UNIVERSITY OF LATVIA
FACULTY OF GEOGRAPHY AND EARTH SCIENCES

"Spatial and temporal prediction of groundwater drought with mixed models for multilayer sedimentary basin under climate change" (LZP-2019/1-0165)

FLPP
FUNDAMENTAL AND APPLIED RESEARCH PROJECTS

Latvian Council of Science

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

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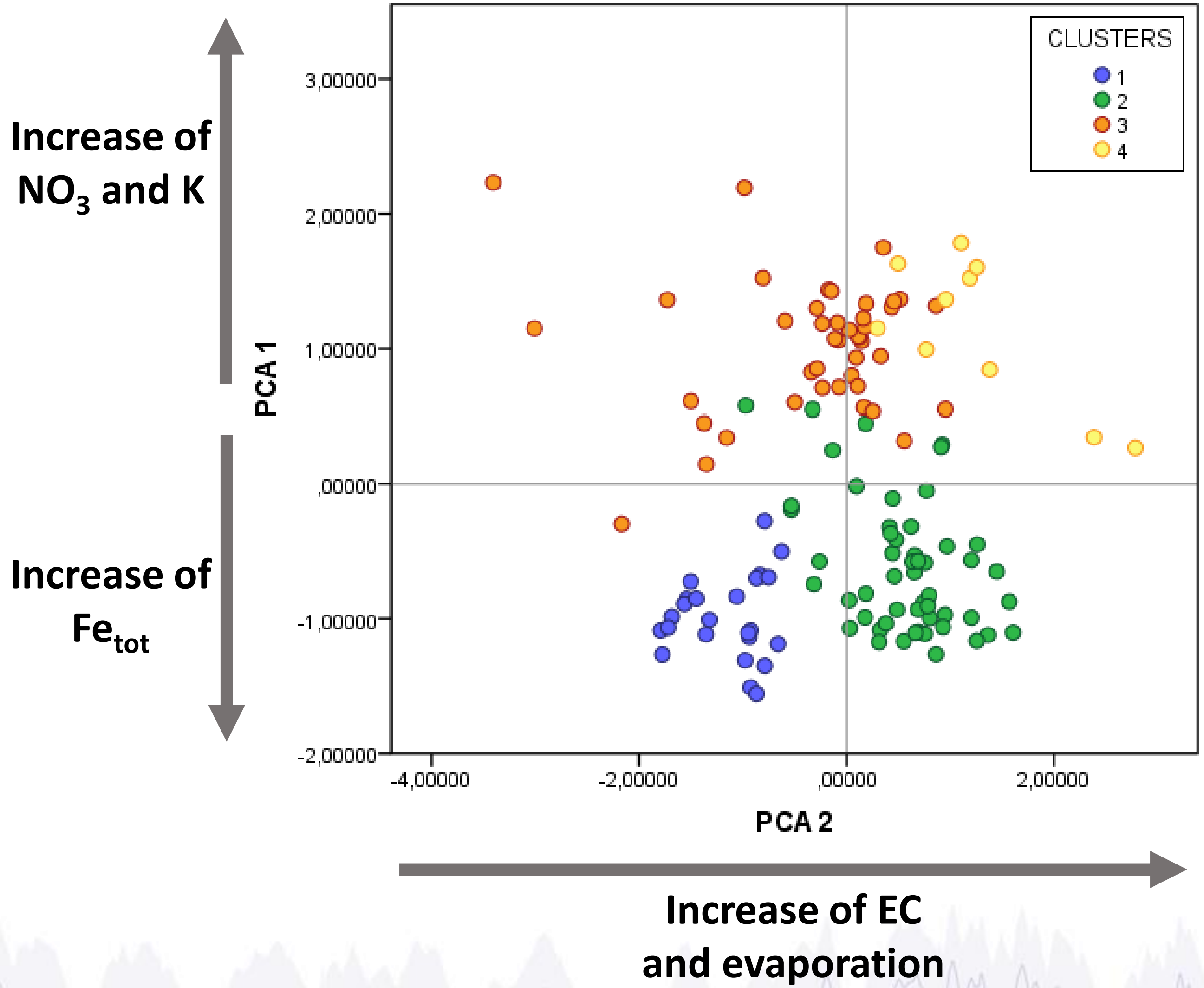
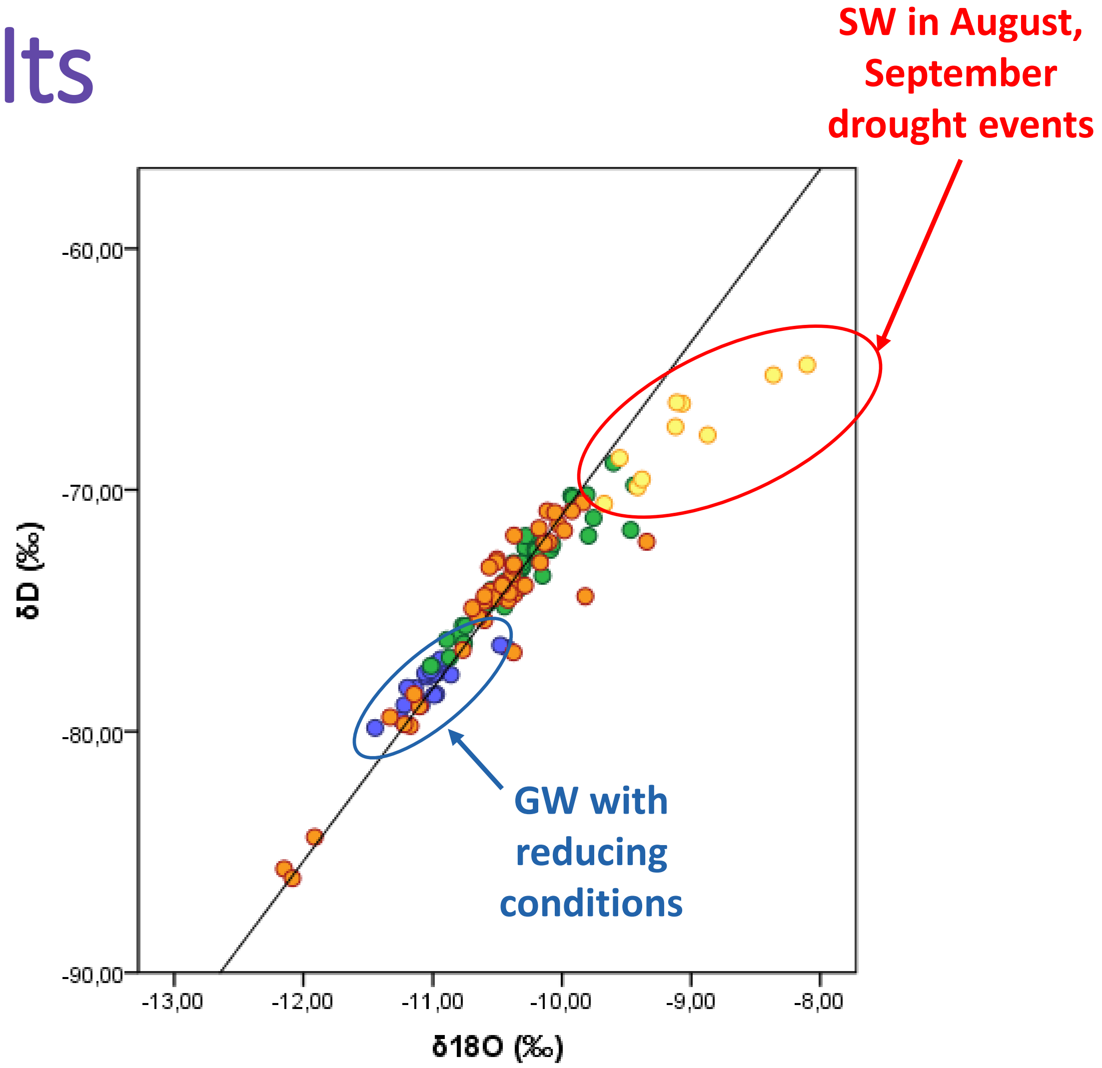
Why?

