Groundwater vulnerability assessment to nitrates pollution in Latvia

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Interreg Estonia-Latvia
European Regional Development Fund

EUROPEAN UNION

WaterAct

Joint actions for more efficient management of common groundwater resources

Groundwater assessment to nitrate pollution

Legislation defining the Nitrate monitoring network:

- Nitrate directive 91/676/EK Article 5, Paragraphe 6
- Regulations No.834 of the Cabinet of Ministers of the Republic of Latvia «Requirements Regarding the Protection of Water, Soil and Air from Pollution Caused by Agricultural Activity» (adopted on 23.12.2014)
- **1 time in 4 years** is prepared so-called **Nitrate Report** (under the NITRATES DIRECTIVE (91/676/EEC) (the reporting period was 2016-2019, reported in 2020)

*The **main objective** of nitrate monitoring is to detect any nitrate pollution in order to ensure good drinking water quality throughout the country, as well as to reduce the impact of nitrate pollution on small and large rivers whose waters flow into the Baltic Sea. In view of these considerations, nitrate monitoring in groundwater is also carried out outside the Nitrate vulnerable zone (NVZ).*

Monitoring points – MP (1)

- **National MP (218 wells)**

Well distribution:

Q (depth 0-5 m) - **17%**

Q (depth 5-15 m) - **7%**

Q (depth 15-30 m) - **3 %**

Q (depth >30 m) - **3 %**

pre-Q - **70 %**

Quality frequency:

1-4 per year to 1 per 6 year

- **Additional MP (20 wells)**

Well distribution:

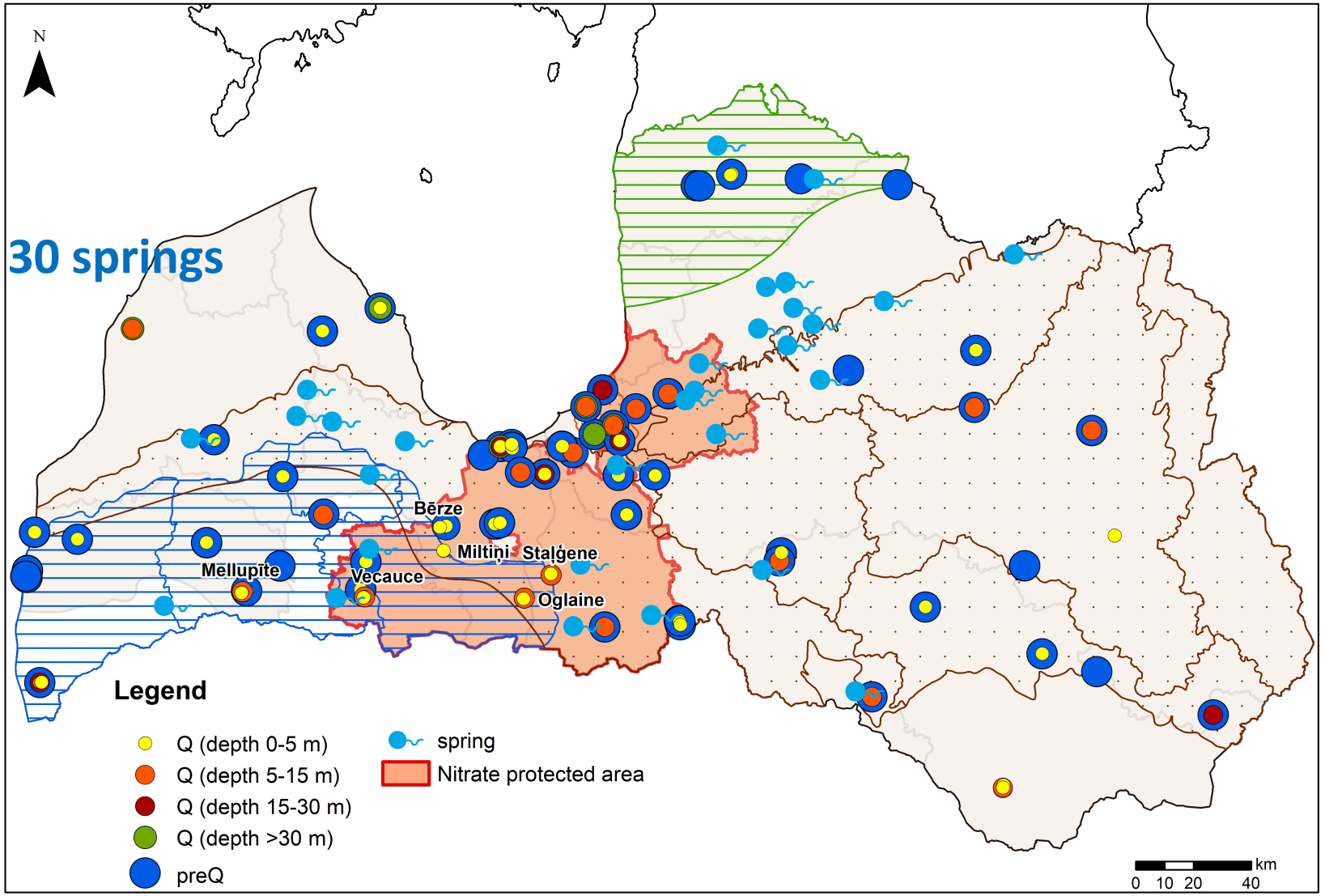
Q (depth 0-5 m) - **75%**

Q (depth 5-15 m) - **20%**

pre-Q - **5 %**

Quality frequency:

2-4 per year (depend from well technical status)



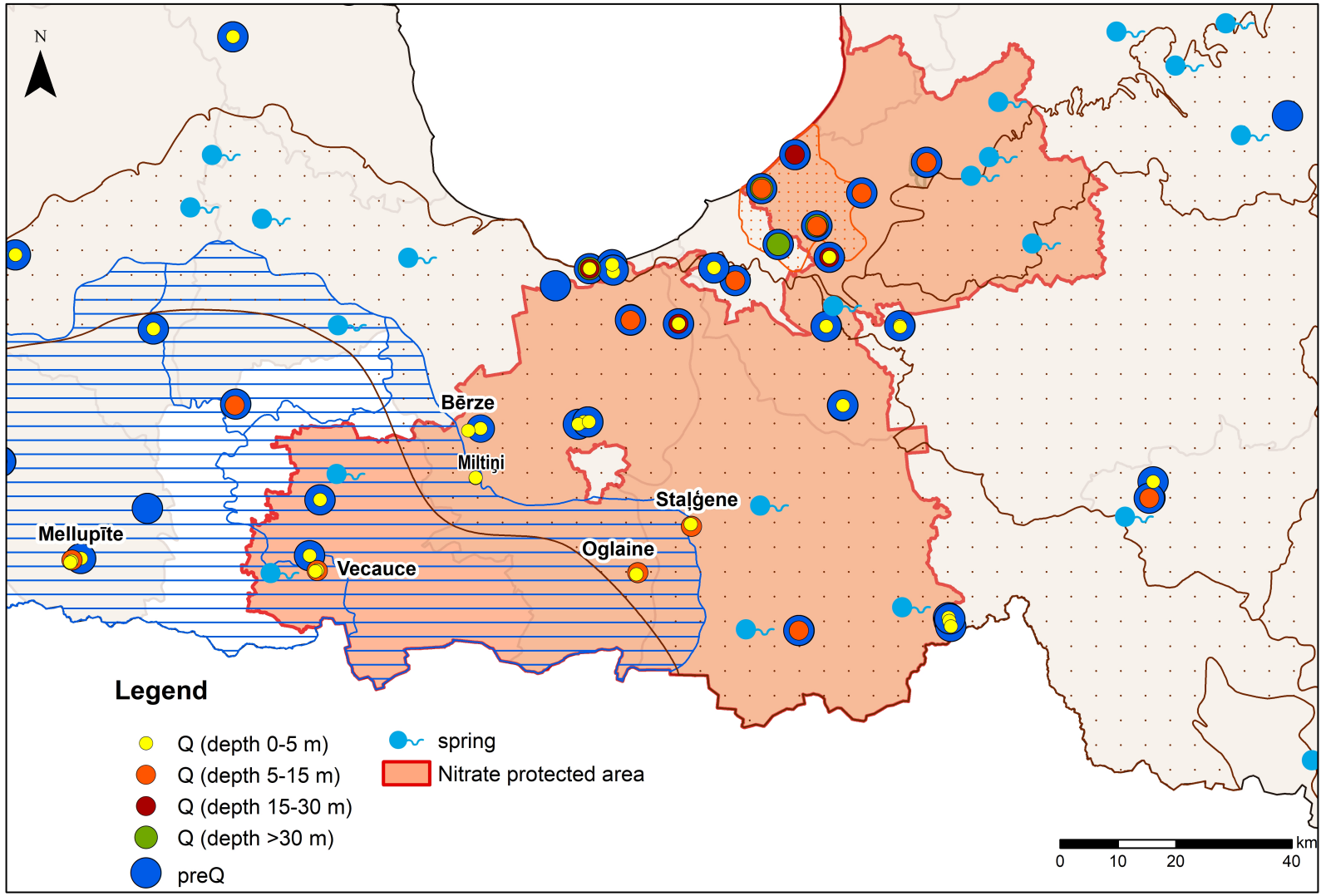
Monitoring points – MP (2)

