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Latvia University of Life Sciences and Technologies

NORDBALT ECOSAFE

#209 - From 20 years of water quality and quantity monitoring at a river scale towards modelling in the future

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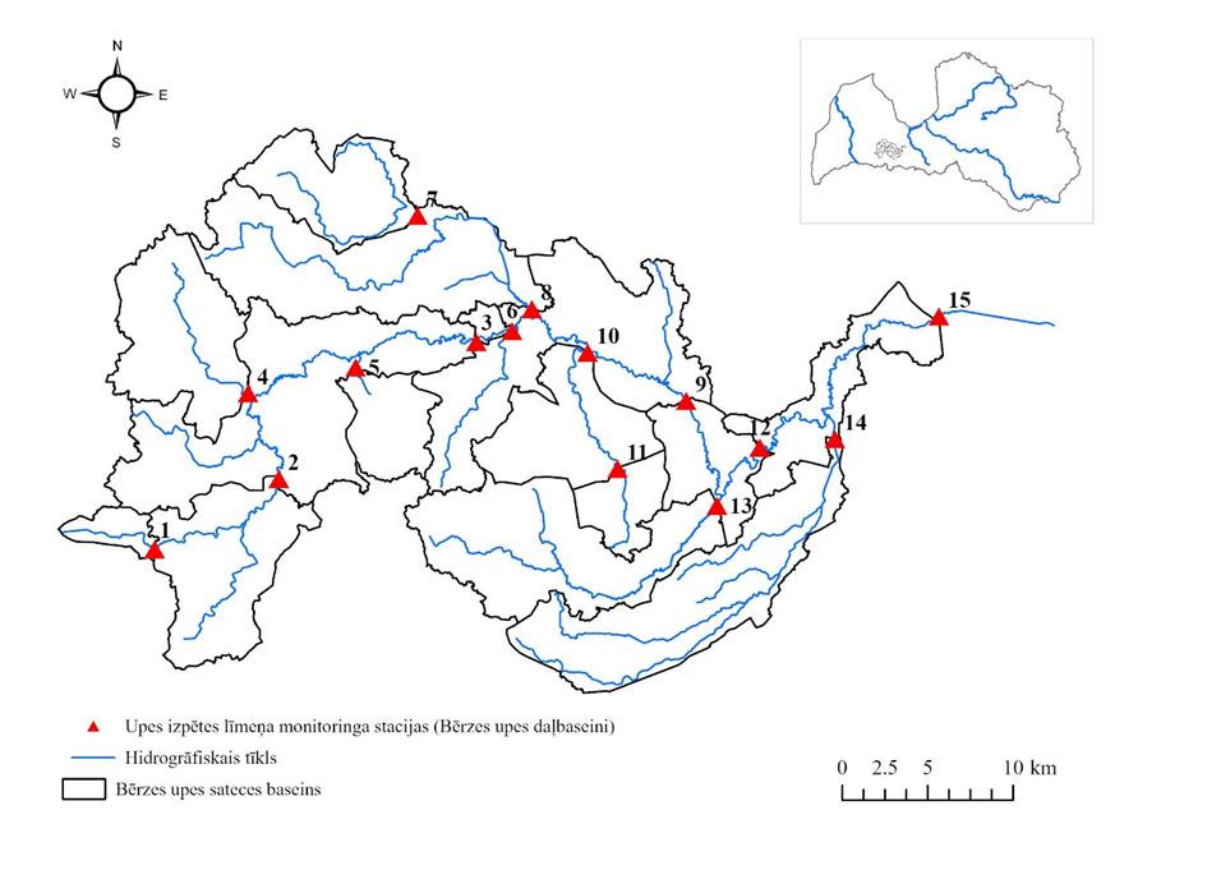
Agricultural Runoff Monitoring Programme in Latvia

This programme aims to document and assess the current status and long-term trends of nutrient concentrations and losses from agricultural areas in different spatial and temporal scales based on systematic and regular water quality and quantity monitoring activities. The monitoring activities has been started in 1995 and is still in operation.

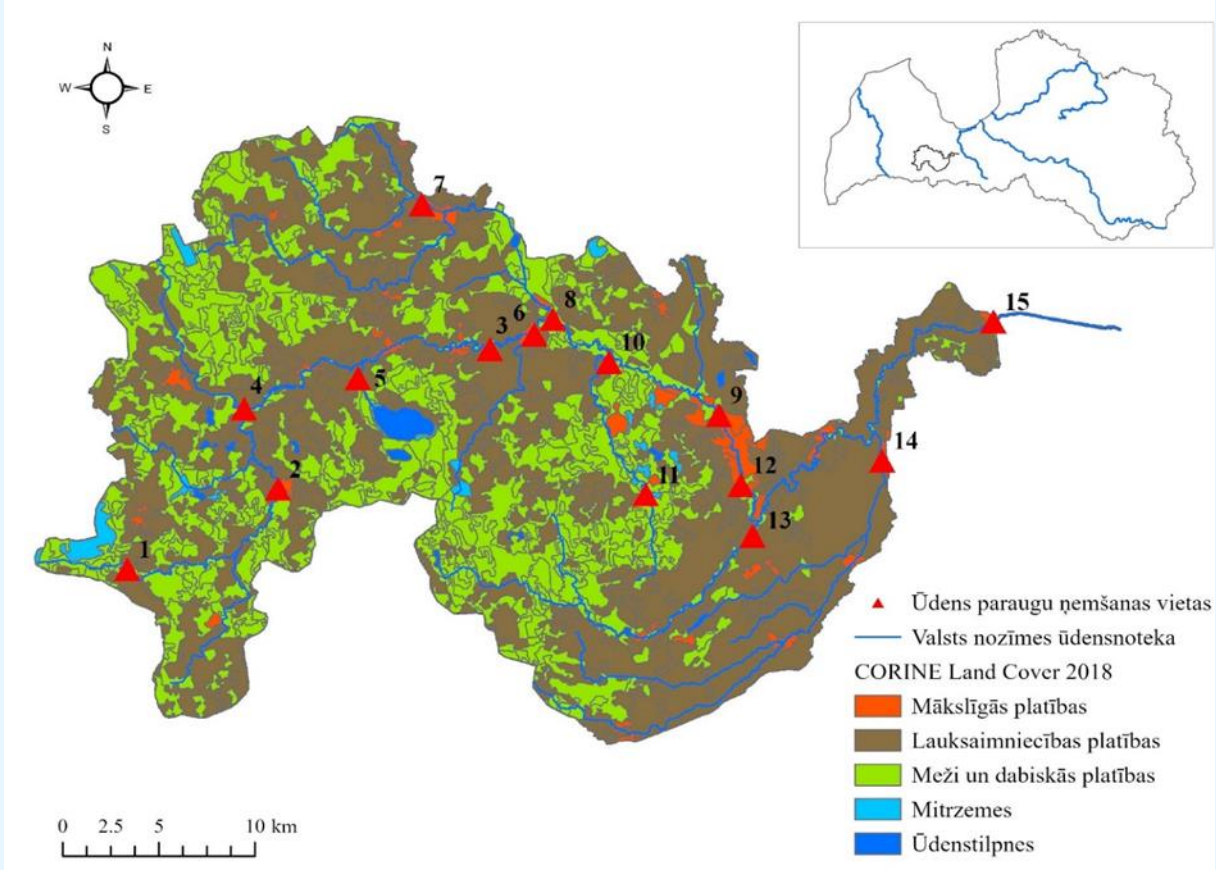
The scales of monitoring activities:

