UNIVERSITY OF LATVIA

SW-GW interaction and GW management in Latvia

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Related experience

EU WFD/GWD:

- Developed GW parts for the 2nd Latvian RBMPs and consulted the 3rd.
- In 2018 reviewed the boundaries of LV GWBs (including GWBs at risk).
- 2018 developed NBLs and TVs for all Latvian GWBs, including GWB at risk (Liepāja seawater intrusion), later also for two others (MAR and historically polluted sulfuric acid ponds).
- 2021 led the methodology development for identification and assessment of GDEs.
- 2019 led the identification of transboundary GWBs with Lithuania and initial assessment, also developed transboundary GW monitoring programme.

- Developed GW part for two previous reporting periods of EU Nitrates directive.
- PhD candidate - thesis topic about EU water policy implementation in groundwater management in Latvia.

References

GAAEs:

- Retike, I. (red) (2021) Authors: Akstinas, V., Bikše, J., Bruzgo, M., Demidko, J., Dimante-Deimantoviča, I., Grīnberga, L., Kokorīte, I., Koļcova, T., Medne, R., Ozoliņš, D., Rakauskas, V., Retike, I., Skuja, A., Steponėnas, A., Virbickas. Methodology of lake ecosystem health assessment https://u.pcloud.link/publink/show?code=XZlBxTXZcgPk8t9a1PhADbY0SBNyOuPBI1jy&fbclid=IwAR3Tp9mHFlGneB_ejA2I7FCcxyy9Q00_zRqjfqLcuCMsYpREFO7zwFc5NPs
- Kalvāns et al (2021) Nitrate vulnerability of karst aquifers and associated groundwater-dependent ecosystems in the Baltic region. https://doi.org/10.1007/s12665-021-09918-7
- Kalvāns et al. (2020) An insight into water stable isotope signatures in temperate catchment. Journal of Hydrology. Volume 582, March 2020, 124442. https://doi.org/10.1016/j.jhydrol.2019.124442

NBLs and TVs:

- Retike, I. and Bikše, J. 2018. New Data on Seawater Intrusion in Liepāja (Latvia) and Methodology for Establishing Background Levels and Threshold Values in Groundwater Body at Risk F5. E3S Web of Conferences, 54, 00027. DOI: https://doi.org/10.1051/e3sconf/20185400027
- Pulido-Velazquez D., Baena-Ruiz L., Fernandes J., Arno G., Hinsby K., Voutchkova D.D., Hansen B., (...), Luque-Espinar J.A. 2022. Assessment of chloride natural background levels by applying statistical approaches. Analyses of European coastal aquifers in different environments. https://doi.org/10.1016/j.marpolbul.2021.113303

GWBs delineation:

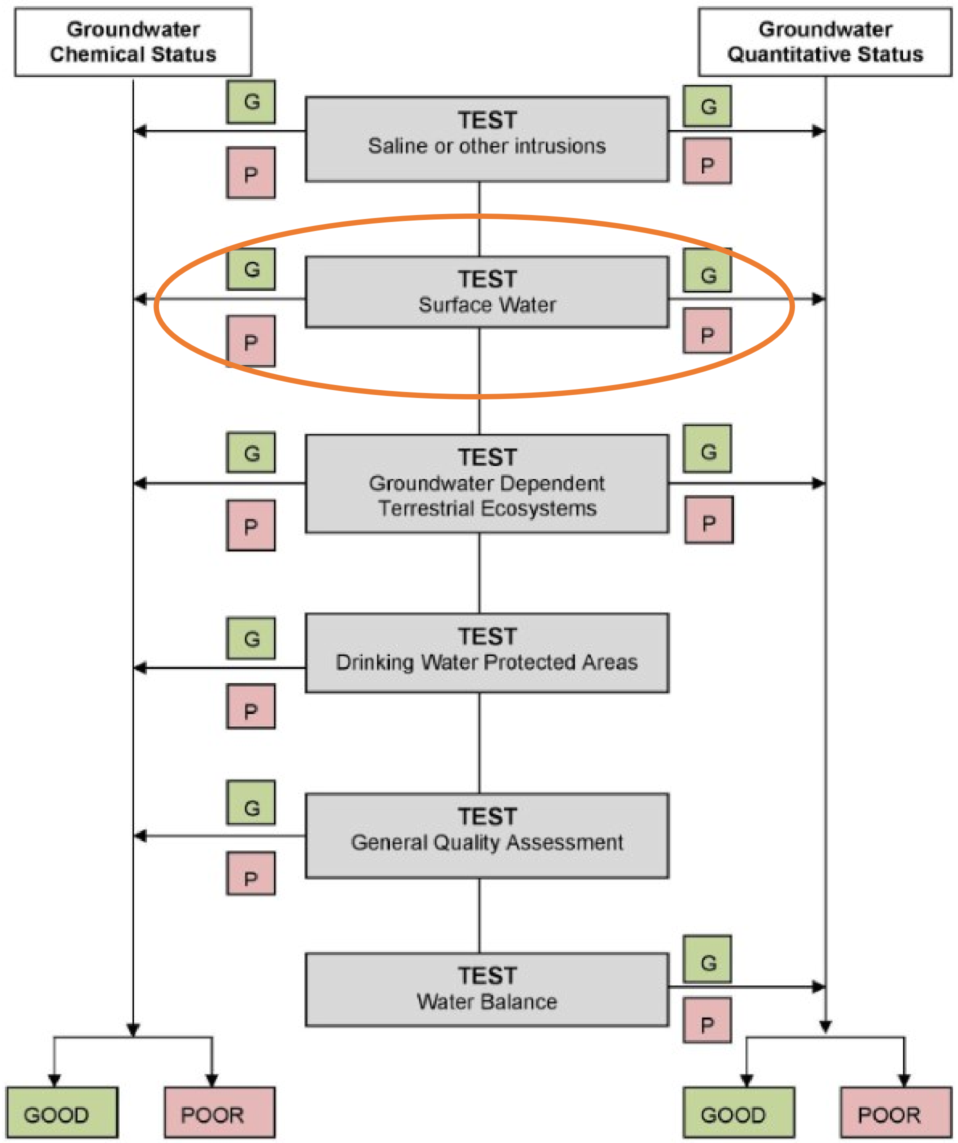
- Bikše, J. and Retike, I. 2018. An Approach to Delineate Groundwater Bodies at Risk: Seawater Intrusion in Liepāja (Latvia). E3S Web of Conferences, 54, 00003. DOI: https://doi.org/10.1051/e3sconf/20185400003.

GW level monitoring:

- Retike et al. (2022) Rescue of groundwater level time series: How to visually identify and treat errors. Journal of Hydrology, 605 , art. no. 127294. https://doi.org/10.1016/j.jhydrol.2021.127294

SW-GW interaction in Latvian RBMPs

Assessed based on «Surface waters» test - we understand associated aquatic ecosystems as lakes, rivers, sink holes.



GAAEs identification

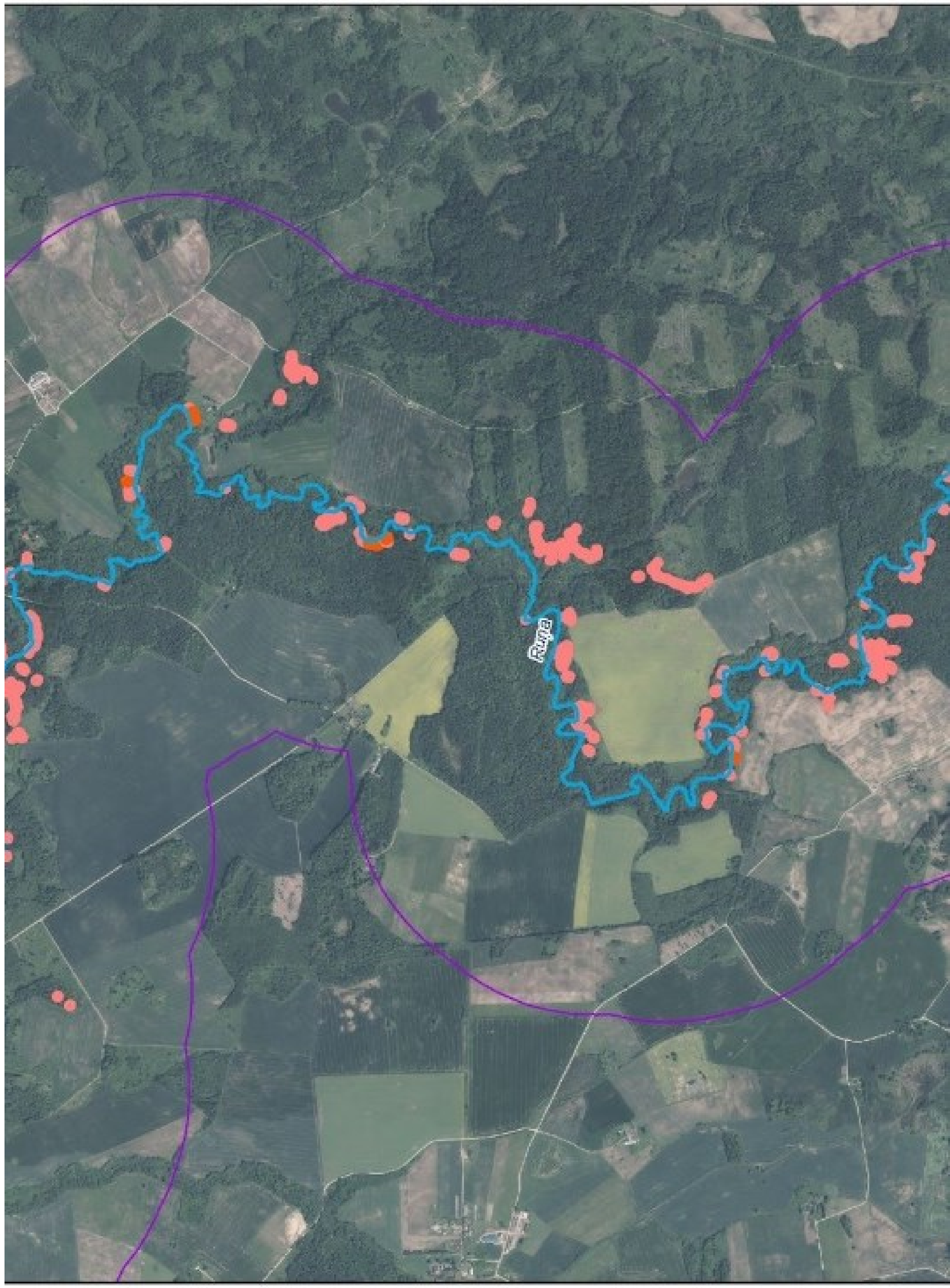
We used **Terasmaa et al.2015** methodology as the basis, but with some updates

General steps for lakes:

- Use SWBs, but remove all «brown» waters,
- Add lakes that are important from expert opinion from Biotope Directive’s Annex 1 (3130, 3140, 3150, 3190).
- Lakes with water exchange >2 years included

