Assessment methodology of riverine ecosystem services in Estonia

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Background

- One of the aims of the CleanEST project is to develop a practically applicable methodology for assessing ES of inland water bodies (rivers and lakes) and to test that methodology in the project area – the Viru subcatchment in northeastern Estonia.
- The services have to be assessed three times during the course of the project: in the beginning (2020), in the middle (2023) and in the end (2027).
- The project concentrates on improving the status of river ecosystems, therefore that ES assessment methodology was developed first.
- In 2016, the assessment methodology of aquatic ecosystem services (rivers, lakes, marine ecosystems) was compiled in Estonia (Kosk et al. 2016).
- It was not applied in practice and the full spectrum of ES has not been assessed in any aquatic ecosystem in Estonia, until now.

Selection of services

- The list of services and indicators from the 2016 methodology was taken as a starting point.
- 17 ES were chosen as important for Estonian riverine ecosystems.
- List of services is (mostly) in accordance with the CICES v.5.1 classification.

Provisioning services
Fish stock for professional fishing – CICES v5.1: 1.1.6.1
Animal and plant material collected for the purposes of maintaining or establishing a population – CICES v5.1: 1.2.2.1, 1.2.1.1
Surface water for drinking – CICES v5.1: 4.2.1.1
Surface water used for other non-drinking purpose – CICES v5.1: 4.2.1.2
Surface water used as an energy source – CICES v5.1: 4.2.1.3
Maintaining and regulating services
Maintaining nursery populations and habitats – CICES v5.1: 2.2.2.3
Dilution and meditation of wastes or toxic substances in surface and groundwater – CICES v5.1: 2.1.1, 5.1.1.1
Maintaining drainage and waste water discharge – CICES v.5.1: 5.2.2.1
Regulation of the chemical condition of freshwater by living organisms (buffer zones on shores) – CICES v5.1: 2.2.5.1

Cultural services
Conditions supporting active recreation – CICES v5.1: 3.1.1.1
Conditions supporting recreational fishing and hunting – CICES v5.1: 3.1.1.1
Conditions supporting passive recreation – CICES v5.1: 3.1.1.2
Conditions that enable scientific investigation – CICES v5.1: 3.1.2.1
Conditions that enable education and training – CICES v5.1: 3.1.2.2
Conditions that enable aesthetic experiences – CICES v.5.1: 3.1.2.4
Provision of cultural, religious and national symbols – CICES v5.1: 3.1.2.3, 3.2.1.1, 3.2.1.2
Maintaining protected and vulnerable species – CICES v5.1: 3.2.2.2.

Not included - Conditions that enable creative work – CICES v5.1: 3.2.1.3. It was considered to be a significant service in Estonia, but is not possible to differentiate its provision by water bodies and measuring the consumption of the service is problematic.

Not included – Hydrological cycle and water flow regulation (Including flood control, and coastal protection) – CICES v5.1: 2.2.1.3. It was considered to be a service provided by terrestrial ecosystems, rather than aquatic.

Indicators

- Two types of indicators were selected:
  - Indicators for the provision/status/functioning/capacity of the service (S).
  - Indicators for the consumption/flow/pressure of/on the service (P).
- Indicators, where data is readily available in existing databases, were preferred.

Fish stock for professional fishing	P Amount of professional catch from the river (t/yr)
	S Fishing resource production (pcs/yr)
Animal and plant material collected for the purposes of maintaining or establishing a population	P Number of animals caught for relocation or breeding material (pcs/yr)
	S Composite index of significance of the provision of the service of maintaining or establishing a population (index)
Surface water for drinking	P Number of drinking water intakes (no)
	P Abstraction of surface water for drinking water (m^3/s)
	S Average minimal monthly discharge that exceeds environmental flow (m^3/s)
	S Accordance of water quality to quality requirements of water used to produce drinking water (quality class)
Surface water used for other non-drinking purpose	P Number of surface water intakes for industrial, irrigation or agricultural water (pcs)
	P Abstraction of surface water for industrial, irrigation or agricultural water (m^3/s)
	P Number of surface water intakes for cooling or aquaculture water (pcs)
	P Abstraction of surface water for cooling or aquaculture water (m^3/s)
	S Average minimal monthly discharge that exceeds environmental flow (m^3/s)
Surface water used as an energy source	P Number of hydropower plants (no)
	P Capacity of hydropower plants (MW)
	S Hydro-energetic potential of the water body (MW)
Maintaining nursery populations and habitats	P Hydromorphological status (status class)
	P Water quality status (status class)
	P Status of aquatic biota in neighbouring water bodies (index)
	S Status of aquatic biota (index)
	S Area of surface water dependent terrestrial ecosystems (ha)
Dilution and meditation of wastes or toxic substances in surface and groundwater	P Point source pollution (point-source pollution index)
	P Nutrient load via diffuse pollution N+P (diffuse pollution index)
	S Water quality status (status class)

Indicators (*continued*)

Maintaining drainage and waste water discharge	P Area of improved land for which the water body is the recipient (ha)
	P Share of water body length that has been declared as recipient for land improvement systems (%)
	P Number of storm and wastewater outlets to the water body (pcs)
	P Discharge of storm- and wastewater to the catchment of the water body (thous m^3/yr)
	S River sinuosity index
	S River gradient (m/km)
	S Share of the water body with restrictions for establishing or renewing land improvement systems (%)
Regulation of the chemical condition of freshwater by living organisms (buffer zones on shores)	P Share of recently (in 4–5 years) clear-cut land or forests with similar disturbance on the shore area of the water body (%)
	P Share of non-natural land cover on the shore area of the water body (%)
	S Share of full-grown forests on the shore area of the water body (%)
	S Share of natural land cover on the shore area of the water body (%)