- **Groundwater (20 wells) – 2005;**
- **Experimental subsurface drainage plots (1 site with 16 plots and 5 treatments) - 1996;**
- **Subsurface drainage fields (6 sites) - 1995;**
- **Small catchments (10 sites) - 1995;**
- **Small and medium size rivers (23 sites) – 2005.**

The Berze River



Water sampling sites at 15 sub-basins



Land use at 15 sub-basins

The Berze River – Agricultural areas

ID	Water sampling site	Catchment area, km²	Land use (% share in the catchment area)				
			Agricultural areas	Forest and semi-natural areas	Wetlands	Water bodies	Artificial surfaces
1	Līčupe	10.2	20.9	53.0	26.1	0.0	0.0
2	Bērze (Zebrene)	75.3	42.7	53.1	3.5	0.0	0.7
3	Bērze (augšpus Annenieku HES)	281.1	45.4	48.7	2.2	2.2	1.5
4	Bērzes pieteka Blīdene	57.2	33.5	62.8	1.3	0.9	1.6
5	Zušupīte (Zebrus ezers, izteka)	27.4	31.0	49.3	2.1	17.6	0.0
6	Bērze (lejpus Annenieku HES)	285.3	46.0	48.1	2.2	2.2	1.6
7	Bērzes pieteka Rūšu strauts	45.4	63.0	35.6	0.0	0.2	1.2
8	Bērzes pieteka Bikstupe	147.3	58.5	38.0	0.7	0.5	2.3
9	Bērze (augšpus Dobeles)	609.3	50.1	44.8	1.8	1.3	2.0
10	Bērzes pieteka Gardene	73.1	37.9	56.9	2.5	0.5	2.1
11	Gardenes augštece	20.8	28.9	69.1	2.0	0.0	0.0
12	Bērze (lejpus Dobeles)	641.7	50.9	43.1	1.7	1.2	3.1
13	Bērzes pieteka Sesava	89.5	44.8	53.2	0.0	0.9	1.1
14	Bērzes pieteka Ālave (Škibe)	94.4	83.1	13.9	0.0	0.4	2.6
15	Bērze, Līvbērze	869.9	55.6	39.2	1.3	1.0	2.8

The Berze River – Forest and semi-natural areas

ID	Water sampling site	Catchment area, km²	Land use (% share in the catchment area)				
			Agricultural areas	Forest and semi-natural areas	Wetlands	Water bodies	Artificial surfaces
1	Līčupe	10.2	20.9	53.0	26.1	0.0	0.0
2	Bērze (Zebrene)	75.3	42.7	53.1	3.5	0.0	0.7
3	Bērze (augšpus Annenieku HES)	281.1	45.4	48.7	2.2	2.2	1.5
4	Bērzes pieteka Blīdene	57.2	33.5	62.8	1.3	0.9	1.6
5	Zušupīte (Zebrus ezers, izteka)	27.4	31.0	49.3	2.1	17.6	0.0
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7	Bērzes pieteka Rūšu strauts	45.4	63.0	35.6	0.0	0.2	1.2
8	Bērzes pieteka Bikstupe	147.3	58.5	38.0	0.7	0.5	2.3
9	Bērze (augšpus Dobeles)	609.3	50.1	44.8	1.8	1.3	2.0
10	Bērzes pieteka Gardene	73.1	37.9	56.9	2.5	0.5	2.1
11	Gardenes augštece	20.8	28.9	69.1	2.0	0.0	0.0
12	Bērze (lejpus Dobeles)	641.7	50.9	43.1	1.7	1.2	3.1
13	Bērzes pieteka Sesava	89.5	44.8	53.2	0.0	0.9	1.1
14	Bērzes pieteka Ālave (Šķibe)	94.4	83.1	13.9	0.0	0.4	2.6
15	Bērze, Līvbērze	869.9	55.6	39.2	1.3	1.0	2.8

The Berze River – Small hydropower plant

ID	Water sampling site	Catchment area, km²	Land use (% share in the catchment area)				
			Agricultural areas	Forest and semi-natural areas	Wetlands	Water bodies	Artificial surfaces
1	Līčupe	10.2	20.9	53.0	26.1	0.0	0.0
2	Bērze (Zebrene)	75.3	42.7	53.1	3.5	0.0	0.7
3	Bērze (augšpus Annenieku HES)	281.1	45.4	48.7	2.2	2.2	1.5
4	Bērzes pieteka Blīdene	57.2	33.5	62.8	1.3	0.9	1.6
5	Zušupīte (Zebrus ezers, izteka)	27.4	31.0	49.3	2.1	17.6	0.0
6	Bērze (lejpus Annenieku HES)	285.3	46.0	48.1	2.2	2.2	1.6
7	Bērzes pieteka Rūšu strauts	45.4	63.0	35.6	0.0	0.2	1.2
8	Bērzes pieteka Bikstupe	147.3	58.5	38.0	0.7	0.5	2.3
9	Bērze (augšpus Dobeles)	609.3	50.1	44.8	1.8	1.3	2.0
10	Bērzes pieteka Gardene	73.1	37.9	56.9	2.5	0.5	2.1
11	Gardenes augštece	20.8	28.9	69.1	2.0	0.0	0.0
12	Bērze (lejpus Dobeles)	641.7	50.9	43.1	1.7	1.2	3.1
13	Bērzes pieteka Sesava	89.5	44.8	53.2	0.0	0.9	1.1
14	Bērzes pieteka Ālave (Šķibe)	94.4	83.1	13.9	0.0	0.4	2.6
15	Bērze, Līvbērze	869.9	55.6	39.2	1.3	1.0	2.8

The Berze River – The city of Dobele

ID	Water sampling site	Catchment area, km²	Land use (% share in the catchment area)				
			Agricultural areas	Forest and semi-natural areas	Wetlands	Water bodies	Artificial surfaces
1	Līčupe	10.2	20.9	53.0	26.1	0.0	0.0
2	Bērze (Zebrene)	75.3	42.7	53.1	3.5	0.0	0.7
3	Bērze (augšpus Annenieku HES)	281.1	45.4	48.7	2.2	2.2	1.5
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7	Bērzes pieteka Rūšu strauts	45.4	63.0	35.6	0.0	0.2	1.2
8	Bērzes pieteka Bikstupe	147.3	58.5	38.0	0.7	0.5	2.3
9	Bērze (augšpus Dobeles)	609.3	50.1	44.8	1.8	1.3	2.0
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12	Bērze (lejpus Dobeles)	641.7	50.9	43.1	1.7	1.2	3.1
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14	Bērzes pieteka Ālave (Šķibe)	94.4	83.1	13.9	0.0	0.4	2.6
15	Bērze, Līvbērze	869.9	55.6	39.2	1.3	1.0	2.8

