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Nutrient losses from artificially drained agricultural areas and mitigation measures monitored in Latvia

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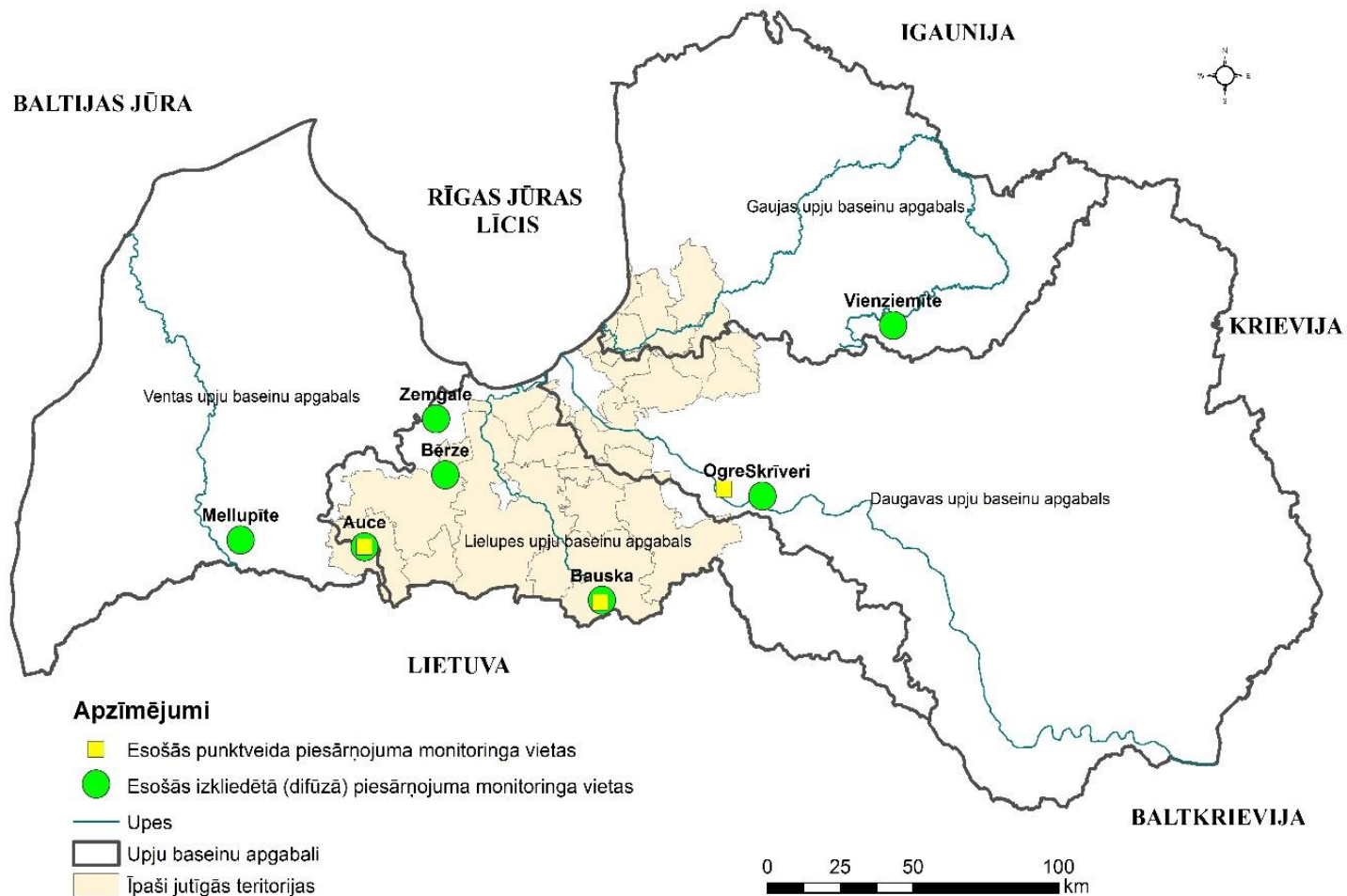
Agricultural Runoff Monitoring Programme in Latvia

Based on systematic and regular water quality and quantity monitoring activities this programme aims to document and assess the current status and long-term trends of nutrient concentrations and losses in different spatial and temporal scales

The scales of monitoring activities:

- Groundwater (20 wells);
- Experimental subsurface drainage plots (1 site with 16 plots and 5 treatments);
- Subsurface drainage fields (6 sites);
- Small catchments (10 sites);
- Small and medium size rivers (23 sites).

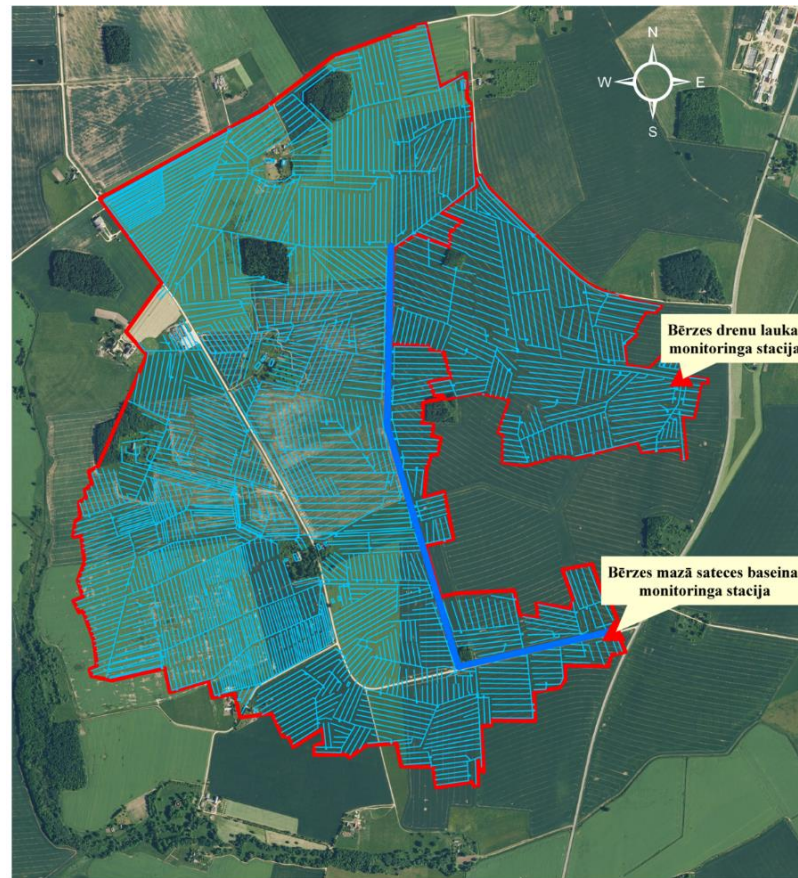
Agricultural nonpoint and point source pollution monitoring sites







Description of monitoring sites and scales

Monitoring site	Scale of research	Area, ha	Agricultural land, %	Dominant soil texture	Flow measurement structure	Water sampling procedure
Mellupīte	Small catchment	960	69	Loam	Crump weir, data logger	Flow proportional
	Drainage field	12	100		Triangular weir, data logger	Flow proportional
	Experimental plots	0.12 x 16	100		Tipping buckets	Flow proportional
Bērze	Bērze River	87205	58	Loam, sandy loam, sand *	LEGMC hydrological monitoring station	Manual
	Ālave River	9368	84	Loam, silty clay loam, clay *	No measurements	Manual
	Small catchment	368	98	Silty clay loam	V-shape Crump weir, data logger	Flow proportional
	Drainage field	77	100		Triangular weir, data logger	Flow proportional
Vienziemīte	Small catchment	592	78	Sandy loam	Combined profile weir, data logger	Manual
	Drainage field	67	100		Triangular weir, data logger	Manual

Berze site for agricultural nonpoint source pollution monitoring



Apzīmējumi

-  Monitoringa stacija
-  Bērzes mazā sateces baseina novadgrāvis
-  Drenu sistēma
-  Sateces baseins

0 0.5 1 km

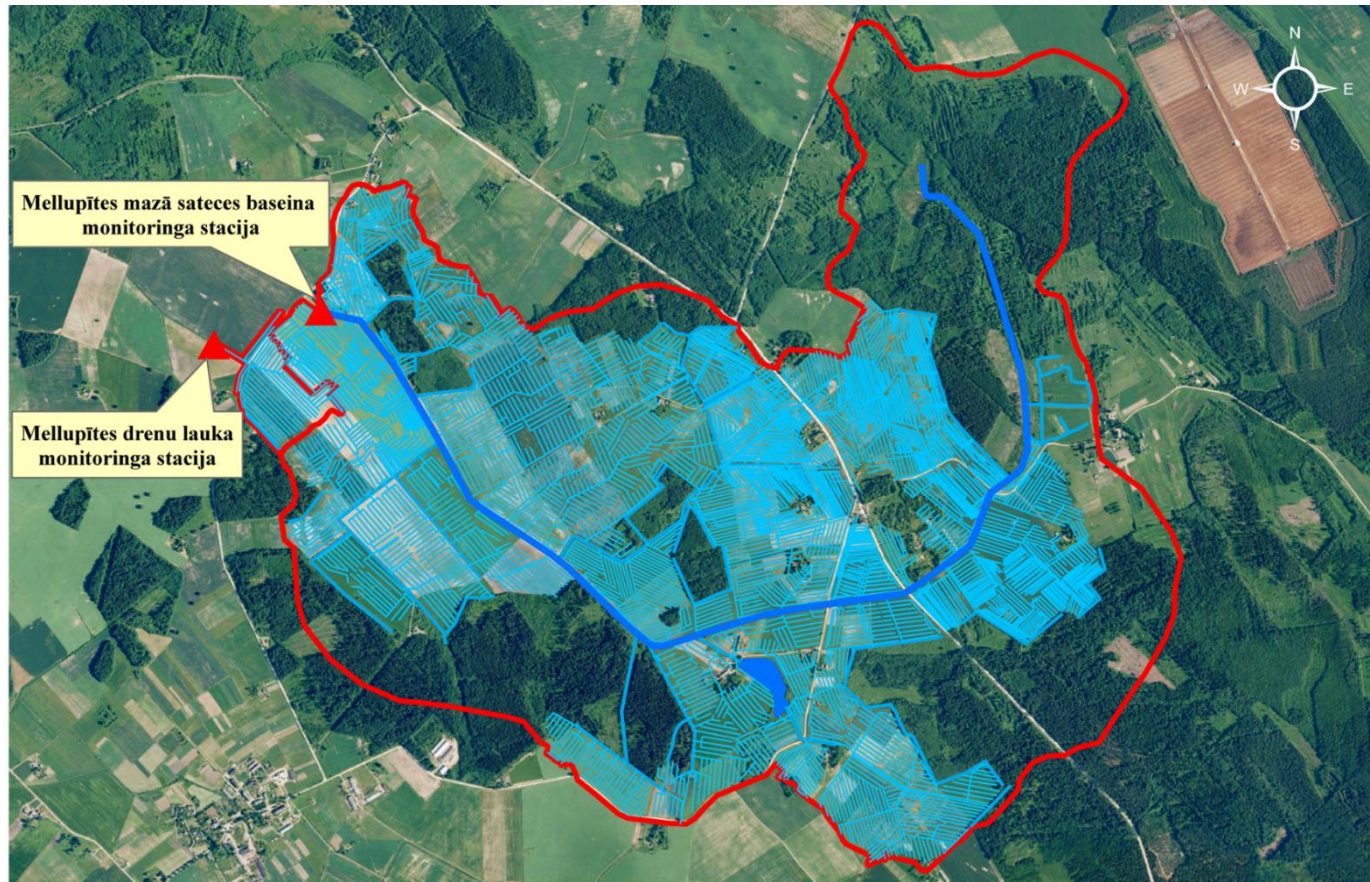
Berze site – subsurface drainage field and groundwater monitoring



Berze site – V-notch weir

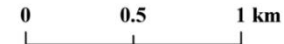


Mellupite site for agricultural nonpoint source pollution monitoring

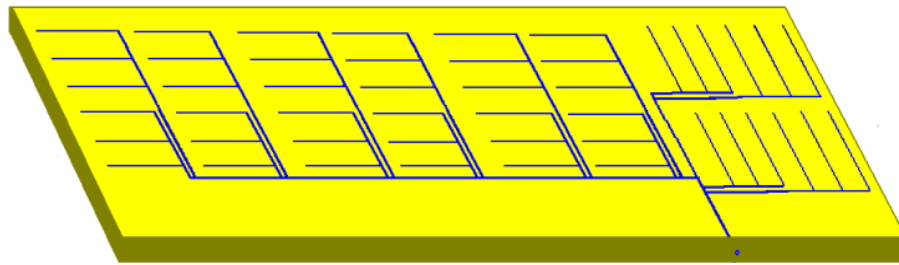


Apzīmējumi

- | | |
|-----------------------|-------------------|
| ▲ Monitoringa stacija | — Mellupīte |
| — Drenu sistēma | ■ Ūdenskrātuve |
| — Novadgrāvis | □ Sateces baseins |



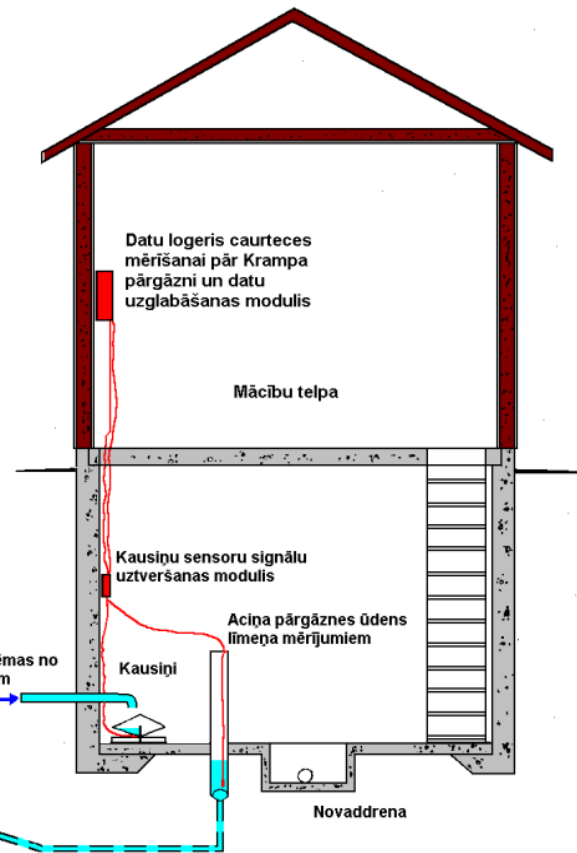
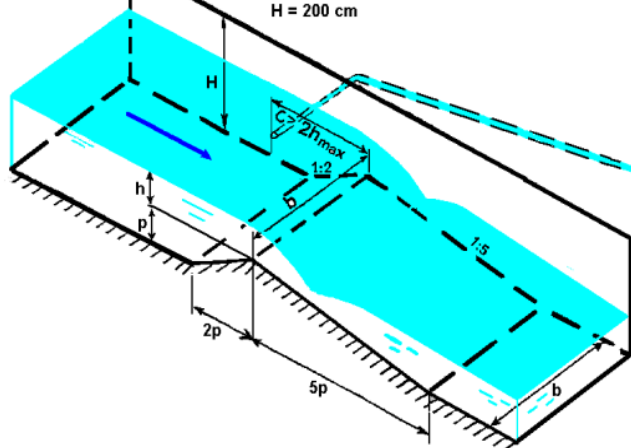
Mellupite site



16 drenāžas izmēģinājumu lauciņi (0,12 ha katrs)
ar dažādiem mēslošanas variantiem

Krampa pargāzne sateces baseina
caurteces mērīšanai

Pārgāznes izmēri
 $p = 80 \text{ cm}$
 $b = 190 \text{ cm}$
 $c = 200 \text{ cm}$
 $H = 200 \text{ cm}$