NVZ include:

- 85 National MP
  (75 wells and 10 springs)
- 17 additional MP (wells)

MP distribution:

- **54%** of them describe pre-Quaternary aquifers;
- **36%** of them describe Quaternary aquifer (*24% of them describe Q aquifer up to 5 m*)
- **10%** springs



Distribution of nitrate observation points – max value (1)

National monitoring network results

Type of groundwater (depth of water horizon)	Reporting period (2016.-2019.)	Amount % of number of monitoring points (NO_3^-, mg/l)			
		<25	25-39.99	40-50	≥50
Phreatic groundwater (0-5m)	**36**/ 28 wells; 8 springs	72	14	3	11
Phreatic groundwater (5-15m)	**34**/ 20 wells; 14 springs	88	12	-	-
Phreatic groundwater (15-30 m)	**7**/ 5 wells; 2 springs	100	-	-	-
Phreatic groundwater (>30 m)	**2**/ 2 wells	100	-	-	-
Captive groundwater	**153**/ 147 wells; 6 springs	100	-	-	-
Total number:	**232**/ 202 wells; 30 springs				

Additional monitoring network results

Type of groundwater (depth of water horizon)	Reporting period (2016.-2019.)	Amount % of number of monitoring points (NO_3^-, mg/l)			
		<25	25-39.99	40-50	≥50
Phreatic groundwater (0-5m)	15 wells	67	-	-	33
Phreatic groundwater (5-15m)	4 wells	100	-	-	-
Phreatic groundwater (15-30 m)	-	-	-	-	-
Phreatic groundwater (>30 m)	-	-	-	-	-
Captive groundwater	1 well	100	-	-	-
Total number:	20 wells				

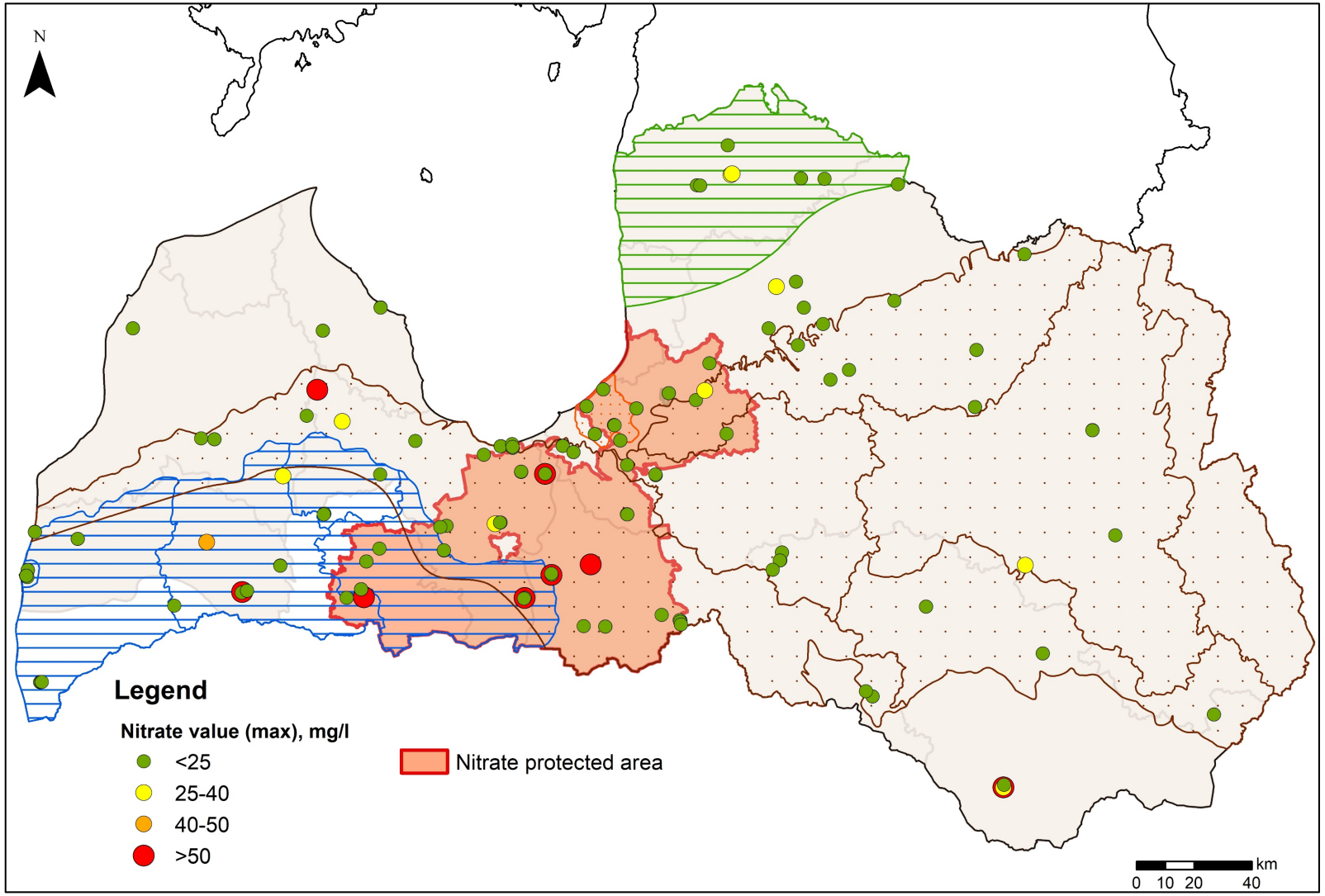
Conclusions:

- Nitrate **pollution** is mainly observed in **shallow groundwater** up to a depth of 15 m (**NO_3^- value – 0.09-360 mg/l**);
- No nitrate pollution has been detected in groundwater **deeper than 30 m** and in **pressurized waters** (**NO_3^- value – 0.09-1.50 mg/l**);
- **NO_3^-** > **50** mg/l observed in 9 MP (*4 National monitoring points + 5 additional monitoring points*) up to a depth of 5 m. **Exceedances are also noted outside the NVZ!**

Distribution of nitrate observation points – max value (2)

Conclusions:

- There is no significant difference between nitrate concentrations inside and outside the nitrate vulnerable zone;
- There is **no significant increase** in groundwater **nitrate pollution** in the sampled MPs;
- There is no reason to predict that nitrate concentrations in groundwater in Latvia could increase in the next reporting period.