Conditions supporting active recreation	P Number of organised canoeing/kayaking, etc. trips on the water body (pcs/yr)
	P Number of people using the water body for swimming (pcs/yr)
	P Number of hikers/walkers on the shore area of the water body (pcs/yr)
	S Length of the water body suitable for canoeing/kayaking, etc. (km)
	S Number of dams on the section of the water body suitable for canoeing/kayaking, etc. (pcs)
	S Number of swimming places on the shore of the water body (pcs)
	S Length of roads/trail suitable for walking/hiking on the shore area of the water body (km)
Conditions supporting recreational fishing and hunting	P Number of recreational fishers (pcs/yr)
	P Number of crayfish catchers (pcs/yr)
	P Number of beaver hunters (pcs/yr)
	S Attractiveness for fishing (grade)
	S Legal possibility for recreational fishing (yes/no)
	S Crayfish abundance (grade)
	S Legal possibility for crayfish catching (yes/no)
	S Number of beaver families on the water body (pcs)

Indicators (*continued*)

Conditions supporting passive recreation	P Number of users of rest stop sites on the shore of the water body (pcs/yr)
	P Number of nights spent in accommodation facilities near the water body (pcs/yr)
	P Number of unique nature observations in the shore area of the water body (pcs/yr)
	S Number of rest stop sites on the shore of the water body (pcs)
	S Number of accommodation facilities on the shore of the water body (pcs)
	S Share of natural land cover in the shore area of the water body (%)
	S Number of residential properties adjacent to the water body (pcs)

Conditions that enable scientific investigation	P Number of scientific publications (pcs)
	P Number of public monitoring data (pcs)
	S *All water bodies are considered equally valuable for scientific investigation therefore no indicator is determined.*

Conditions that enable education and training	P Number of educational trips in nature and public schools related to the water body (pcs/yr)
	S Number of educational programmes in nature and public schools related to the water body (pcs)
Conditions that enable aesthetic experiences	P Number of photos in the web depicting the water body (pcs)
	S Attractiveness for landscape watching (index)
Provision of cultural, religious and national symbols	P Number of visitors of natural symbolic sites (pcs/yr)
	S Number of natural symbols (pcs)
	S Number of folklore items related to the water body (pcs)
Maintaining protected and vulnerable species	P Hydromorphological status (status class)
	P Water quality status (status class)
	S Amount of protected species (index)
	S Status of protected species (grade)
	S Share of salmonid habitats of the water body length (%)

Assessment on a common scale

- In order to compare the situation between the water bodies and between the services, the indicators had to be normalised on a 0–4 scale.
- For the services, where several indicators of provision or consumption were used, their share in the total score of provision or consumption had to be fixed.
- For example:

Ecosystem service	Score of ES provision	Indicator I	Indicator II
Maintaining nursery populations and habitats		Ecological status according to biological elements (index)	Area of surface water dependent terrestrial ecosystems (ha)
	0	0–0.4	0
	1	0.5–1.4	<10
	2	1.5–2.4	10–99
	3	2.5–3.4	100–499
	4	3.5–4.0	>=500
	Share of indicator	*0,75*	*0,25*

Ecosystem service	Score of ES provision	Indicator I		Indicator II	Indicator III
Conditions supporting active recreation		Suitability for boating		Number of swimming places on the shore of the water body (pcs)	Length of roads/trail suitable for walking/hiking on the shore area of the water body (km)
		Length of the water body suitable for canoeing/kayaking, etc. (km)	Number of dams on the suitable section of the water body (pcs)		
	0	0	>=6	0	<0,5
	1	1–4	4–5	1	0,5-1
	2	5–9	2–3	2–3	2-4
	3	10–19	1	4–5	5-9
	4	>=20	0	>=6	>=10
	Share of indicator	*0,6*	*0,4*	*0,2*	*0,4*
		0,6			

Prioritisation of the services

- All of the 17 services are not equally important for the society. Therefore the services were ordered by the working group members and the relative importance of the first and last service in the list was estimated. Based on that ES weights were calculated.

No	Ecosystem service	Weight
1	Maintaining nursery populations and habitats	4.0
2	Dilution and meditation of wastes or toxic substances in surface water	4.0
3	Maintaining protected and vulnerable species	3.0
4	Regulation of the chemical condition of freshwater by living organisms (buffer zones on shores)	2.75
4	Conditions supporting recreational fishing and hunting	2.75
4	Maintaining drainage and waste water discharge	2.75
7	Surface water for drinking	2.25
8	Conditions supporting active recreation	2.0
8	Animal and plant material collected for the purposes of maintaining or establishing a population	2.0
10	Surface water used for other non-drinking purpose	2.0
11	Fish stock for professional fishing	1.75
11	Conditions supporting passive recreation	1.75
11	Conditions that enable aesthetic experiences	1.75
14	Conditions that enable education and training	1.5
14	Conditions that enable scientific investigation	1.5
16	Provision of cultural, religious and national symbols	1.25
17	Surface water used as an energy source	1.0

Ecosystem services index

- In order to compare water bodies, the ecosystem services index (*ÖSTI*) was proposed in the 2016 methodology. The value of the index is between 0 and 1, but will never reach 1,0.
- May be calculated for both, provision (*ÖSTI$_p$*) and consumption (*ÖSTI$_c$*).
- That index was modified in the current methodology to include the weights:

