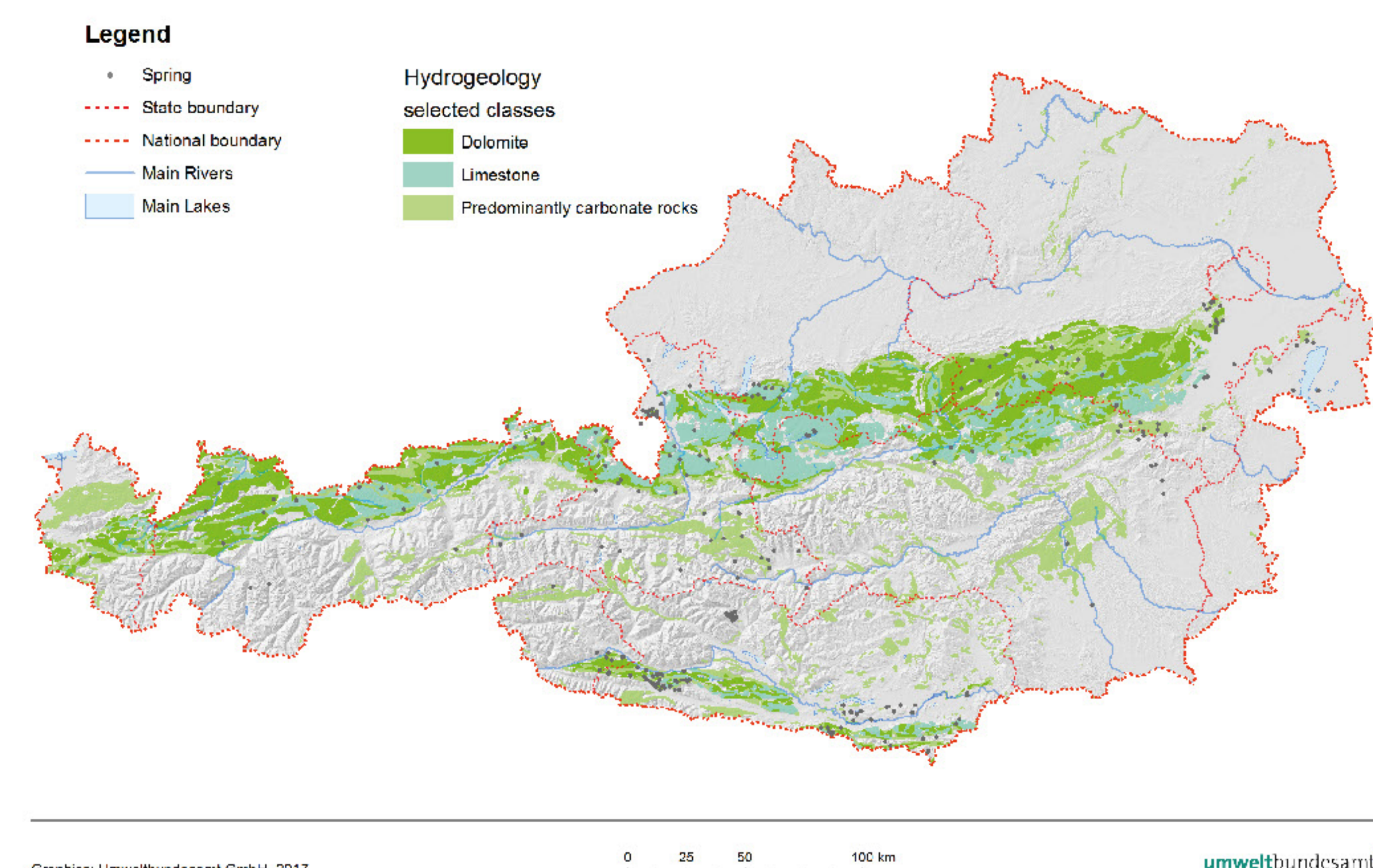**Andreas Hartmann[1,2], Heike Brielmann[3], Rudolf Philippitsch[4]**

MOTIVATION

Austria obtains almost half of its drinking water from karst aquifers. To manage karst aquifers in a sustainable way, reliable estimations of available karst water resources, their renewal rates and their hydrodynamics are of utmost importance. Hydrological models, which are a common tool for water resources assessment and planning, are difficult to apply at karst aquifers as their strong heterogeneity of hydraulic properties requires detailed measurements that are mostly not available.

This research project is the very first attempt to derive large-scale information of the degree of karstification over entire Austria to improve future water resources management.