Flooding in 2017



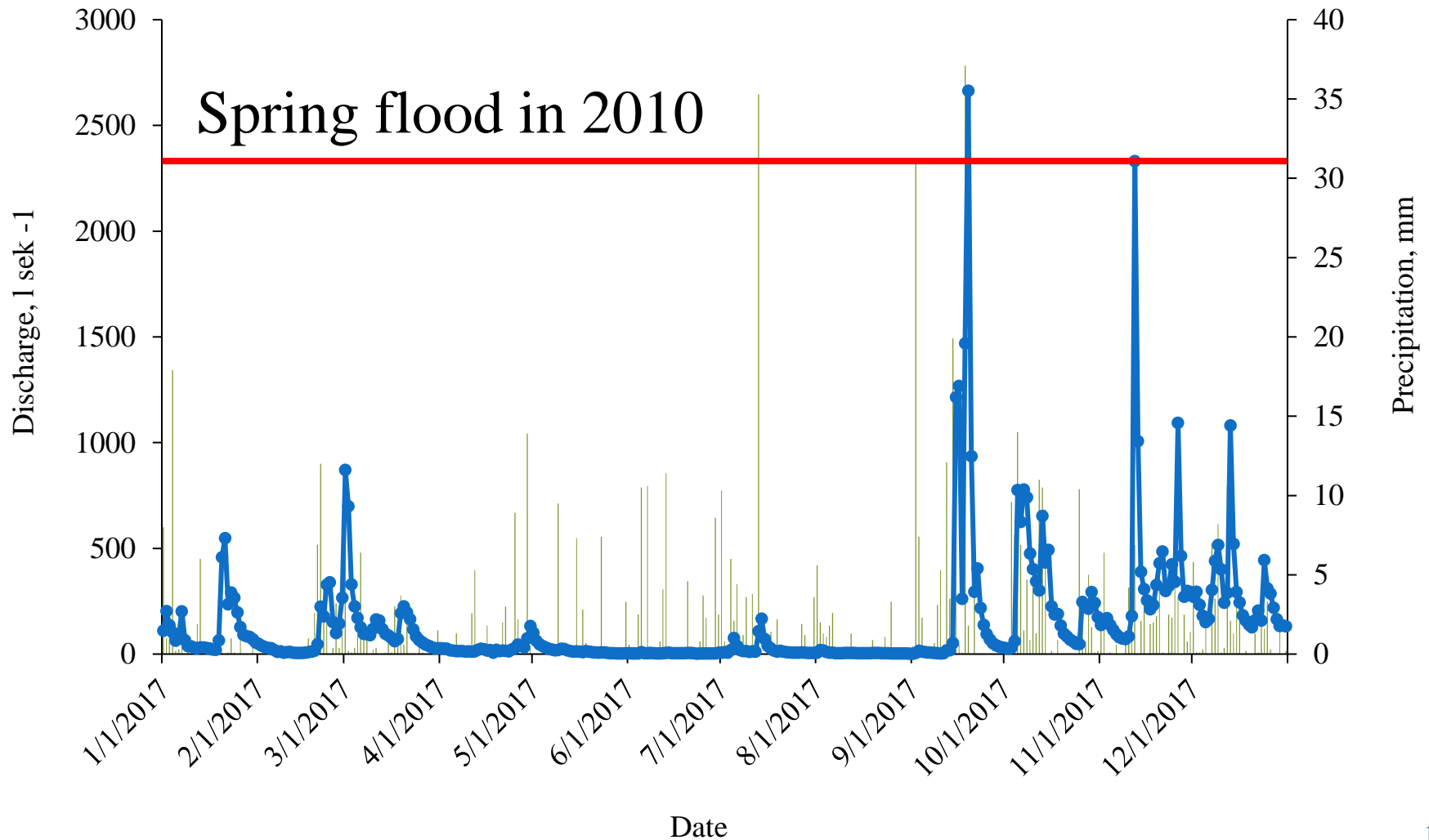
Flooding in 2017



Flooding in 2017



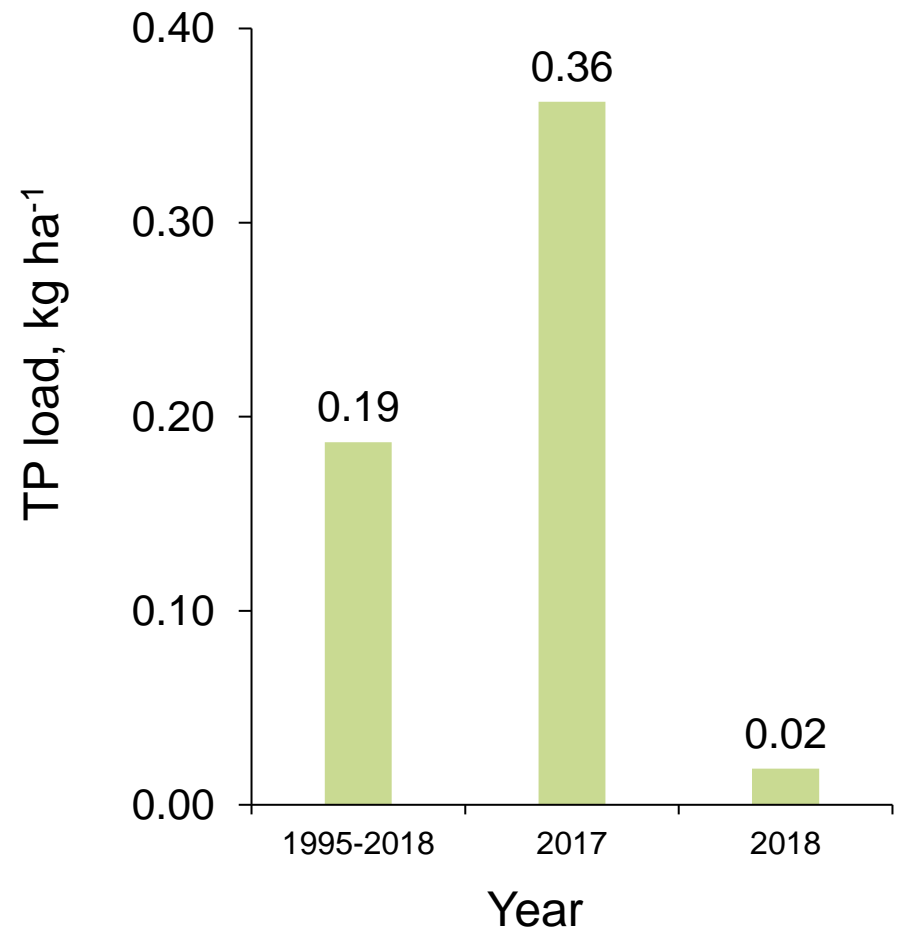
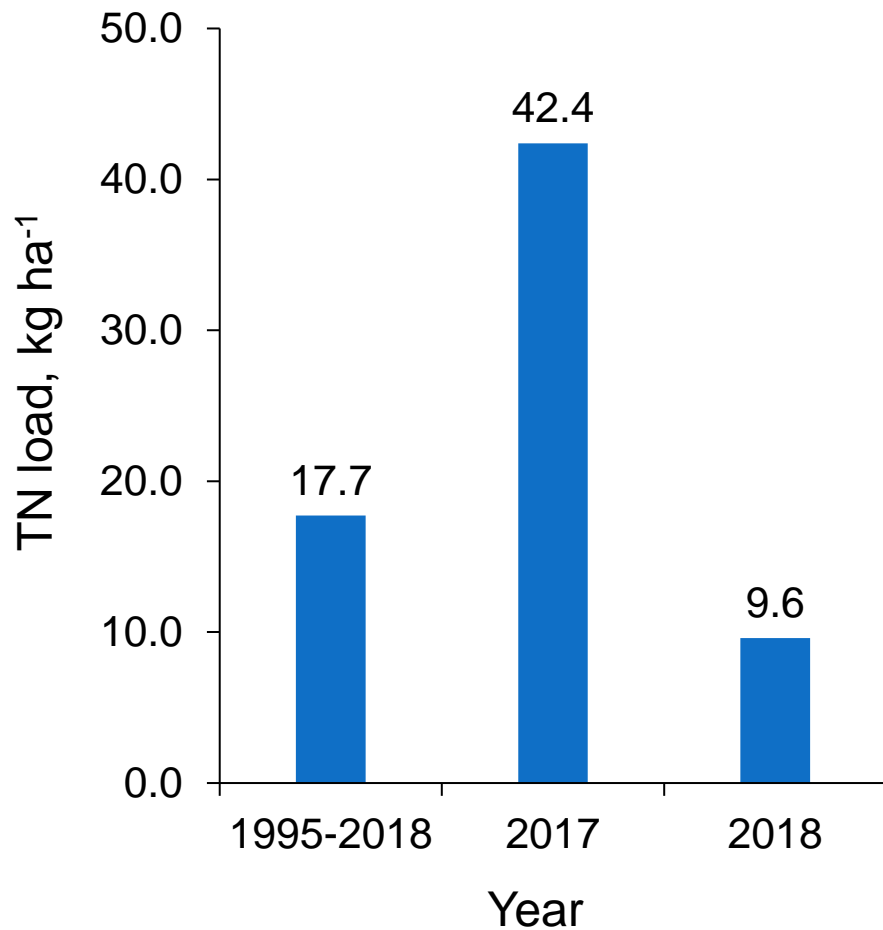
Flooding in 2017



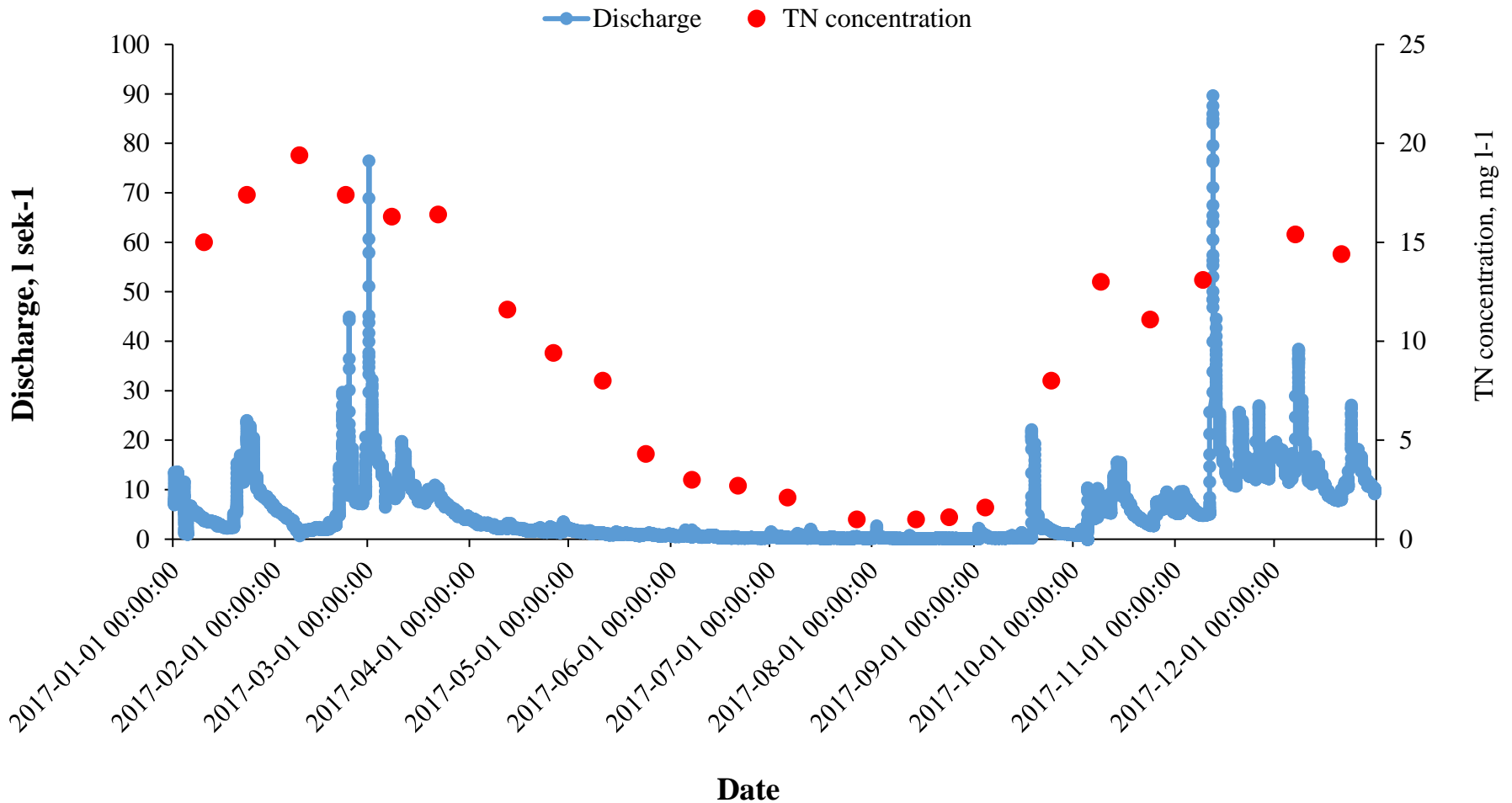
Drought in 2018



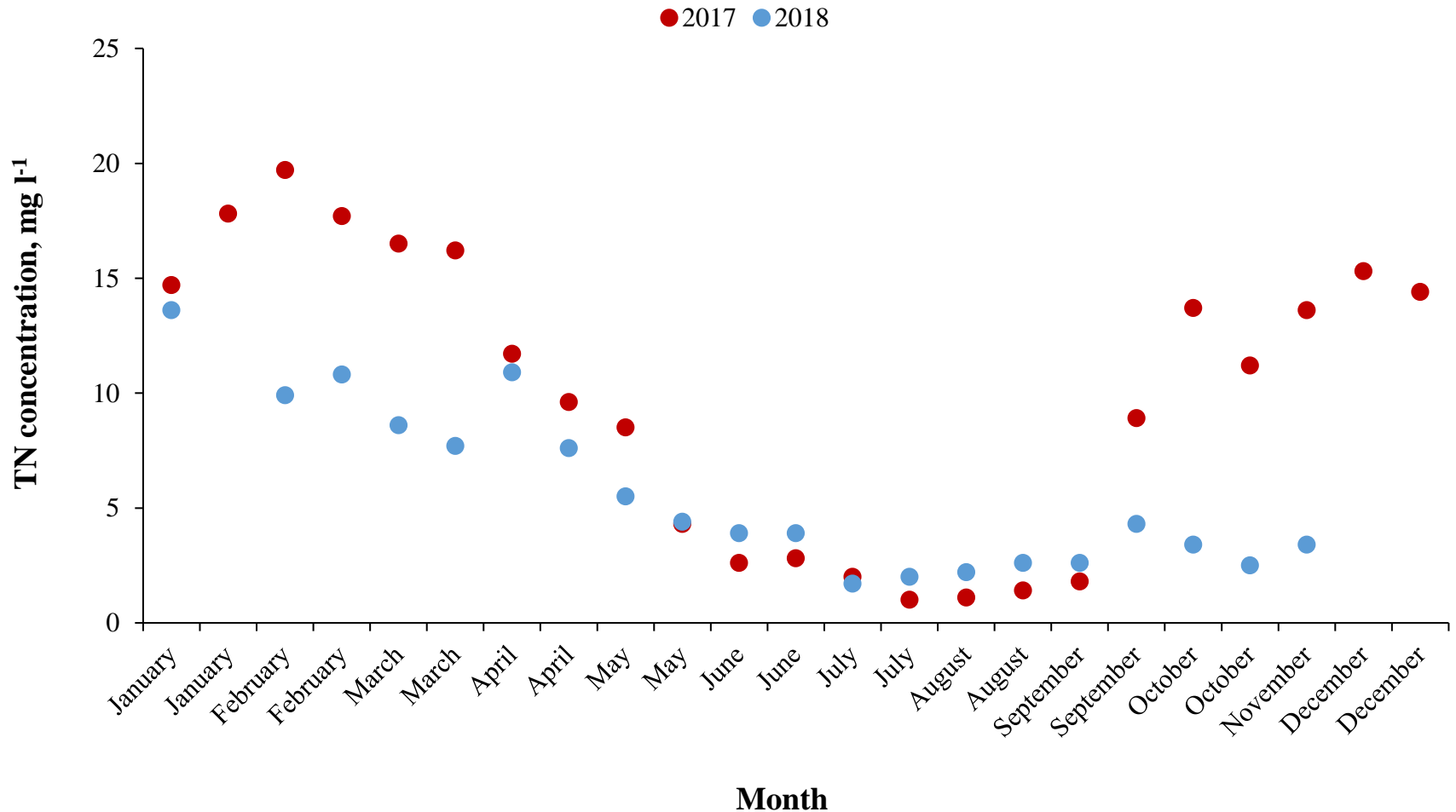
TN and TP load, kg ha⁻¹ year⁻¹ (Mellupīte)