The Berze River – Wetlands and Water bodies

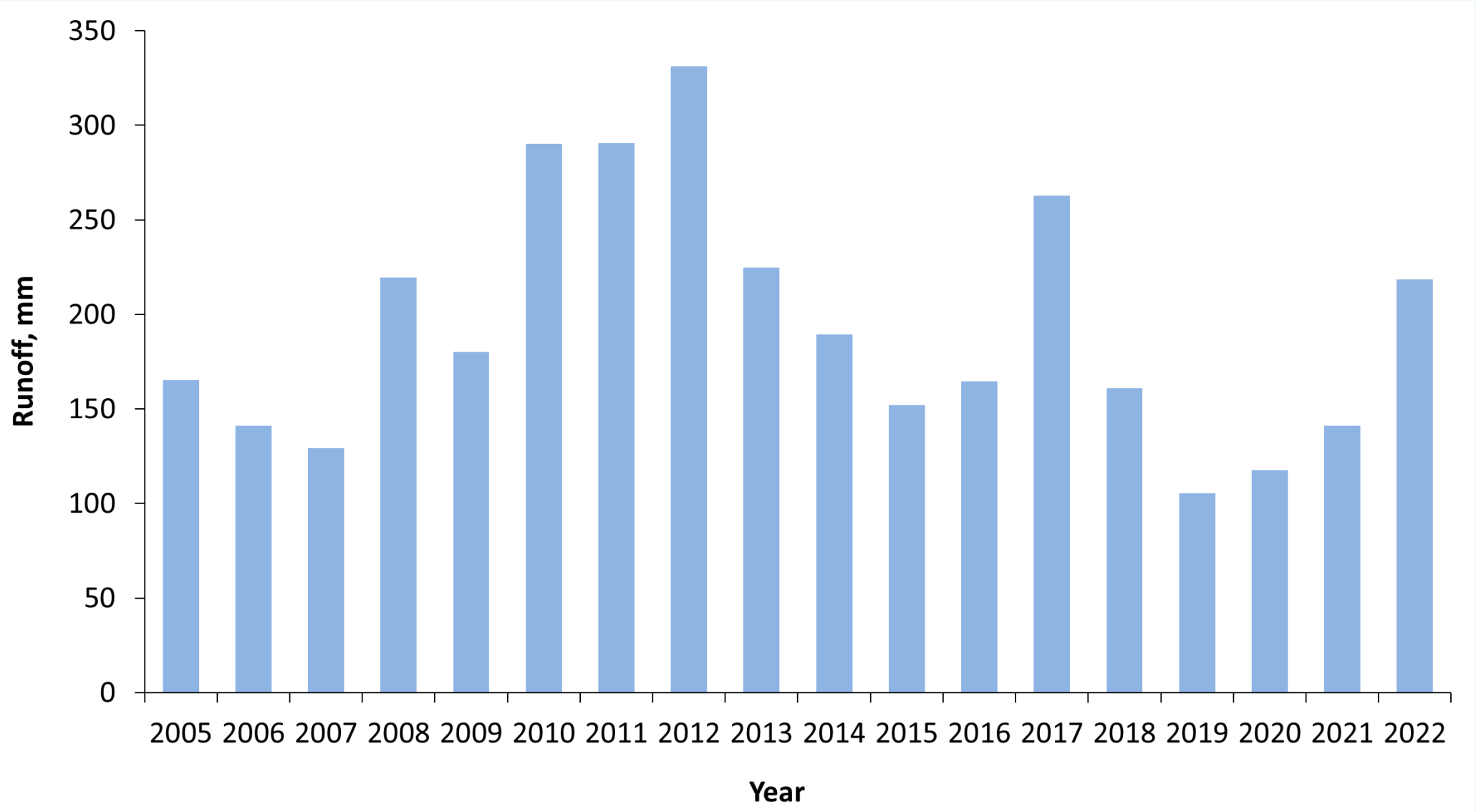
ID	Water sampling site	Catchment area, km²	Land use (% share in the catchment area)				
			Agricultural areas	Forest and semi-natural areas	Wetlands	Water bodies	Artificial surfaces
1	Līčupe	10.2	20.9	53.0	26.1	0.0	0.0
2	Bērze (Zebrene)	75.3	42.7	53.1	3.5	0.0	0.7
3	Bērze (augšpus Annenieku HES)	281.1	45.4	48.7	2.2	2.2	1.5
4	Bērzes pieteka Blīdene	57.2	33.5	62.8	1.3	0.9	1.6
5	Zušupīte (Zebrus ezers, izteka)	27.4	31.0	49.3	2.1	17.6	0.0
6	Bērze (lejpus Annenieku HES)	285.3	46.0	48.1	2.2	2.2	1.6
7	Bērzes pieteka Rūšu strauts	45.4	63.0	35.6	0.0	0.2	1.2
8	Bērzes pieteka Bikstupe	147.3	58.5	38.0	0.7	0.5	2.3
9	Bērze (augšpus Dobeles)	609.3	50.1	44.8	1.8	1.3	2.0
10	Bērzes pieteka Gardene	73.1	37.9	56.9	2.5	0.5	2.1
11	Gardenes augštece	20.8	28.9	69.1	2.0	0.0	0.0
12	Bērze (lejpus Dobeles)	641.7	50.9	43.1	1.7	1.2	3.1
13	Bērzes pieteka Sesava	89.5	44.8	53.2	0.0	0.9	1.1
14	Bērzes pieteka Ālave (Šķibe)	94.4	83.1	13.9	0.0	0.4	2.6
15	Bērze, Līvbērze	869.9	55.6	39.2	1.3	1.0	2.8