STUDY AREA & DATA

The data base of the project consists so far of isotopic data from 290 springs archived in the Water-Isotope Map of Austria (https://secure.umweltbundesamt.at/webgis-portal/isotopen/map.xhtml and map below) and another 8300 water samples taken from karst springs across Austria (aimed to be analysed within the frame of this project).
Spring discharge observations are available from the global karst data base (http://ahartmann.weebly.com/karst-data-base.html) and will be drawn from the Austrian Water data base eHYD (http://ehyd.gv.at/).

Legend
- Spring
- State boundary
- National boundary
- Main Rivers
- Main Lakes

Hydrogeology selected classes
- Dolomite
- Limestone
- Predominantly carbonate rocks

Graphics: Umweltbundesamt GmbH, 2017

See also Kralik, M., Benischke, R., Wyhlidal, S. & Philippitsch, R. (2015): Wasserisotopenkarte Österreichs. BMLFUW, Wien.

RECESSION ANALYSIS TO ASSESS KARSTIFICATION
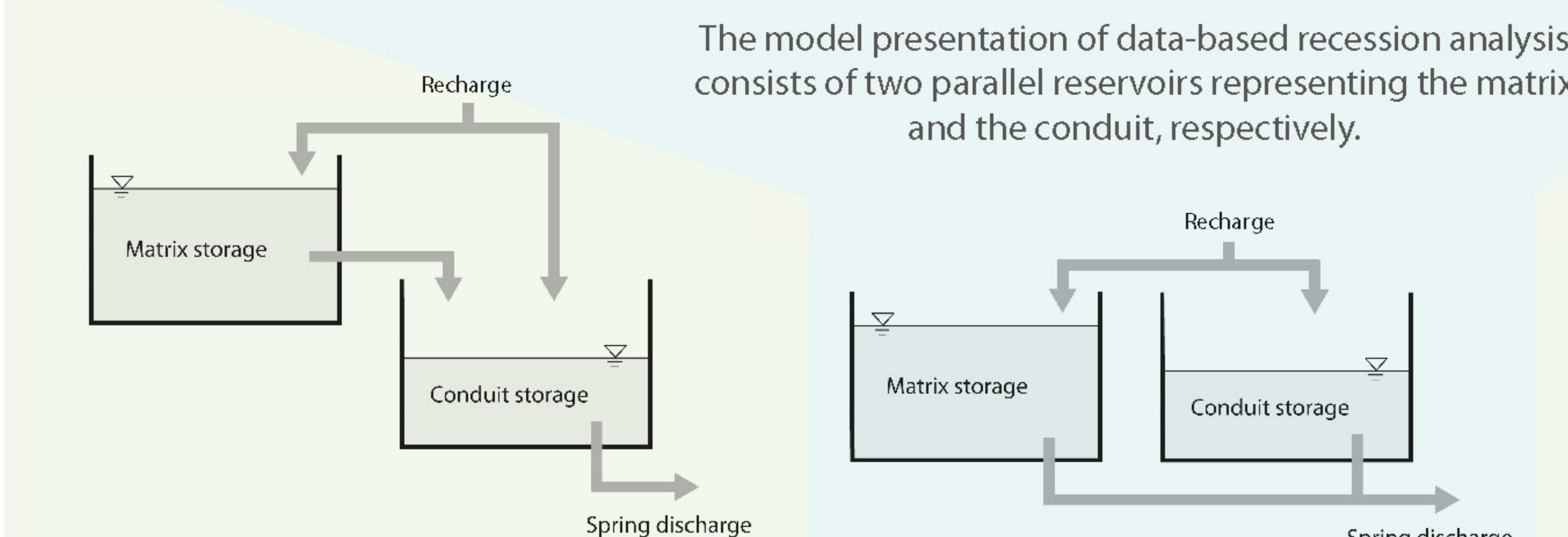
DATA-BASED RECESSION ANALYSIS
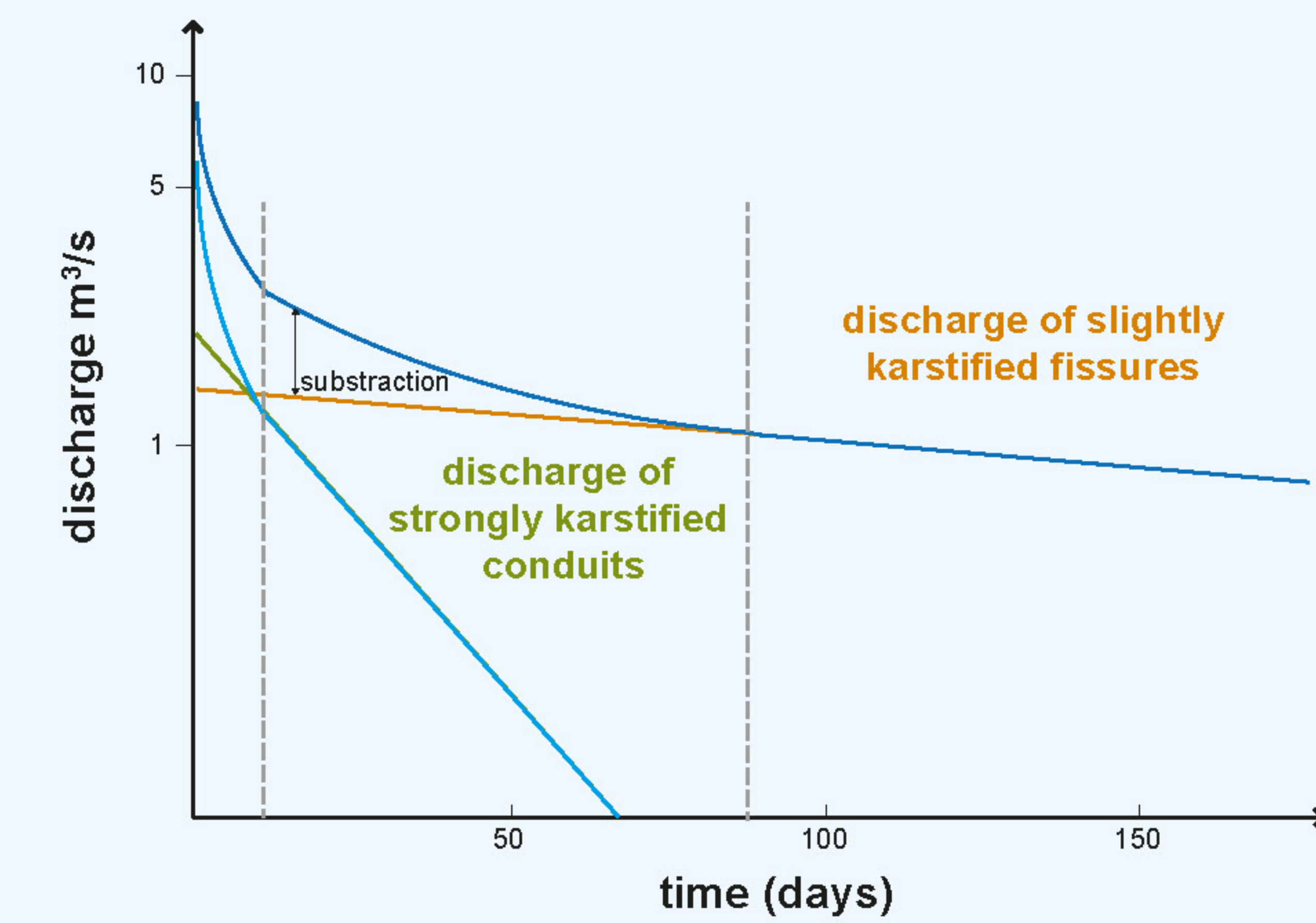
Traditional recession analysis in karst considers the drainage two storages: the fissured