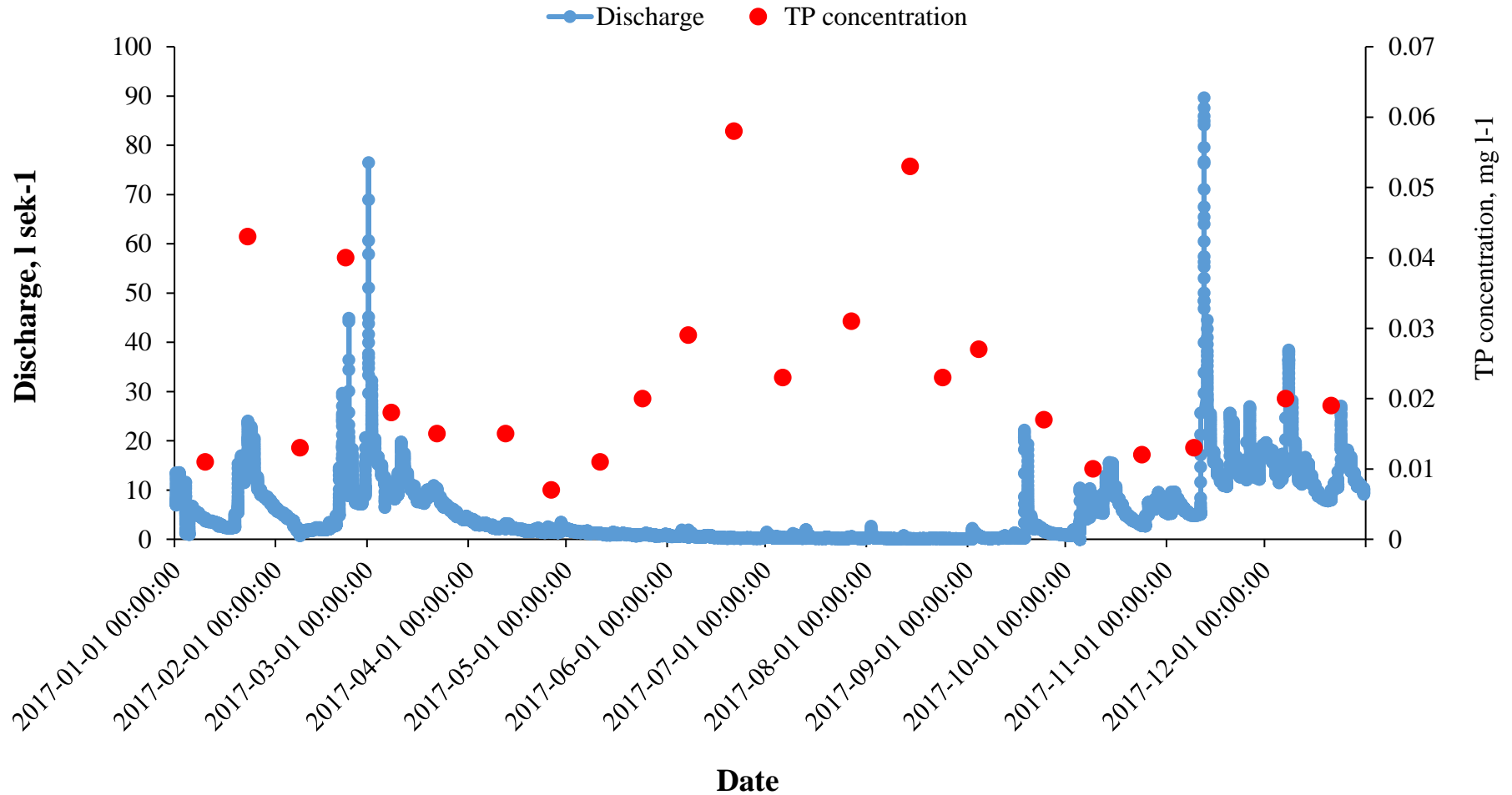
Results: Discharge and TN concentration (Auce)



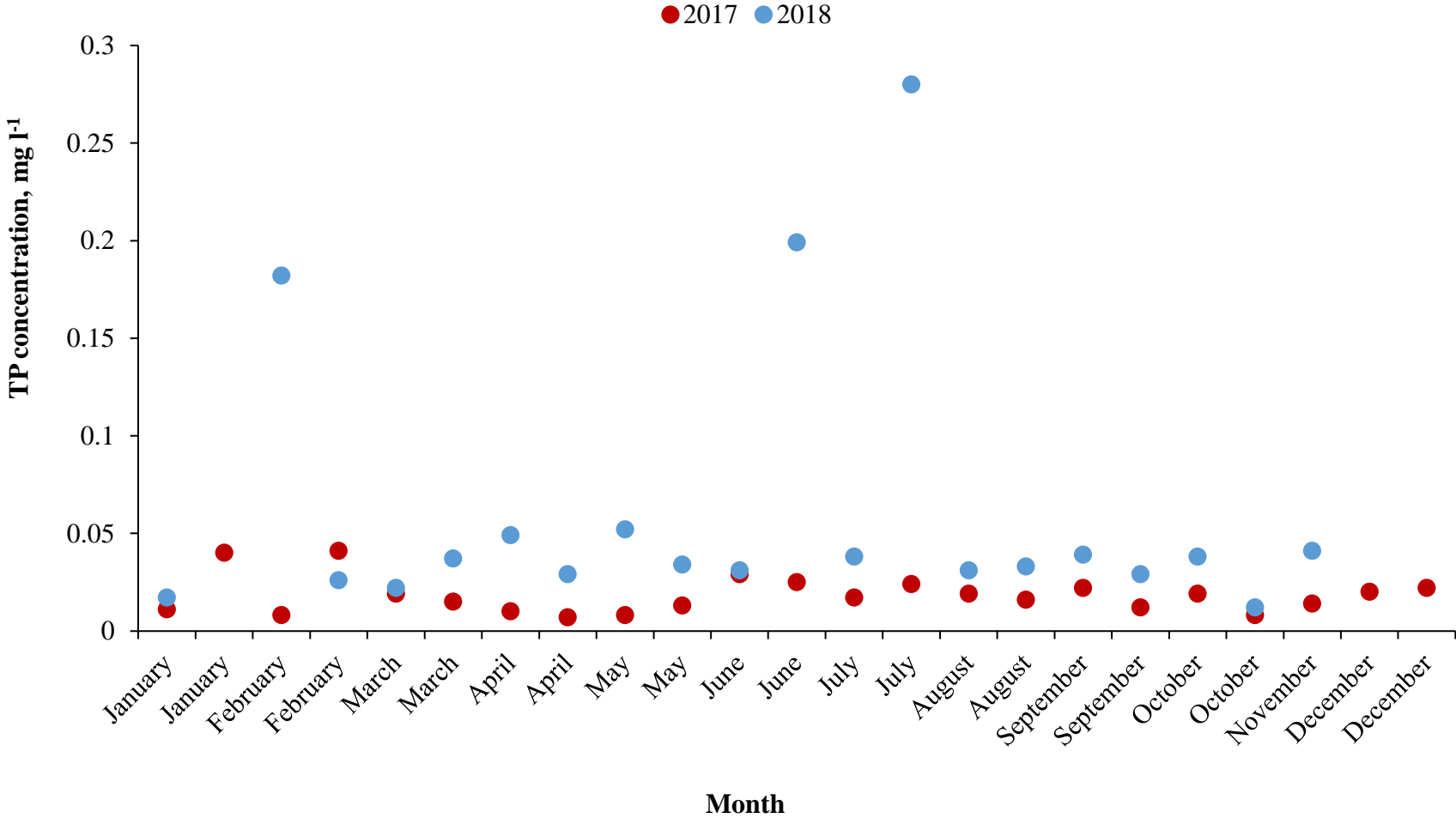
Results: TN concentrations in 2017 and 2018 (Auce)



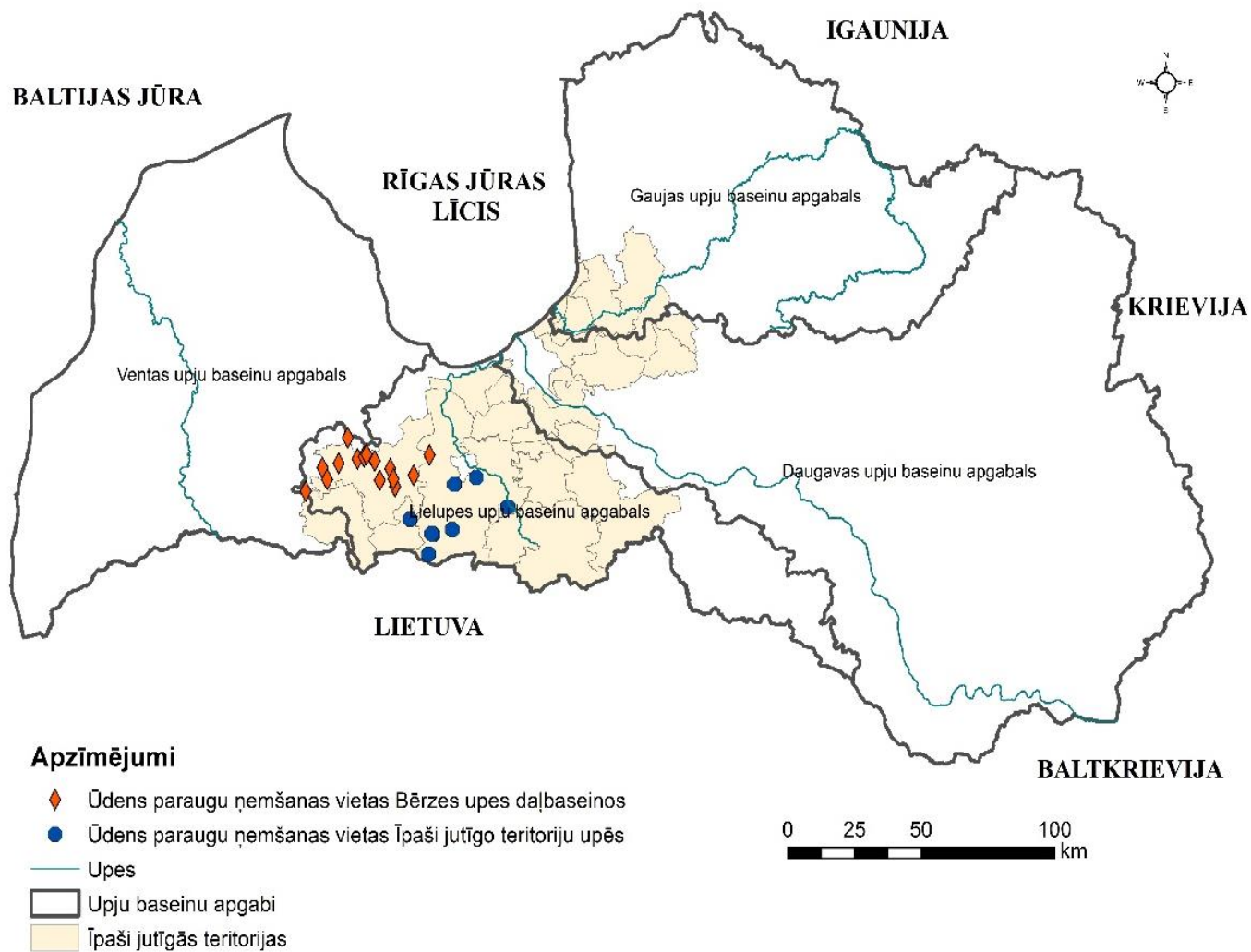
Results: Discharge and TP concentration (Auce)



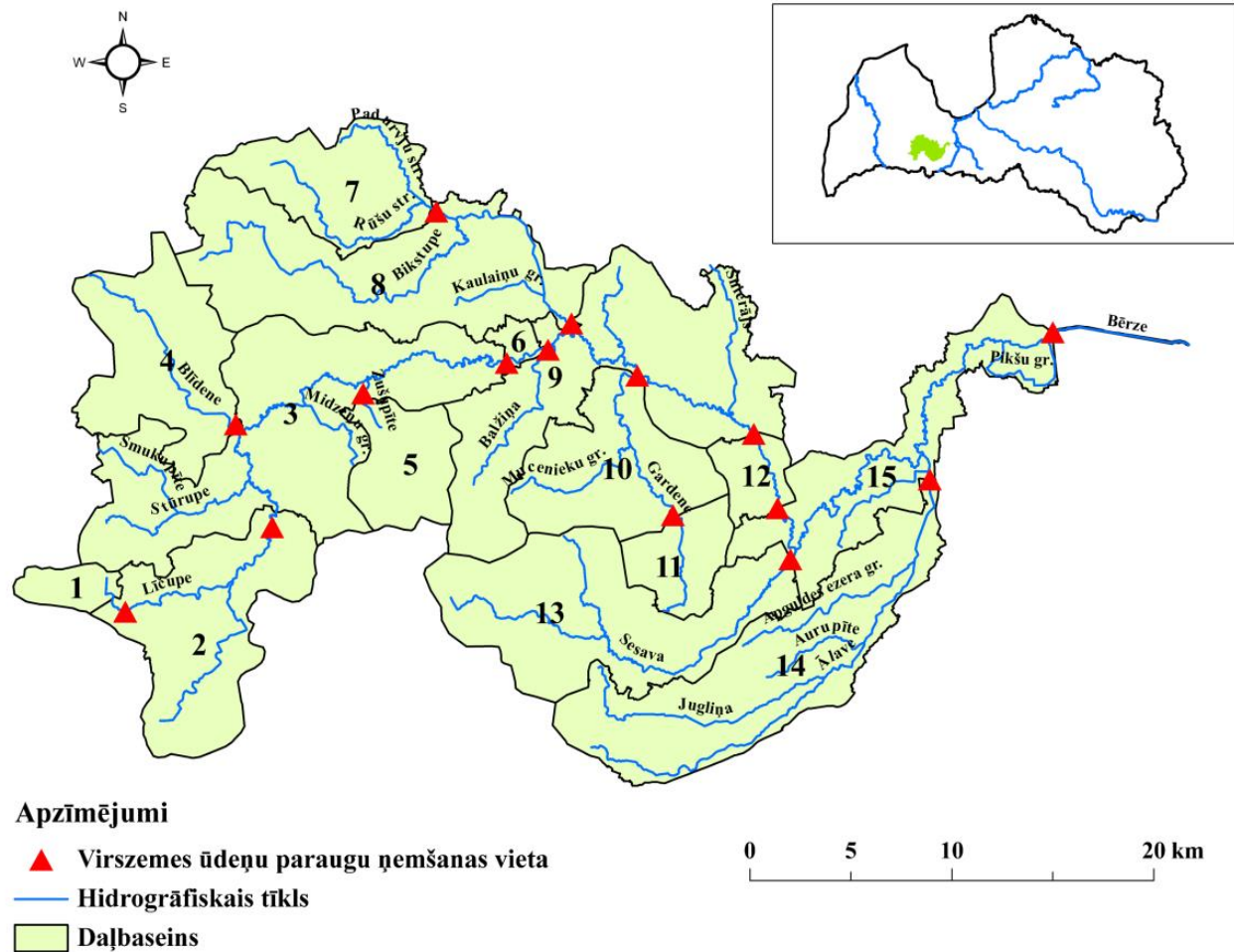
Results: TP concentrations in 2017 and 2018 (Auce)