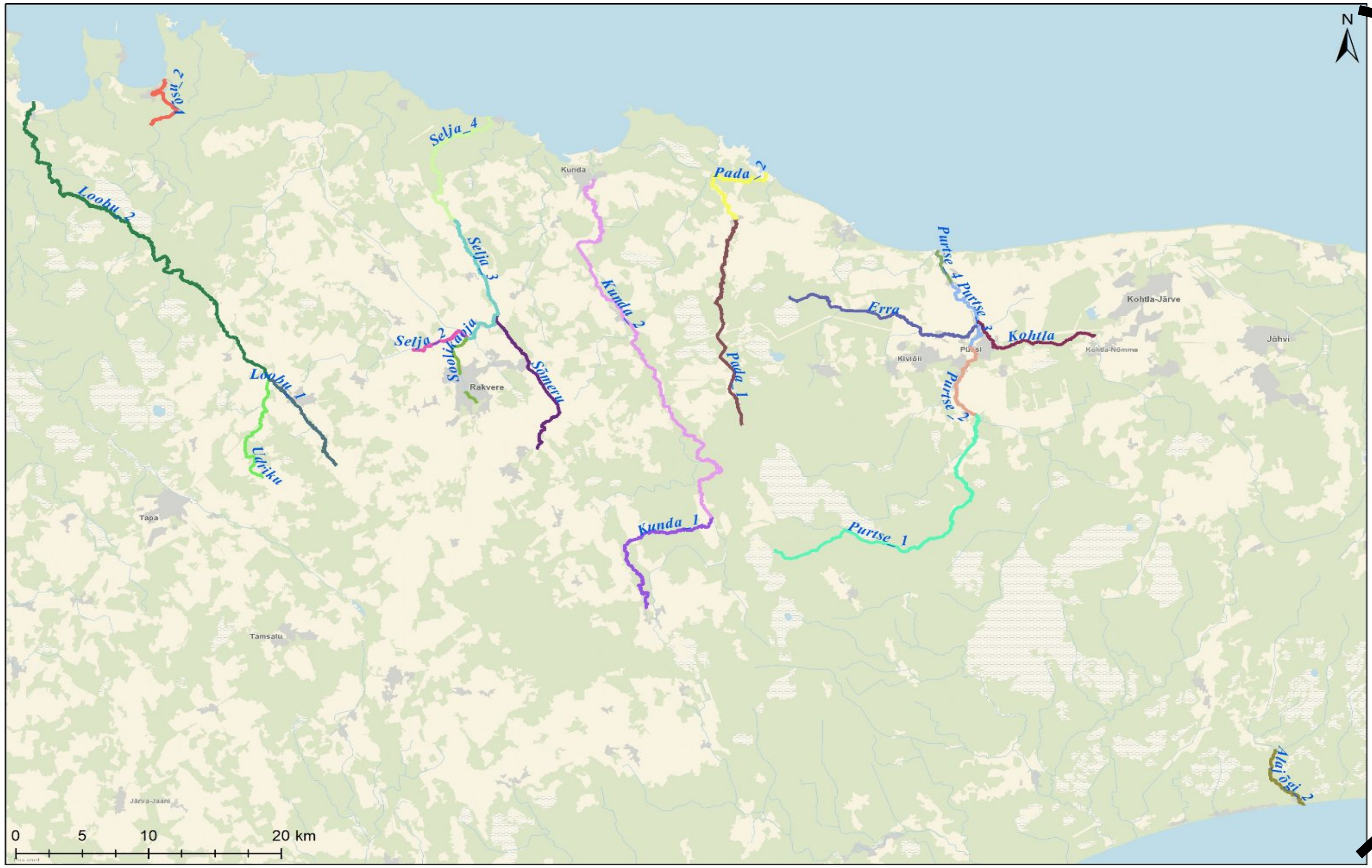
$$\text{Ö}STI = \frac{\sum_i^n (kx_p)}{4 * \sum_i^n (k)}$$

n – number of evaluated ecosystem services, *k* – weight of the i-th ES, *x* – the value of provision or consumption of the i-th ecosystem service.

For the calculation of *ÖSTIc* the services whose larger consumption does not result in increased pressure on the riverine ecosystem are not taken into account: Conditions that enable aesthetic experiences; Con. that enable education and training; Con. that enable scientific investigation; and Provision of cultural, religious and national symbols.

Application

- 20 riverine water bodies in the Viru subcatchment in northeastern Estonia.



Data from 2019/2020 was used to assess all the indicators.

The results of an example service

Conditions supporting active recreation									
Water body	P Number of organised canoeing/kayaking, etc. trips on the water body (pcs/yr)	P Number of people using the water body for swimming (pcs/yr)	P Number of hikers/walkers on the shore area of the water body (pcs/yr)	S Length of the water body suitable for canoeing/kayaking, etc. (km)	S Number of dams on the section of the water body suitable for canoeing/kayaking, etc. (pcs)	S Number of swimming places on the shore of the water body (pcs)	S Length of roads/trails suitable for walking/hiking on the shore area of the water body (km)	Score of ES consumption	Score of ES provision
Alajõgi_2	0	1700	4600	0	0	1	4	2	1
Erra	0	0	1800	0	0	0	9	1	1
Kohtla	0	0	2200	0	0	0	3	1	1
Kunda_1	0	300	1900	0	0	0	3	1	1
Kunda_2	8	1100	4700	29	0	3	12	3	4
Loobu_1	4.3	1000	5100	1	0	1	4	2	2
Loobu_2	4.3	1000	4000	39	2	4	7	2	3
Pada_1	0	0	2400	0	0	0	4	1	1
Pada_2	0	0	1100	0	0	0	3	1	1
Purtse_1	0	300	1000	0	0	0	11	1	2
Purtse_2	9.3	1300	3900	8	3	2	5	3	2
Purtse_3	12	300	2900	8	2	0	3	3	2
Purtse_4	12	1000	6100	3	0	1	2	3	2
Selja_2	0	600	1300	0	0	1	1	1	1
Selja_3	0.7	200	900	5	0	0	3	1	2
Selja_4	0.7	700	2200	18	1	1	2	2	2
Soolikaoja	0	100	8800	0	0	0	5	1	1
Sõmeru	0	300	1600	0	0	1	4	1	1
Udriku	0	0	600	0	0	0	2	0	1
Võsu_2	0	0	7700	0	0	0	5	1	1