matrix and the karst conduits. Plotting the recession limb with a semi-log scale, the part drained by the matrix can be identified by its constant slope. Subtracting the matrix drainage from the recession limb will reveal another constant slope representing the conduits.
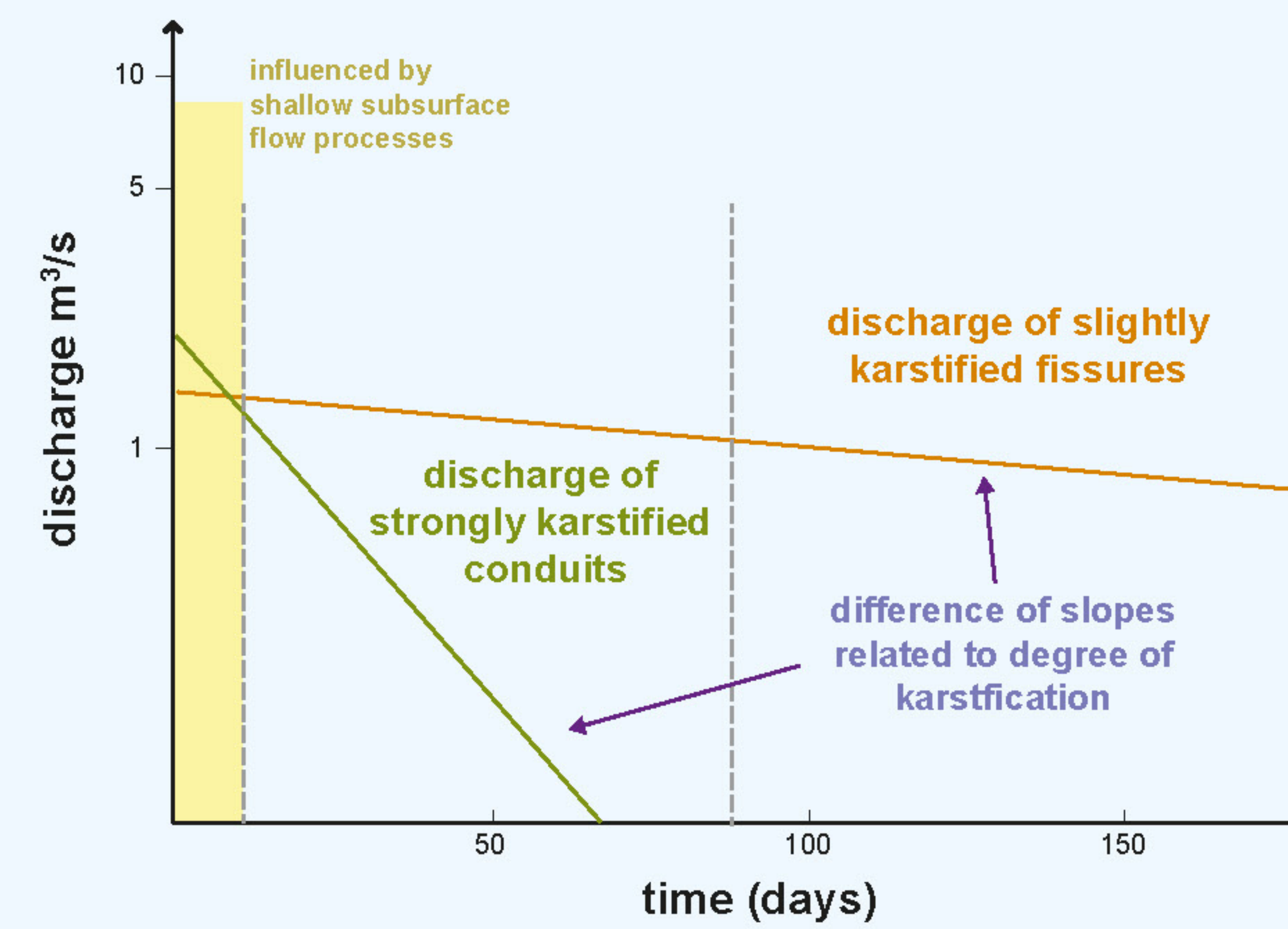
With the slopes of the matrix drainage and the conduit drainage identified, their difference can be used as a metric to quantify the degree of karstifcation. **However, the results are based on the simple assumption that both systems drain independently.**