The river scale monitoring sites



The Berze River monitoring sites



Land use in the Berze River sub-basins

ID	Water sampling site	Catchment area, km ²	Land use (% share in the catchment area)				
			Agricultural areas	Forest and semi-natural areas	Wetlands	Water bodies	Artificial surfaces
1	Līčupe	9.3	10.4	61.9	27.7	0.0	0.0
2	Bērze (Zebrene)	78.6	44.4	51.4	3.3	0.0	0.8
3	Bērze (augšpus Annenieku HES)	284.9	46.1	48.1	2.1	2.2	1.5
4	Bērzes pieteka Blīdene	57.2	36.1	59.6	1.5	1.0	1.8
5	Zušupīte (Zebrus ezers, izteka)	27.9	28.8	51.8	2.1	17.3	0.0
6	Bērze (lejpus Annenieku HES)	289.1	46.7	47.4	2.1	2.3	1.6
7	Bērzes pieteka Rūšu strauts	43.2	63.8	35.1	0.0	0.2	0.9
8	Bērzes pieteka Bikstupe	144.1	58.7	38.2	0.2	0.6	2.3
9	Bērze (augšpus Dobeles)	612.4	50.7	44.3	1.7	1.4	2.0
10	Bērzes pieteka Gardene	73.6	38.0	57.1	2.4	0.5	2.0
11	Gardenes augštece	20.6	27.9	70.2	1.9	0.0	0.0
12	Bērze (lejpus Dobeles)	625.2	50.6	43.6	1.6	1.3	2.9
13	Bērzes pieteka Sesava	89.5	46.6	51.5	0.0	0.9	1.0
14	Bērzes pieteka Ālave (Šķībe)	93.7	83.4	13.5	0.0	0.4	2.6
15	Bērze, Līvberze	872.0	56.3	38.6	1.2	1.1	2.8

Land use in the Berze River sub-basins

ID	Water sampling site	Catchment area, km ²	Land use (% share in the catchment area)				
			Agricultural areas	Forest and semi-natural areas	Wetlands	Water bodies	Artificial surfaces
1	Līčupe	9.3	10.4	61.9	27.7	0.0	0.0
2	Bērze (Zebrene)	78.6	44.4	51.4	3.3	0.0	0.8
3	Bērze (augšpus Annenieku HES)	284.9	46.1	48.1	2.1	2.2	1.5
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9	Bērze (augšpus Dobeles)	612.4	50.7	44.3	1.7	1.4	2.0
10	Bērzes pieteka Gardene	73.6	38.0	57.1	2.4	0.5	2.0
11	Gardenes augštece	20.6	27.9	70.2	1.9	0.0	0.0
12	Bērze (lejpus Dobeles)	625.2	50.6	43.6	1.6	1.3	2.9
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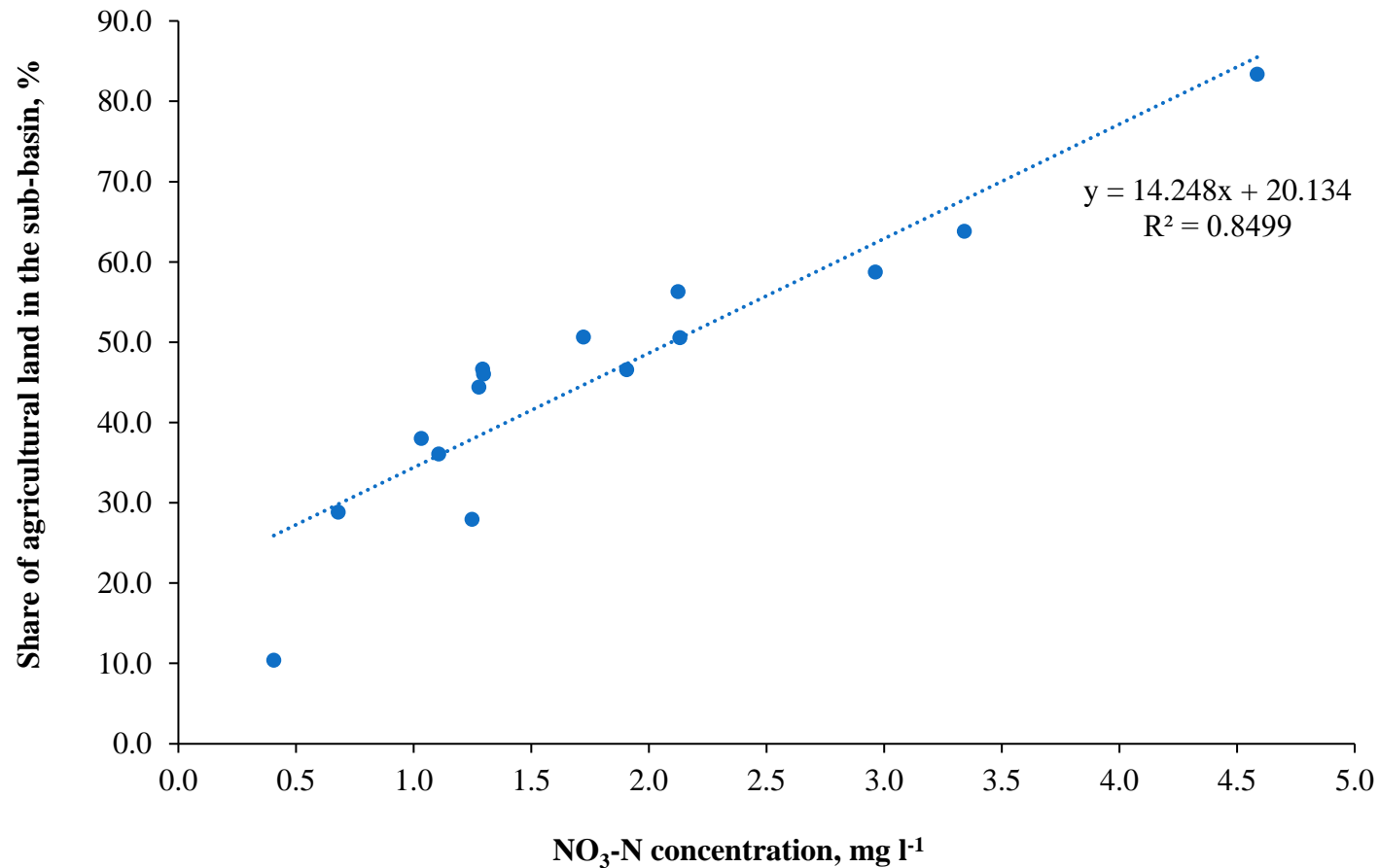
Land use in the Berze River sub-basins

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			Agricultural areas	Forest and semi-natural areas	Wetlands	Water bodies	Artificial surfaces
1	Līčupe	9.3	10.4	61.9	27.7	0.0	0.0
2	Bērze (Zebrene)	78.6	44.4	51.4	3.3	0.0	0.8
3	Bērze (augšpus Annenieku HES)	284.9	46.1	48.1	2.1	2.2	1.5
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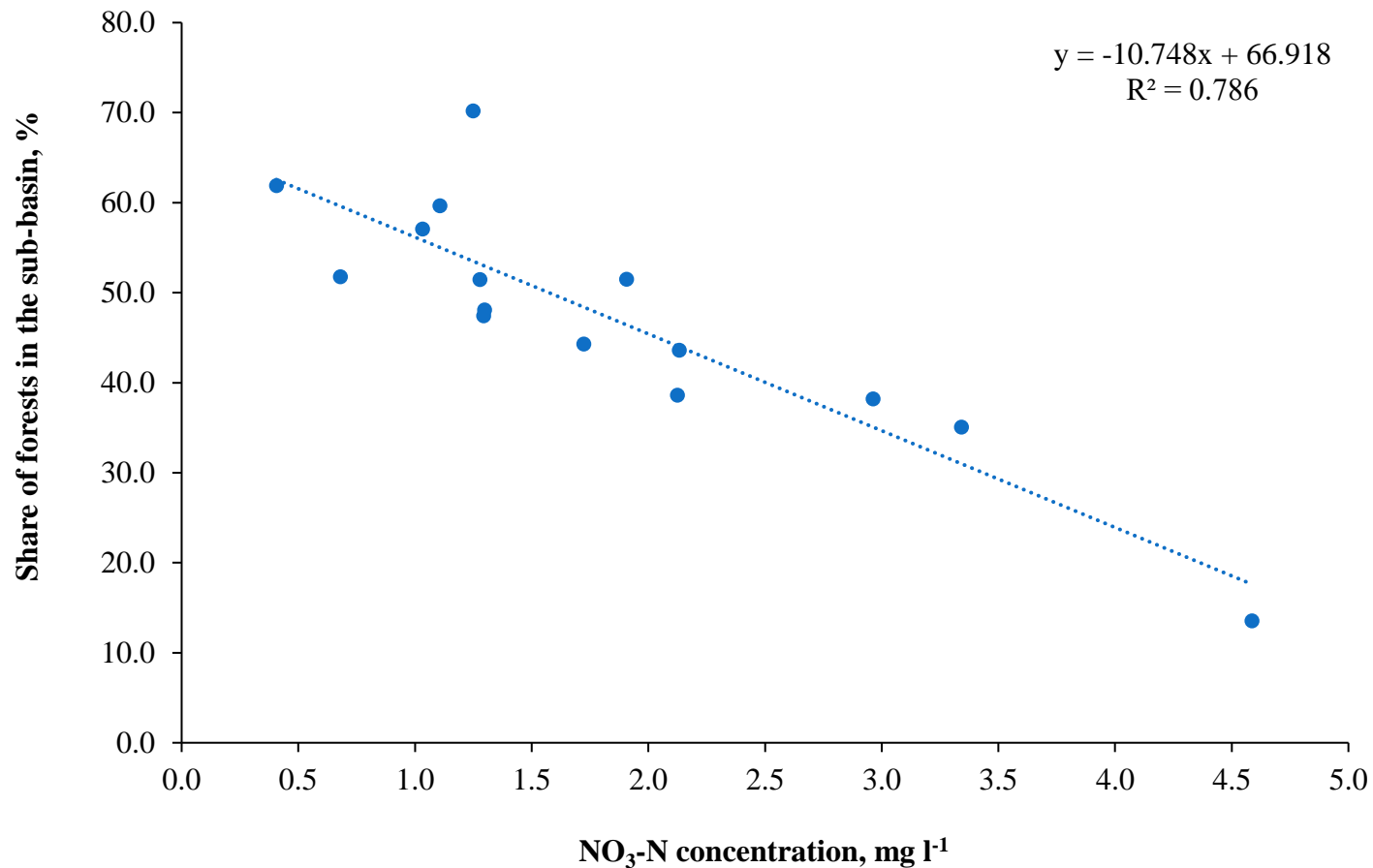
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9	Bērze (augšpus Dobeles)	612.4	50.7	44.3	1.7	1.4	2.0
10	Bērzes pieteka Gardene	73.6	38.0	57.1	2.4	0.5	2.0
11	Gardenes augštece	20.6	27.9	70.2	1.9	0.0	0.0
12	Bērze (lejpus Dobeles)	625.2	50.6	43.6	1.6	1.3	2.9
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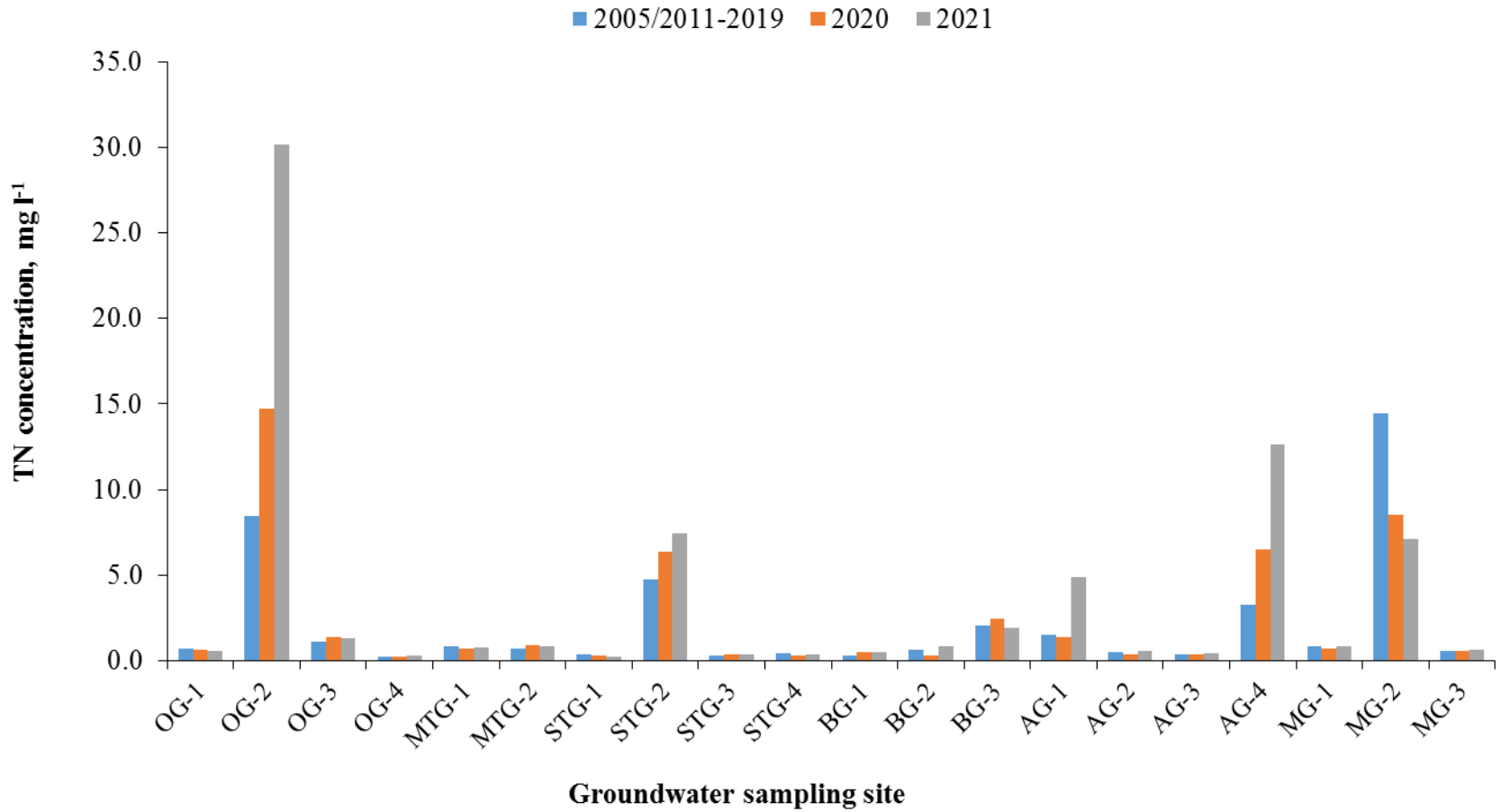
Land use and NO₃-N concentrations in the Berze River sub-basins