ES provision

Water body	Fish stock	Pop. maintaning	Drinking water	Other water	Energy	Habitats	Water quality	Drainage and waste water discharge	Buffer zones on shores	Active recreation	Rec. fishing and hunting	Passive recreation	Science	Education	Aesthetics	Symbols	Important species
Alajõgi_2	0	2	3	2	0	2	1	2	3	1	2	2	4	0	2	0	1
Erra	0	1	2	2	0	3	1	3	2	1	2	2	4	1	1	1	1
Kohtla	0	1	0	2	1	1	1	3	3	1	1	2	4	0	2	1	1
Kunda_1	0	2	2	2	0	3	1	1	3	1	2	2	4	0	1	1	3
Kunda_2	0	3	0	3	1	3	4	2	2	4	3	2	4	3	2	2	3
Loobu_1	0	2	2	2	0	2	0	2	2	2	2	2	4	2	2	3	4
Loobu_2	3	3	4	2	1	3	1	2	3	3	3	3	4	1	2	2	4
Pada_1	3	1	0	2	0	3	1	2	3	1	3	3	4	0	2	3	3
Pada_2	3	2	2	2	0	3	1	1	3	1	2	2	4	0	2	0	3
Purtse_1	0	2	1	2	1	3	1	3	3	2	2	2	4	0	1	1	2
Purtse_2	0	2	0	2	1	2	1	3	2	2	1	2	4	1	3	1	2
Purtse_3	3	3	0	3	2	2	1	4	2	2	2	2	4	1	3	2	3
Purtse_4	2	2	0	3	1	2	1	4	2	2	2	1	4	0	4	1	3
Selja_2	0	1	0	2	0	2	2	2	3	1	2	2	4	0	2	0	2
Selja_3	0	3	0	2	0	2	1	2	2	2	2	1	4	0	1	1	3
Selja_4	3	3	4	2	0	3	1	2	3	2	2	2	4	0	3	2	2
Soolikaoja	0	1	0	2	0	1	1	4	2	1	2	2	4	4	2	0	1
Sõmeru	0	2	0	2	0	3	1	2	2	1	2	1	4	0	1	2	3
Udriku	0	2	2	2	0	2	2	2	2	1	1	1	4	0	1	1	2
Võsu_2	1	2	0	2	0	2	1	2	3	1	1	4	4	0	3	0	2

ES consumption/pressure

Water body	Fish stock	Pop. maintaning	Drinking water	Other water	Energy	Habitats	Water quality	Drainage and waste water discharge	Buffer zones on shores	Active recreation	Rec. fishing and hunting	Passive recreation	Science	Education	Aesthetics	Symbols	Important species
Alajõgi_2	0	0	0	0	0	2	1	1	0	2	2	2	2	0	1	0	3
Erra	0	0	0	0	0	3	1	1	1	1	1	1	2	2	1	3	3
Kohtla	0	0	0	0	0	2	3	1	1	1	0	2	4	0	0	4	3
Kunda_1	0	0	0	0	0	2	2	1	0	1	2	2	2	0	1	0	3
Kunda_2	0	0	0	1	0	1	2	2	1	3	3	2	3	3	2	3	2
Loobu_1	0	0	0	0	0	3	2	1	1	2	3	2	1	2	1	3	3
Loobu_2	1	0	0	0	1	2	2	1	1	2	3	3	2	3	2	4	3
Pada_1	0	0	0	0	0	2	2	1	0	1	2	2	1	0	1	4	3
Pada_2	1	0	0	0	0	2	2	1	1	1	1	1	2	0	0	0	3
Purtse_1	0	0	0	0	0	2	1	2	1	1	2	2	3	0	1	0	3
Purtse_2	0	0	0	0	0	2	3	2	1	3	2	2	3	1	1	0	3
Purtse_3	0	0	0	1	1	2	3	2	1	3	2	2	4	1	1	0	3
Purtse_4	0	0	0	0	0	2	3	2	1	3	2	2	4	0	1	0	3
Selja_2	0	0	0	0	0	2	3	1	1	1	2	1	2	0	1	0	2
Selja_3	0	0	0	0	0	3	3	3	1	1	2	1	3	0	1	4	3
Selja_4	1	0	0	0	0	2	2	2	0	2	2	1	3	0	0	0	3
Soolikaoja	0	0	0	0	0	3	4	1	1	1	1	2	1	4	2	0	4
Sõmeru	0	0	0	1	0	3	3	1	1	1	2	2	1	0	2	4	3
Udriku	0	0	0	0	0	2	2	1	1	0	1	1	0	0	0	0	3
Võsu_2	0	0	0	0	0	3	2	1	0	1	1	2	1	0	1	0	3

Ecosystem service index and its relevance for water management

The results of the assessment in the Viru subcatchment:

Water body	ESI provision/status	ESI consumption/pressure
Loobu_2	0.66	0.38
Kunda_2	0.64	0.36
Selja_4	0.57	0.34
Purtse_3	0.55	0.43
Pada_1	0.52	0.30
Purtse_4	0.51	0.41
Pada_2	0.49	0.28
Loobu_1	0.48	0.39
Purtse_1	0.47	0.29
Kunda_1	0.45	0.30
Purtse_2	0.43	0.41
Erra	0.43	0.29
Võsu_2	0.42	0.31
Alajõgi_2	0.42	0.29
Selja_3	0.41	0.42
Sõmeru	0.41	0.40
Selja_2	0.41	0.30
Udriku	0.40	0.23
Soolikaoja	0.39	0.42
Kohtla	0.35	0.29

Relevance of the results:

- It is possible to pinpoint, which water bodies provide the least ecosystem services and to channelize more effort to them.
- It is possible to assess the effect of mitigation projects with a single number – if the value of the index increases, even just a bit, then the provision of ES's has increased in that water body and the effort has been justified.
- It is possible to evaluate, whether a proposed development is acceptable or not. If the *ÖSTI* is expected to increase or stay stable as a result of that development, then it is acceptable. If the *ÖSTI* decreases, then not. So it could be used as a new methodology for environmental impact assessments.
- The Environmental Ministry wishes that ES assessment results would be used for evaluating the effectiveness of River Basin Management Plans. Whether it is achievable, will be seen in the next steps.

