Concentration-discharge relationships vary among hydrological events, reflecting differences in event characteristics

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These results are published here: Knapp et al. (2020), *HESS-D.*

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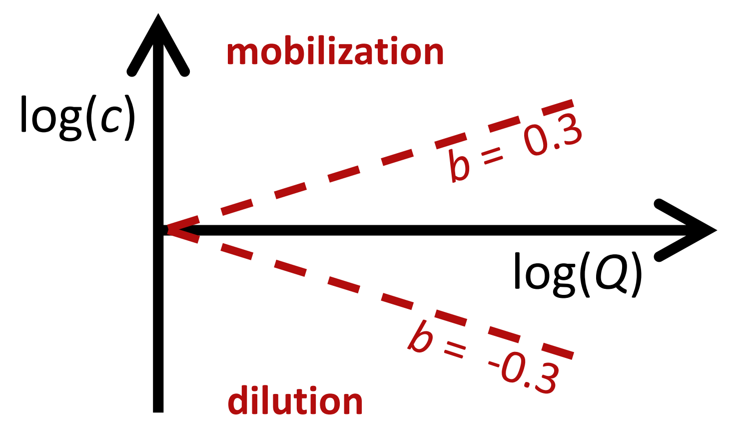
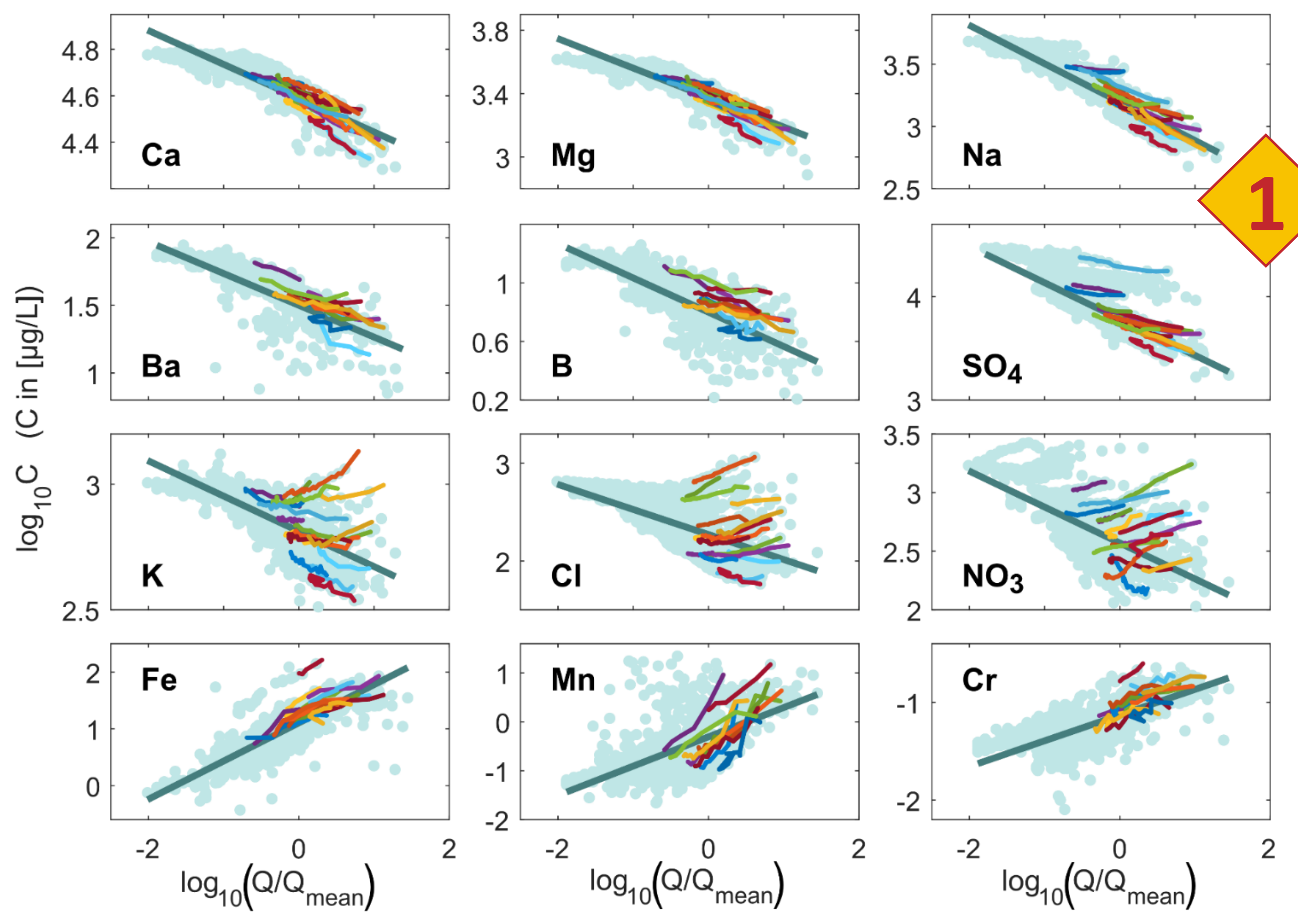
Background

Responses of streamwater chemistry (c) to changes in discharge (Q), as well as the variability in responses among rain events, can provide important insight into how catchments store and release water on short timescales.