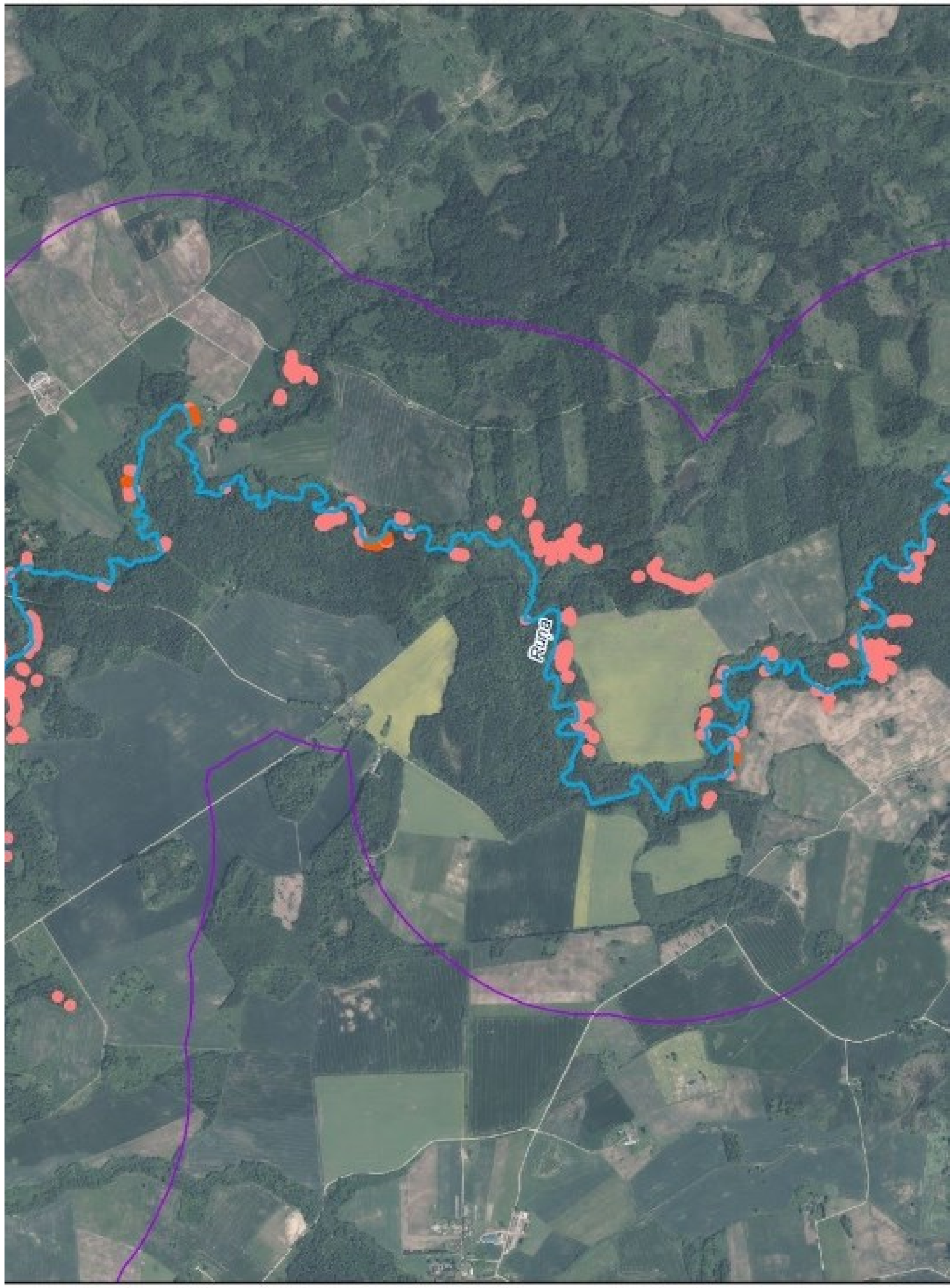
General steps for rivers:

- Use SWBs and by expert judgement assess the potential connection by the presence of springs (1km) (sources allikad.info + national biotope inventory).
- Included if average water temperature <18^{o}C



GAAEs quality assessment

- SWB status from 3rd RBMPs.
- As potentially at risk GAAES identified based on the pressure analysis and low or unknown ecological quality.
- For lakes not included into SWBs (but as part of Biotope Directive’s Annex I) and sink holes national inventory results were used.



Results

- 492 SWBs (river WBs) but only **12** (2.4%) are GAAEs.
- 261 lake WBs but **82** or 31% considered as GAAEs.
- **10** Biotope Directive's Annex I lakes: Ummis, Pinku ezers, Lieluikas ezers, Mazuikas ezers, Dienvidu Garezers, Vidējais Garezers, Ninieris, Driškins, Ojatu ezers un Langstiņu ezers.
- **65** sink holes.

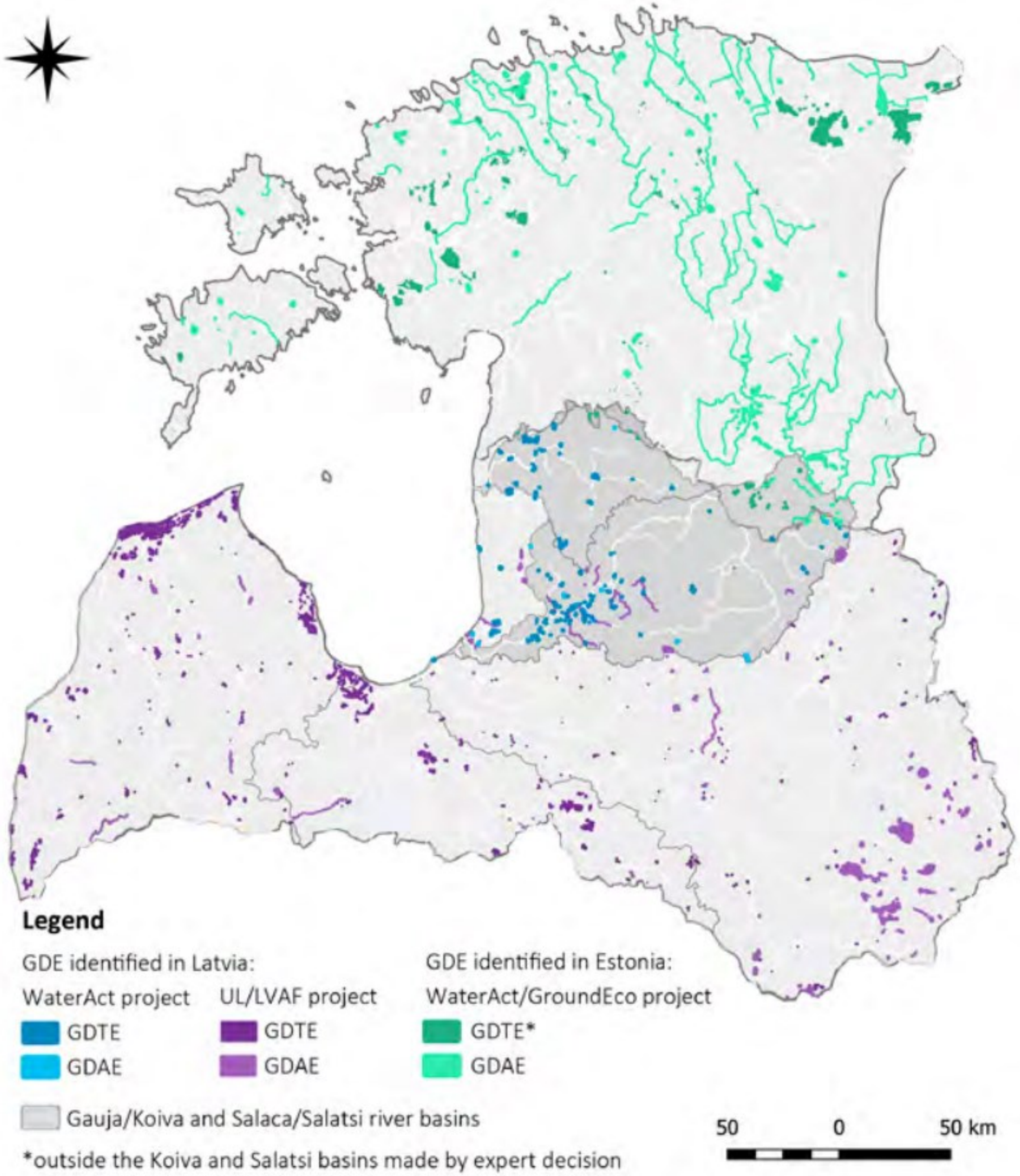


Figure 3.8. *GDEs identified in the Gauja/Koiva river basin and Salaca/Salaca river basin and in the rest of the country in Latvia and Estonia. Data source: GroundEco project (Retike et al. 2020), WaterAct project (final report, in prep.), Nature Conservation Agency 2021, University of Latvia (Retiķe et al. 2021), Tallinn University (Terasmaa et al. 2015).*