Geospatial information

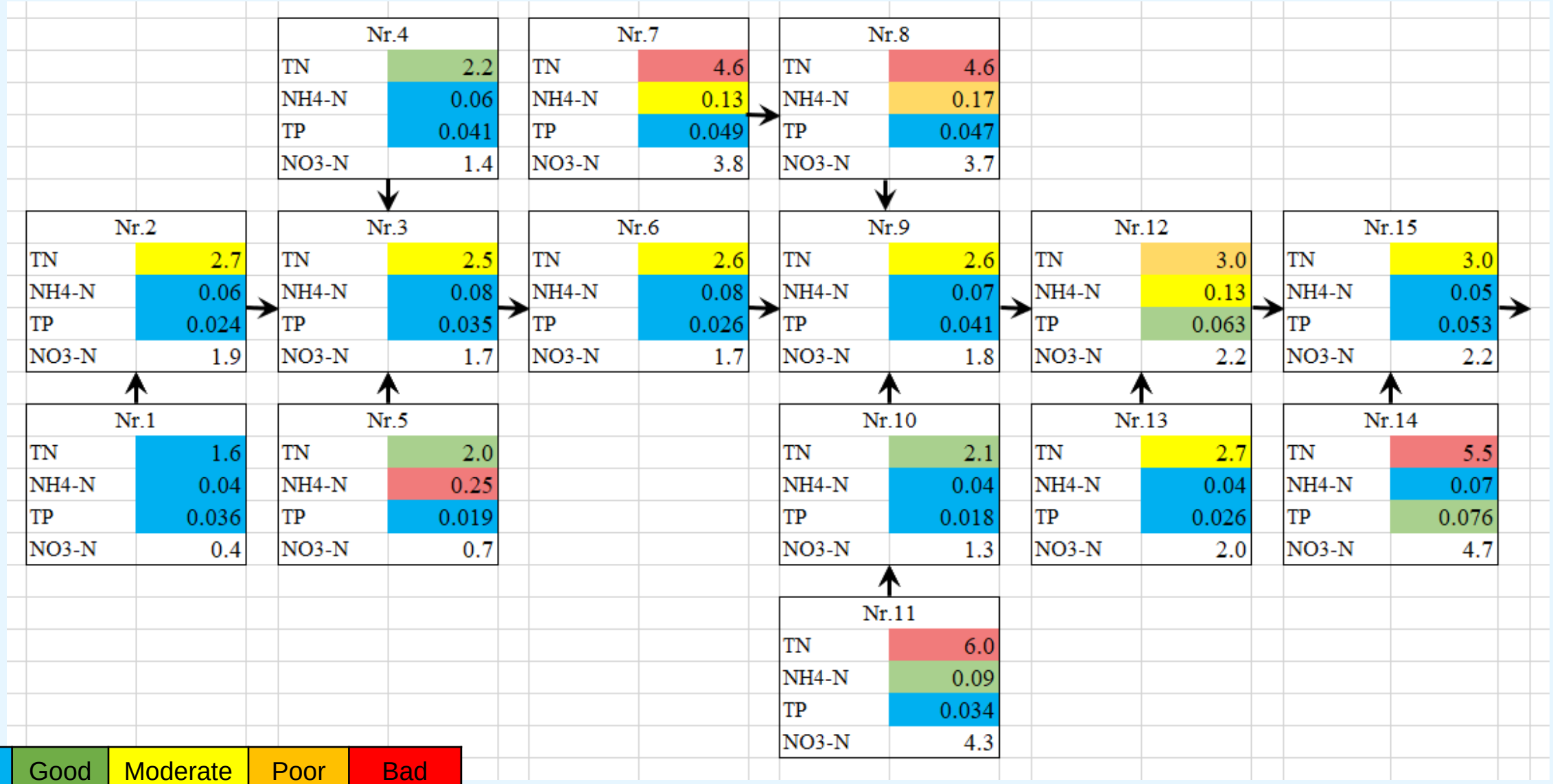
In recent years geospatial information have become more accessible and applicable to interpret the results of water quality monitoring and perform modelling tasks:

- **hydrological network including subsurface drains, collectors, open ditches, rivers,**
- **reservoirs, and lakes;**
- **land use;**
- **soils;**
- **agricultural crops;**
- **livestock facilities;**
- **small hydropower plants;**
- **wastewater treatment plants;**
- **digital elevation model.**

The Berze River – Hydrology (2005-2022)



The Berze River – Average nutrient concentrations (2005-2022)



High	Good	Moderate	Poor	Bad

The Berze River – Mann-Kendal trend test (2005-2023)

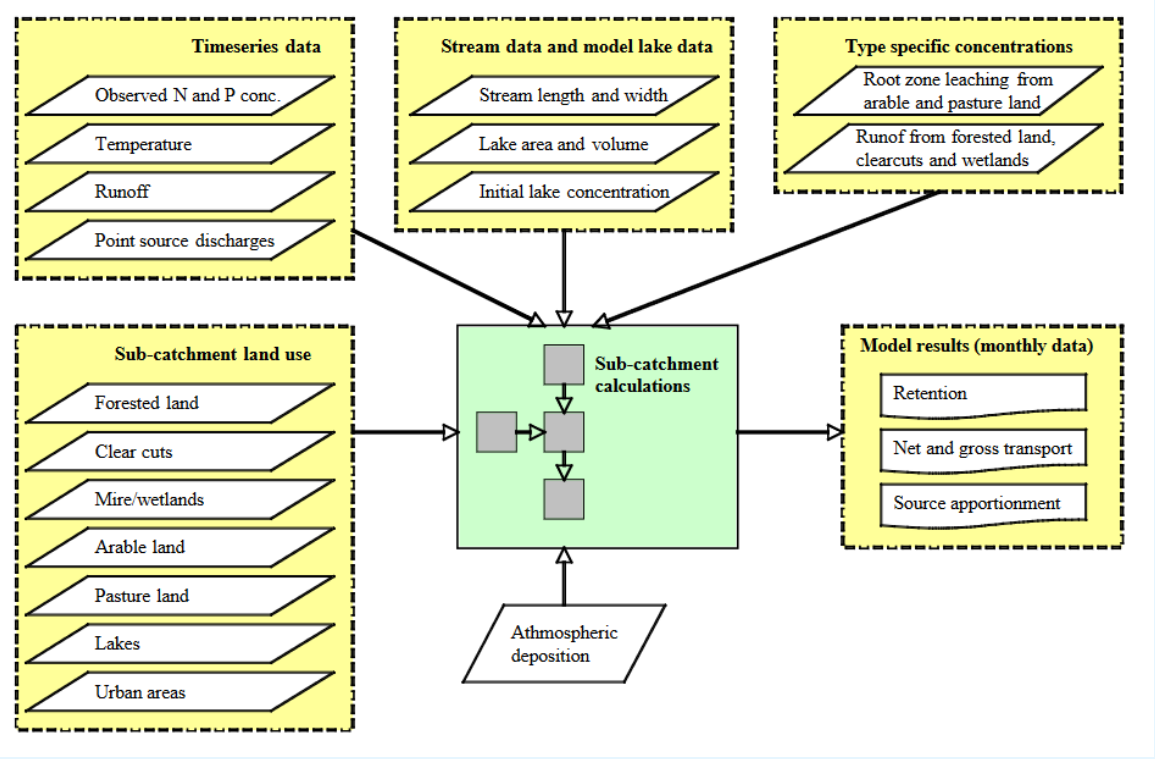
ID	Water sampling site	NO_3-N, mg L^{-1}	NH_4-N, mg L^{-1}	TN, mg L^{-1}	PO_4-P, mg L^{-1}	TP, mg L^{-1}
1	Līčupp	1.54	-0.85	0.08	-0.79	0.79
2	Bērze-Zebrene	**2.63**	-0.05	0.67	-1.86	-1.66
3	AnnA	1.24	-0.81	0.58	**-2.10**	**-1.97**
4	Blīd	**2.66**	0.56	1.88	-1.01	0.25
5	Zebr	0.90	-0.91	-0.12	**-3.60**	-0.29
6	AnnL	**2.30**	0.47	1.23	-1.92	-1.85
7	Jaunp	0.12	0.97	0.20	**-2.22**	-1.52
8	Bikstu	1.67	**2.64**	1.24	1.82	1.13
9	DobA	1.65	-0.09	0.37	-0.65	0.01
10	Gard	1.88	0.49	1.07	**-2.72**	-1.67
11	Gar-M	1.89	-1.85	1.39	**-2.60**	-1.75
12	DobL	**2.75**	1.85	**2.65**	0.83	1.03
13	Sesava	**2.62**	0.87	1.92	-1.66	0.28
14	Ālave	0.29	0.86	-0.28	-1.00	-0.79
15	Līvb	1.87	1.84	1.01	**-2.86**	-1.90