$$c = aQ^b \quad \rightarrow \quad \log(c) = \log(a) + b\,\log(Q)$$



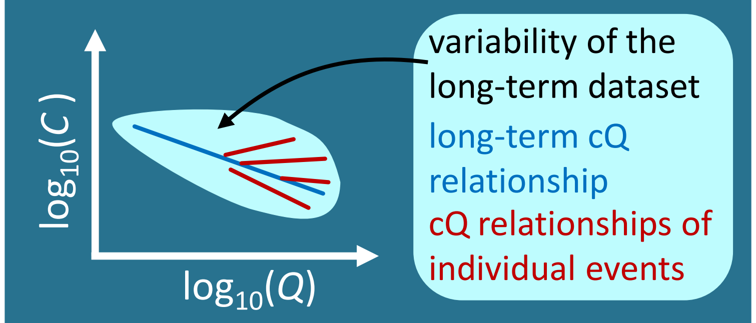
The regression slopes b of concentration-discharge (cQ) relationships are commonly analyzed to understand solute mobilization processes in catchments.



Data

Where?
The Erlenbach, a 0.7 km² pre-alpine catchment in Switzerland.

Which solutes and how often?
- 14 solutes (major and trace elements)
- measured every 30-60 min for ~2 years
- 30 events during the snow-free season



Questions

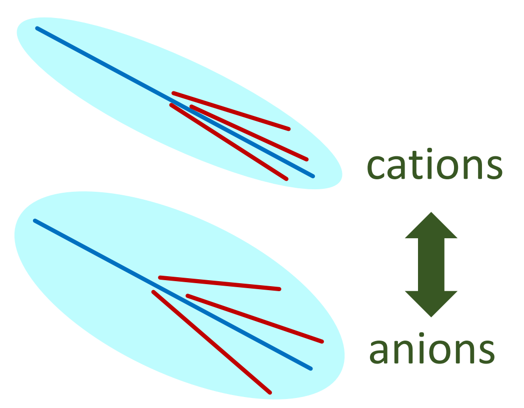
- How variable are cQ relationships among individual events?
- How do event-scale cQ relationships differ from long-term cQ behavior?
- Can inter-event variability in cQ relationships be explained by specific environmental controls?

Analysis

We compared cQ relationships of individual events to those of the 2-year dataset.

We also investigated the correlation between event-slope values b and parameters describing antecedent catchment conditions, event size, event-water contributions, and season. 3

Results



Groundwater-derived solutes

- low variability (event-scale and long-term)
- potential modulators of event-scale behavior: *ionic form*
- slopes were affected by event size

→ *stronger dilution during larger events*

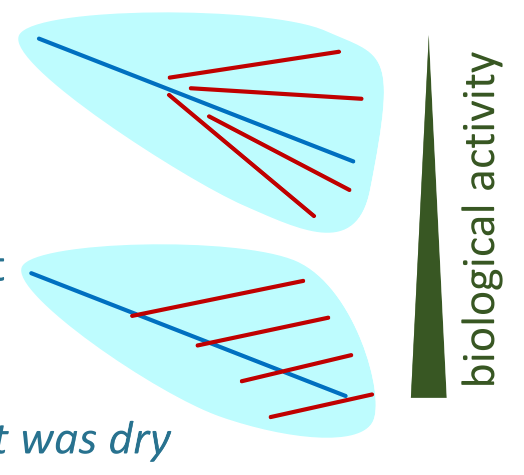
Solutes at Erlenbach: Ca, Mg, Na, Ba, B, SO_4

The 2-year cQ behavior of groundwater-sourced solutes was representative of their cQ behavior during hydrologic events. 2

Solutes with contribution from the atmosphere

- high variability (event-scale)
- potential modulators of event-scale behavior: *biological activity*
- slopes were affected by antecedent conditions & event-water contributions

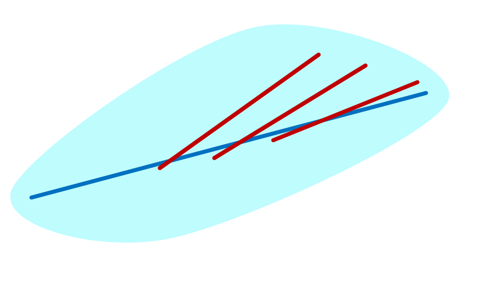
→ *solute mobilization if the catchment was dry and the event-water contribution was higher*



Solutes at Erlenbach: Cl, NO_3, K (K also GW contribution)

Atmospheric and/or biologically active solutes exhibited very different cQ patterns at the event and long-term scale.

2



Soil layer-derived solutes

- potential modulators of event-scale behavior: *presence as nanoparticulates*
- heterogeneous distribution in the soil layers

→ *No consistent behavior/link*

Solutes at Erlenbach: Fe, Mn, Cr

Trace metals exhibited very different cQ patterns at the event and long-term scale.

1 Event-scale cQ relationships may be highly variable among hydrologic events.

2 The degree of variability differed depending on the dominant source of the solutes in the catchment.

3 Most of the observed inter-event variability in cQ behavior could be explained by catchment wetness, season, event size, and event-water contributions.

References

click to view the paper!

For more details on this study please see:

Knapp, J. L. A., von Freyberg, J., Studer, B., Kiewiet, L., & Kirchner, J. W. (2020). Concentration-discharge relationships vary among hydrological events, reflecting differences in event characteristics. *Hydrology and Earth System Sciences Discussions*, 1-27.