Report (summary in English):
https://lifecleanest.ee/okosusteemiteenuste-hindamine

Challenges (instead of conclusions)

- Data acquisition – Though data for most of the indicators is available in national databases, there are still (too) many indicators that require specific data collection. Especially for the indicators of consumption. The need for specific data collection makes the application of the methodology on a larger scale expensive.
- Subjectivity – There will always be subjectivity in the assessment. The order of importance of the services, the share of indicators in the total score of a service, the scales used for normalisation – there will always be stakeholders with differing value judgement.

Virumaa veed puhtaks!

Let’s clean the waters of Virumaa!

LIFEConnects

LIFE CONNECTS
- towards restored ecosystem services in rivers

Rönne å River, 1817

Länsstyrelsen Skåne

KLIPPANS KOMMUN

uniper

SportFiskarna

Havs och Vatten myndigheten

Länsstyrelsen Kalmar län

Life

Karin Olsson, PhD | Project Manager *LIFE CONNECTS*

County Administrative Board Skåne

LIFE CONNECTS

The LIFE CONNECTS project:

7 partners

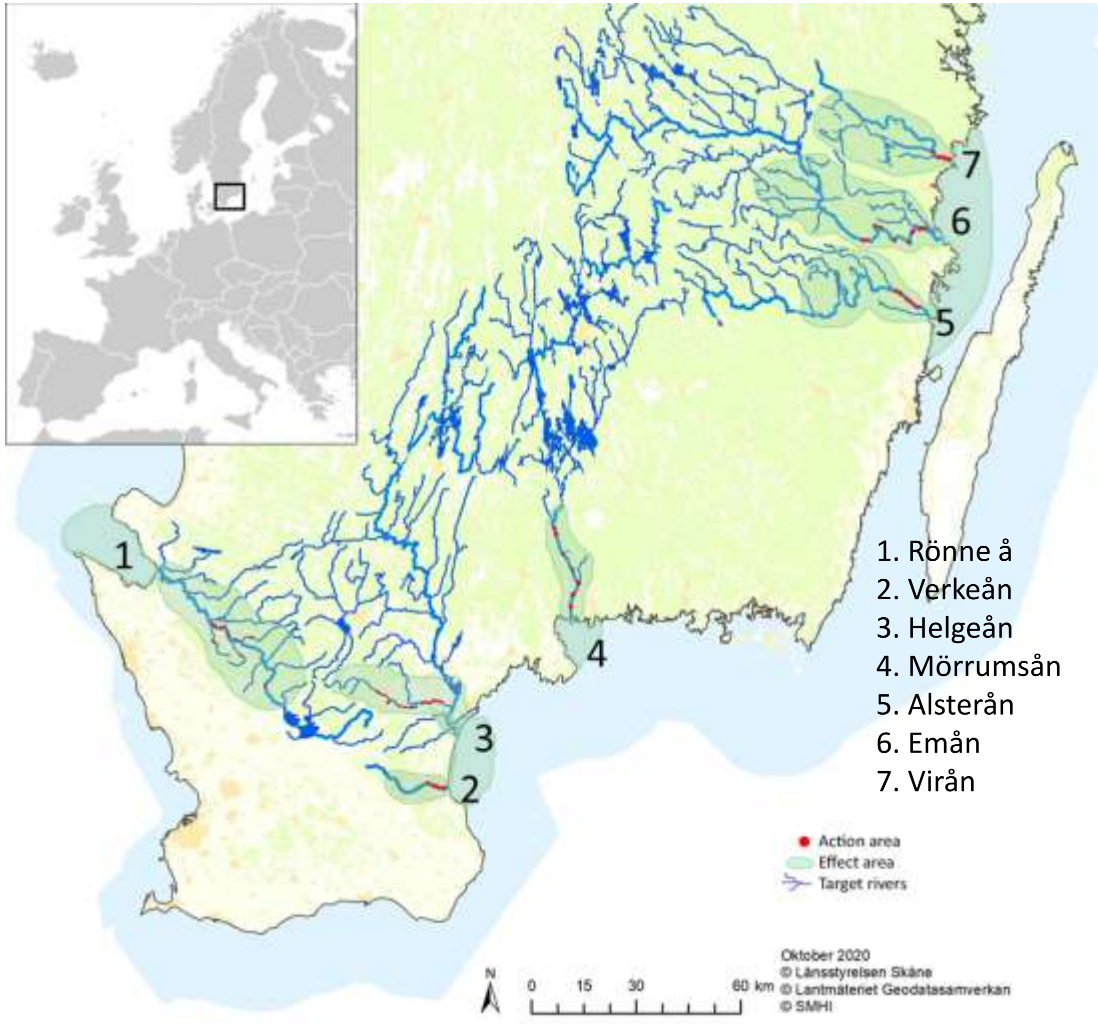
7 target rivers

Period: 2019-2025

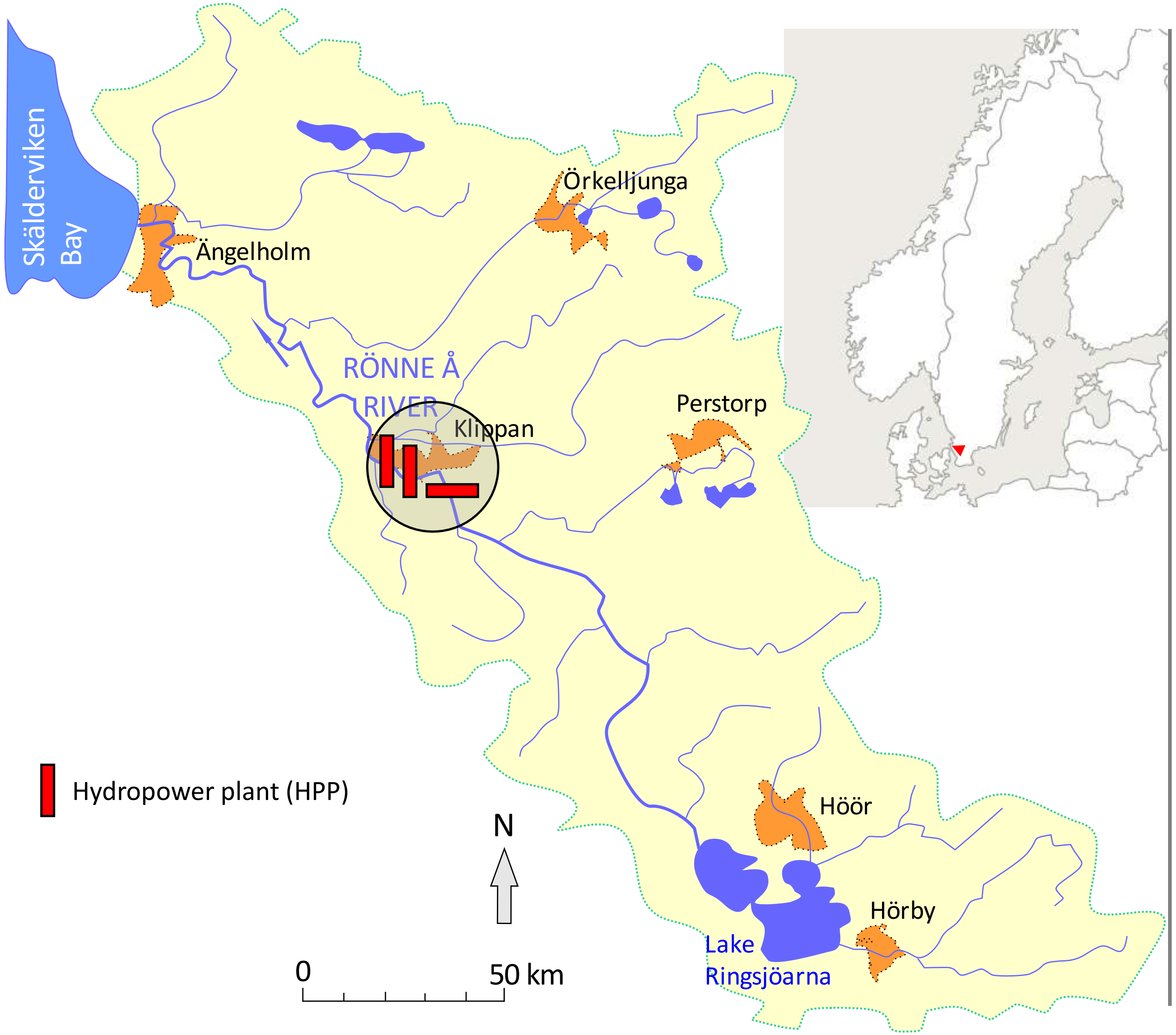
Buget: ~ 10 M€

Actions: river restoration, dam removal, fishpassages, mussel introduction and much more.

Target species: Atlantic salmon (*Salmo salar*), Freshwater pearl mussel (*Margaritifera margaritifera*), Thickshelled river mussel (*Unio crassus*), European eel (*Anguillera anguillera* and many more species will benefit from the project.



Rönne å River



Catchment size: 1900 km^2

Mean discharge: 23 m^3 per s

Most southerly **salmon** river in SE

River subjected to stocking by **European eel**

Two threatened species of **freshwater mussels**
- fragmented populations (few individuals)

Three **hydropower plants** in the main stem blocking migrations and species distribution.

- Distribution range limited by diadromous fish
- Turbine mortality
- Fragmentation
- Loss of ecosystem functions and services