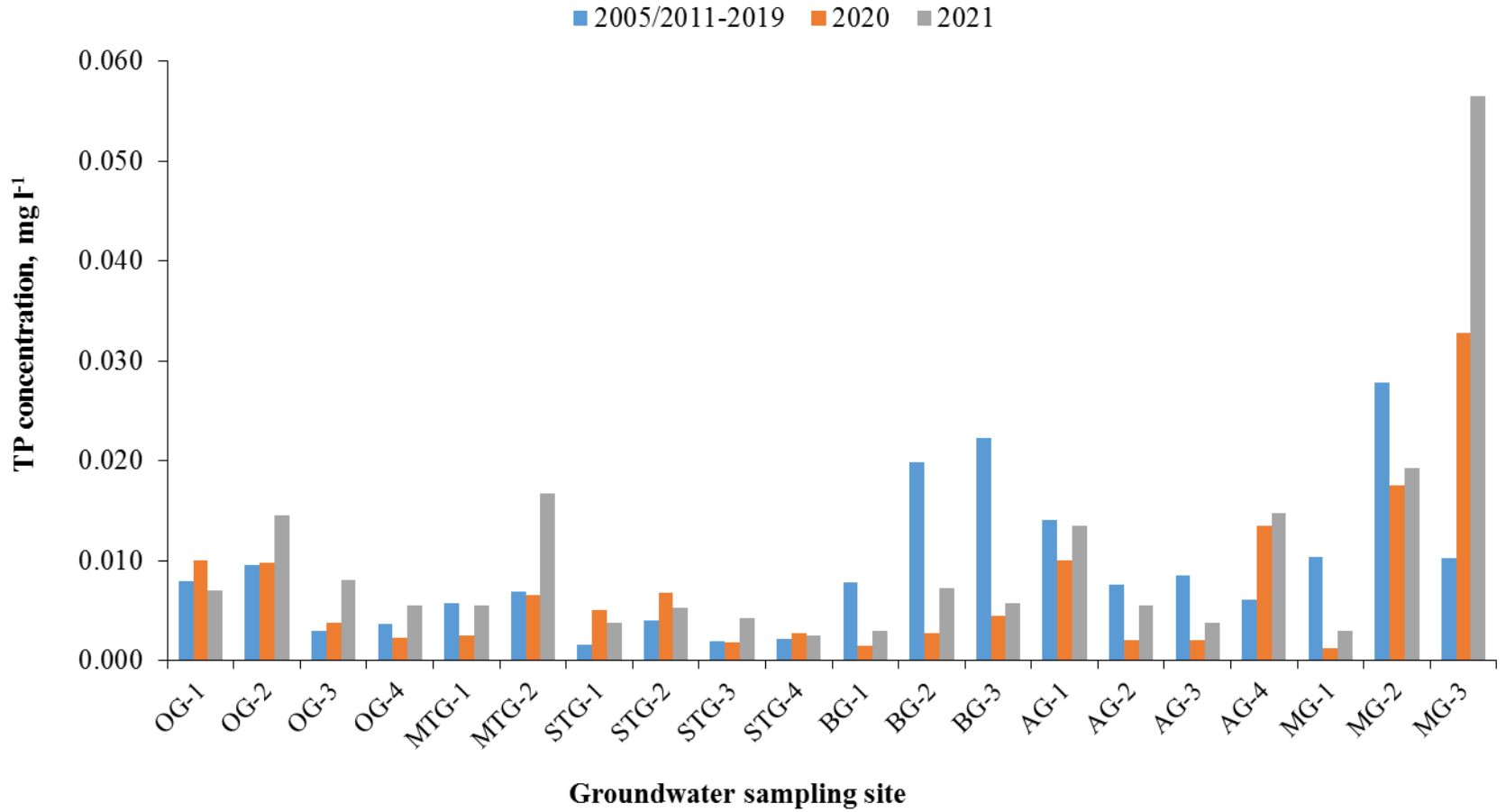
Land use and NO₃-N concentrations in the Berze River sub-basins