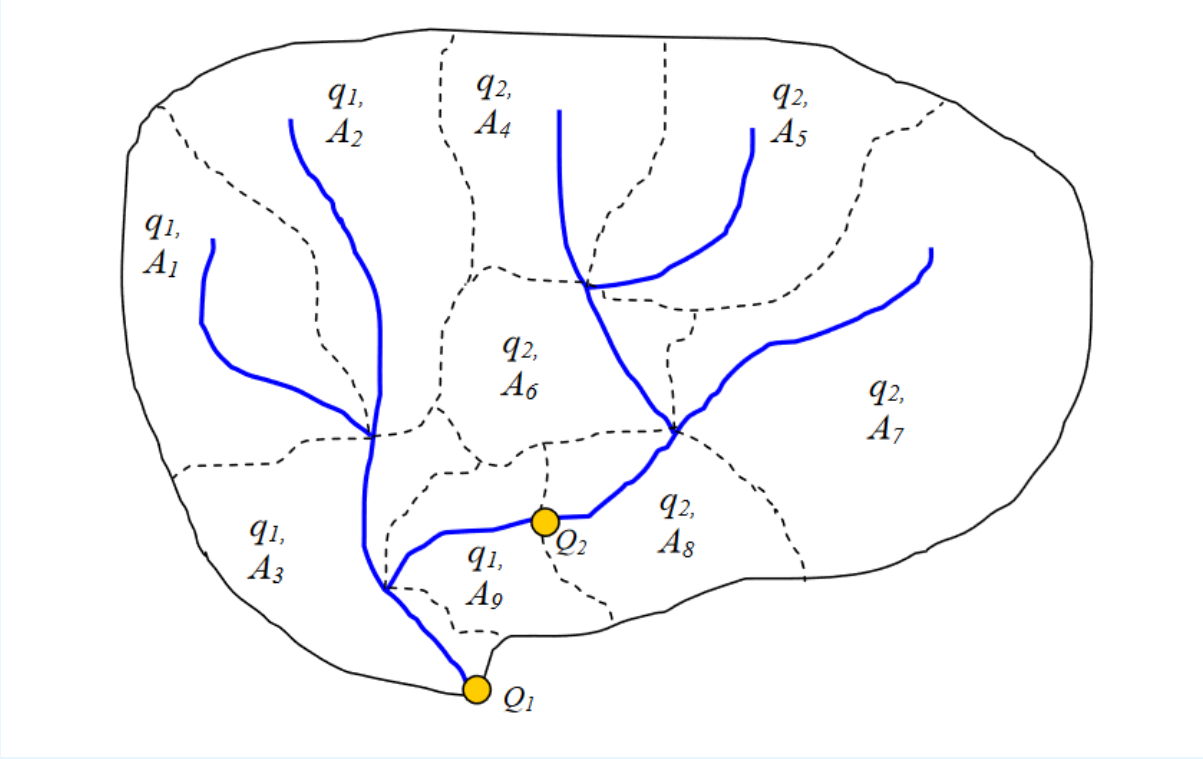
Bold – statistically significant trend ($p < 0.05$)

Application of FyrisNP

FyrisNP - A tool for catchment-scale modelling of source apportioned gross and net transport of nitrogen and phosphorus in rivers

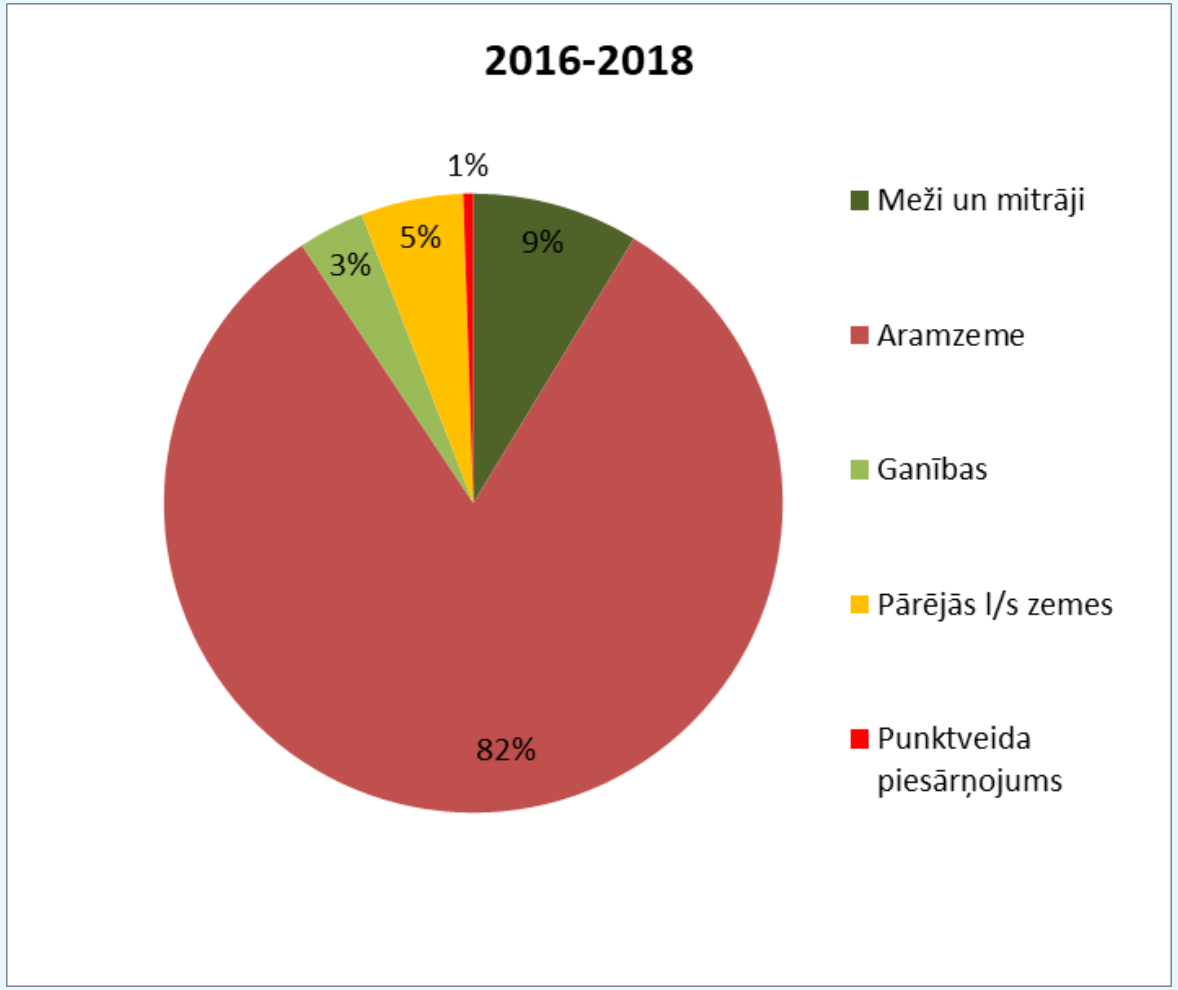
Developed by the Swedish University of Agricultural Sciences