- 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





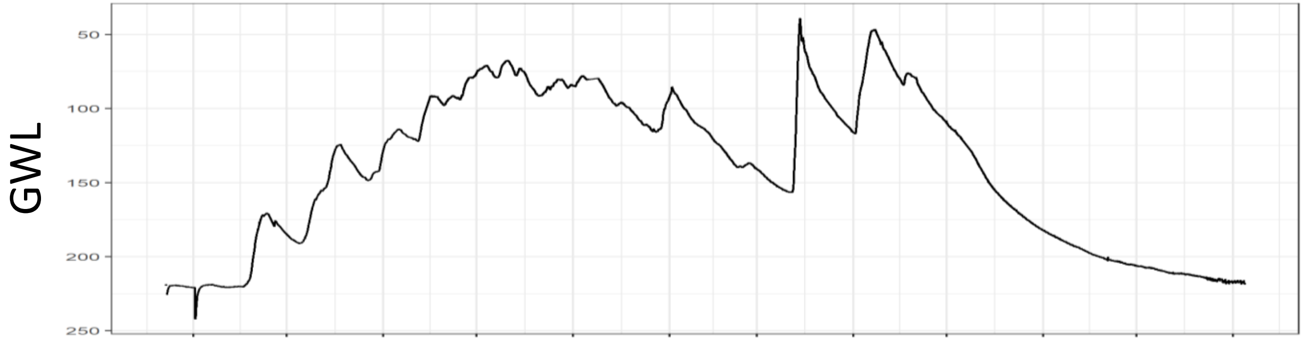
Cluster 1 – GW with reducing conditions

Cluster 2 – water with oxic conditions (baseline NO_3)

Cluster 3 – anthropogenic influence (↑ NO_3, ↑ K, ↓ Fe_{tot})

Cluster 4 – SW with slightly highlighted NO_3 and NO_2

Station No.2
(Upesdaujati)



Water type	ID	Sampling campaigns					
		Sep	**Nov**	**Jan**	**Mar**	**May**	**Aug**
Groundwater	P2-1						
	P2-2						
	P2-3						
	P2-4						
River	P2-BE						

Cluster 1 – GW with reducing conditions

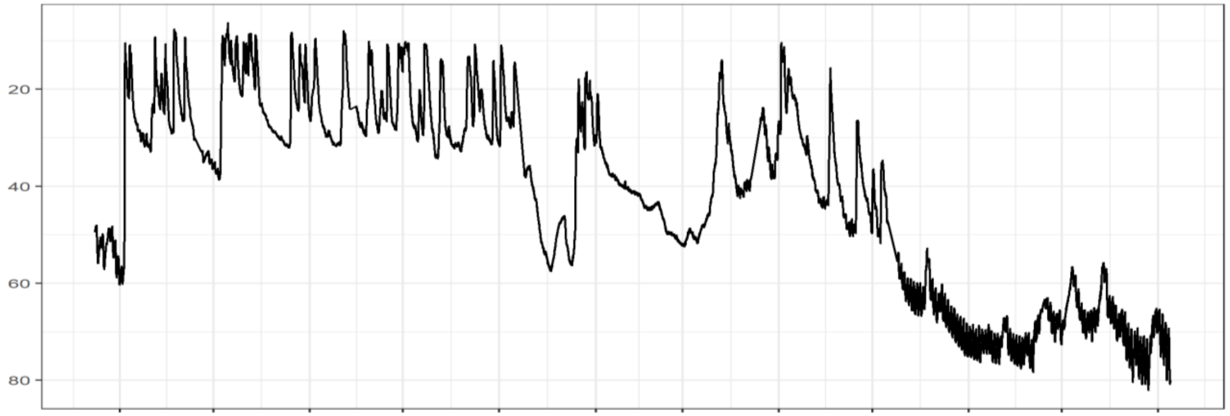
Cluster 2 – water with oxic conditions

Cluster 3 – anthropogenic influence

Cluster 4 – SW with slightly highlighted NO_3 and NO_2

- 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.

Station No.1
(Mazklaukas)



Water type	ID	Sampling campaigns					
		1	2	3	4	5	6
Groundwater	P1-1						
	P1-2						
Spring	P1-KU						
	P1-MA						
River	P1-SK						

Cluster 1 – GW with reducing conditions

Cluster 2 – water with oxic conditions

Cluster 3 – anthropogenic influence

Cluster 4 – SW with slightly highlighted NO_3 and NO_2

- Again, river shows lower NO_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 NO_3 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 NO_3, NO_2, Fe_{tot} 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
- → **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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