MODEL-BASED RECESSION

The model presentation of data-based recession analysis consists of two parallel reservoirs representing the matrix and the conduit, respectively.

A more realistic assumption a matrix reservoir that drains into the conduits before they discharge at a karst spring.

But at many karst systems, the assumption of independent matrix and conduit reservoirs may be inadequate.
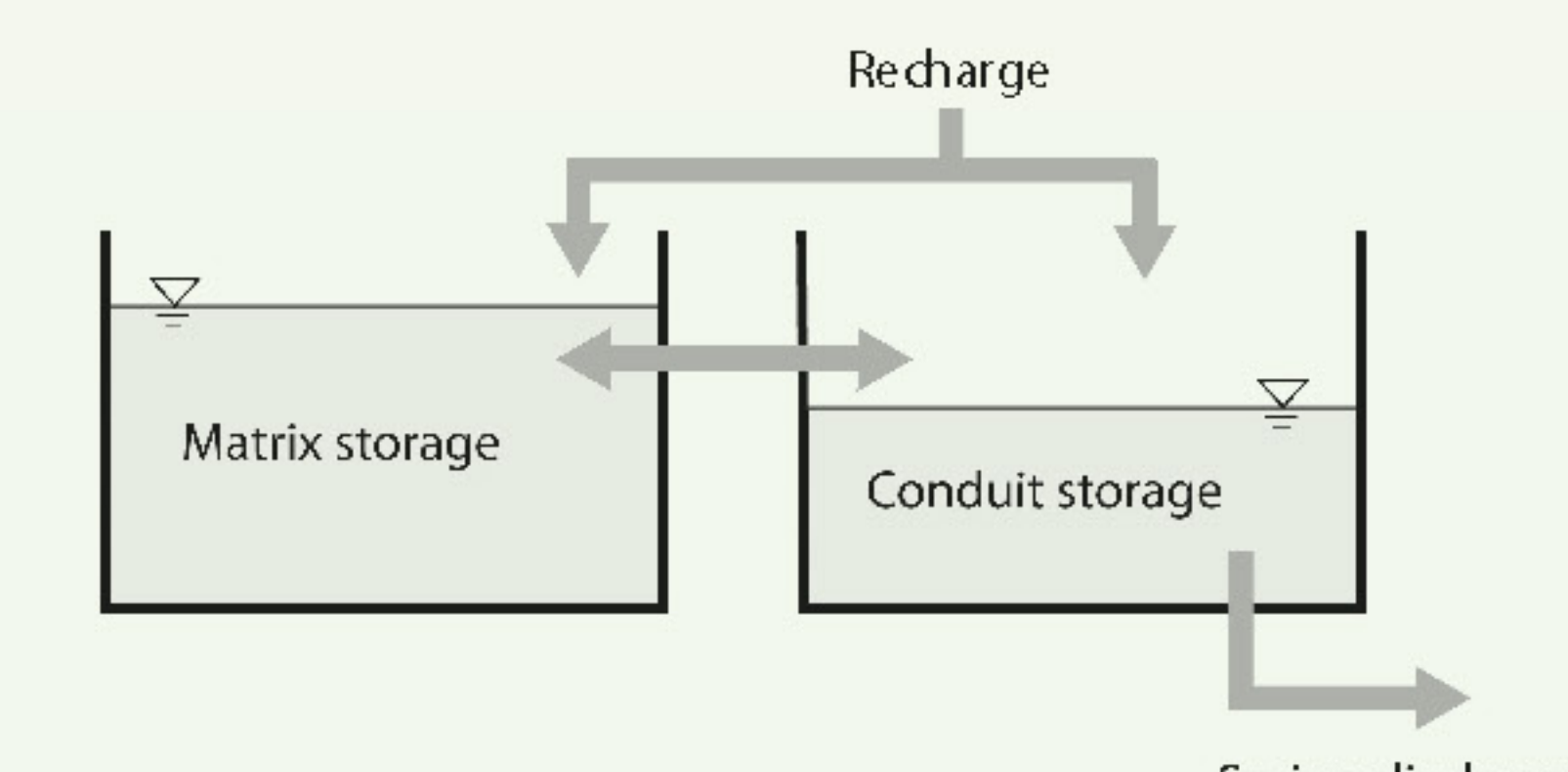
Also, karst systems are known for a dynamic exchange between the matrix system and the conduit system that drains the system.

Although often more realistic, alternative model-based approaches require estimation of their parameters. With increasing model complexity, their identification may involve large uncertainties.