Groundwater monitoring program

The **groundwater monitoring program** is being gradually adapted to the **requirements of the Nitrates Directive**, for example:

- improving the number of observation wells in the National Monitoring Network inside the Nitrate Vulnerable Zone;
- extending agricultural runoff monitoring network;
- related research projects are ongoing (more information later ☺):

Latvijas vides aizsardzības fonds

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NITRA

Project “New data on nitrate loads on groundwater in standard sediments in Latvia” financed by the Latvian Environmental Protection Fund

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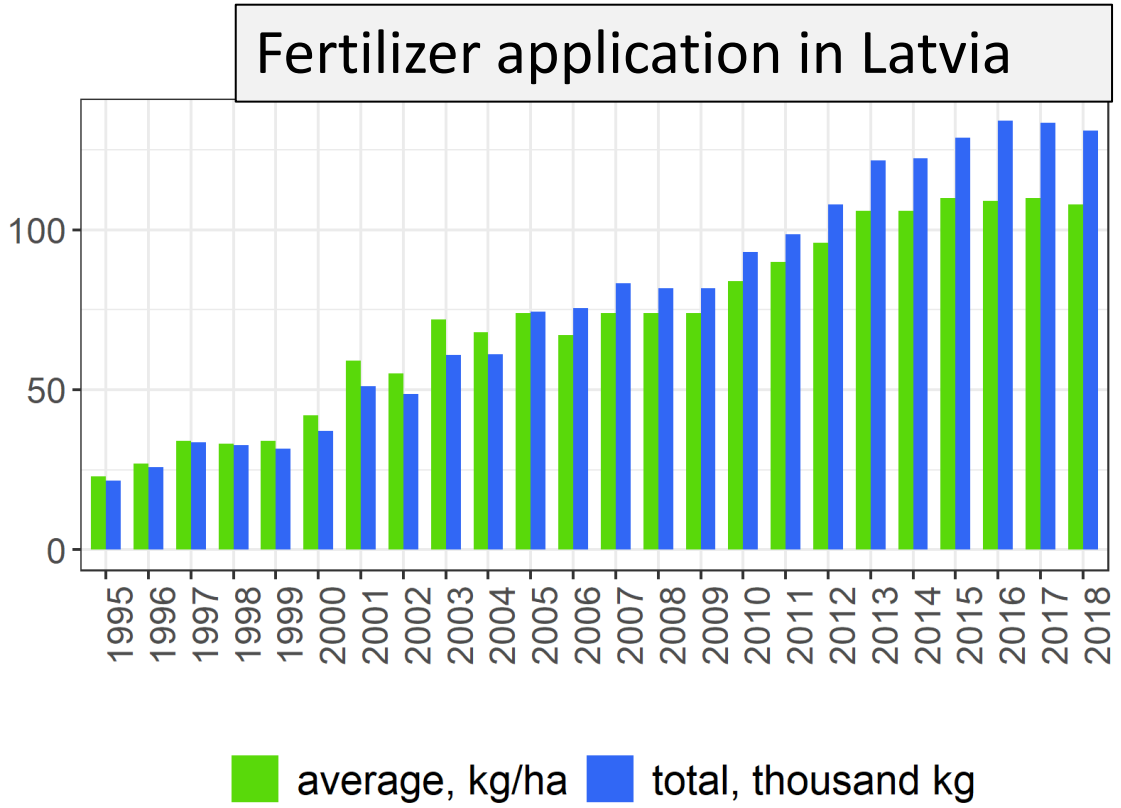
LATVIJAS VIDES, ĢEOLOĢIJAS UN METEOROLOĢIJAS CENTRS

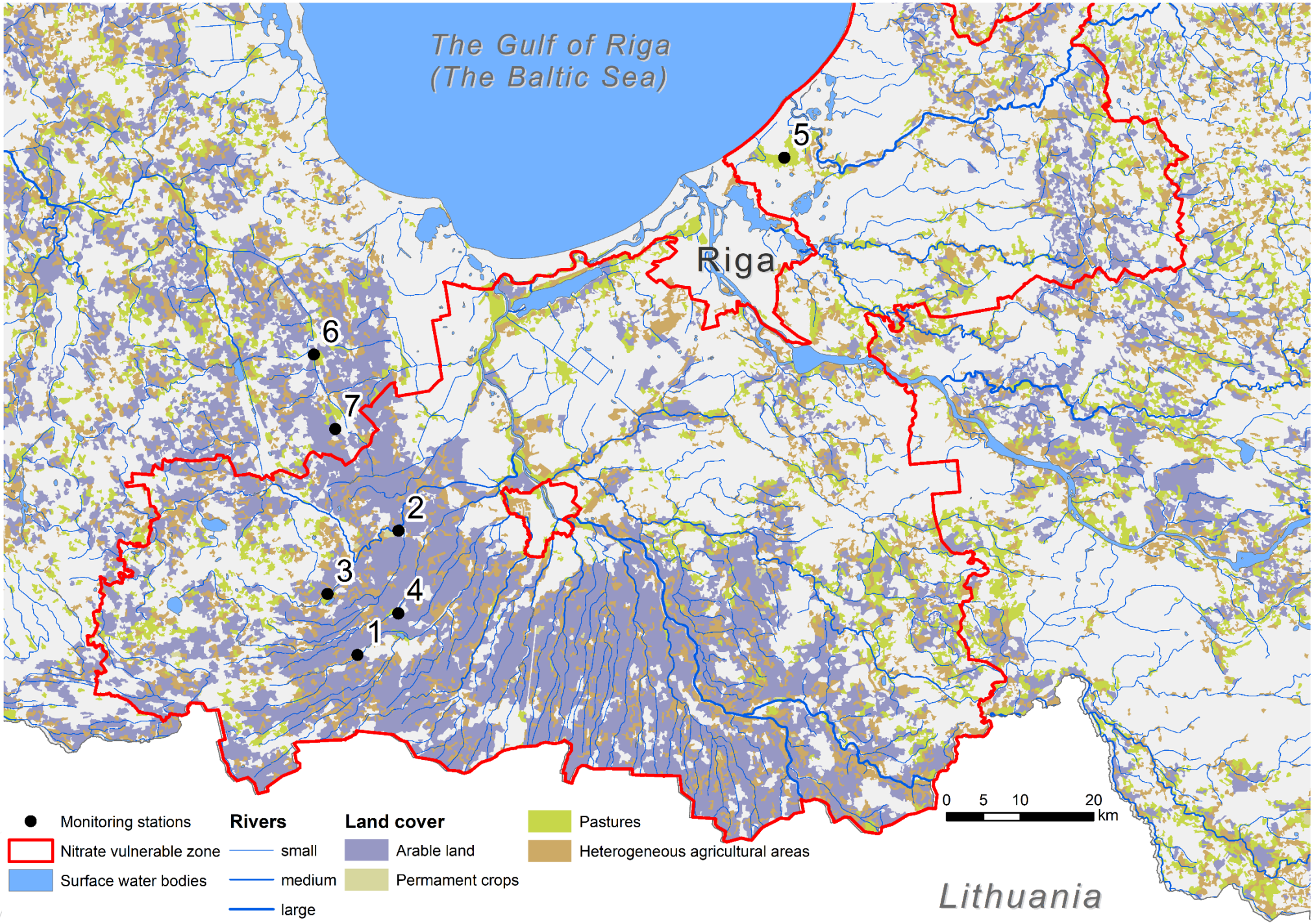
Assessment of seasonal changes in spring water chemistry for national groundwater monitoring optimization in Latvia