Impact on GWB quantitative status

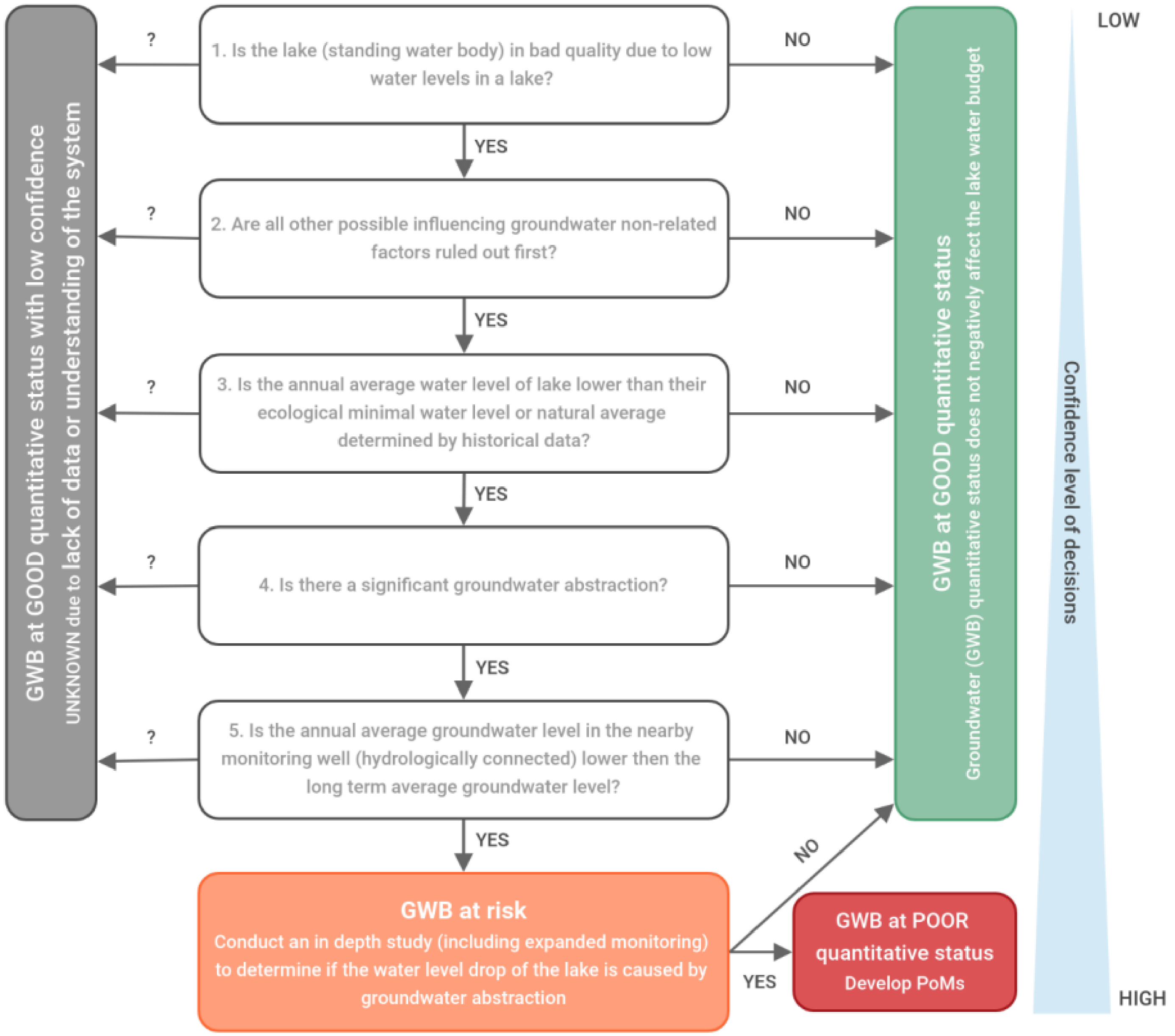


Figure 15. Procedure for the quantitative status assessment of groundwater (GWB) due to potential negative pressures on GAAE.

Impact on GWB qualitative status

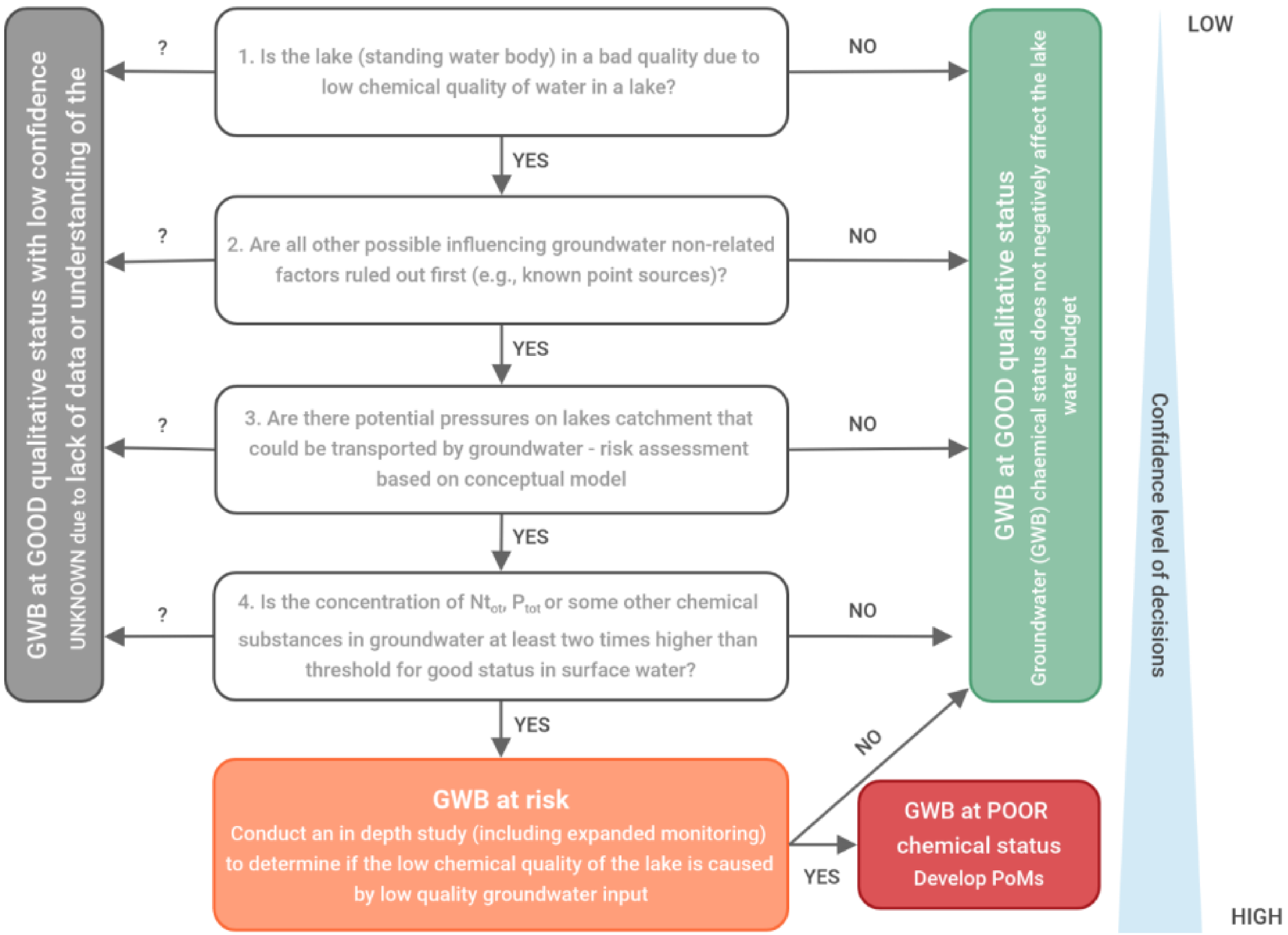


Figure 16. Procedure for the qualitative (chemical) status assessment of groundwater (GWB) due to potential negative pressures on GAAE.

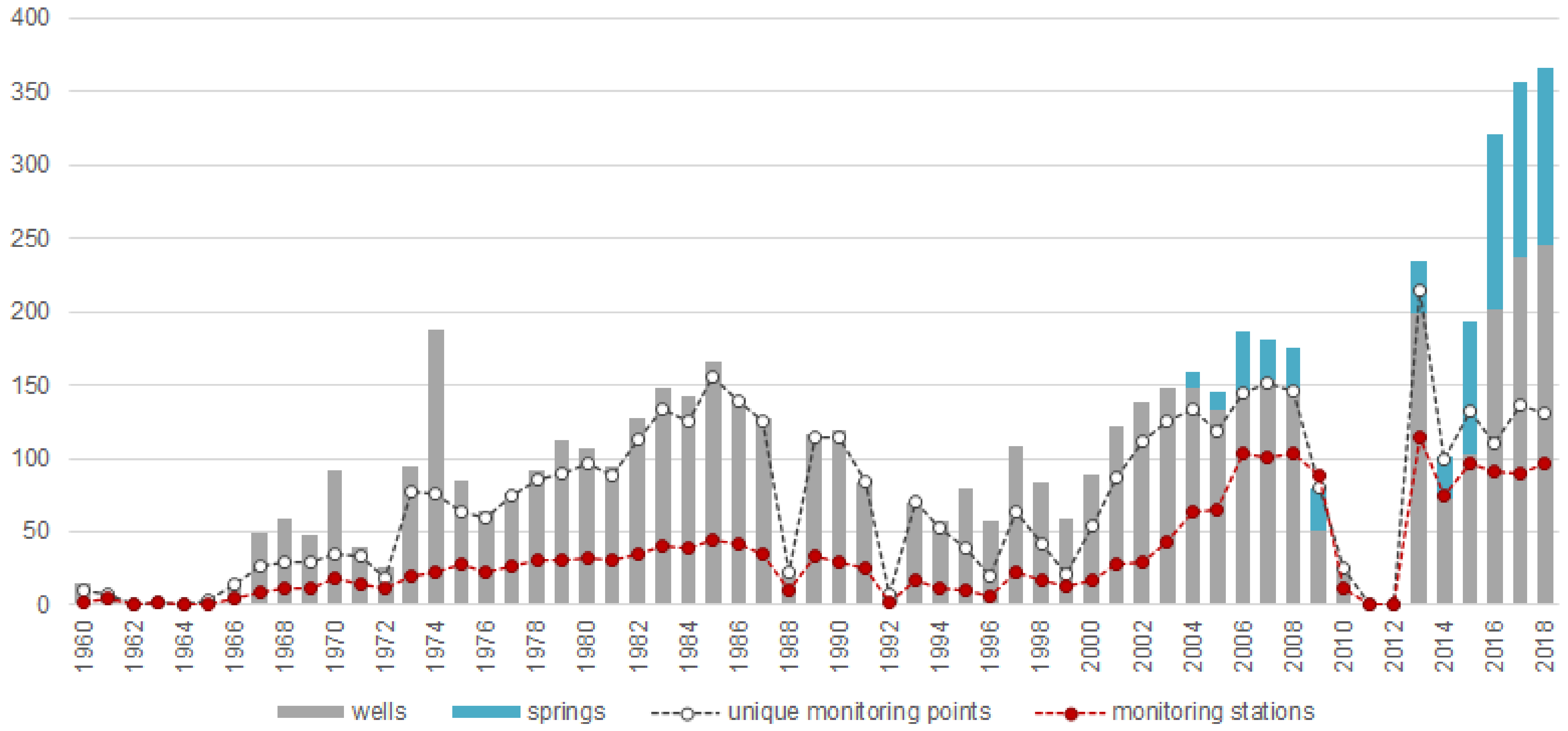


Figure X. **Changes in the number of samples taken from wells and springs, and amount of unique monitoring points and active stations in qualitative groundwater monitoring over the period 1960-2018**