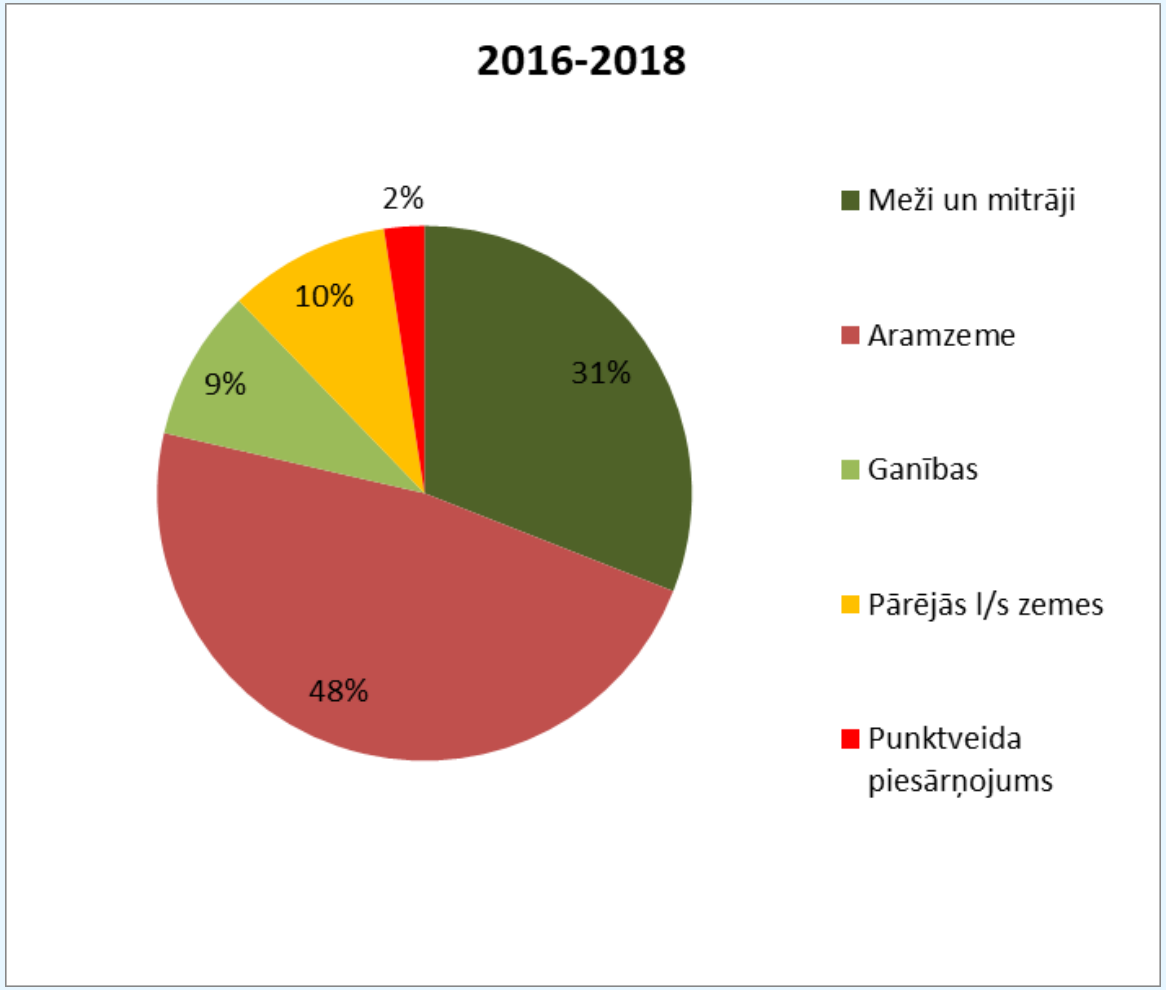


Source: https://www.slu.se/globalassets/ew/org/centrb/vanav/publikationer/fyrisnp/technical-description_fyrisnp_ver3.2_1.pdf

The results of FyrisNP for the Berze River



The sources of N in the Alave River

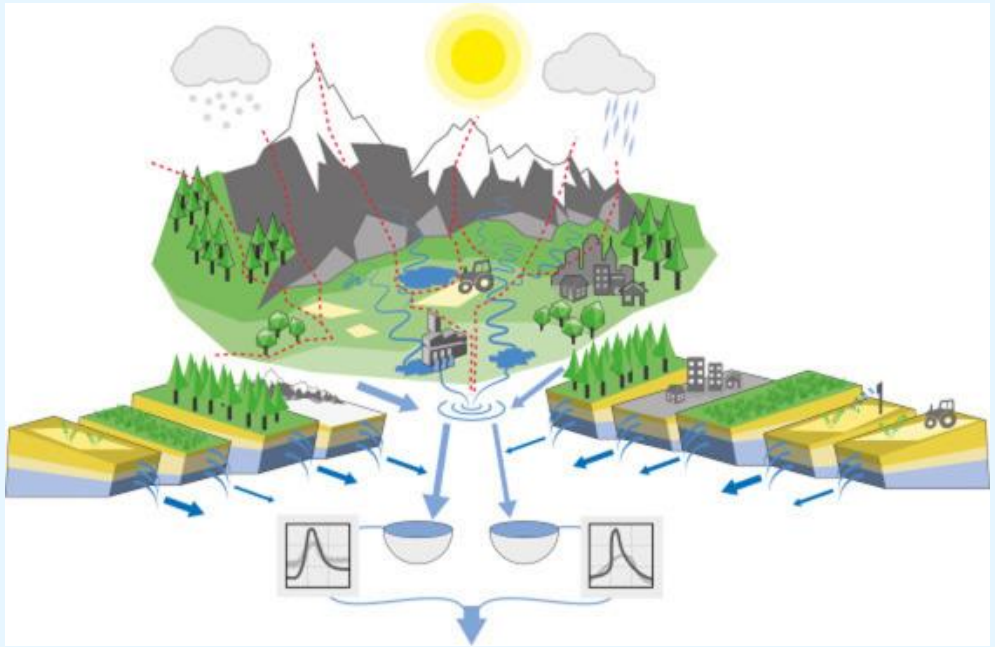


The sources of N at the outlet of the Berze River

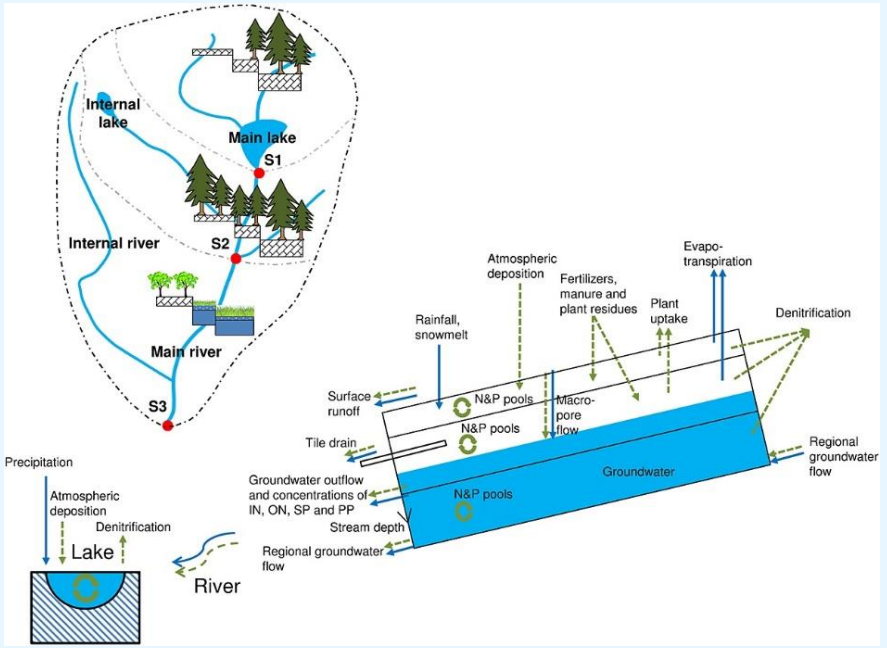
Application of HYPE

HYPE (HYdrological Predictions for the Environment) – simulates the sources, state, flow and transformation of water, nutrients and other substances in soil, lakes and rivers