INCLUSION OF ISOTOPES

Observations additional to discharge can improve the identifcation of recession model parameters without significantly reducing their performance.
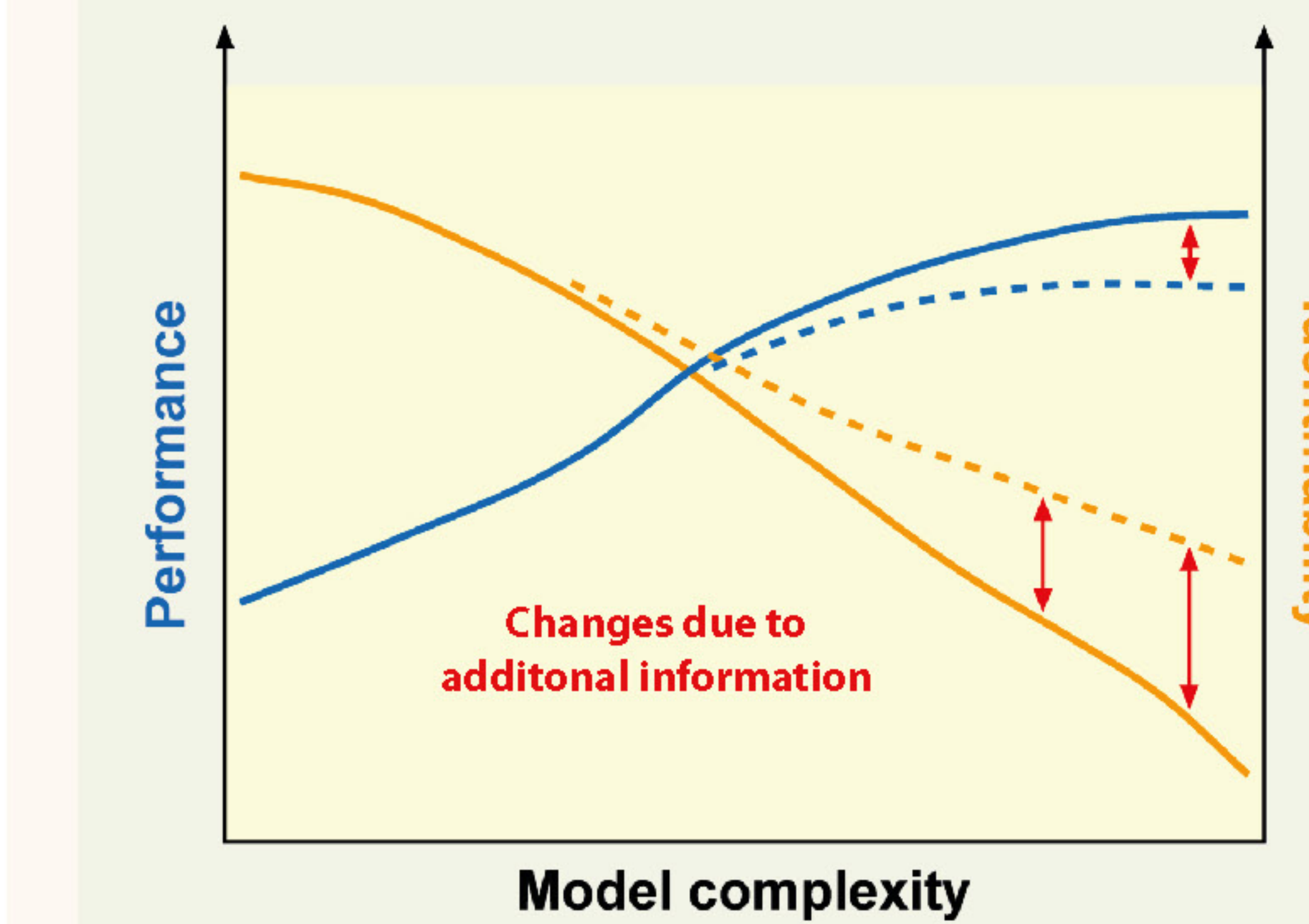
As "ideal tracer" water isotopes of karst springs provide a very good source for additional information to characterise karst spring recession by modelling.
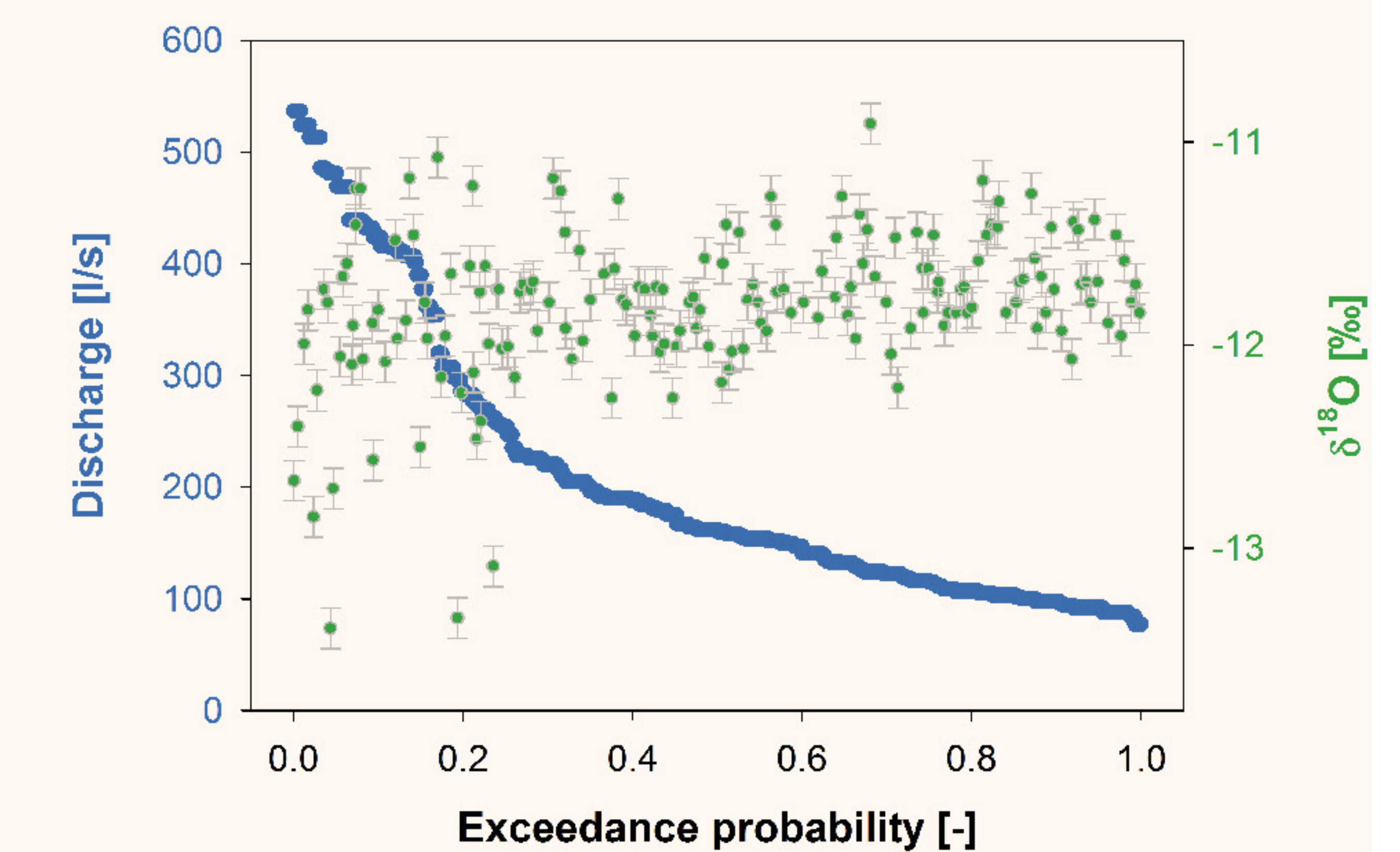
ASSESSMENT OF KARSTIFICATION OVER AUSTRIA