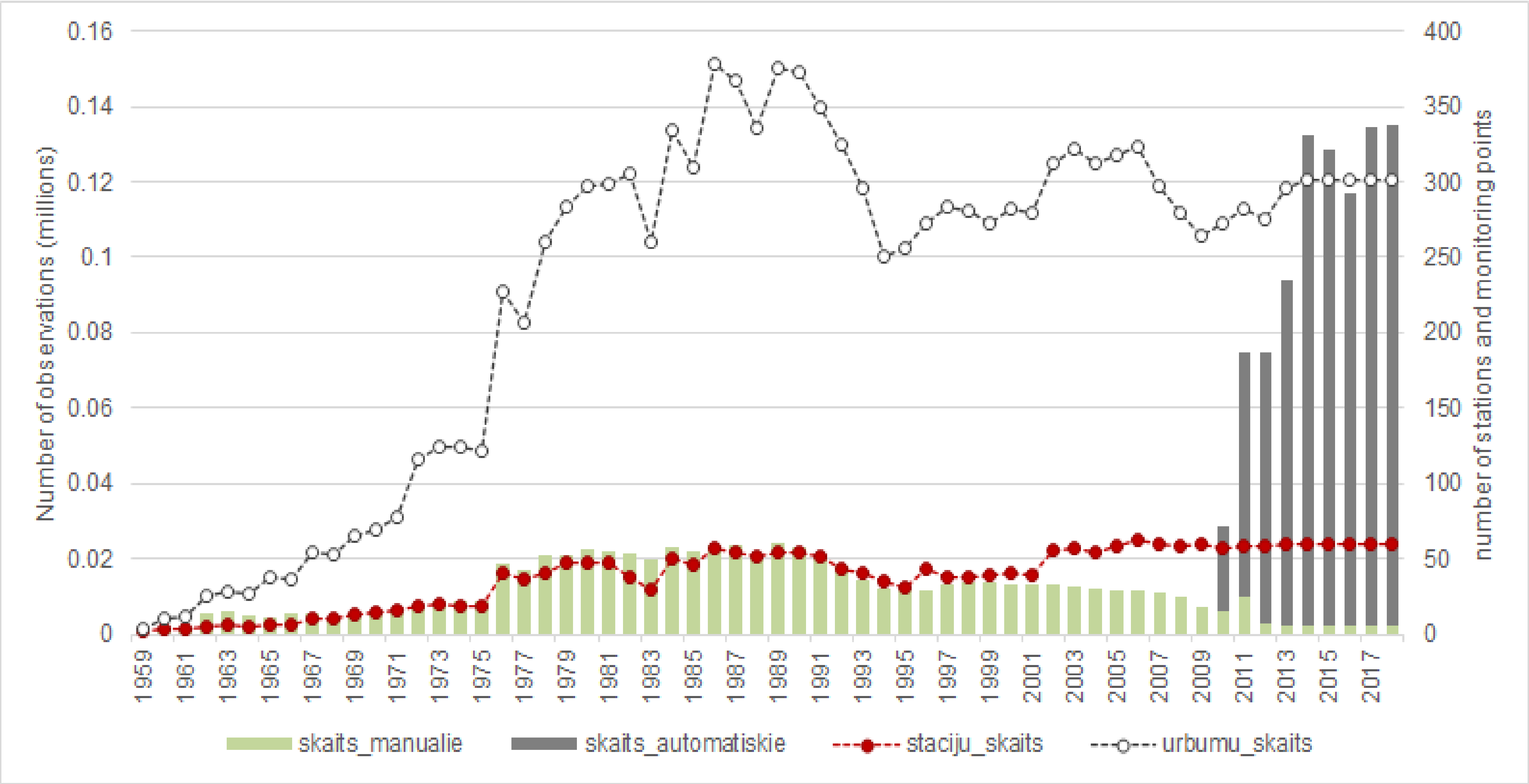


Figure X. **Changes in the number of observations and amount of unique monitoring points and active stations in quantitative groundwater monitoring over the period 1960-2018**

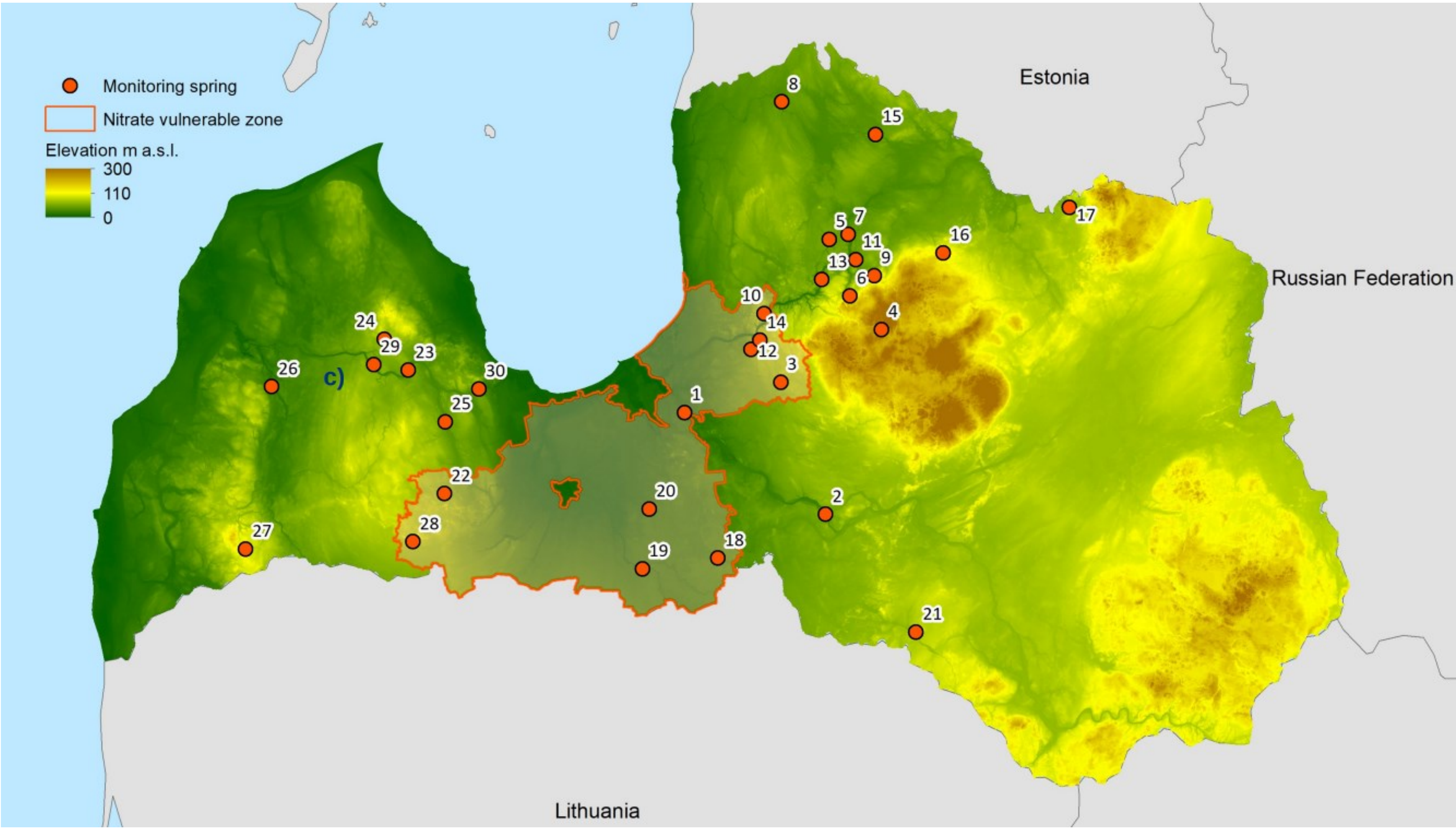
Springs as part of the monitoring network

PROS +

- No need for installation (?) and maintenance
- No need for pumping
- Can benefit both – GW body and popular drinking water sources monitoring

CONS –

- Locations does not always complement monitoring needs
- Investigations needed to delineate watersheds and assess the representative sampling periods (seasonality)
- Installation costs for discharge measurements in some cases

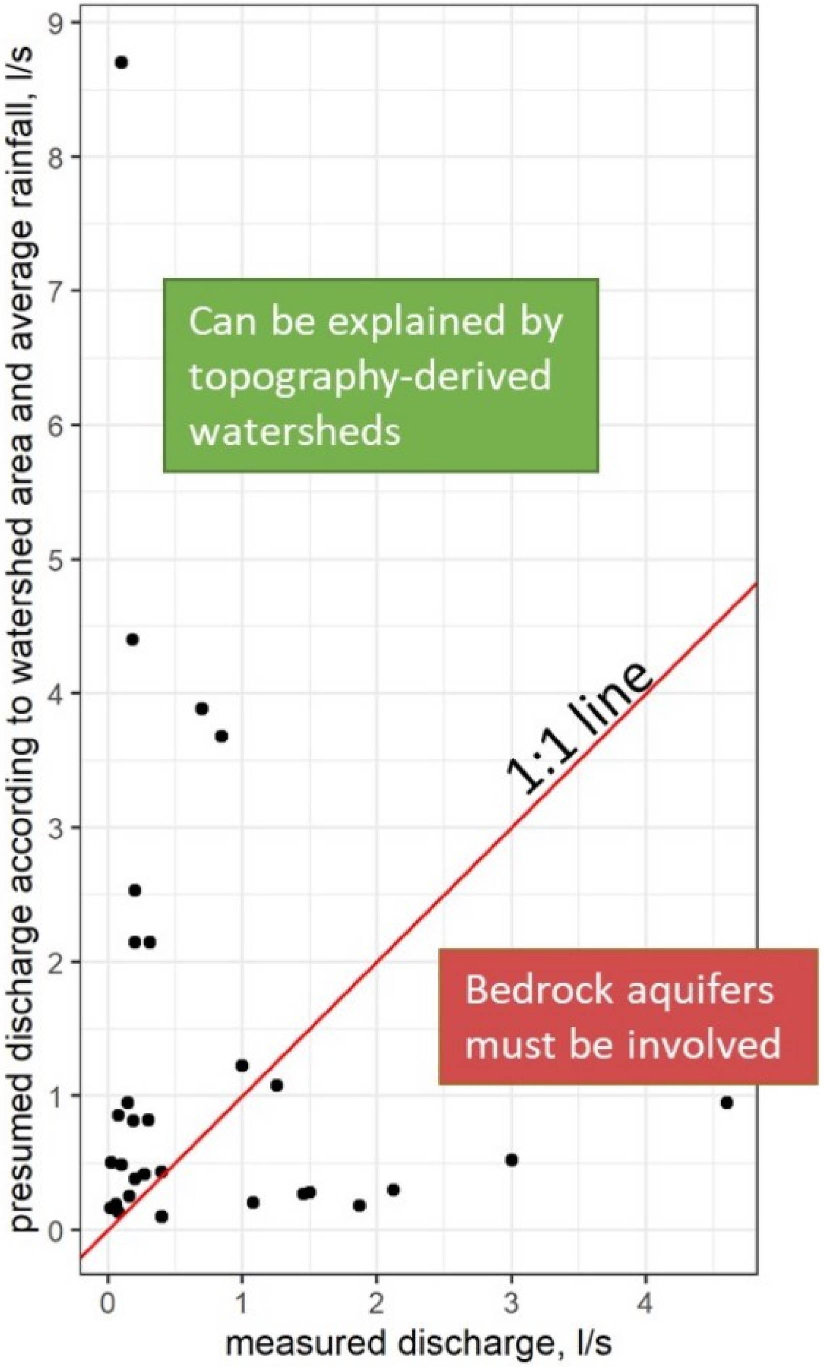


30 springs are included into Latvian GW monitoring network since 2004

Some insights into the spring catchments

Spring watersheds are calculated whether from a) topography or b) bedrock aquifer modelling (results often do not overlap).