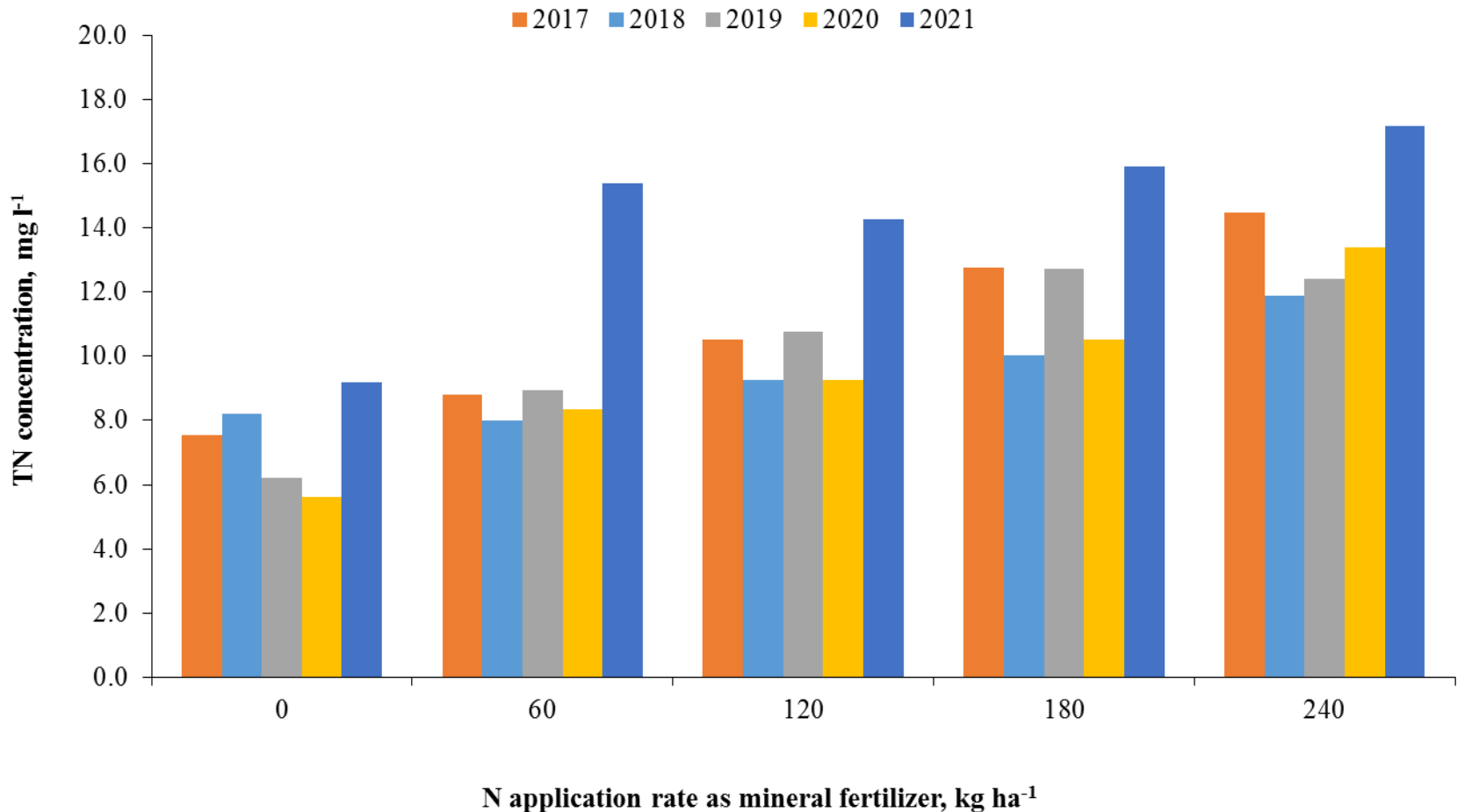
Groundwaters



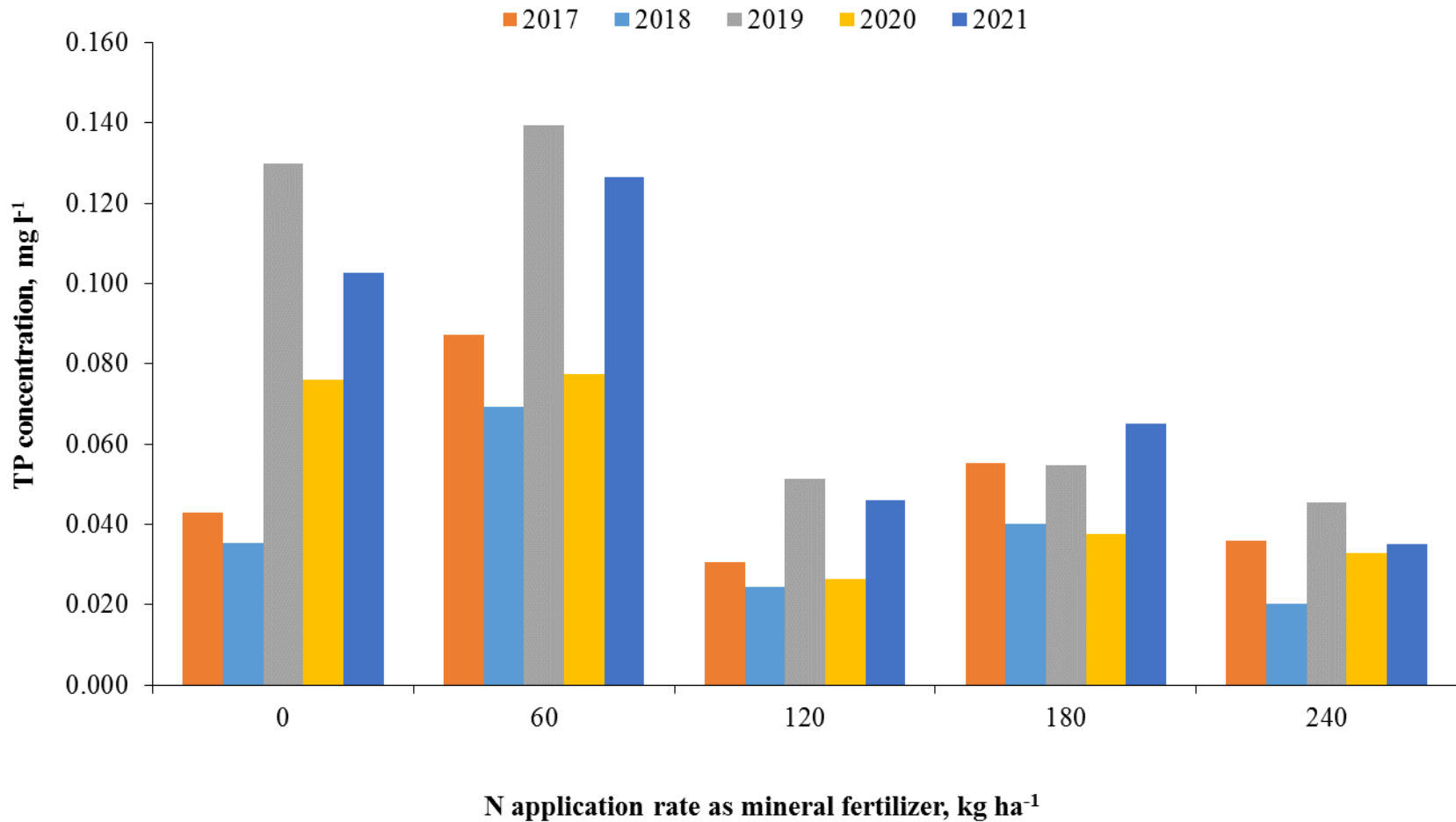
Groundwaters



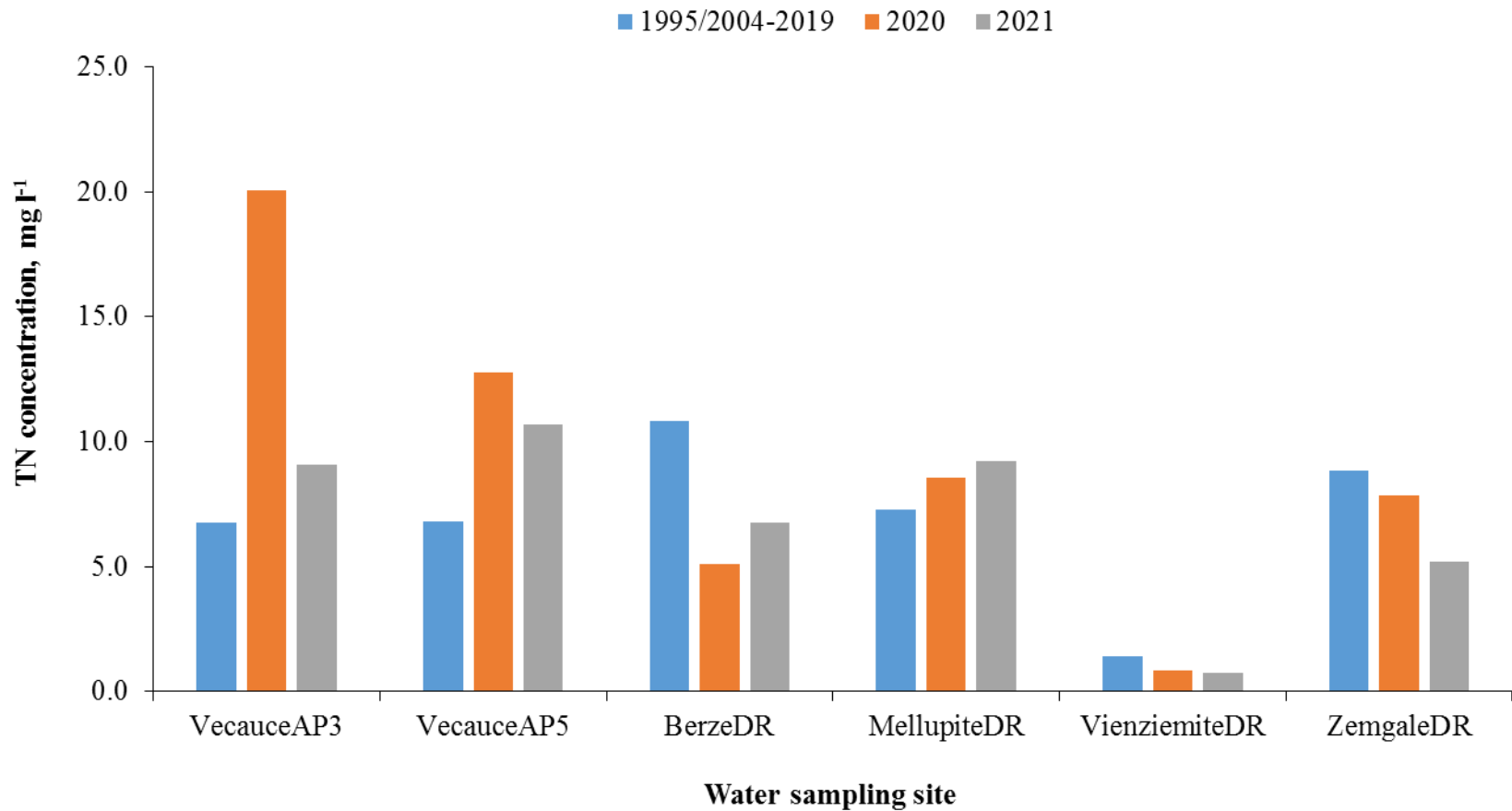
Experimental plots – N application rate



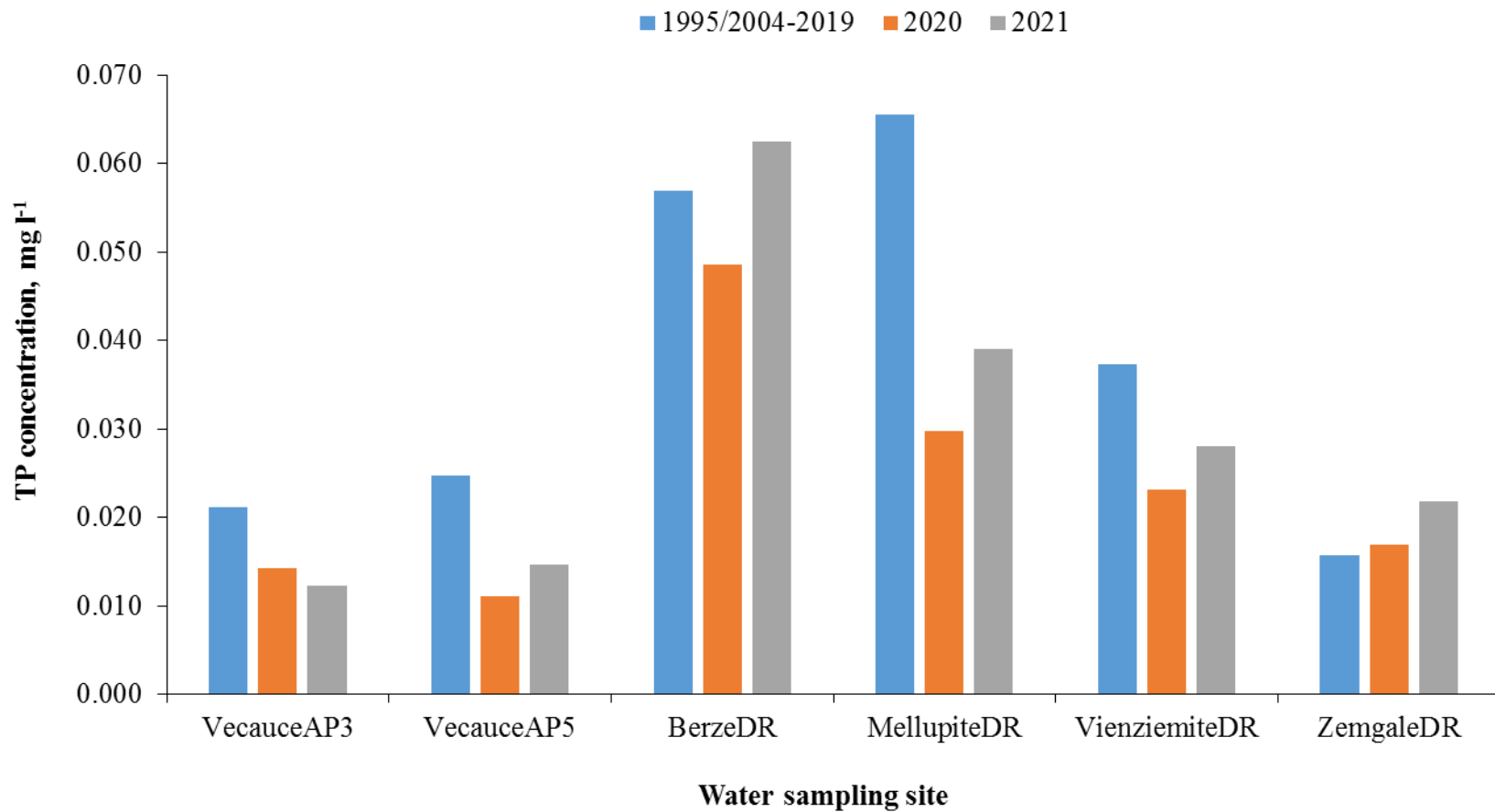
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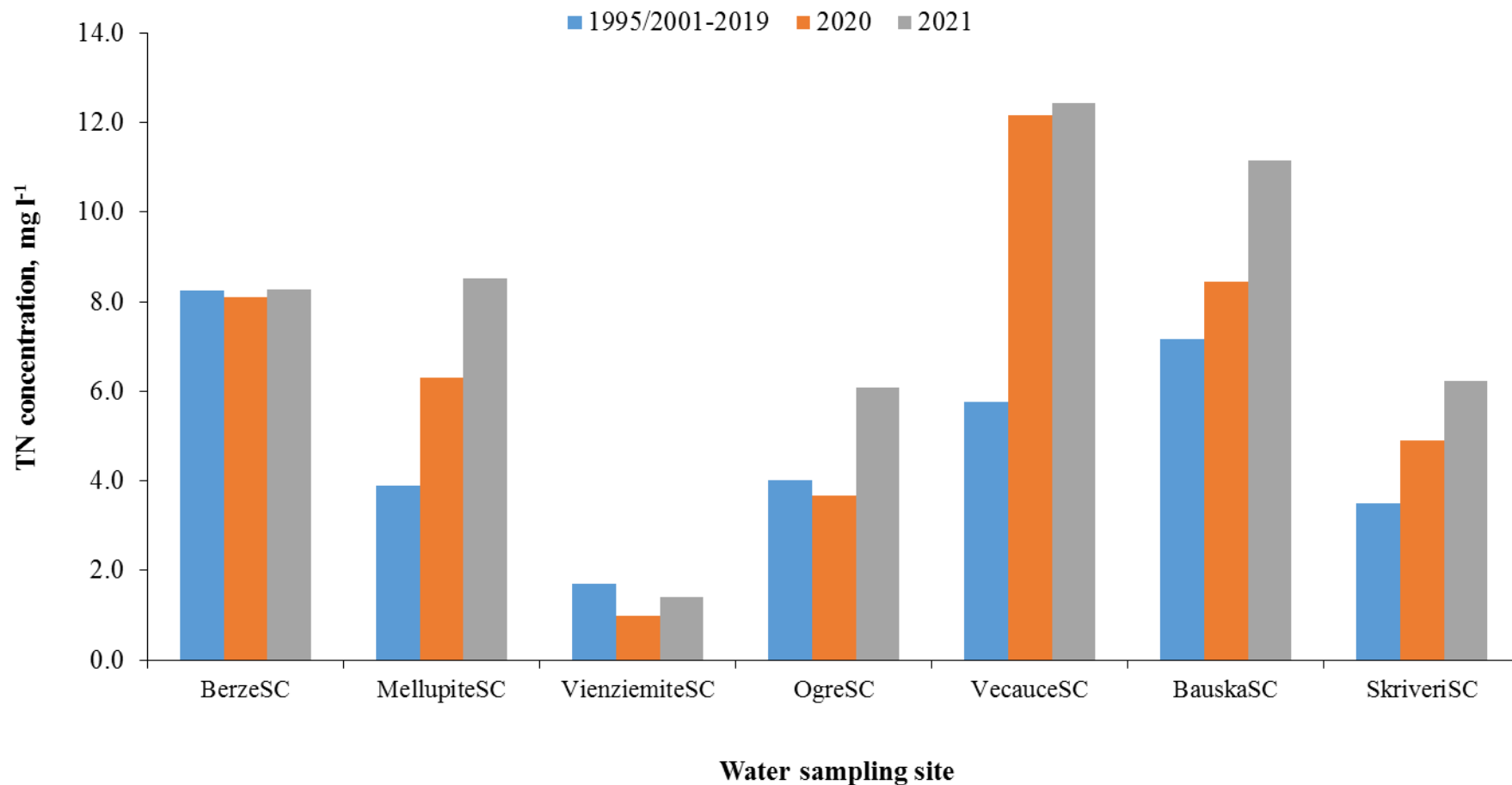
Subsurface drainage field



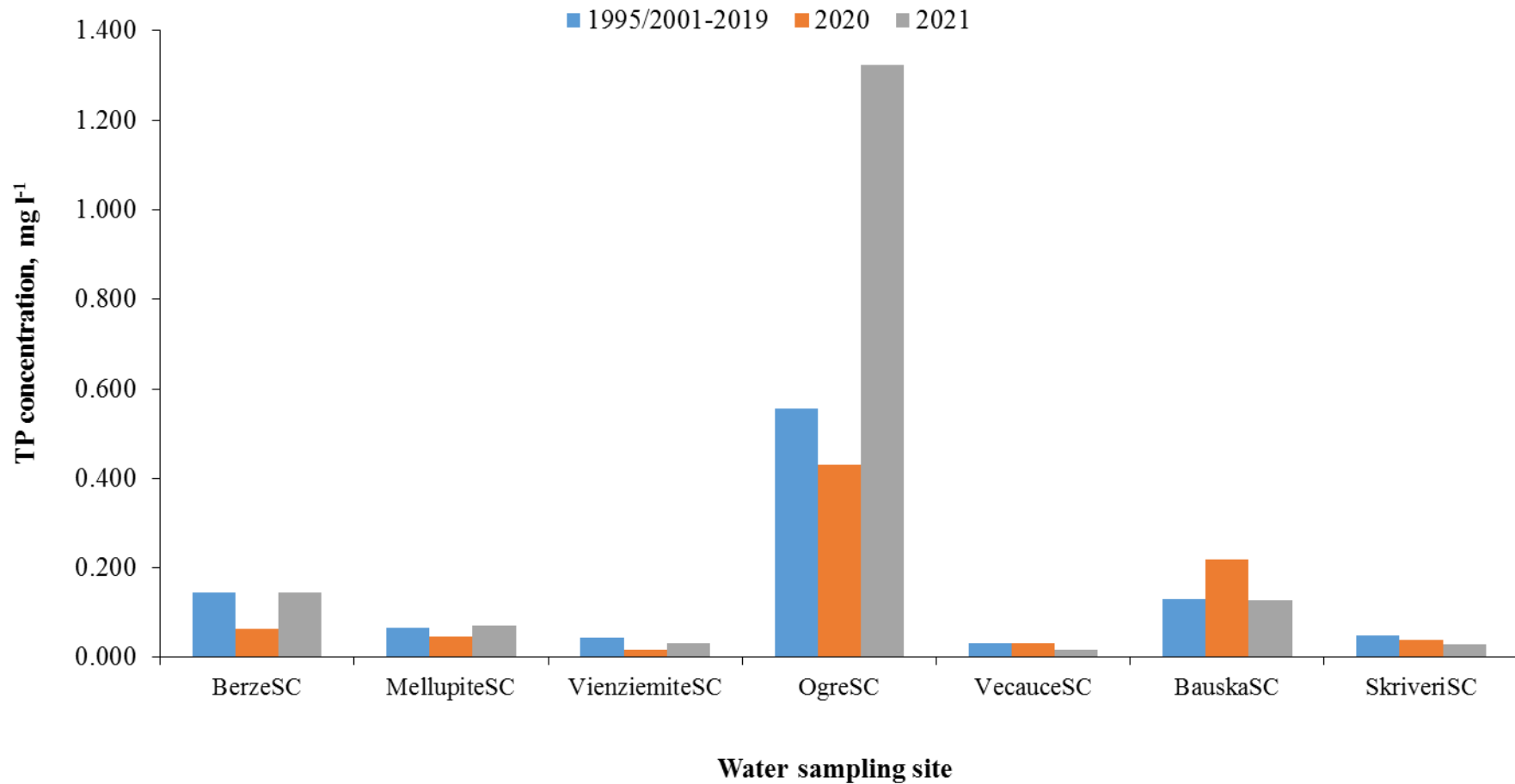
Subsurface drainage field



Small catchment



Small catchment



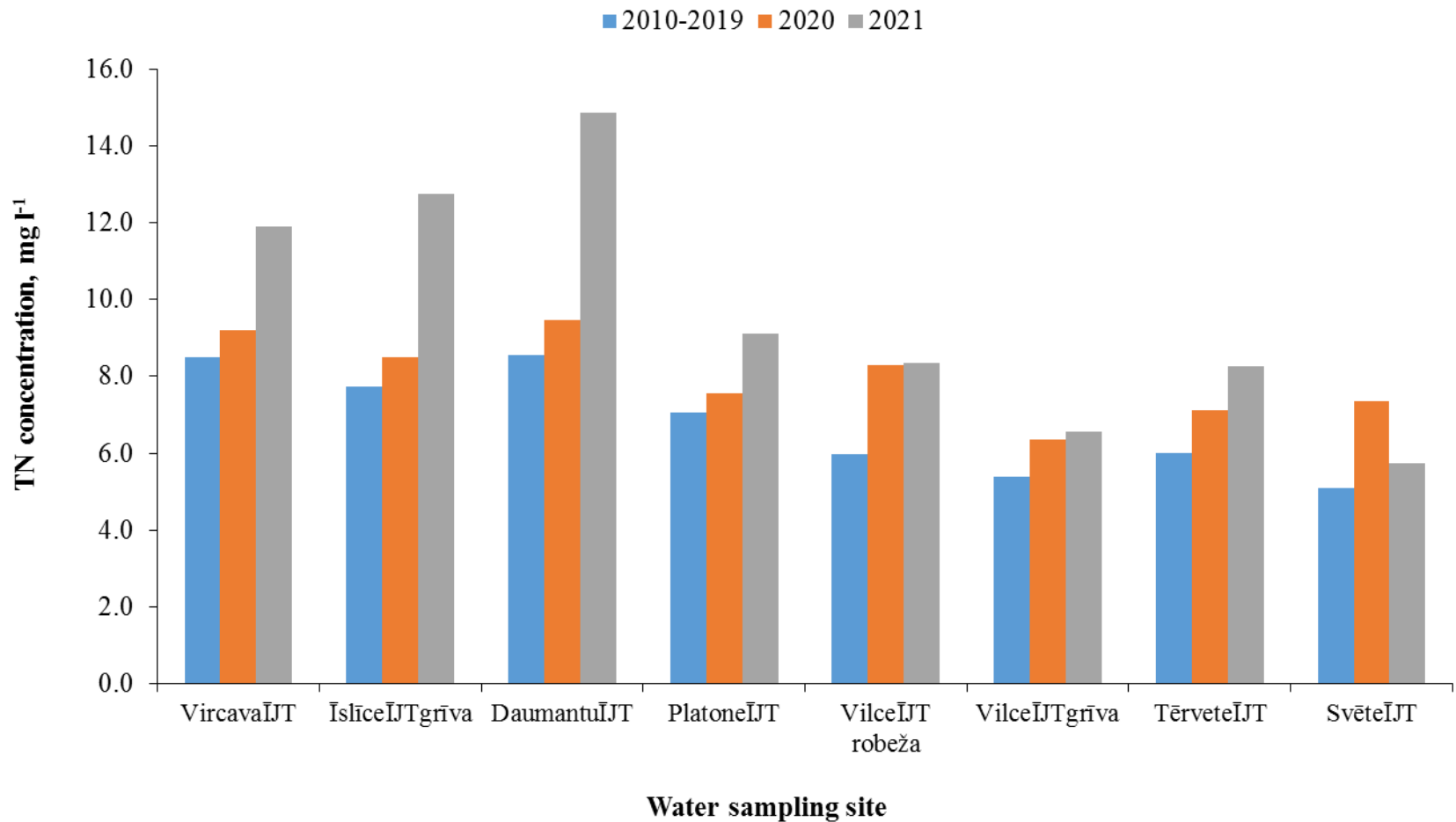
Trends (1995 – 2018)

Study site	Q	MK-stat, TN		MK-stat, NO ₃ -N		
		Losses kg ha ⁻¹	Concentrations mg l ⁻¹	Losses kg ha ⁻¹	Concentrations mg l ⁻¹	
Berze	subsurface drainage field	(+) 0.510	(+) 0.195	(-) 0.330	(+) 0.170	(-) 0.206
	small catchment	(-) 0.186	(-) 0.390	(+) 0.237	(+) 0.117	(+) 0.644
Mellupite	subsurface drainage field	(+) 0.137	(+) 0.399	(+) 0.826	(+) 0.555	(+) 1.122
	small catchment	(-) 0.589	(+) 0.333	(+) 1.422	(+) 1.040	(+) 1.762
Vienziemite	subsurface drainage field	(+) 1.635	(+) 0.363	(-) 3.689*	(-) 0.966	(-) 3.469*
	small catchment	(+) 0.539	(+) 0.183	(-) 1.238	(+) 0.435	(+) 0.281

