Groundwater chemical composition response to the most recent drought event in Europe in 2018 (central part of Latvia).

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Why?

• Most recent drought event in Europe in 2018 significantly affected shallow groundwater aquifers in the Baltic states.

• This study used surface (SW), shallow groundwater (GW) and spring water (SP) chemistry and water stable isotope data obtained during six sampling campaigns in 2017-2018 in central part of Latvia.
  
  • Initially the data were collected to evaluate nitrates fluctuations in Nitrates vulnerable zone (for the needs of EU Nitrates directive).

• The aim was to apply multivariate statistics (PCA and HCA) as a tool to identify changes which could be related to drought events in pilot area.

• Future ambition – to research historical long-term GW level data series in Baltics and look for links between GW drought events and chemistry response (as a support tool for water managers and development of River Basin Management plans in line with EU Water Framework Directive).
Results

- Increase of EC and evaporation
- Increase of $\text{NO}_3$ and K
- Increase of $\text{Fe}_{\text{tot}}$

Cluster 1 – GW with reducing conditions
Cluster 2 – water with oxic conditions (baseline $\text{NO}_3$)
Cluster 3 – anthropogenic influence ($\uparrow$ $\text{NO}_3$, $\uparrow$ K, $\downarrow$ $\text{Fe}_{\text{tot}}$)
Cluster 4 – SW with slightly highlighted $\text{NO}_3$ and $\text{NO}_2$

SW in August, September drought events
River shows lower NO$_3$ concentrations during drought events in September and August and it can be also observed as associated cluster change (from CLU3 to CLU4).

The reason is dominance of baseflow from GW with lower NO$_3$ content.

GW do not show any significant changes.
### Water type | ID | Sampling campaigns | Cluster 1 – GW with reducing conditions | Cluster 2 – water with oxic conditions | Cluster 3 – anthropogenic influence | Cluster 4 – SW with slightly highlighted NO\textsubscript{3} and NO\textsubscript{2}
--- | --- | --- | --- | --- | --- | ---
Groundwater | P1-1 | 1 | 1 | 1 | 1 | 1 | 1
 | P1-2 | 2 | 2 | 2 | 2 | 2 | 2
Spring | P1-KU | 3 | 3 | 3 | 3 | 3 | 3
 | P1-MA | 4 | 4 | 4 | 4 | 4 | 4
River | P1-SK | 5 | 5 | 5 | 5 | 5 | 5

- Again, river shows lower NO\textsubscript{3} concentrations during drought events in September and August (associated cluster change from CLU3 to CLU4).
- Springs represent regional flow.
- GW well P1-1 has deeper screen interval than P1-2, thus reached reducing conditions. Both wells reflect very local conditions and are located on the opposite side of the river than springs.
Conclusions

• Multivariate statistics allowed to identify changes in river water chemical composition in drought events (August, September), but not always.

• Drought related changes could not be observed in GW, most probably because of the natural conditions and chosen parameters - e.g. if NO₃ concentrations are generally low in GW and there are no large pressures in the catchment, no changes can be observed.

• Water stable isotopes in combination with NO₃, NO₂, Fe₉₀Cargo and EC have a potential to be used in multivariate statistics to identify drought related changes in SW chemistry and spring outflows. The usefulness for GW is not straightforward and should be tested on bigger dataset.

• Future steps – calculation of GW drought indices (e.g. SGI) from historical long-term GWL data series and assessment of associated changes in GW chemistry
Lessons learned

• First attempt to use various chemical parameters in multivariate statistics (major ions, trace elements etc. in total 18) failed as geological characteristics overwhelmed the results:
  • Each cluster represented one station
  • Gypsum presence in pilot area (associated with SO$_4$, F, Sr) did not allowed to distinguish differences between SW and GW

• $\rightarrow$ **for this case less is more** (finally only isotopes, EC, NO$_3$, NO$_2$, Fe$_{tot}$, K was used).

• Dataset is too short to fill the gaps, thus missing parameters significantly affect the interpretation of results.

• Ironically, drought events affected the possibility to research drought impacts - mostly because of dry wells and rivers when samples could not be taken.
Thank you!

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