The verification is based on (1) seasonal spring sampling, and (2) discharge measurements comparison with precipitation data from satellites.



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EVIDEnT

LuWQ 2017
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The Hague, the Netherlands, 29 May-1 June 2017

Isotopic signatures of precipitation and surface water- groundwater interaction in Salaca river basin (Latvia)

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Study area

The study region is located in part of Salaca river basin- **starting from Lake Burtnieks** (surface area ~40 km^2; the source of Salaca river,) **to bridge near Vīķi** (SV3 in Figure B). Total study area is 684 km^2.

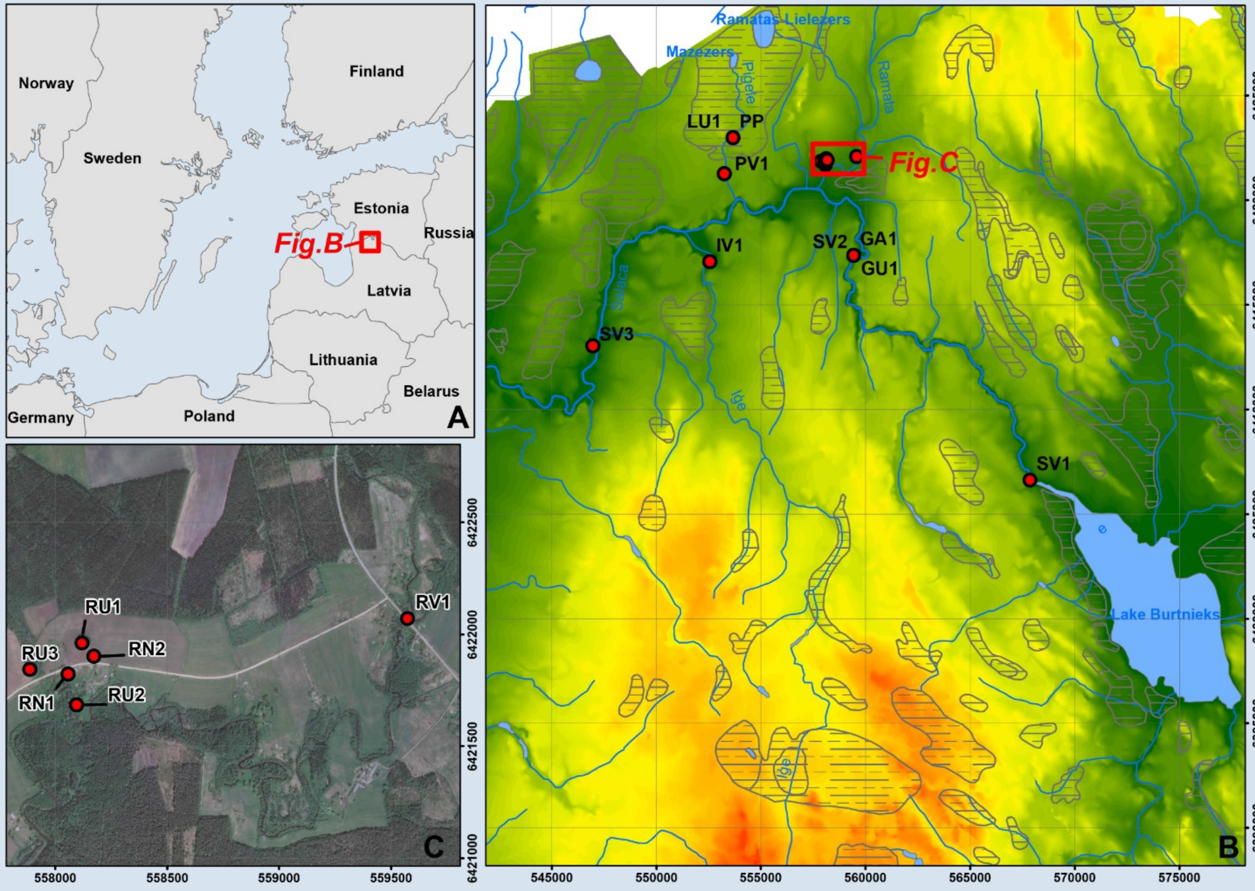


Fig.1 Study area and sampling location ID

- About 56% of Salaca river basin is covered by forests, 37% by arable land and pastries and 4% by bogs.
- Average air temperature is 4-5 °C.
- The average precipitation is close to 700 mm per year and infiltration is about 20 mm per year.

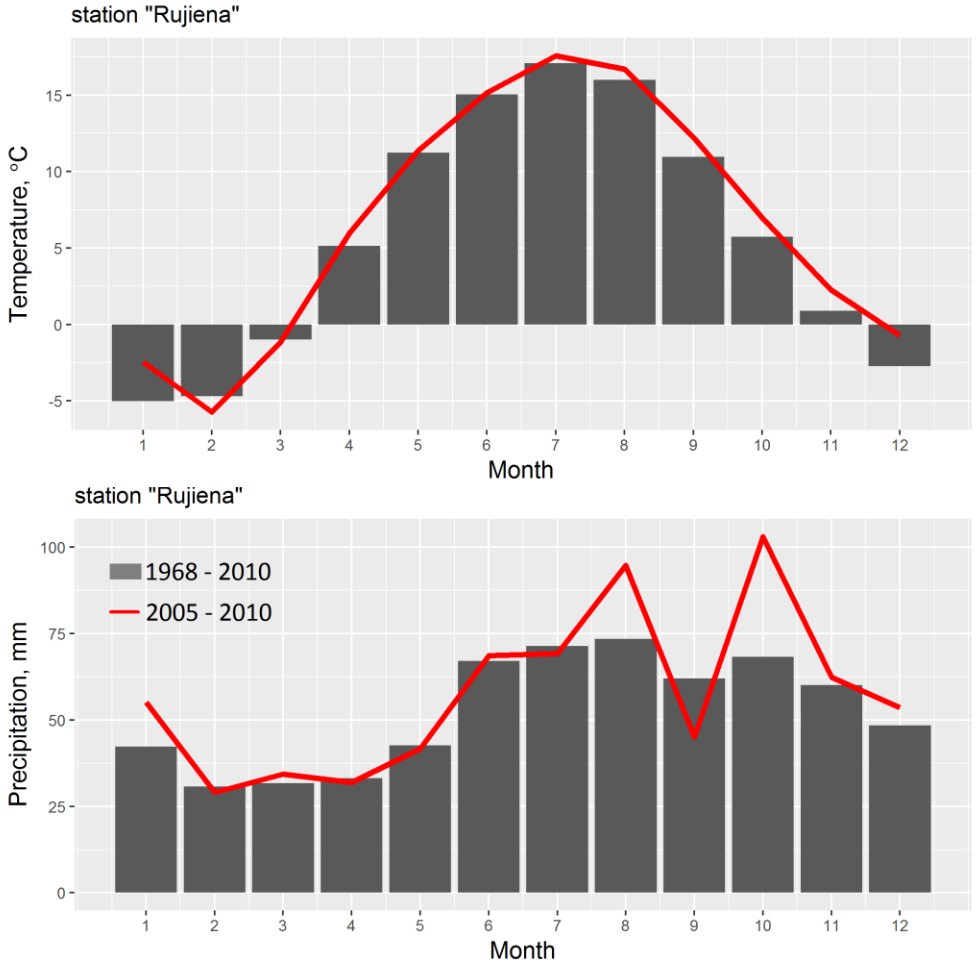


Fig.2 Precipitation and temperature average values at meteorological station «Rūjiena»

Sampling sites and plan

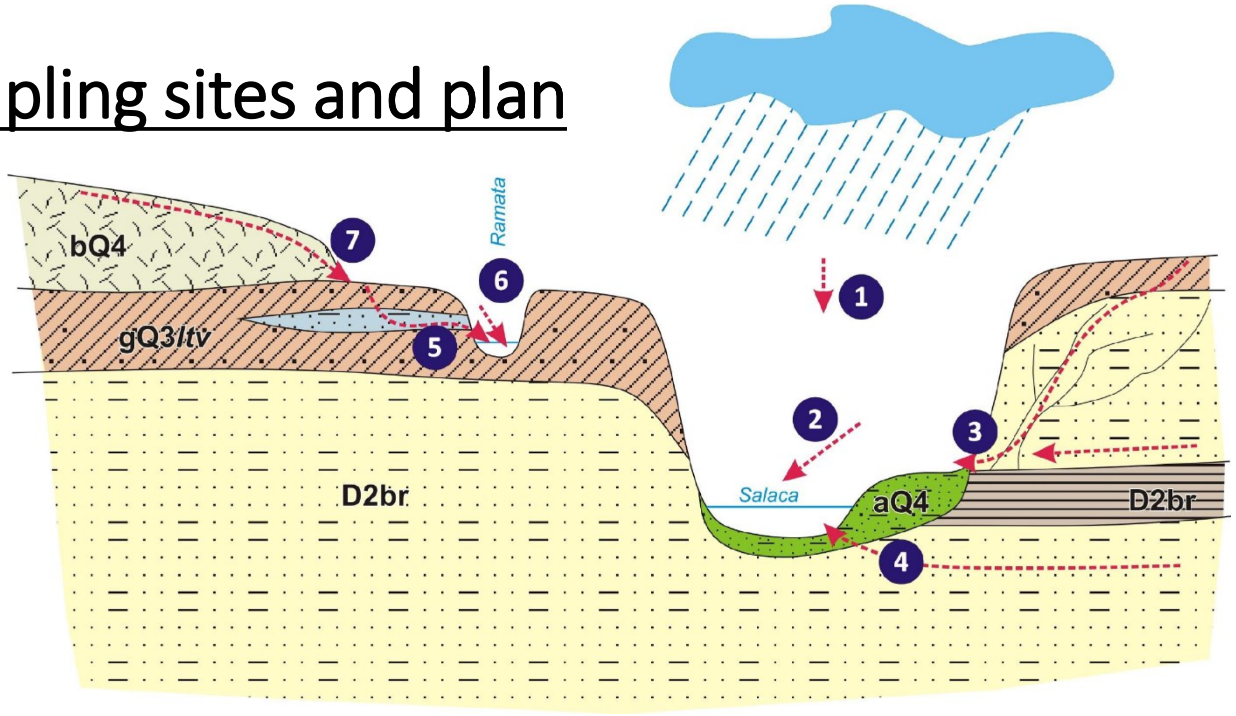


Fig.3. Conceptual cross-section of study area

Period of monitoring: 2015-2018 (once a month + two extra campaigns)
Number of sampling sites: 15