Nitrate distribution in shallow groundwater – case study in 2017/2018

The justification

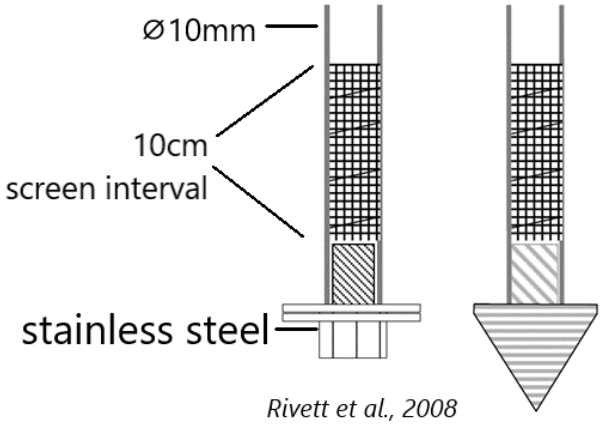
- Rapid increase of fertilizer application during last two decades
- Nitrate vulnerable zone might be not supported by groundwater data
- Insufficient amount of monitoring wells in shallow groundwater
- gaps in nitrate distribution knowledge (spatially and temporally)




The Gulf of Riga
(The Baltic Sea)
Riga
5
6
7
2
3
4
1
Monitoring stations
Nitrate vulnerable zone
Surface water bodies
Rivers
small
medium
large
Land cover
Arable land
Permament crops
Pastures
Heterogeneous agricultural areas
0 5 10 20
km
Lithuania

Techniques for low volume sampling

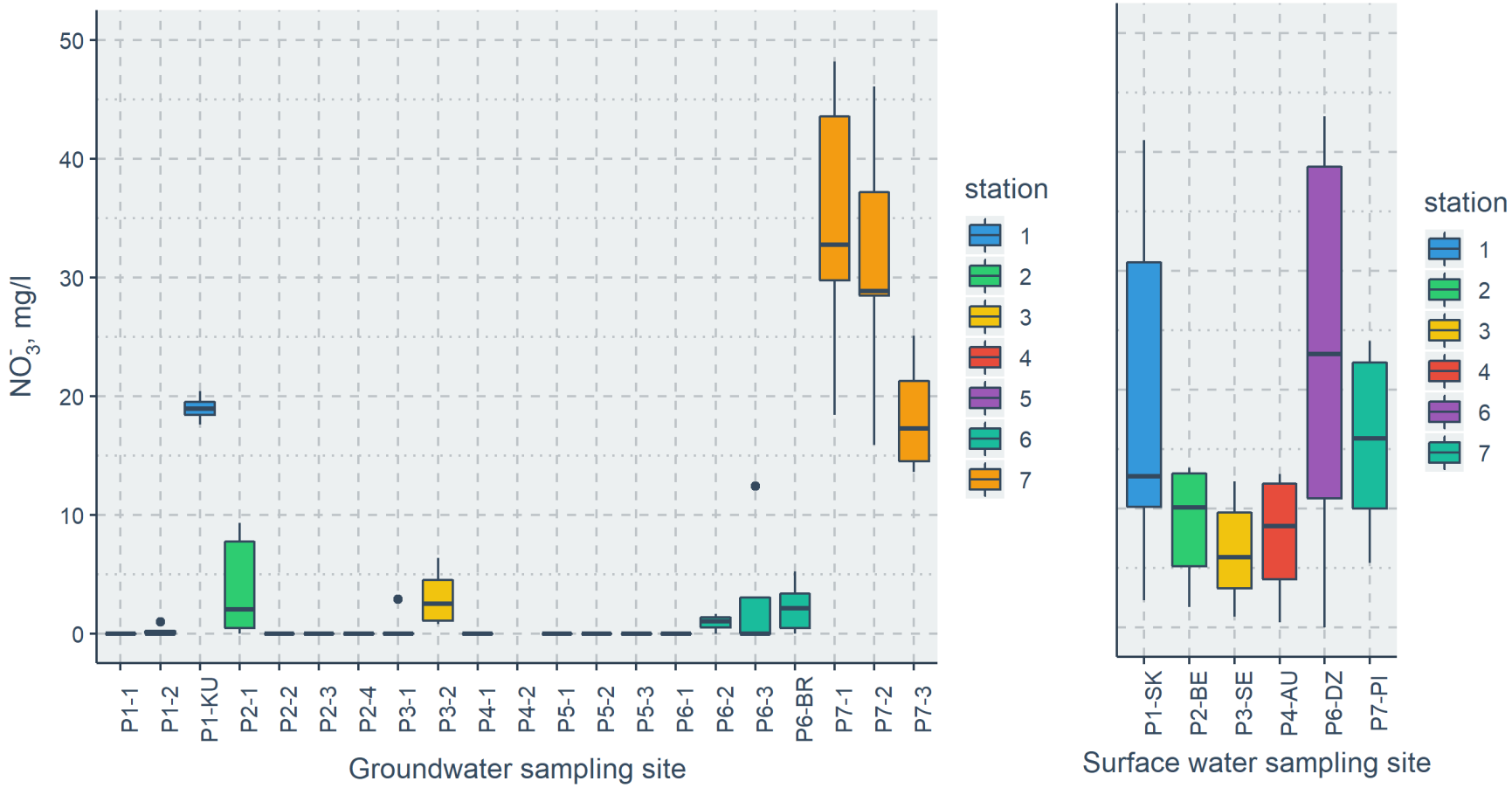
- Mini wells/piezometers installed by direct push method.
- Low volume sampling, screen intervals 10-30cm
- Samples from 7 monitoring stations, 20 wells, 1x2 months
- Well depths range from 1.5 to 4 meters