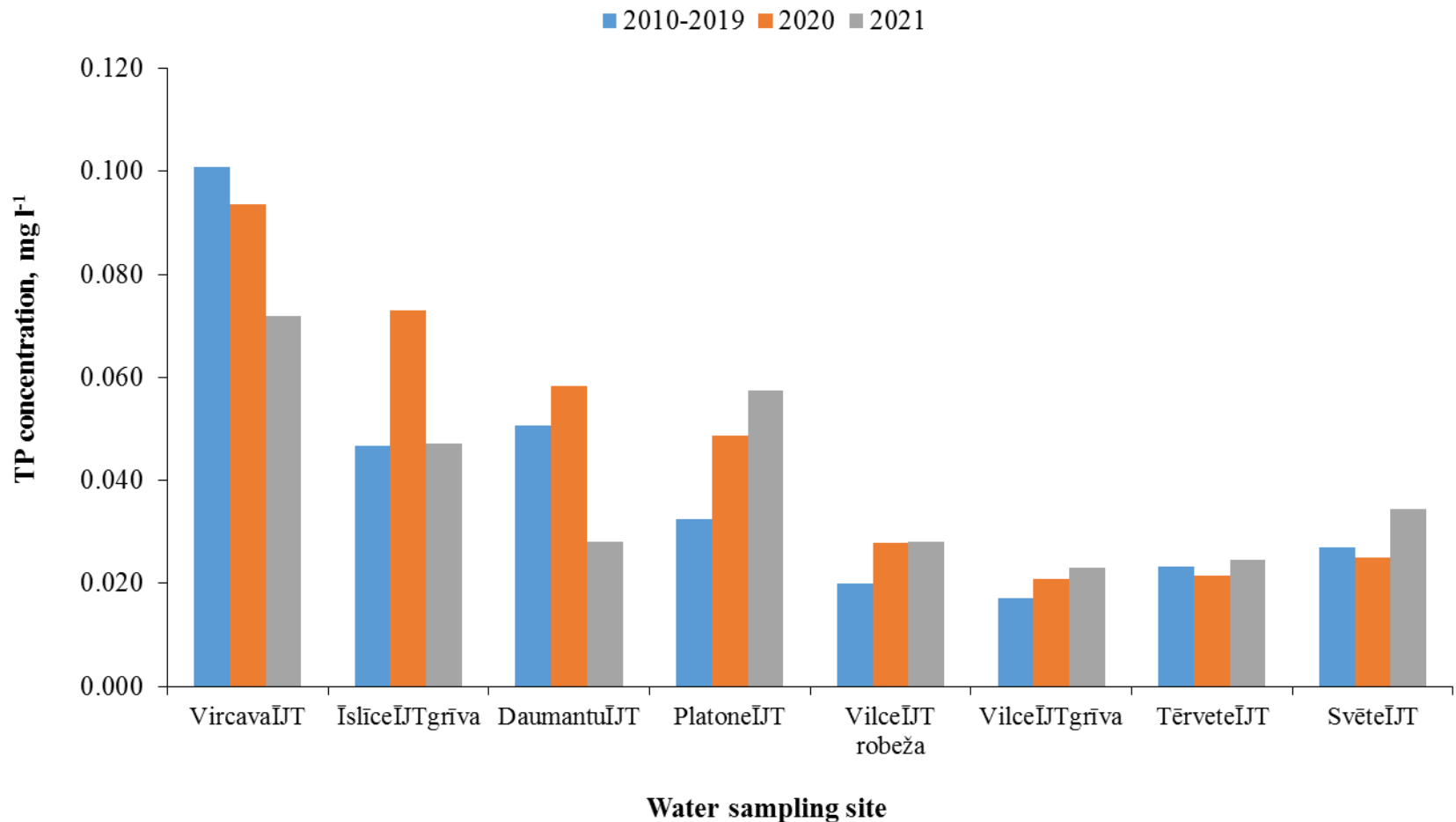
Study site	Q, mm	MK-stat, TP		MK-stat, PO ₄ -P		
		Losses kg ha ⁻¹	Concentrations mg L ⁻¹	Losses kg ha ⁻¹	Concentrations mg L ⁻¹	
Berze	subsurface drainage field	(+) 0.510	(-) 0.233	(-) 1.973*	(+) 0.111	(-) 0.349
	small catchment	(-) 0.186	(-) 1.915	(-) 3.257*	(-) 0.400	(-) 1.987*
Mellupite	subsurface drainage field	(+) 0.137	(-) 0.830	(-) 1.713	(+) 0.368	(+) 0.259
	small catchment	(-) 0.589	(-) 2.283	(-) 1.137	(-) 0.056	(+) 0.358
Vienziemite	subsurface drainage field	(+) 1.635	(+) 0.595	(-) 2.225*	(+) 1.007	(-) 1.739
	small catchment	(+) 0.539	(-) 0.943	(-) 2.425*	(-) 0.834	(-) 2.292*

Note: the * refers to statistically significant trends, where $p < 0.05$.

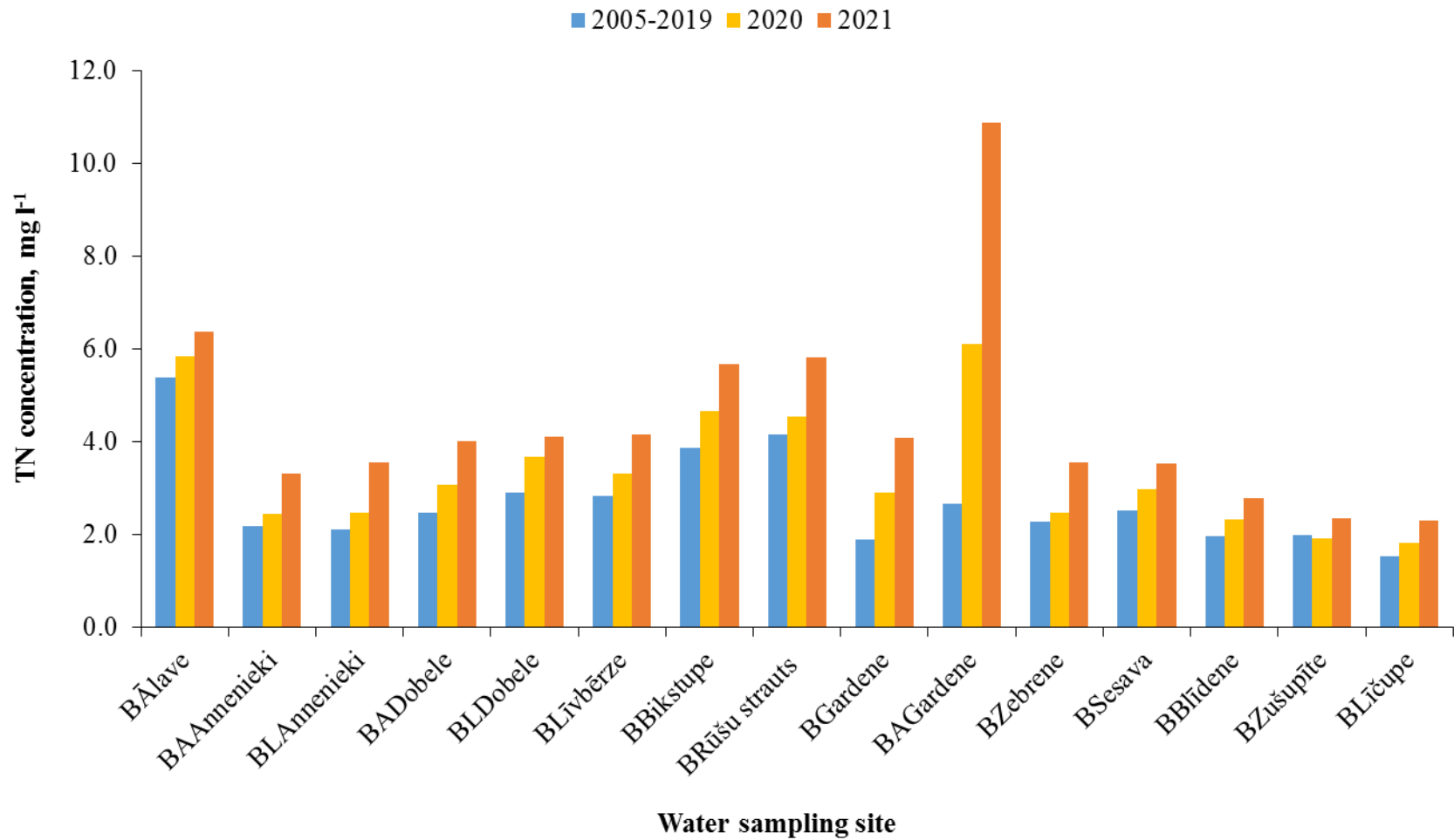
Rivers of Nitrate Vulnerable Zones



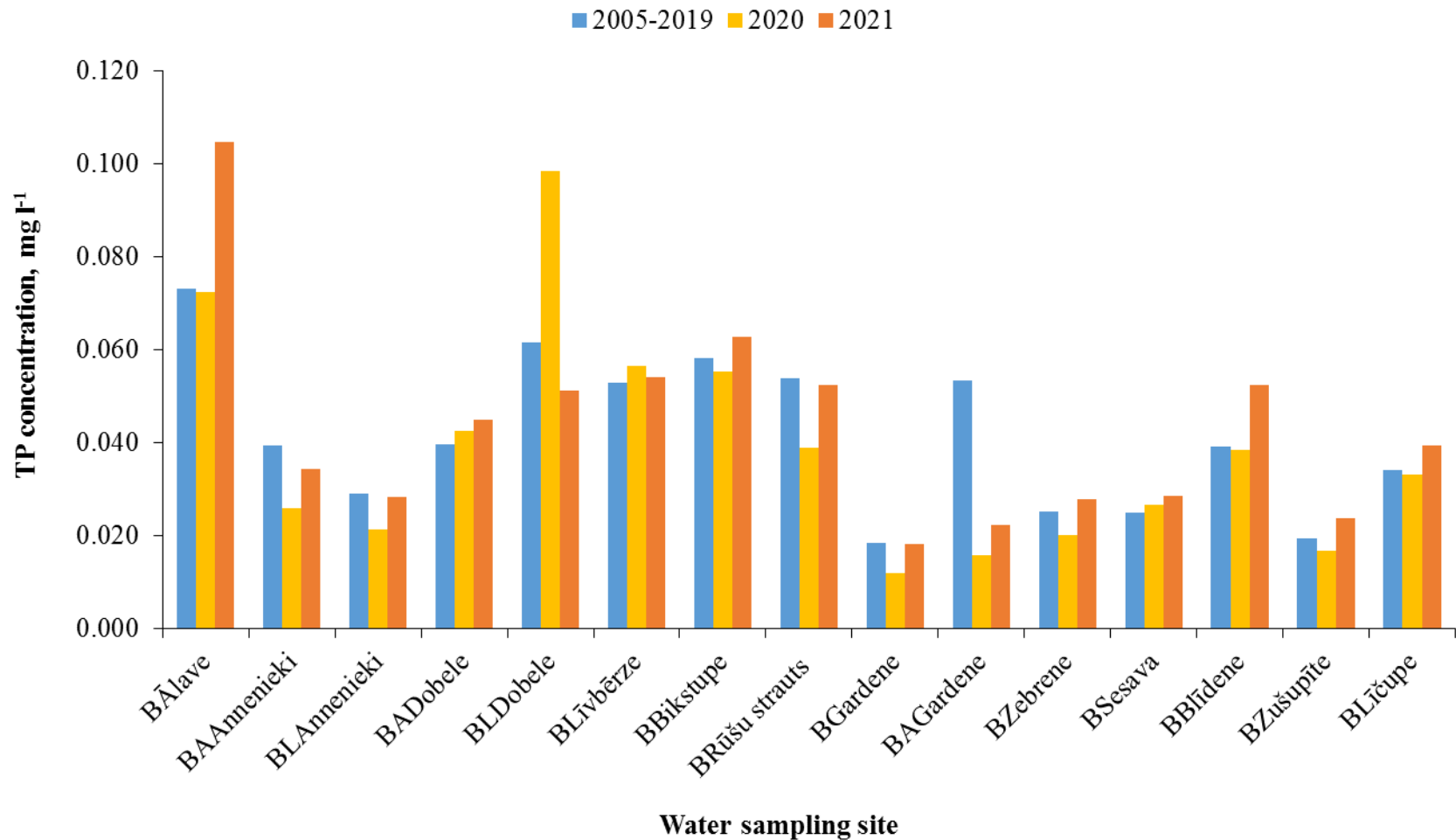
Rivers of Nitrate Vulnerable Zones



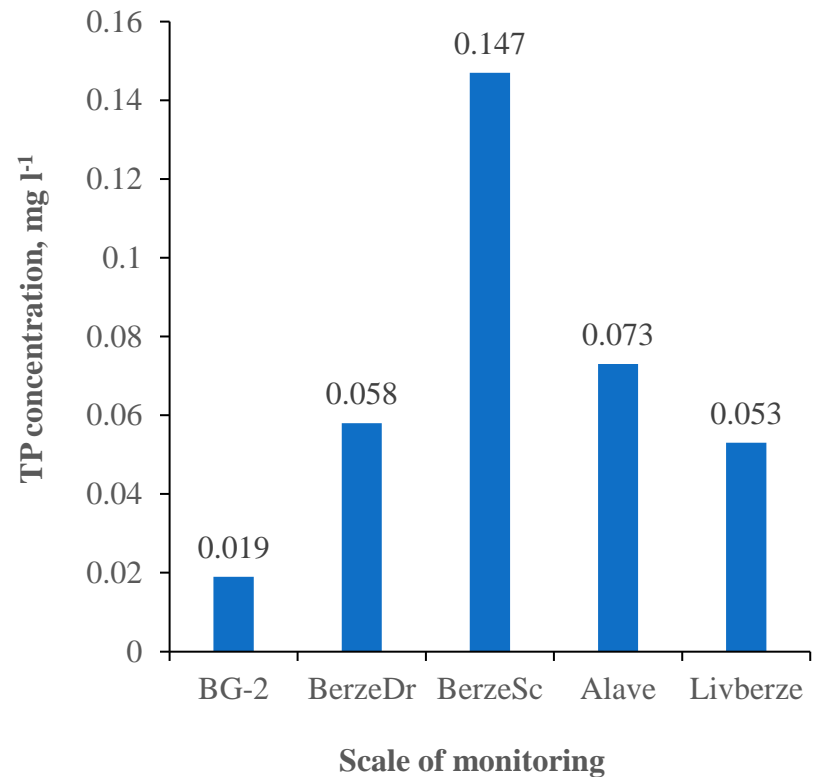
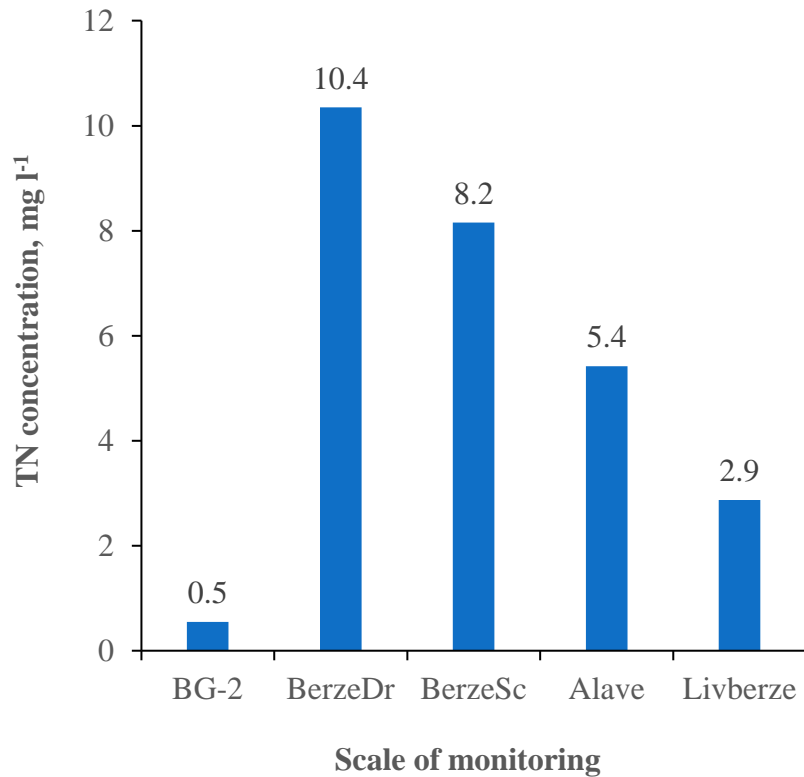
Sub-catchments of the Berze River