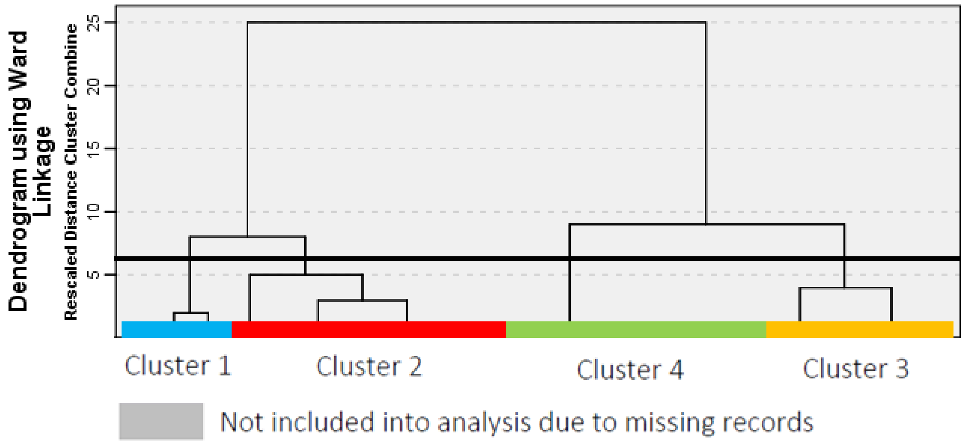
- **Precipitation** (RN1, RN2)
- **Surface water**- river Salaca (SV1, SV2,SV3), tributaries of Salaca (RV1- Ramata, Iģe- IV1, PV1- Piģele)
- **Raised bog** Lielpurvs- LU1, PP
- **Groundwater**- wells (GU1, RU1, RU2), spring Govsala (GA1)
- **Drainage** (RU3)

Field campaigns:
- groundwater level, electric conductivity and water temperature is measured each time
- **Precipitation**, are acumulated in manual rain gauges
- **Well** samples are collected after well is pumped

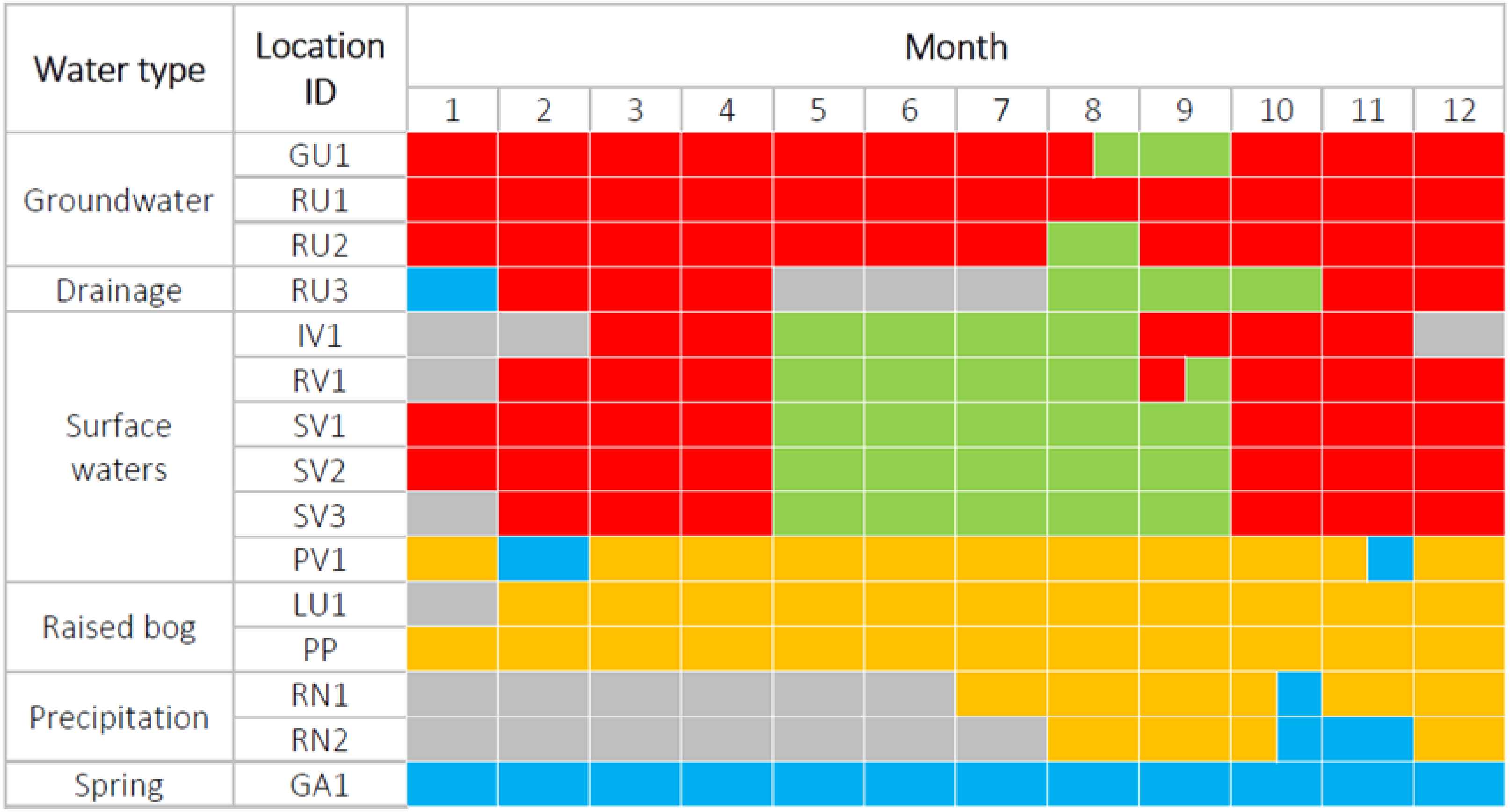
Laboratory analysis:
- δ^{18}O, δD analysis performed in Environment Dating Laboratory at the University of Latvia using Picarro laser cavity ring down spectrometer
- The repetitiveness is ±0.07‰ for δ18O and ±0.5‰ for δ2H,however result error ±0.2‰ for δ18O and ±1‰ for δ2H is adopted following Clark&Fritz, (1997)

Results from hierarchical cluster analysis

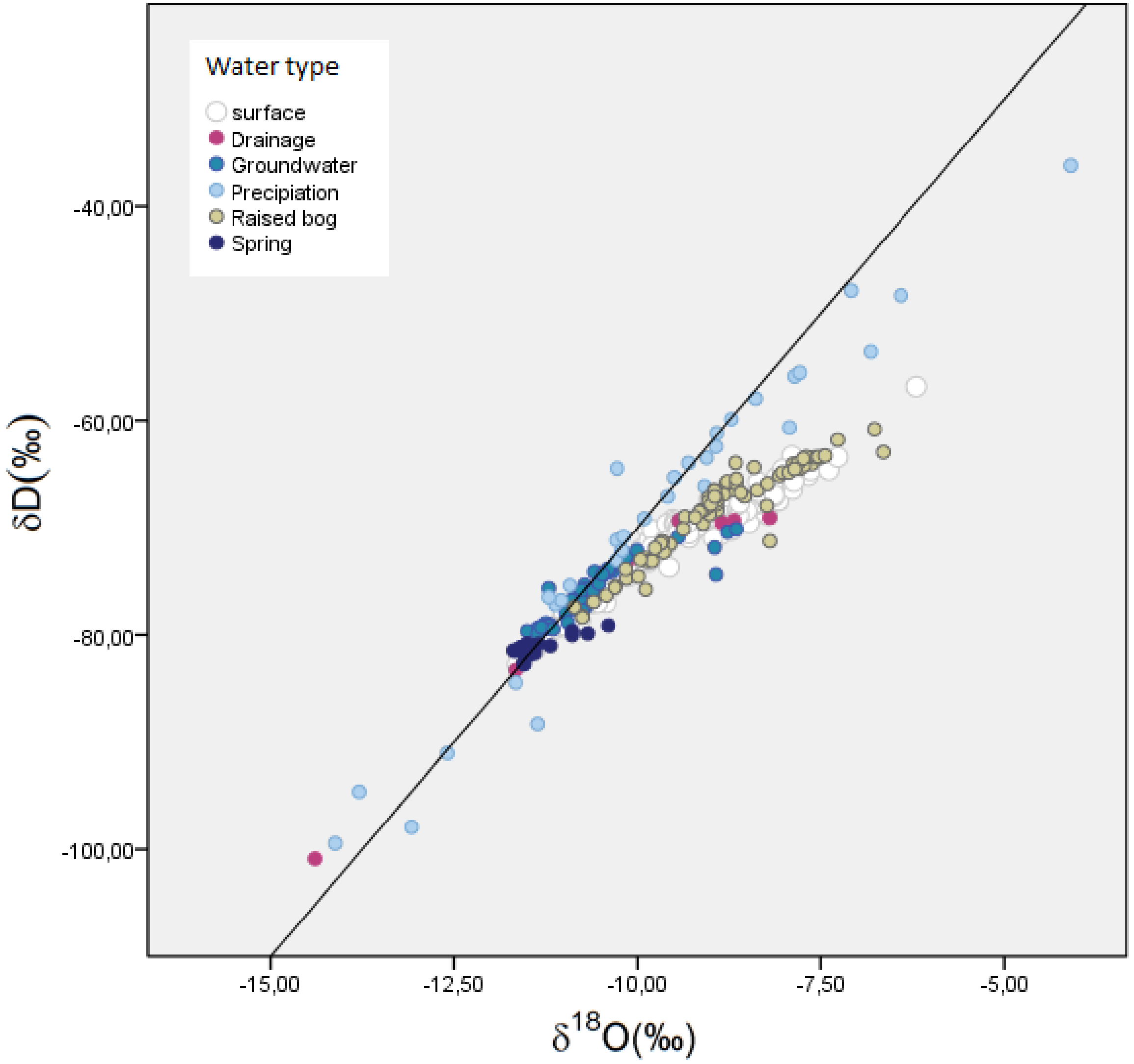
- $\delta^{18}O$
- δD
- Water temperature
- Electrical conductivity



- **Cluster 1:** constant isotopic signal in spring Govsala (GA1)
- **Cluster 2:** groundwater all year round and surface water + drainage during cold autumn- winter seasons
- **Cluster 3:** raised bog + precipitation
- **Cluster 4:** surface water and drainage during warm season- May till September