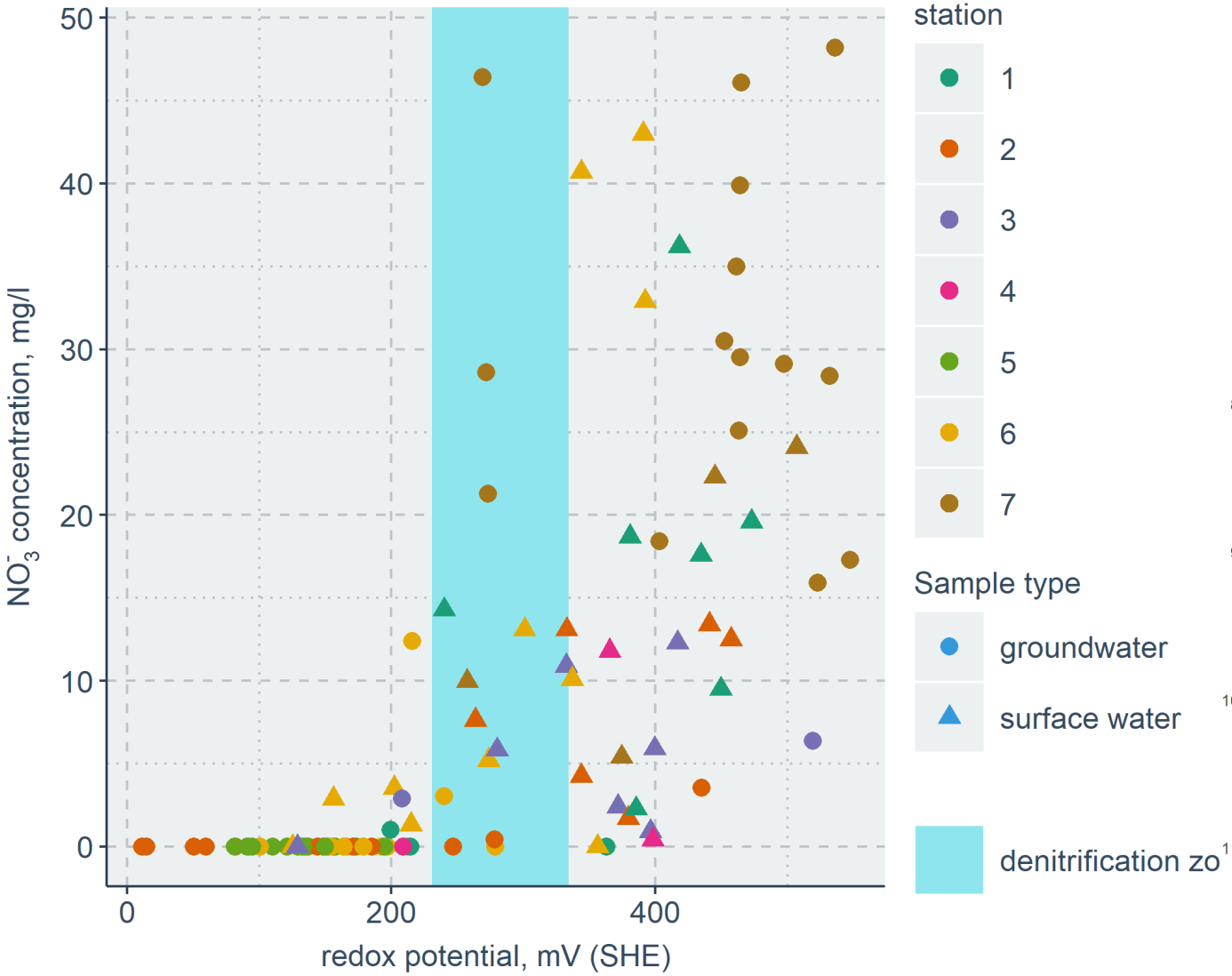
Rivett et al., 2008

Results. Nitrates

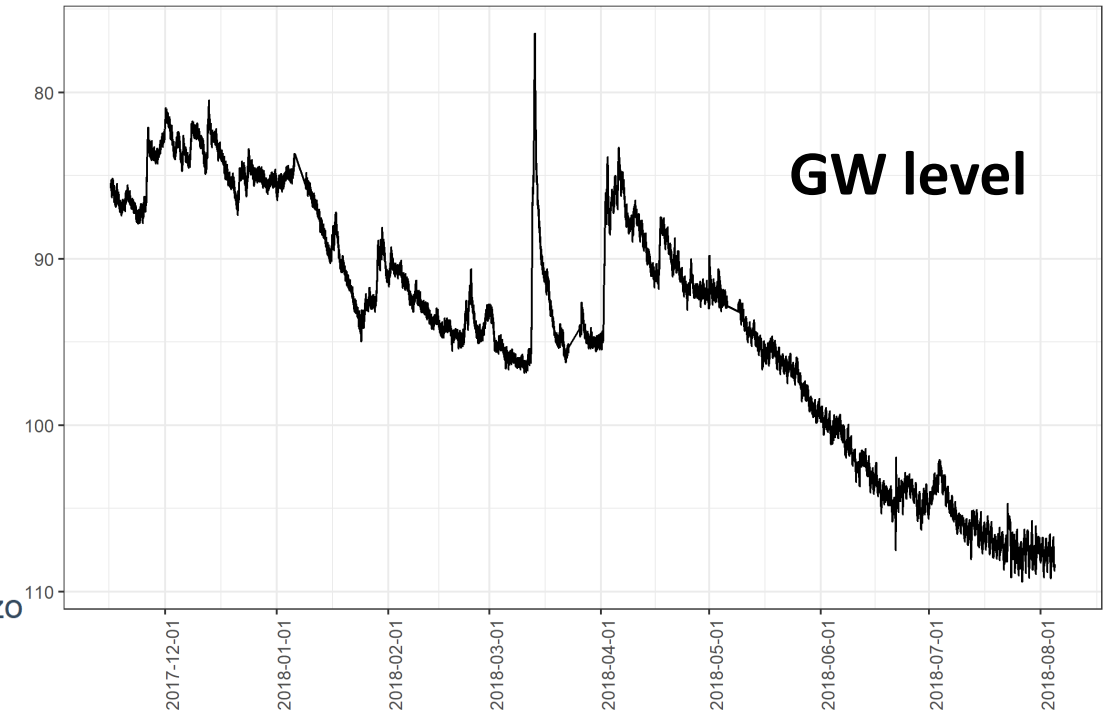
- Most groundwater wells are free from nitrates despite the fact they are in vicinity of agricultural activities
- Significantly more nitrates in nearby rivers



Results. Nitrates vs redox

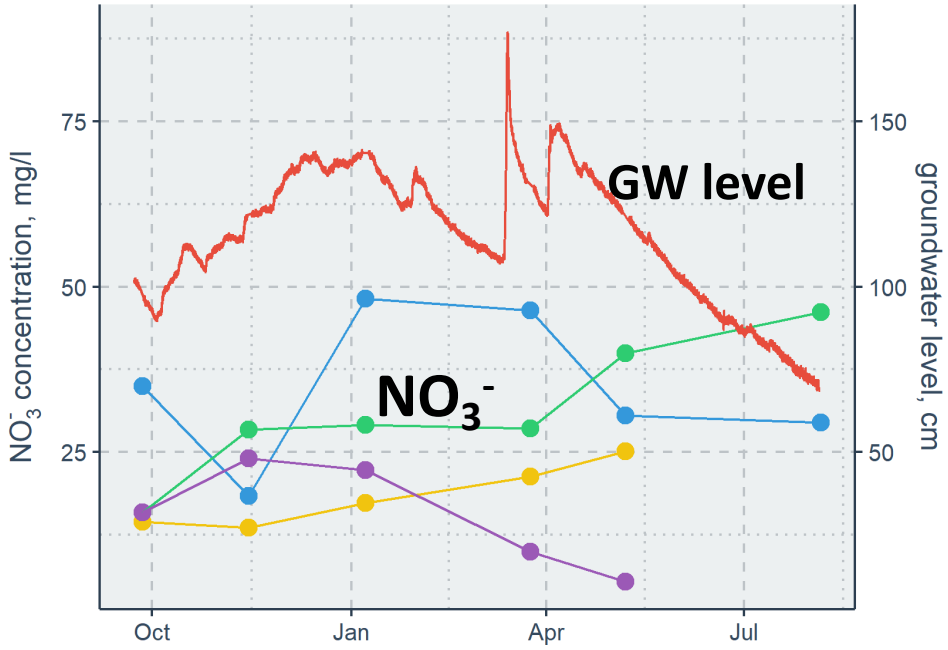


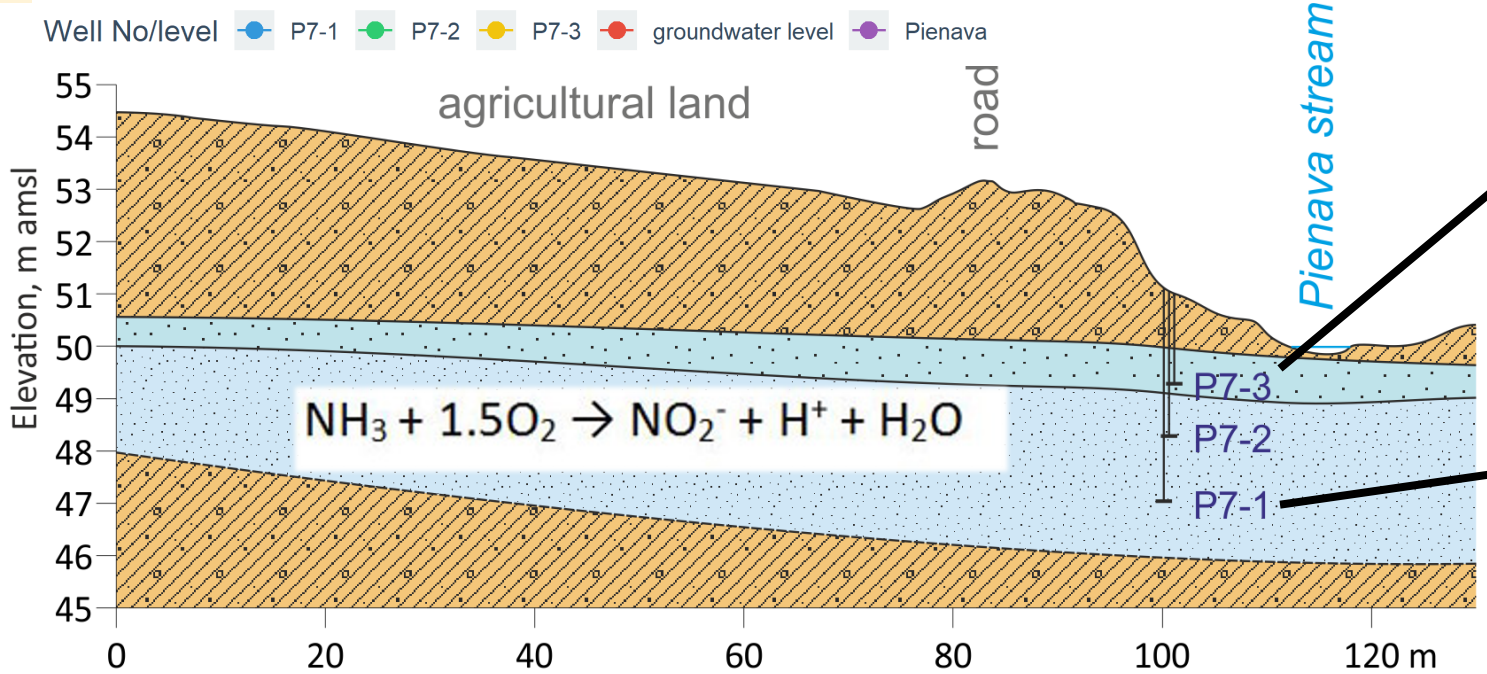
- Most shallow groundwater wells have reducing conditions that limits nitrate concentrations