Target areas

Total elevation gradient 30 m

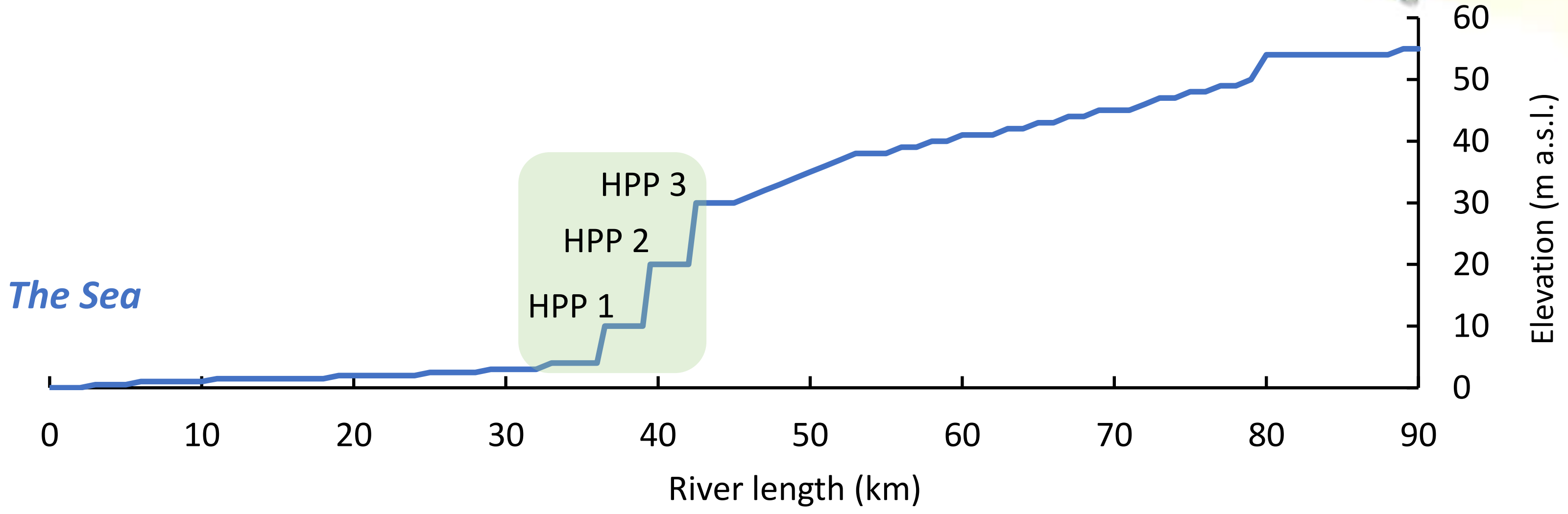
Production: 10 GWh per year

Kaplan turbines, not fish friendly

No regulation capacity, i.e. the HPP:s can’t store water for later use

Purchase price: 2.8 M€ (2019)

Financing: the state (50%), KM (40%), SNF (10%)



LIFEConnects

The hydropower plants (HPP)

Stackarp, HPP1

Klippan, HPP2

Forsmöllan, HPP3

Aerial view

Downstream view

Negative effects…

Fish populations:
Not passible for upstream moving fish.

Production areas for e.g. salmon and trout (migratory) lost / not utilized.

High turbine mortality rates (> 90% in total)
Reduced migration speed (> one month).

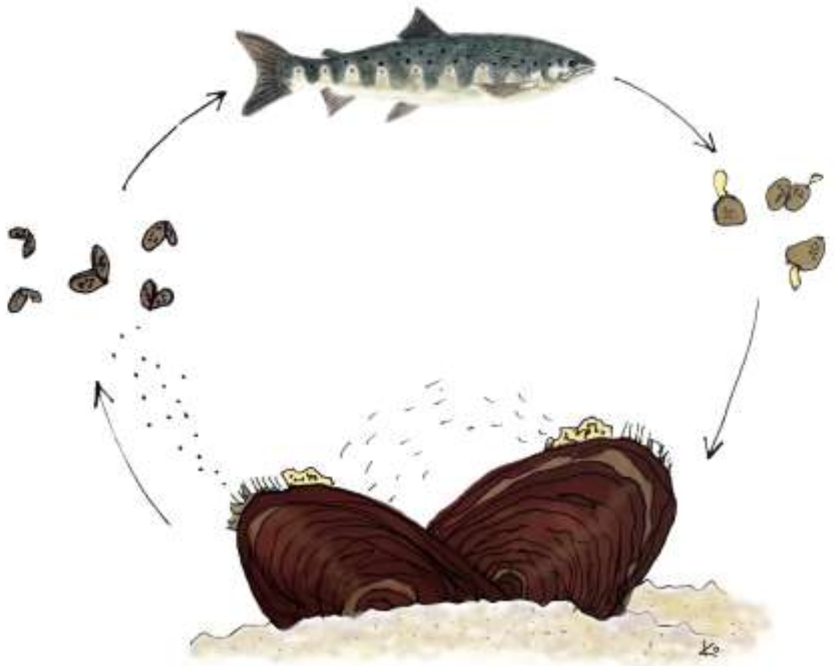
Mussel populations (FPM and TSRM):

Fragmented populations without recruitment.

< 300 individuals of the freshwater pearl mussel (FPM)

< 50 individuals of the thick shelled river mussel (TSRM)

Lack of host fish species:



Ecosystem functions and services

Recreation, tourism (blue growth), e.g. fishing and canoeing

Water temperatures and flow regimes

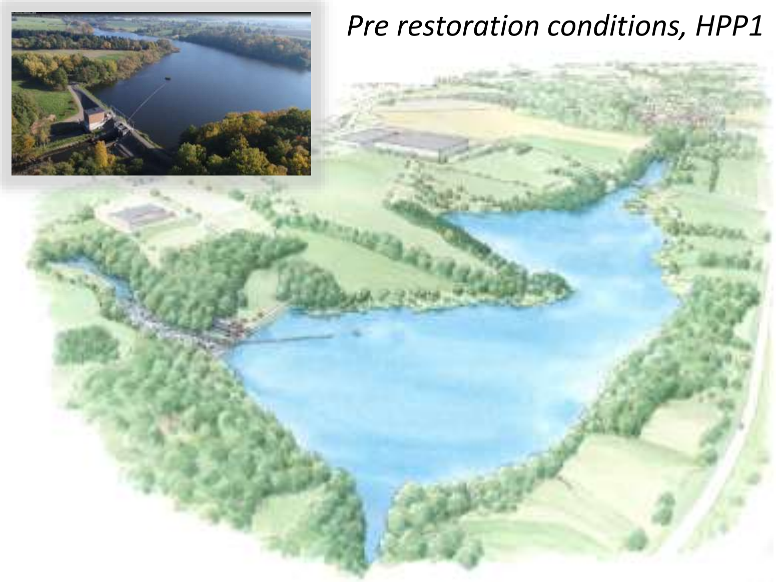
Climate adaptation / resilience, flood control, etc