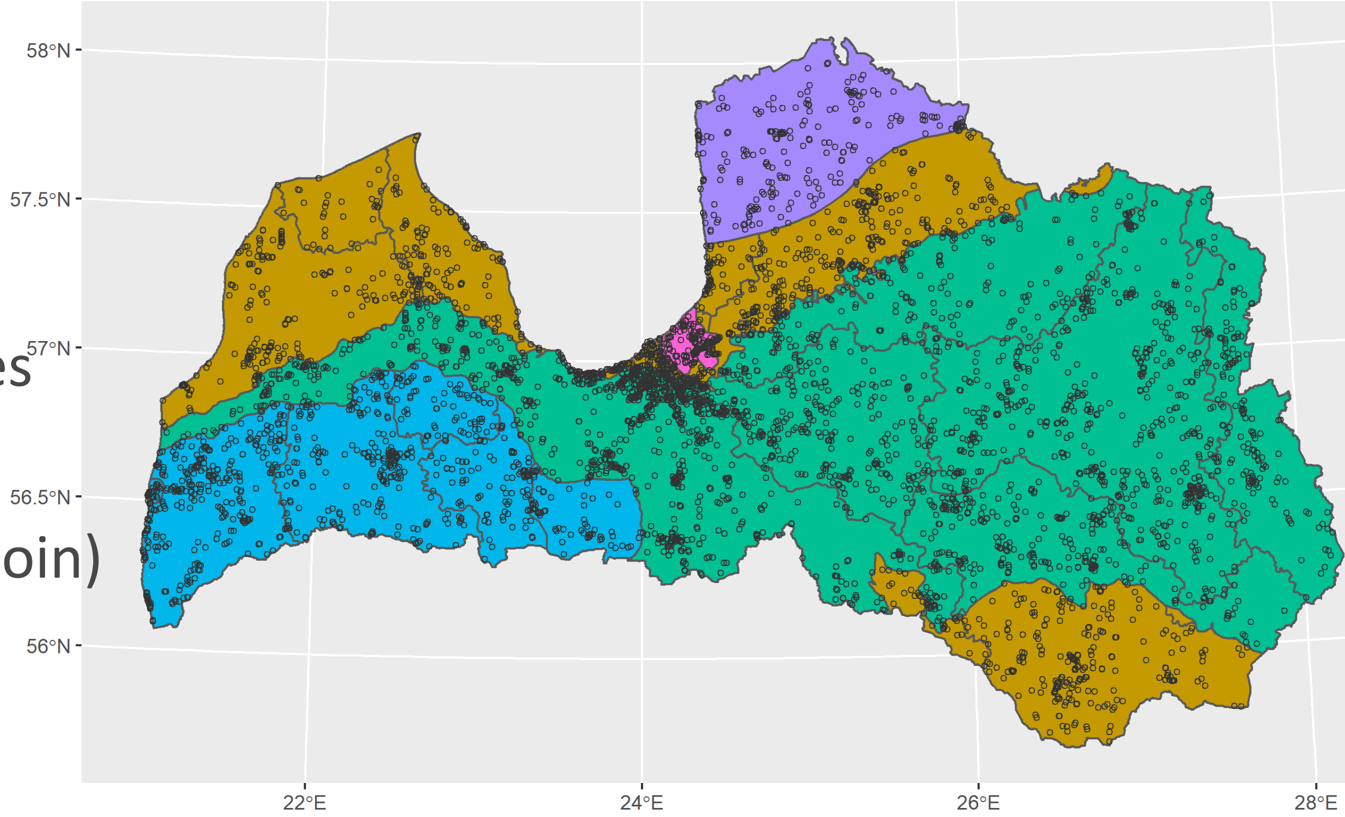
Conclusions



- During this study stable isotopes together with water temperature and EC are found to be a useful tool to identify distinct water components and their evolution during seasons
- The pattern of depletion of water stable isotopes downstream river Salaca can be observed during cold season
- Samples collected in raise bog (well, river) and precipitation act as a similar system all year round
- Seasonality was identified: cold autumn-winter period and warm spring-summer period
- Spring Govsala and nearby well (GU1) both show constant but different isotopic values and EC, therefore it clearly points to different water sources
- Drainage pattern is similar to surface water

Natural background levels in Latvia – a brief description of the approach

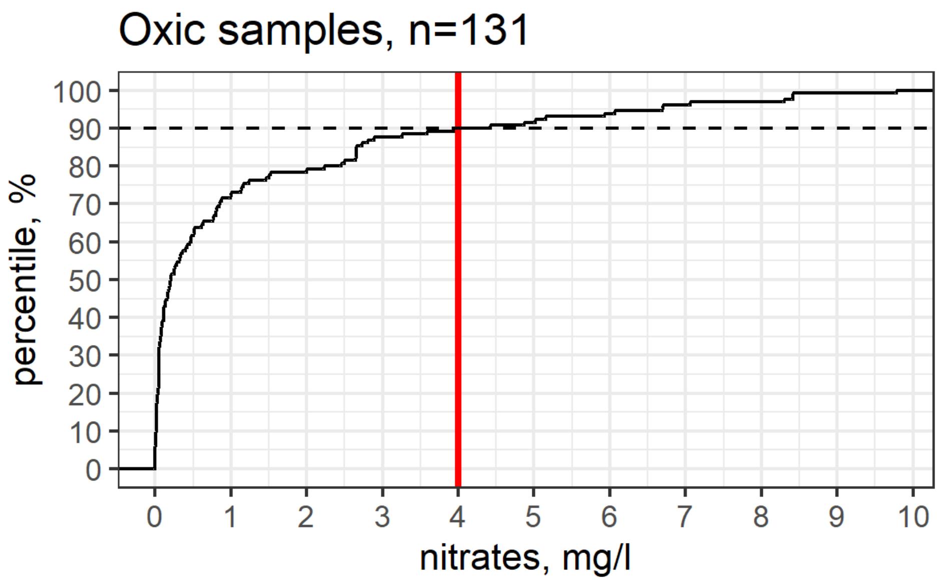
- Began with all samples from both **monitoring and abstraction wells** (~17k samples)
- Excluded:
  - old samples due to improper procedures
  - Anthropogenic impacted samples
  - Samples with incorrect ion balance (±10%)
  - Sites/wells having median NO_3 > 10 mg/l
- Final dataset – 5758 unique sampling sites
- 5660 sites actually belong to any GWB
- Site assignment to specific GWB (spatial join)

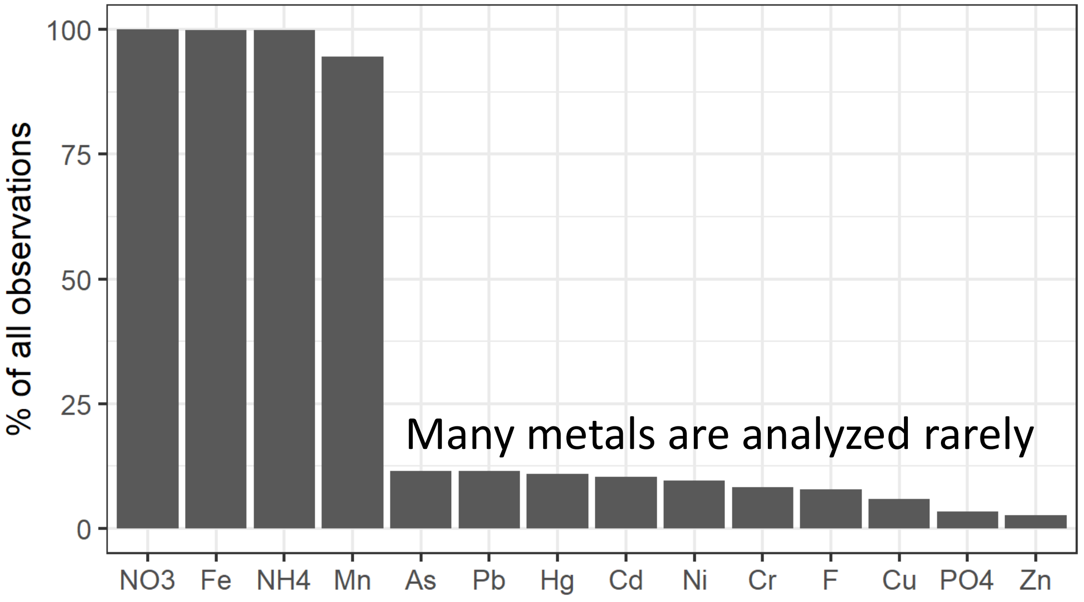


Finding natural background levels for each GWB

For each substance in each GWB values at 90th (and at 95th) percentiles are determined:

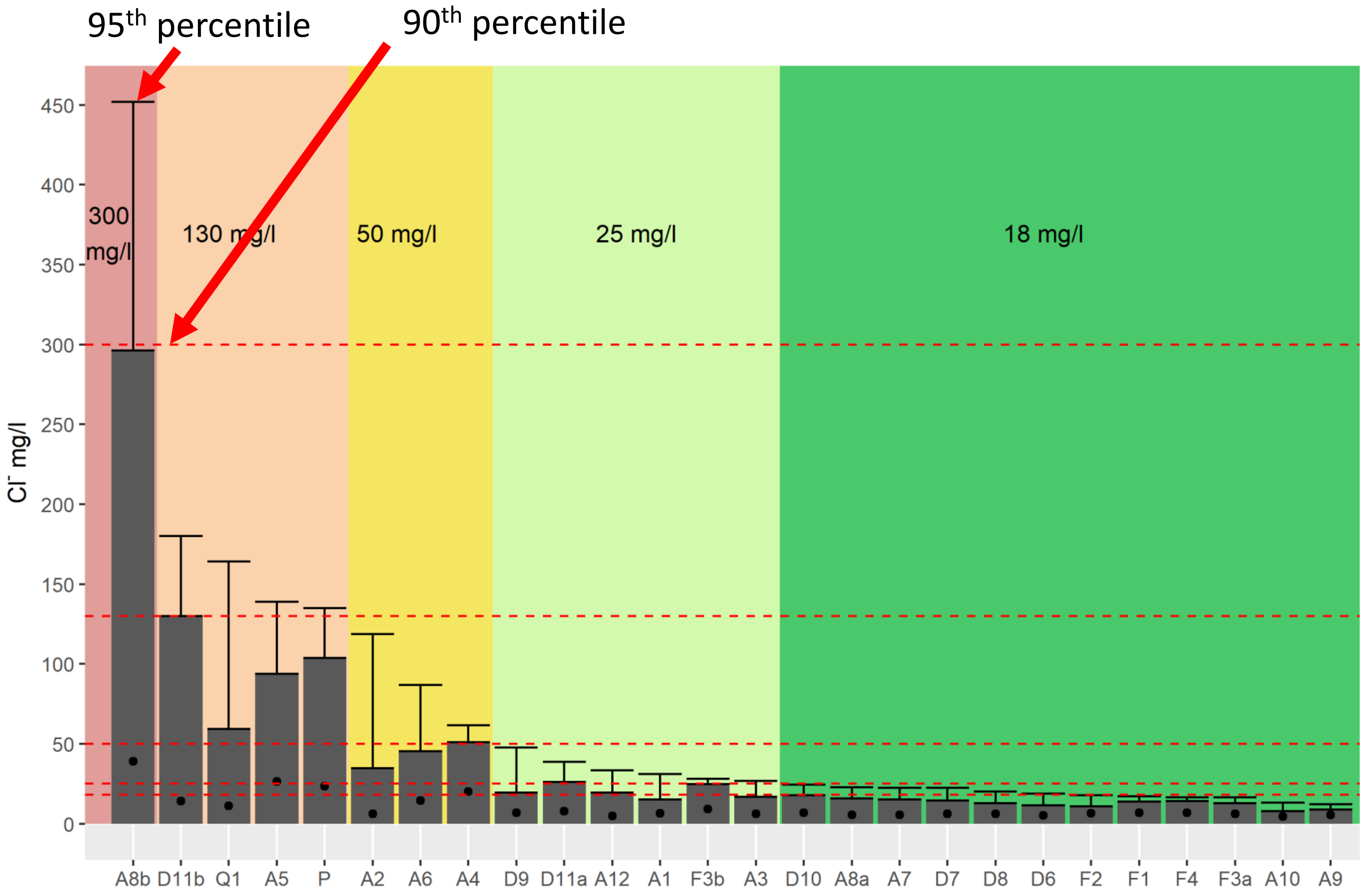
- If large number of samples in each GWB → establish individual NBL in each GWB!
- If number of samples too low → single NBL for all GWBs
- For redox-specific substances → individual NBL for each redox environment (if enough samples)