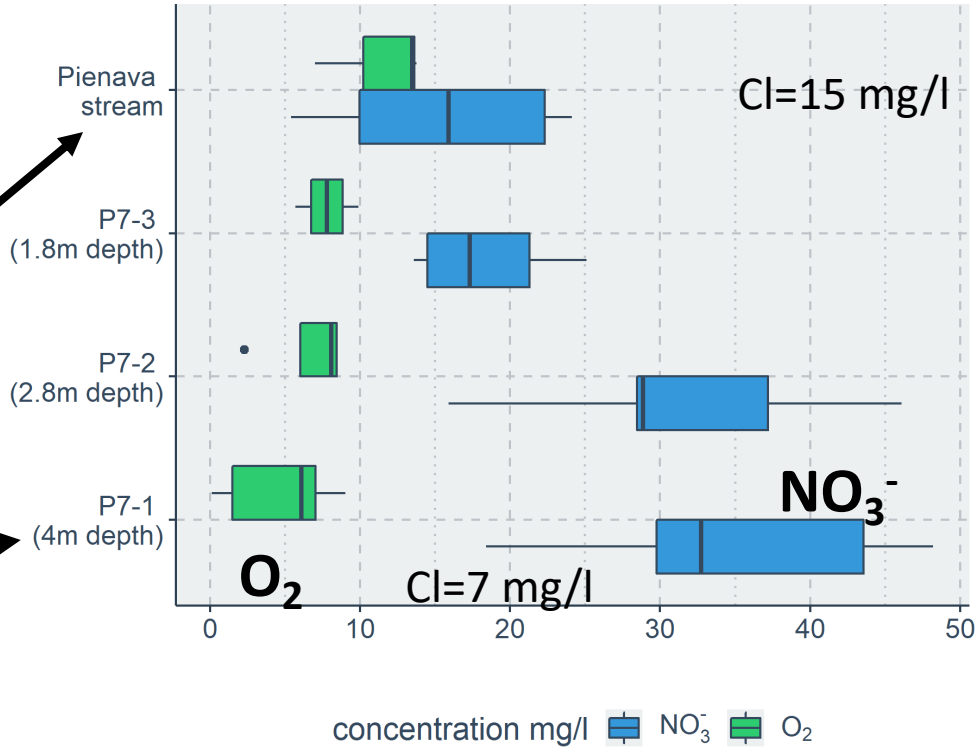


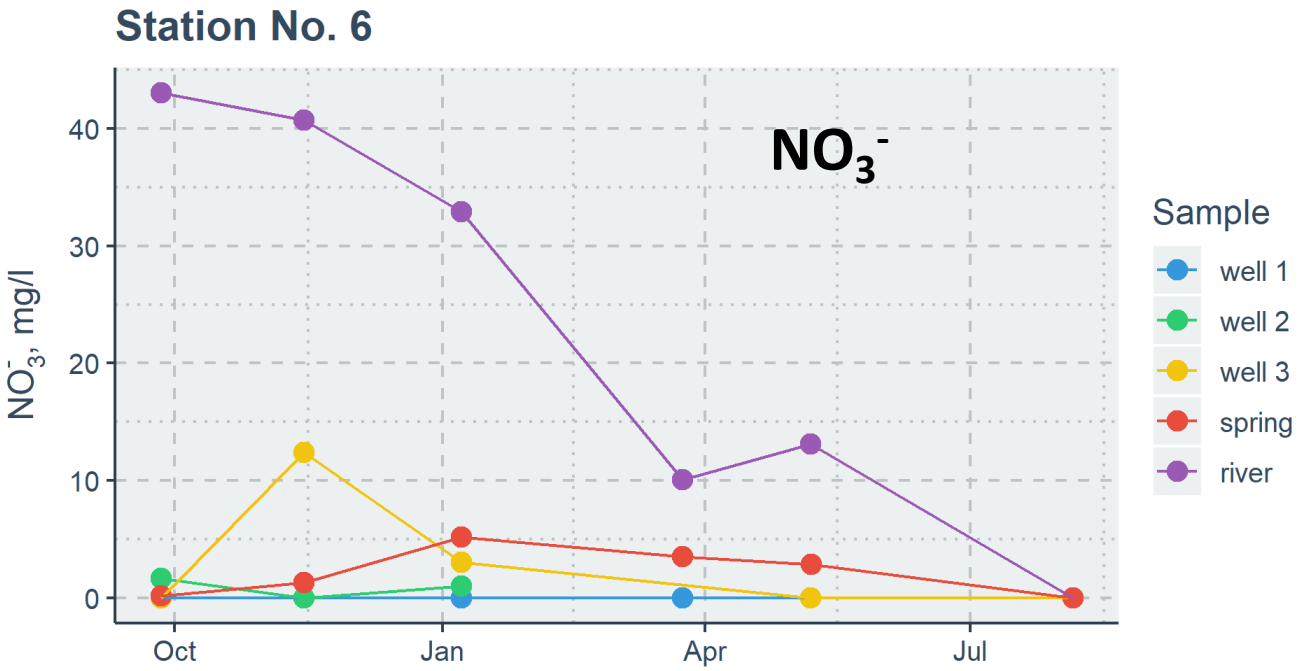
Example of a station No.7

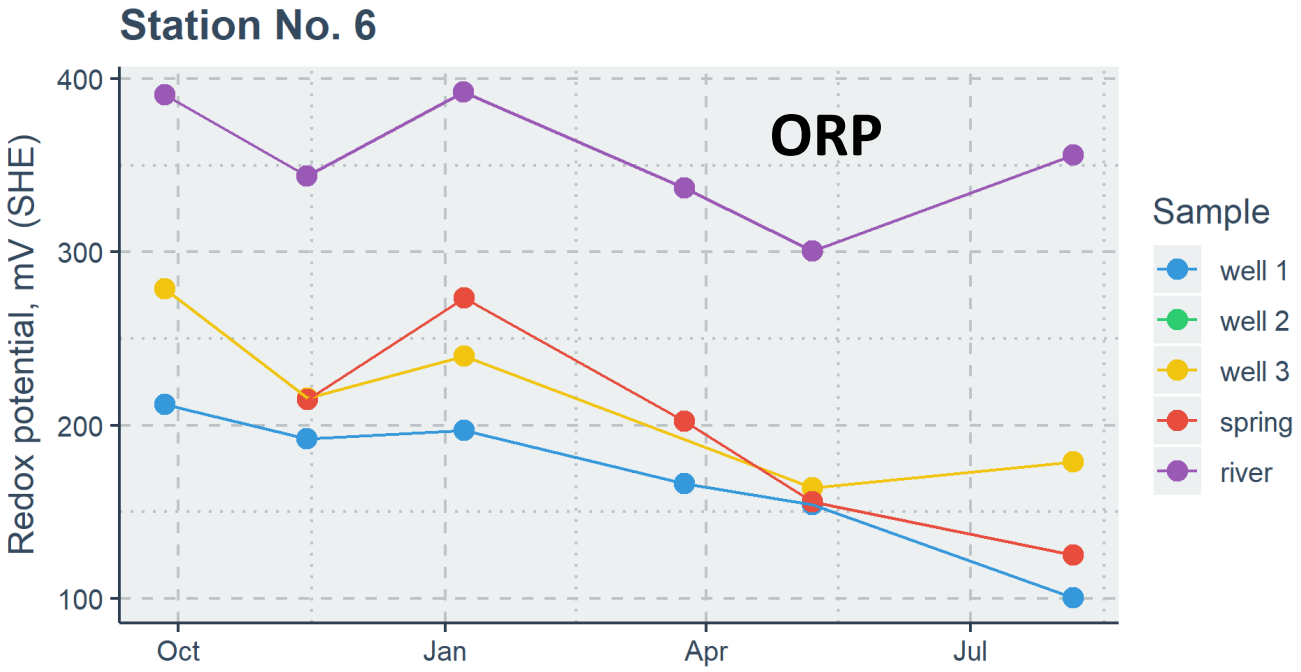
- Prevails glacial till with low hydraulic conductivity in upper part, so the vulnerability should be lower, but it's not.