Developed by the Swedish Meteorological and Hydrological Institute

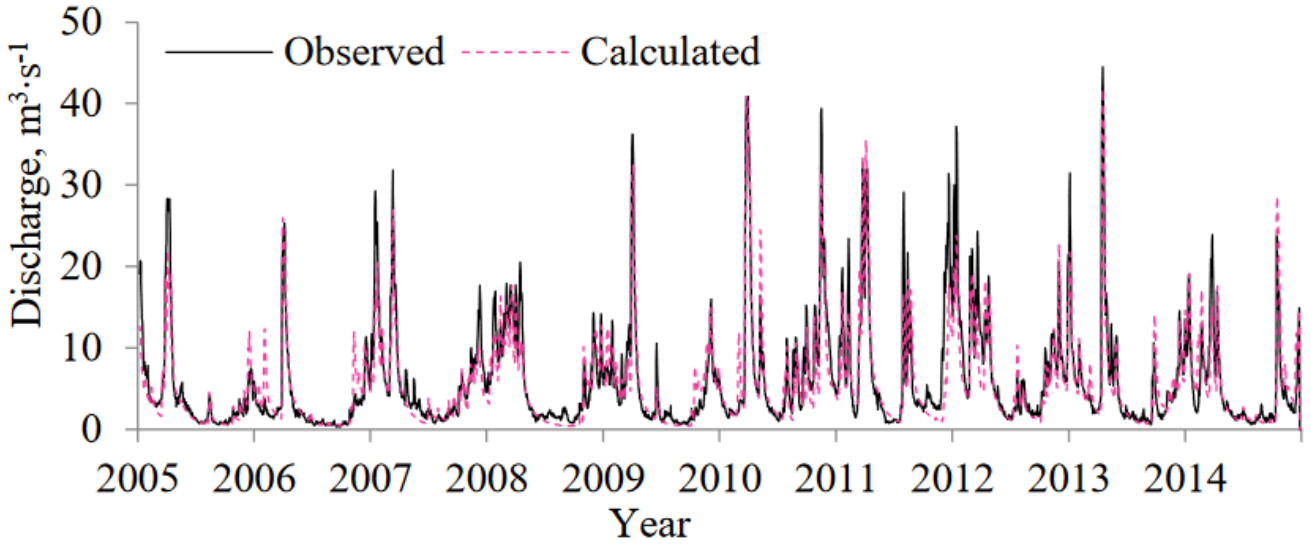


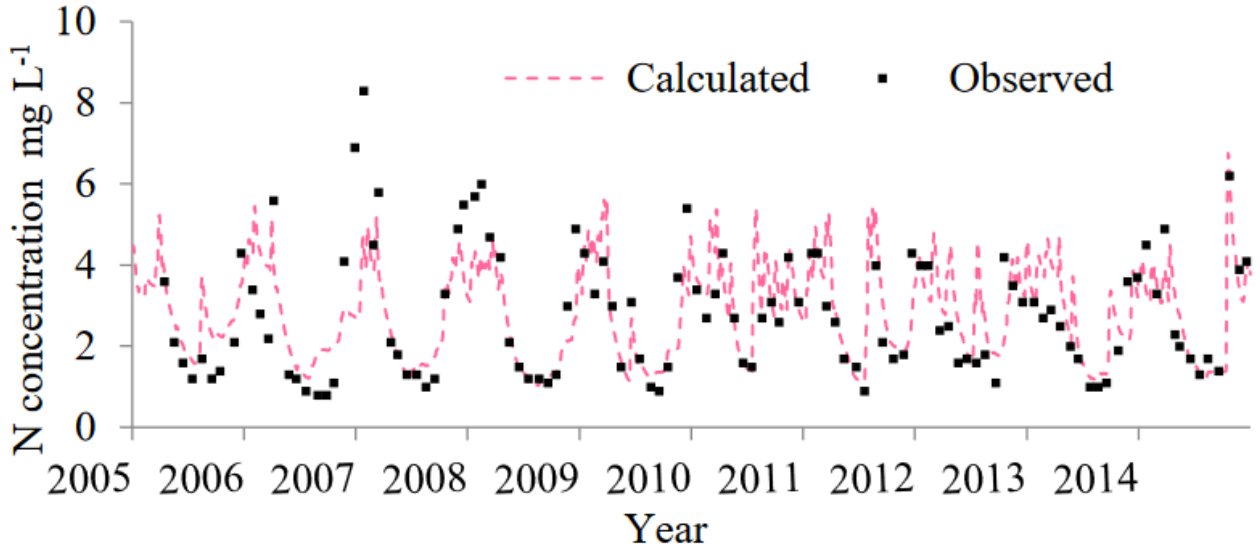
Source: Hundecha Y., Arheimer B., Donnelly C., Pechlivanidis I. (2016) A regional parameter estimation scheme for a pan-European multi-basin model. Journal of Hydrology: Regional Studies. Vol. 6, p. 90–111. https://doi.org/10.1016/j.ejrh.2016.04.002



Source: Jiang S., Jomaa S., Rode M. (2014) Modelling inorganic nitrogen leaching in nested mesoscale catchments in central Germany. Ecohydrology. Vol. 7 (5), p. 1345–1362. https://doi.org/10.1002/eco.1462