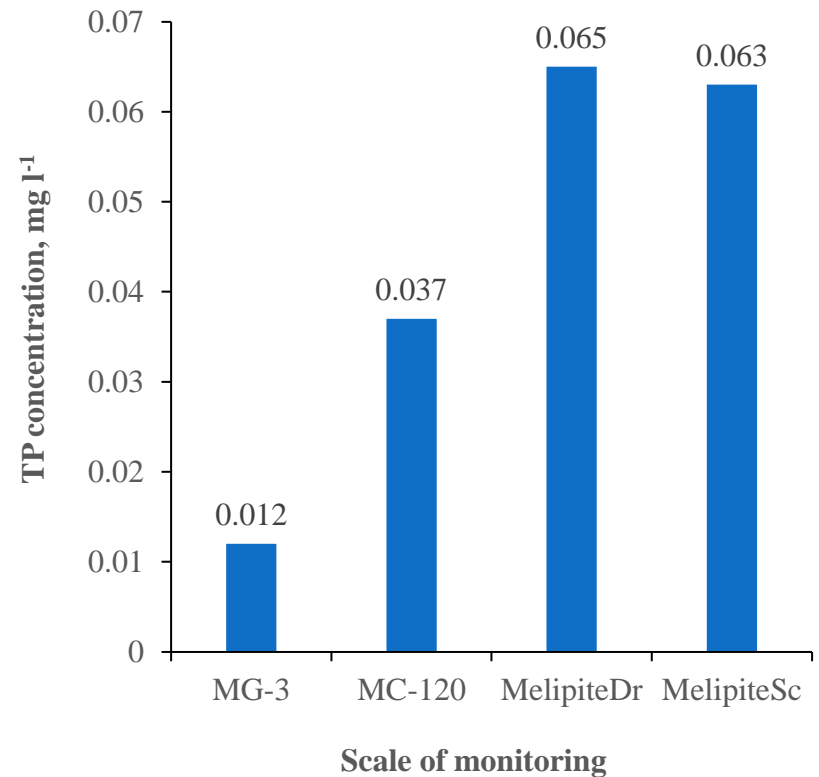
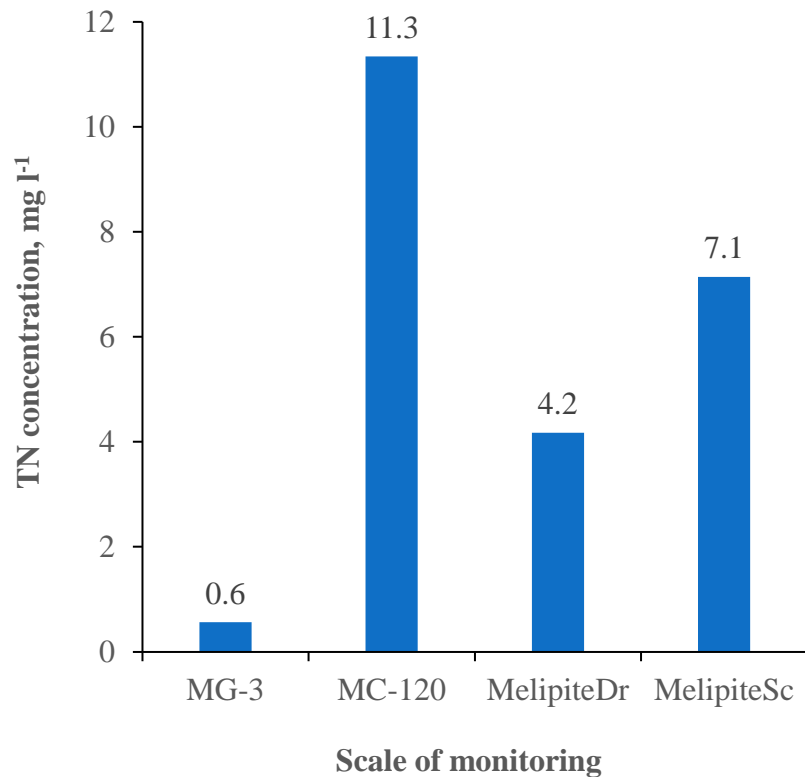
Sub-catchments of the Berze River



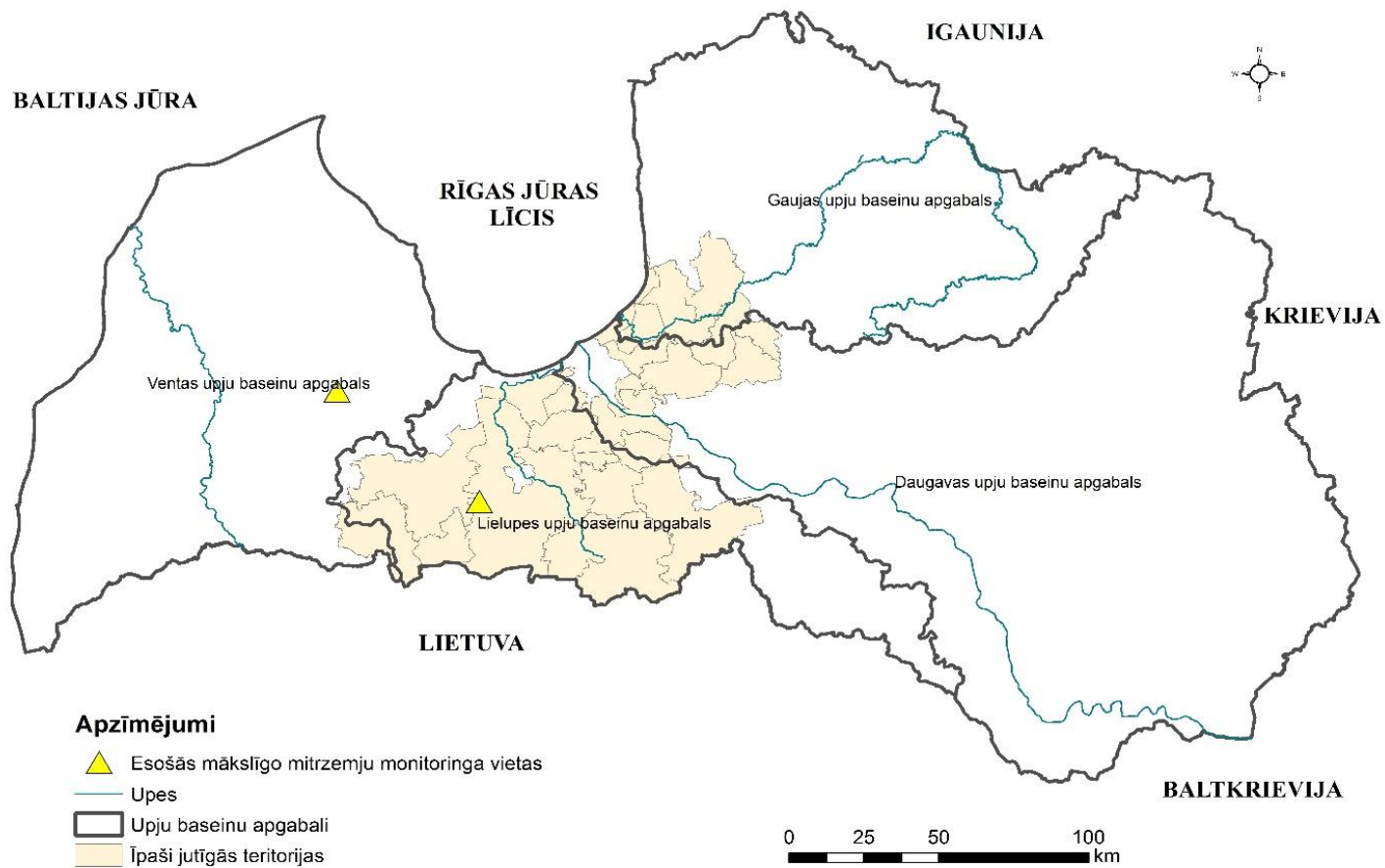
The scales of monitoring at the Berze site – TN and TP concentrations



The scales of monitoring at the Mellupite site – TN and TP concentrations



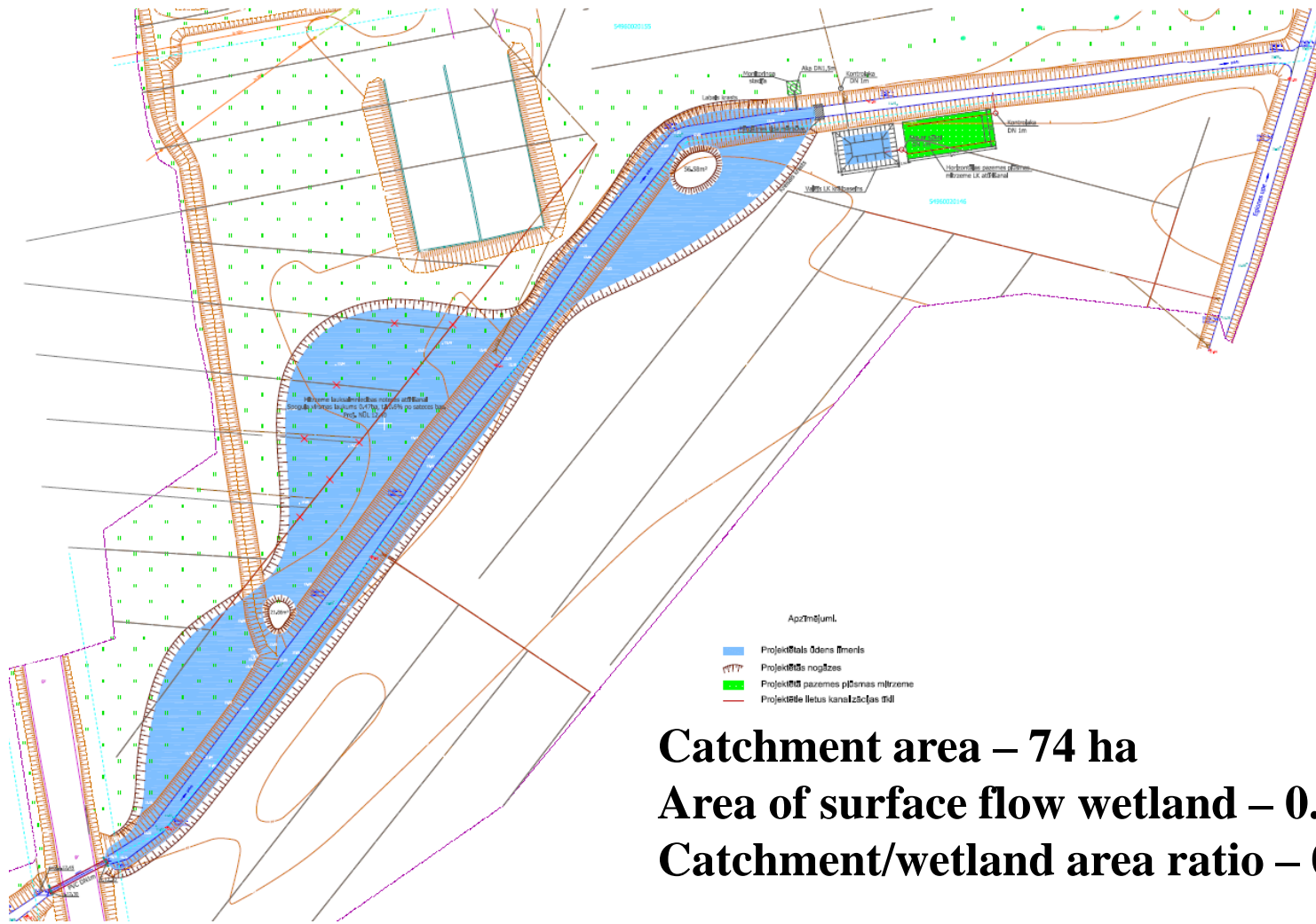
Constructed wetlands



Constructed wetlands – z/s „Mežacīruļi”



Constructed wetlands – z/s „Mežacīruļi”



Catchment area – 74 ha

Area of surface flow wetland – 0.4 ha

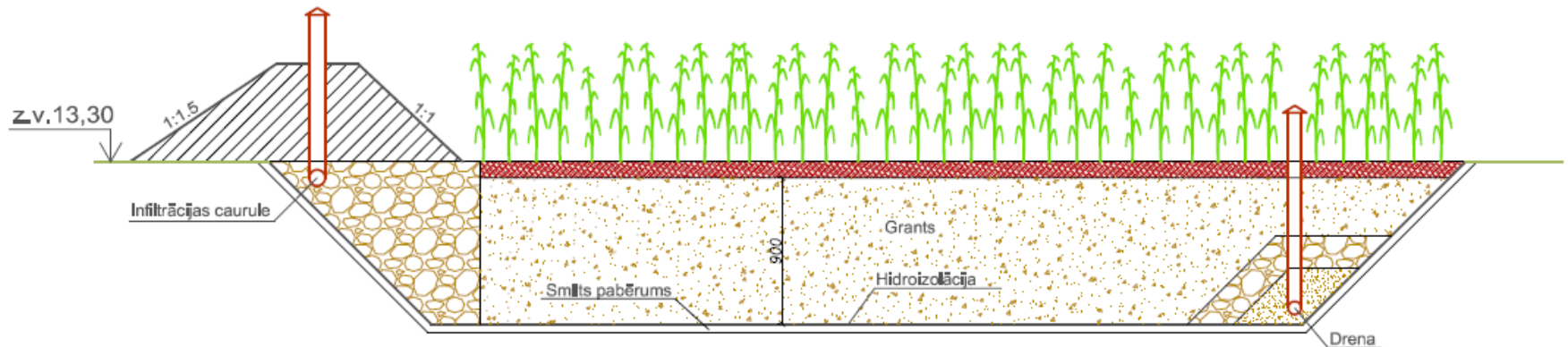
Catchment/wetland area ratio – 0.5 %

Surface flow constructed wetland – z/s „Mežacīruļi”



Subsurface flow constructed wetland – z/s „Mežacīruļi”

Pazemes plūsmas mitrzes šķēsgriezums



Subsurface flow constructed wetland – z/s „Mežacīruļi”



Constructed wetlands – monitoring results (2014-2021)

Parameter	pH	NO ₃ -N, mg l ⁻¹	NH ₄ -N, mg l ⁻¹	TN, mg l ⁻¹	PO ₄ -P, mg l ⁻¹	TP, mg l ⁻¹	TSS, mg l ⁻¹
Surface flow constructed wetland							
Inflow	8.0	10.7	0.499	12.3	0.111	0.190	45.0
Outflow	8.1	8.8	0.356	10.2	0.081	0.114	38.0
Difference, %	1	-18	-29	-18	-27	-40	-16
Subsurface flow constructed wetland							
Inflow	7.3	2.6	7.380	15.1	5.582	6.763	103.3
Outflow	7.6	2.2	2.429	6.9	1.823	1.893	39.0
Difference, %	4	-17	-67	-54	-67	-72	-62

Constructed wetland – z/s „Vilciņi-1”



Constructed wetland – z/s „Vilciņi-1”









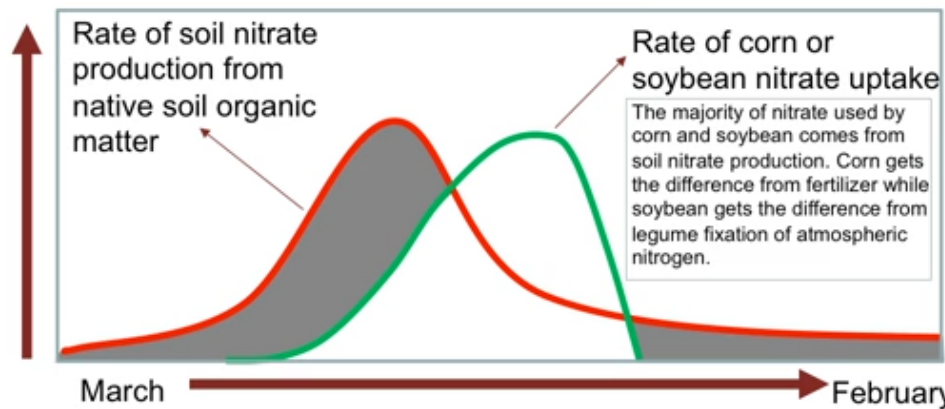
Constructed wetlands – monitoring results (2018-2021)

Parameter	pH	NO ₃ -N, mg l ⁻¹	NH ₄ -N, mg l ⁻¹	TN, mg l ⁻¹	PO ₄ -P, mg l ⁻¹	TP, mg l ⁻¹	TSS, mg l ⁻¹
Surface flow constructed wetland							
Inflow	8.0	2.3	0.023	2.8	0.027	0.046	32.2
Outflow	8.0	2.4	0.032	2.9	0.028	0.048	29.7
Difference, %	0	3	37	3	4	3	-8

Discussion - where does the nitrogen come from?

The Nitrogen Cycle

Soil Nitrate Production vs. Crop Nitrate Uptake



In the shaded areas, the soil produces nitrate, but there is no crop to use it. As a result, some nitrate is lost to waterways.

This video is a combined presentation by Mike Castellano, an Iowa State assistant professor of agronomy, and Matt Helmers, an Iowa State agricultural and biosystems engineering professor. Castellano presents information on the soil nitrogen cycle. Helmers discusses drainage and nitrate loss.



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Thank you for your attention!

Questions or comments?