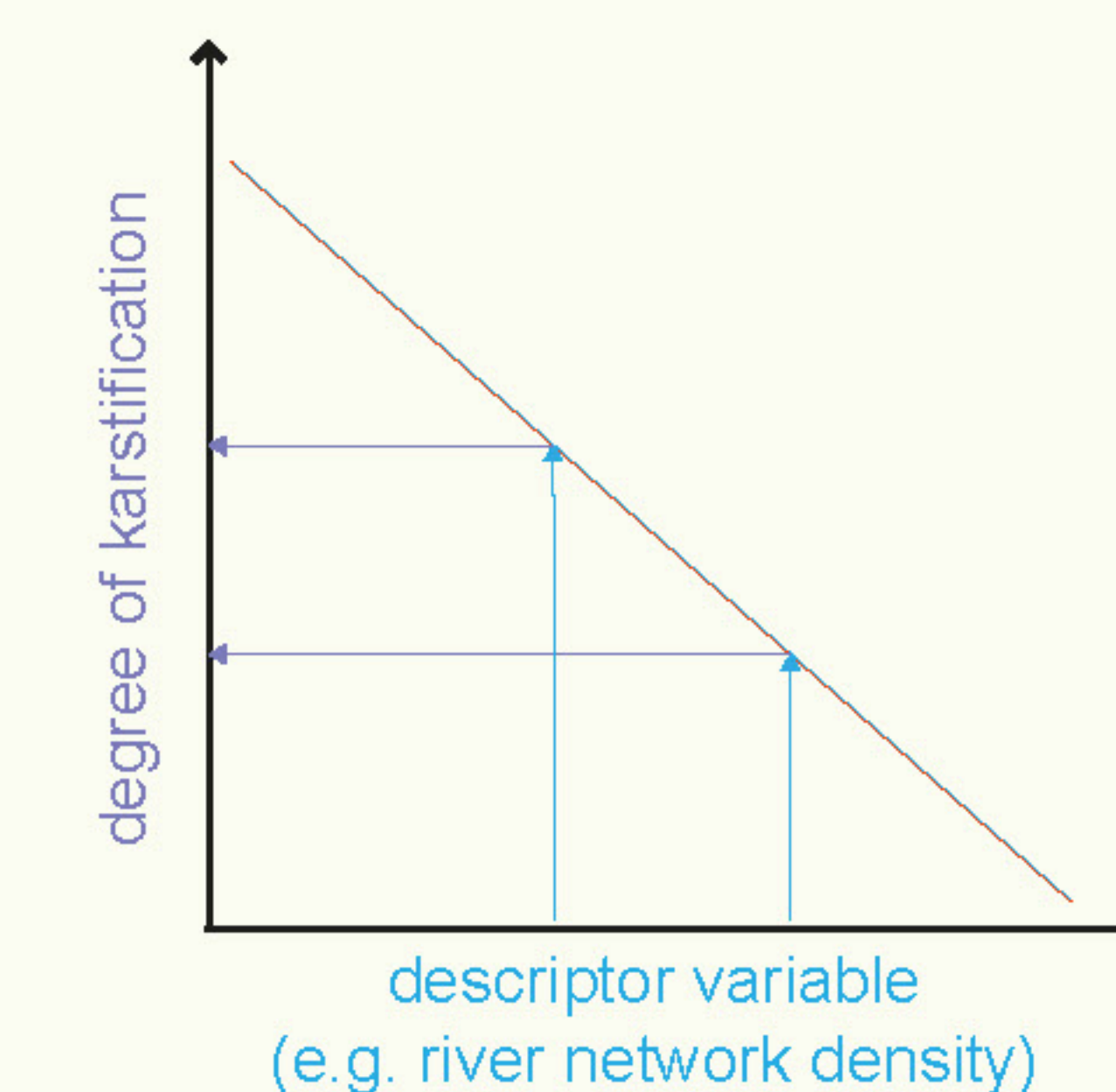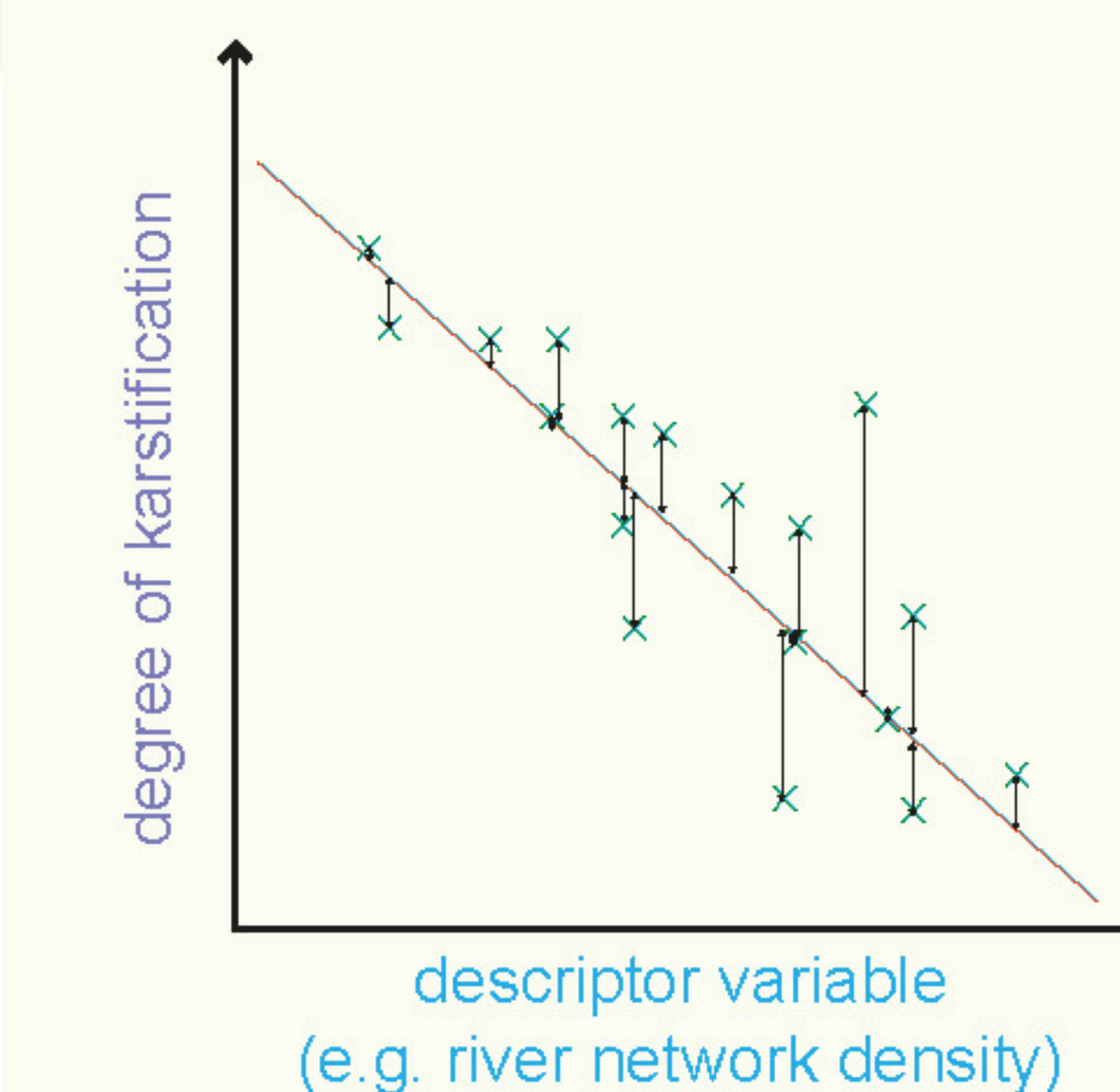
The degree of karstification derived by the isotope supported model-based recession analysis will be compared to regionally available surface descriptors, e.g. the river network density, to derive large-scale estimates of the degree of karstification over Austria's karst regions.

OUTLOOK

This project is meant to provide, for the first time, a regional assessment of the degree of karstification beyond well-equipped study sites. The newly analysed data will be incorporated into the Water-Isotope Map of Austria and Austrian wide maps of the degree of karstification will be made available to the public.

Furthermore the results will contribute to the global karst modelling project „Global Assessment of Water Stress in Karst Regions in a Changing World" funded by the Emmy Noether-Programme of the German Research Foundation (DFG).

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