The results of HYPE for the Berze River



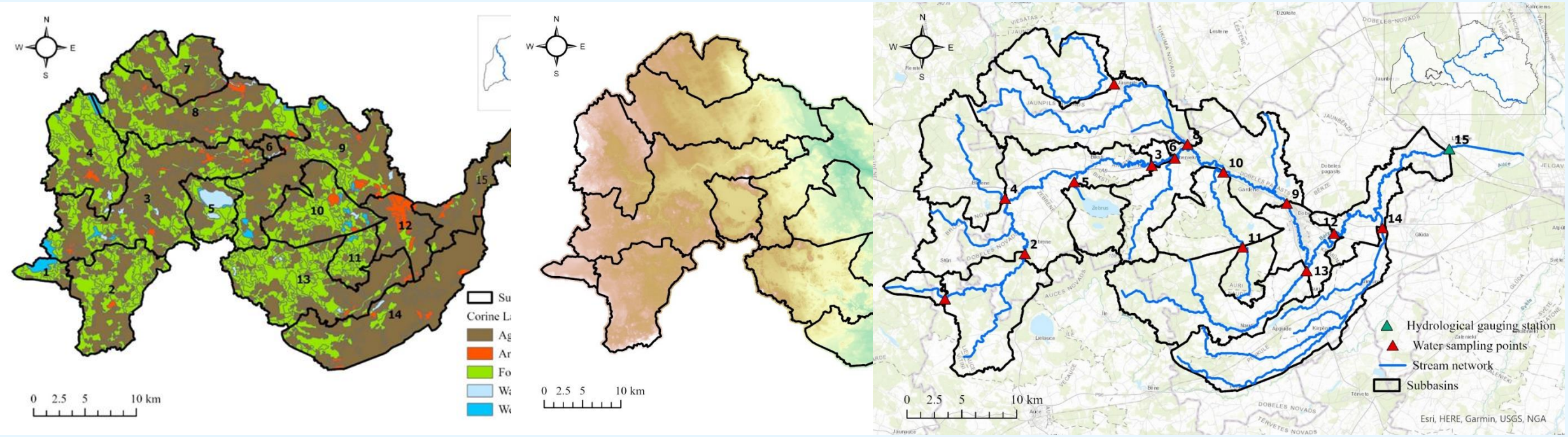


Source: Veinbergs A. (2020) The simulation of hydrochemical parameters for poorly gauged river catchments. PhD thesis. https://llufb.llu.lv/dissertation-summary/hydrology/Arturs-Veinbergs_LI05233_prom_darba_kopsavilkums2020_LLU_VBF.pdf

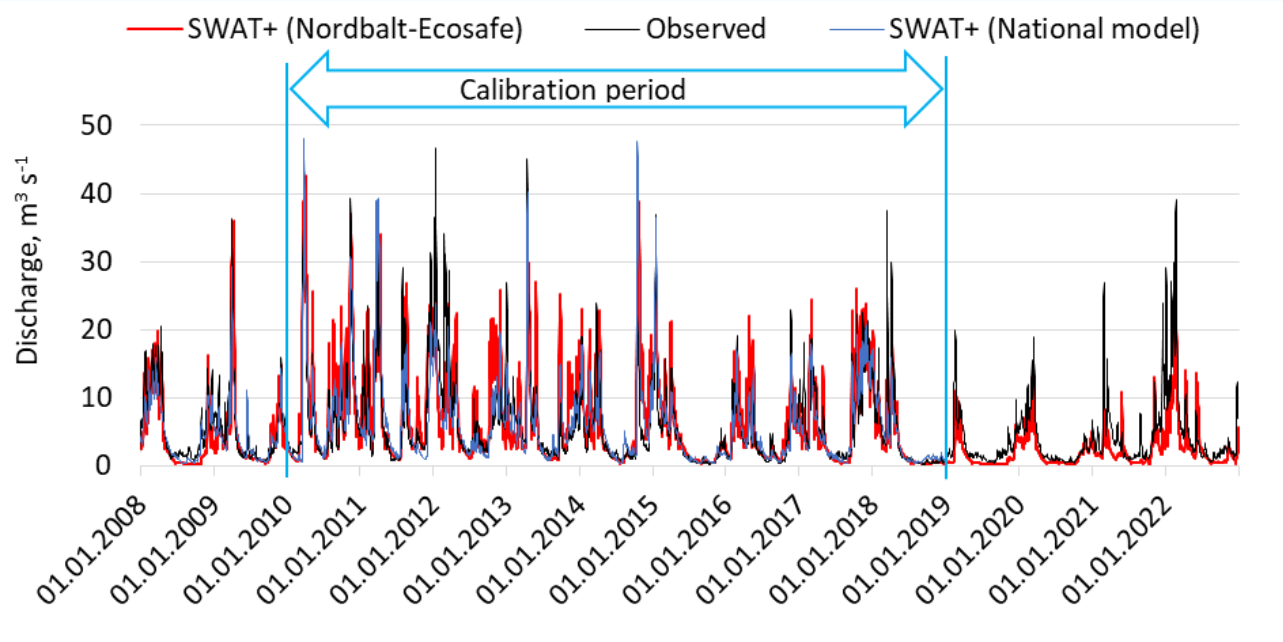
Application of SWAT+

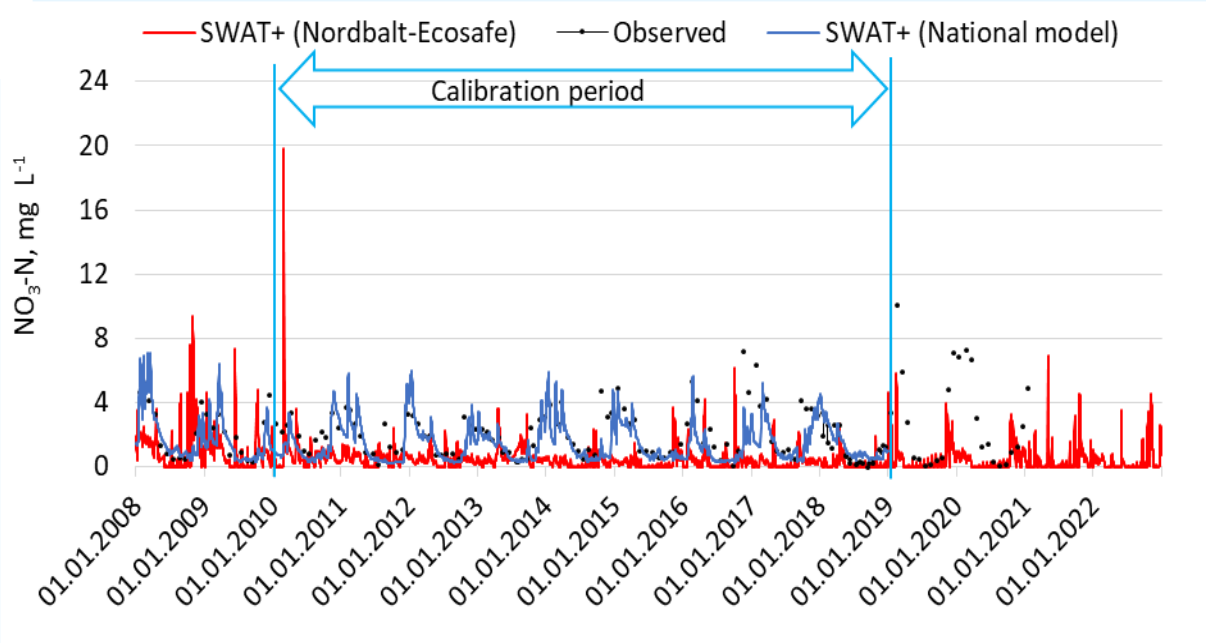
SWAT+ (The Soil & Water Assessment Tool) - a small watershed to river basin-scale model used to simulate the quality and quantity of surface and ground water and predict the environmental impact of land use, land management practices, and climate change

Developed by the Texas A&M University and USDA Agricultural Research



The results of SWAT+ for the Berze River





SWAT+ modelling tasks within the NORDBALT-ECOSAFE project

The monitoring data and geospatial information collected, systematized and analyzed has become of high importance to perform SWAT+ modelling tasks within the NORDBALT-ECOSAFE project in order to simulate the effects of the following measures:

- **buffer strips;**
- **crop rotation;**
- **application rates of mineral and organic fertilizers;**
- **constructed wetlands.**

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101060020

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NORDBALT ECOSAFE

Thank you for your attention!

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