- High nitrate concentrations observed (up to 48 mg/l) + concentrations increase with depth – nitrification
- O2 decreases with depth, but at 4m depth still 1-7 mg/l



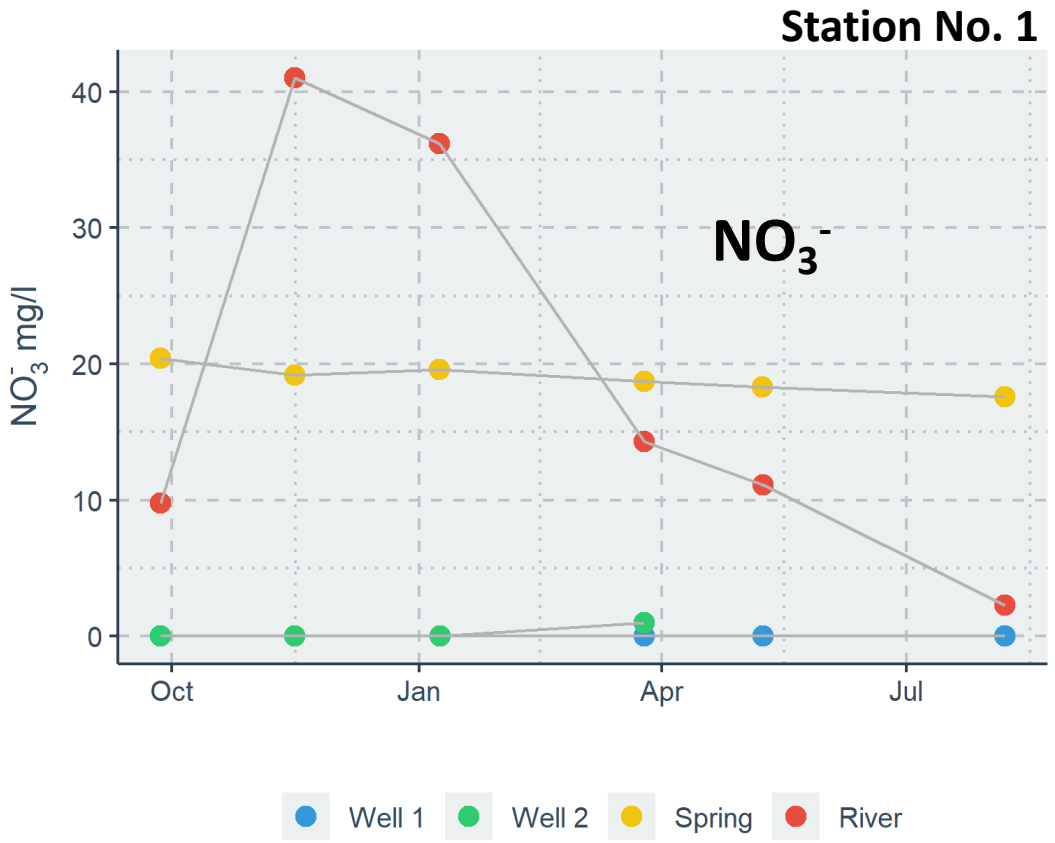






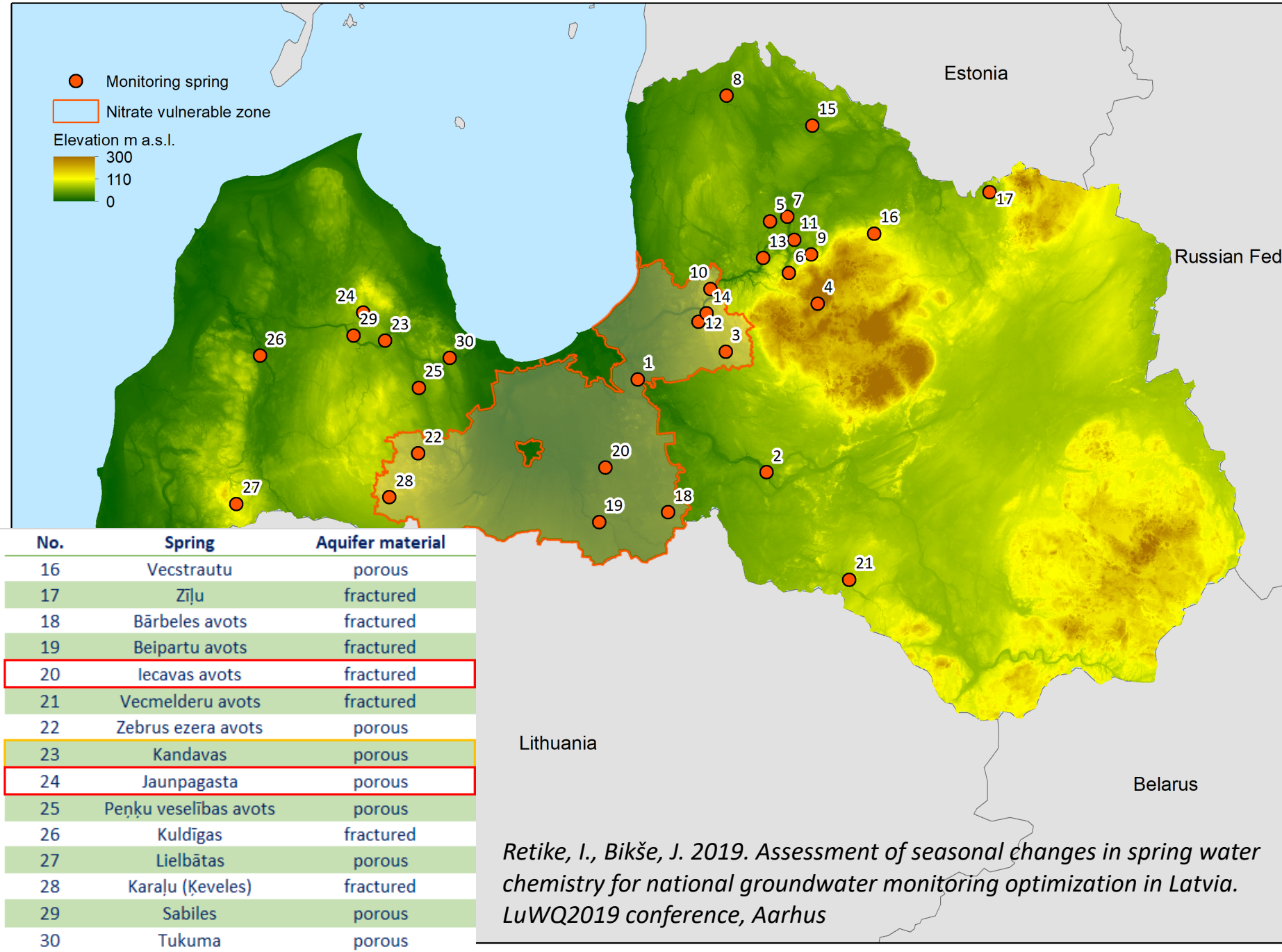


- GW levels decreasing due to drought in 2018:
  - more intense reducing conditions
  - less nitrates