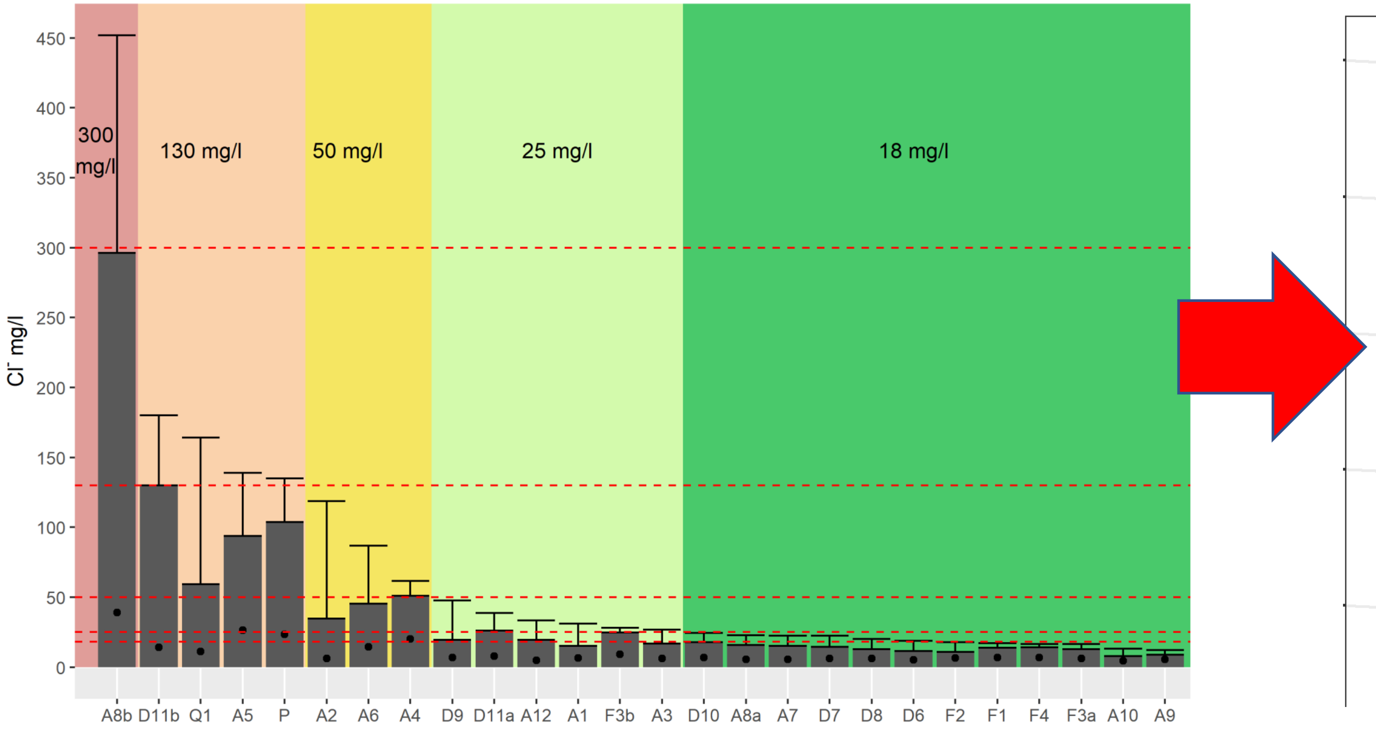
Finding natural background levels for each GWB

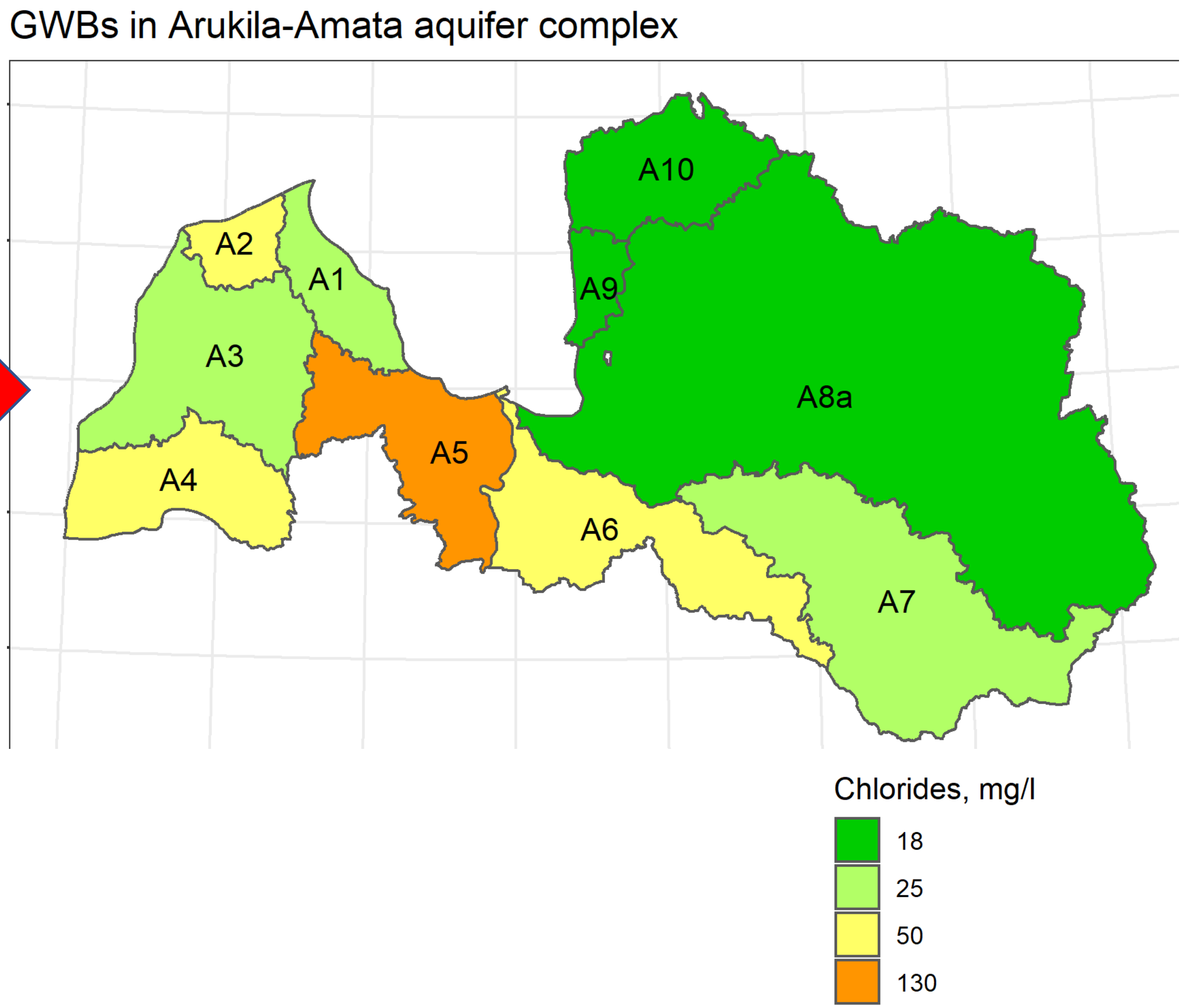
- Rounding of NBL final values
- Combining GWBs of similar NBLs if individual values falls within 90th and 95th percentiles interval



Finding natural background levels for each GWB

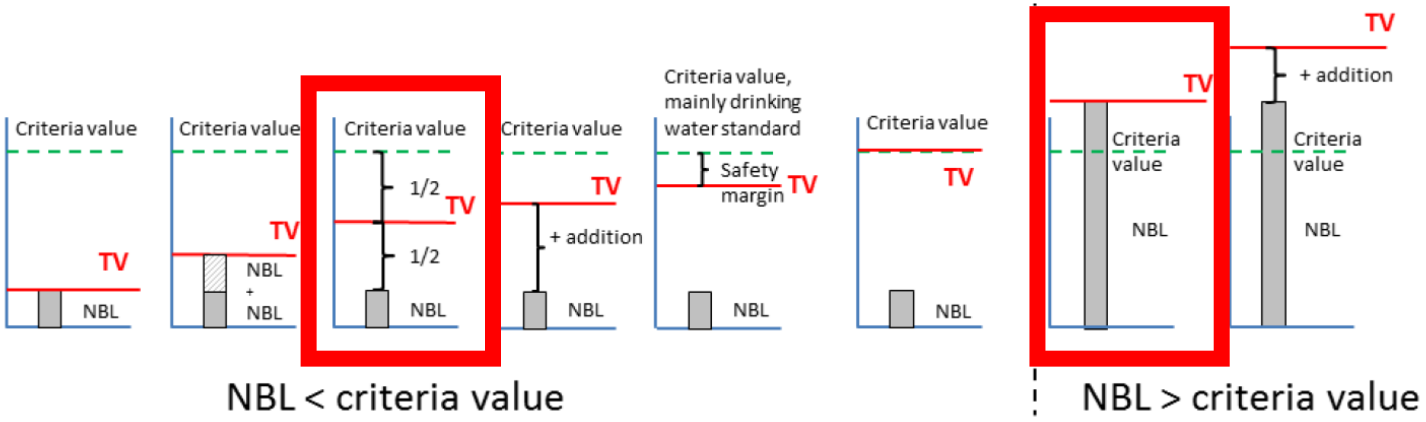
Example of the result





Threshold values for Latvian GWB

The groundwater **TVs** were derived considering **standards for drinking water** as criteria value and **NBLs**



TV ... Groundwater threshold value; NBL ... Natural background level

(Scheidleder , 2012)

Example of the result

NBL 130 mg/l -> **TV 190 mg/l**
NBL 50 mg/l -> **TV 150 mg/l**
NBL 25 mg/l -> **TV 137.5 mg/l**
NBL 18 mg/l -> **TV 134 mg/l**

NBL 300 mg/l -> **TV 300 mg/l**