Nitrates in spring water in Latvia

In red springs >50 NO_3^-, mg/l
In orange 25-49 NO_3^-, mg/l



No.	Spring	Aquifer material
1	Sauriešu	porous
2	Sērenes	fractured
3	Slieseru	fractured
4	Bānūžu	porous
5	Briņķu saltavots	porous
6	Dāvida dz.	fractured
7	Dukuļu	porous
8	Govs	porous
9	Ķērpju	fractured
10	Līdumnieku	porous
11	Lielās Ellītes	porous
12	Mežmuižas	fractured
13	Rūcamavots	porous
14	Saltavots	fractured
15	Spiģu	porous

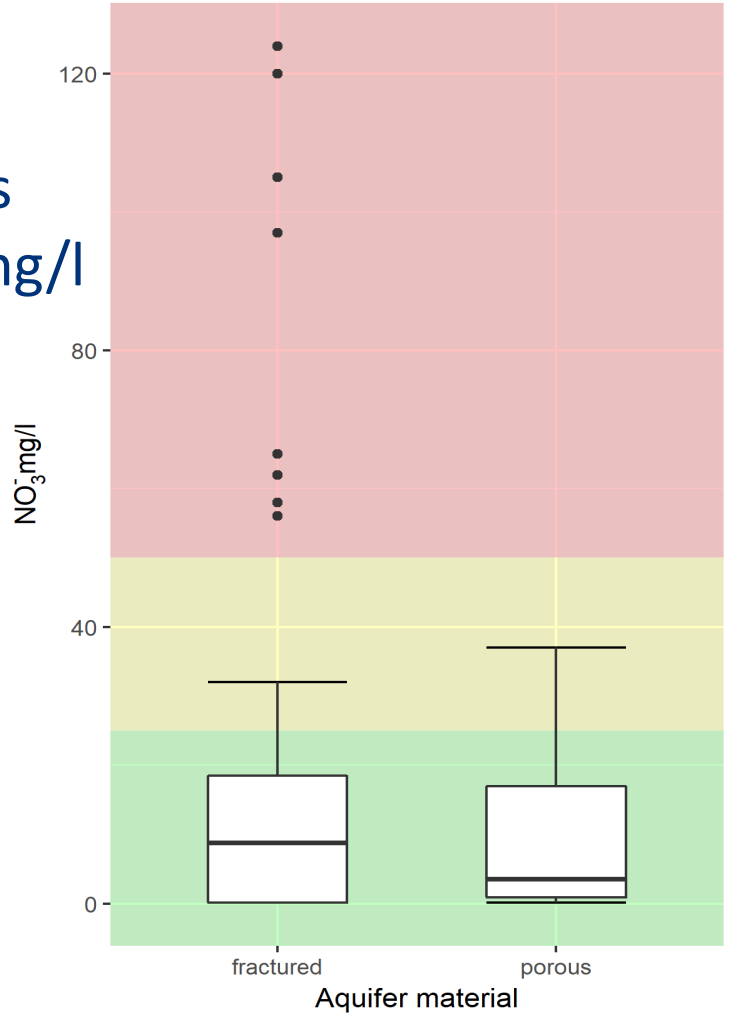
No.	Spring	Aquifer material
16	Vecstrautu	porous
17	Zīļu	fractured
18	Bārbeles avots	fractured
19	Beipartu avots	fractured
20	Iecavas avots	fractured
21	Vecmelderu avots	fractured
22	Zebrus ezera avots	porous
23	Kandavas	porous
24	Jaunpagasta	porous
25	Peņķu veselības avots	porous
26	Kuldīgas	fractured
27	Lielbātas	porous
28	Karaļu (Ķeveles)	fractured
29	Sabiles	porous
30	Tukuma	porous

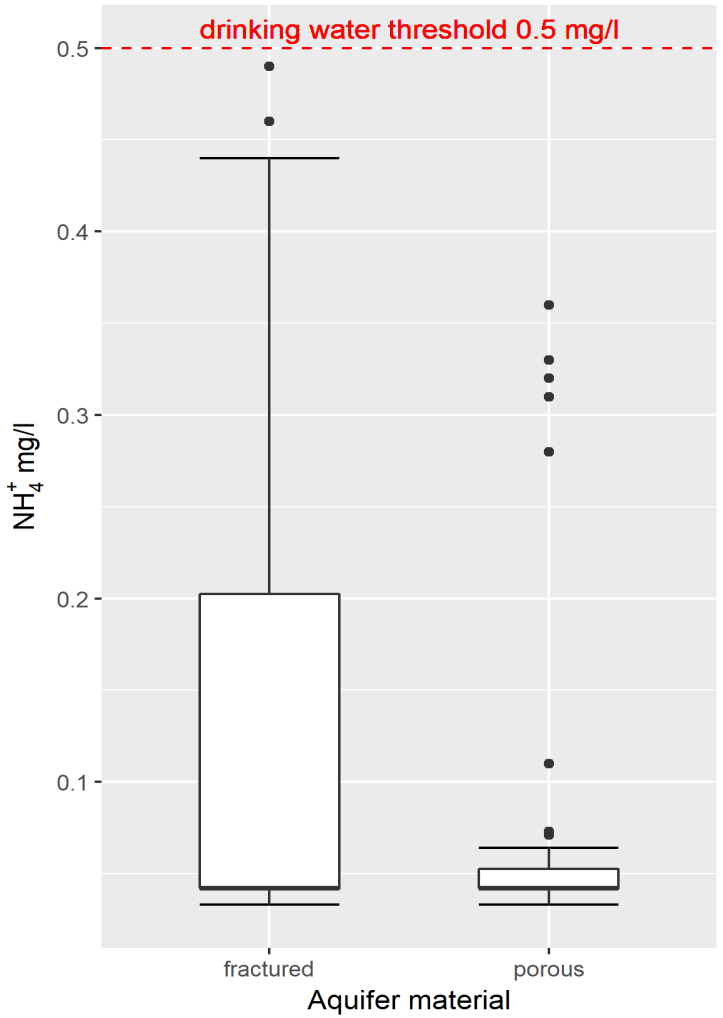
Retike, I., Bikše, J. 2019. Assessment of seasonal changes in spring water chemistry for national groundwater monitoring optimization in Latvia. LuWQ2019 conference, Aarhus

Nitrates in spring water in Latvia

- Fractured aquifer generally supports higher nitrate and ammonium level than in porous aquifers

nitrates
NO_3^-, mg/l





ammonium
NH_4^+, mg/l

Retike, I., Bikše, J. 2019. Assessment of seasonal changes in spring water chemistry for national groundwater monitoring optimization in Latvia. LuWQ2019 conference, Aarhus

Thank you for the attention!

bit.ly/WaterAct-project

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