Potential **pay-off** is high (ecosystem services) following restoration…

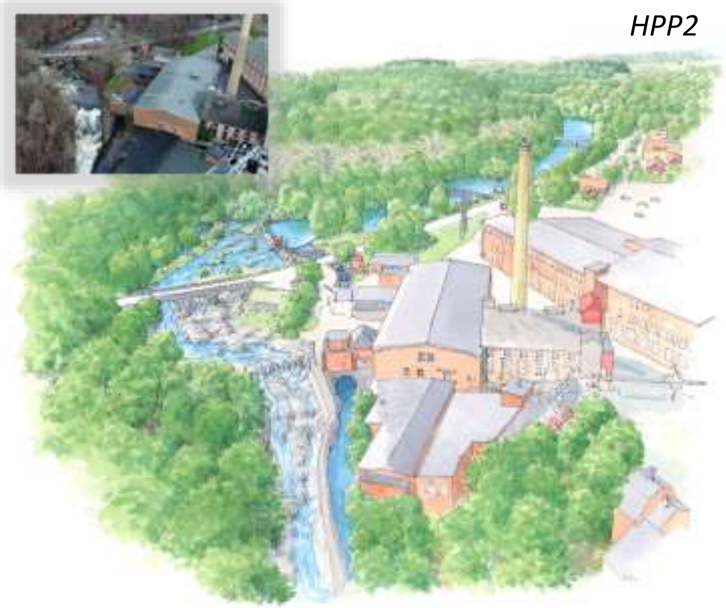
- The benefits removing the plants outweigh the energy production

Becoming free flowing

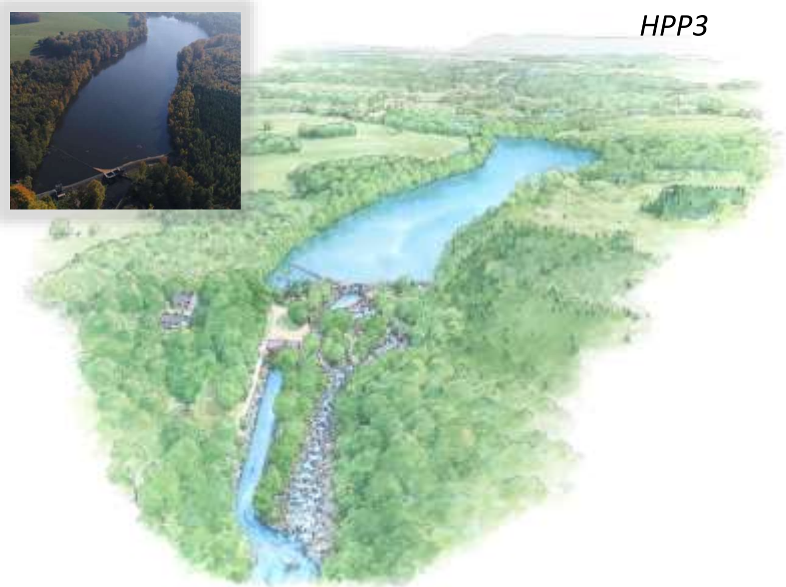
Pre restoration conditions, HPP1



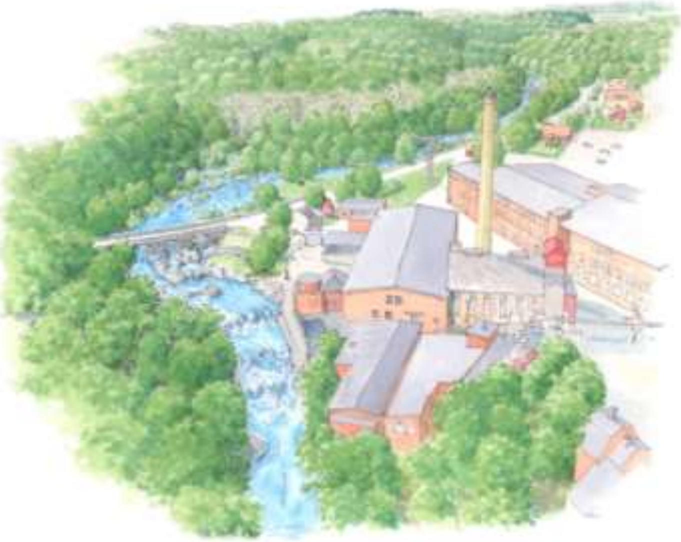
HPP2



HPP3



Post restoration conditions (2030)



LIFEConnects

Predicted outcome

Connectivity: > 125 km of “pristine” production areas accessible in the river

Habitats: > 40 ha transformed into floodplain and lotic habitats

Positive impacts on fish…

Production increase of salmonid smolts (>20000)

Survival of eels (>10000)

European river lamprey (?)

Host fish species for mussels: (20%)

Positive impacts on mussels / biodiversity …

A salmon caught (2018) downstream the HPP’s in Rönne å River (Sommer)

Positive impacts on ecosystem services…

Increases in “blue growth” corresponding to > 4 M€ annually, e.g. angling tourism, tax revenues, coastal sand deposition

Timeline

2018 - 2019: HPP's purchased, downstream migration by fish secured by closing turbines and opening spill gates.

2020 - 2021: Monitoring (pre restoration) programs.

2020 - 2022: Technical and environmental impact assessment plans established, permits / licenses granted.

2022 - 2025: Dismantling and removal of HPP-structures

2025 - 2026: Monitoring (post restoration) programs.

2027 - 2030: Follow up phase, additional restoration spin-offs(?)

Potential risks *and* possibilities

Public **opinion** …

Sediment **contaminations** higher than predicted …

Lack of funding – for robust (costly) long term monitoring programs

Permissions (by the environmental court) will be appealed by stakeholders

Research programs:

- *Terrestrial / aquatic interactions*
- *Migration ecology - host fish / mussel dispersal*
- *Dam removal and sand dynamics*
- *Socio-economic impacts*

Boosting up **public understanding** for river restoration and management.

Transfer and replicate methods / achievements / results elsewhere.

Ecosystem services assessments

Cost benefit analysis (CBA) and Spredsheet method for Rönne å

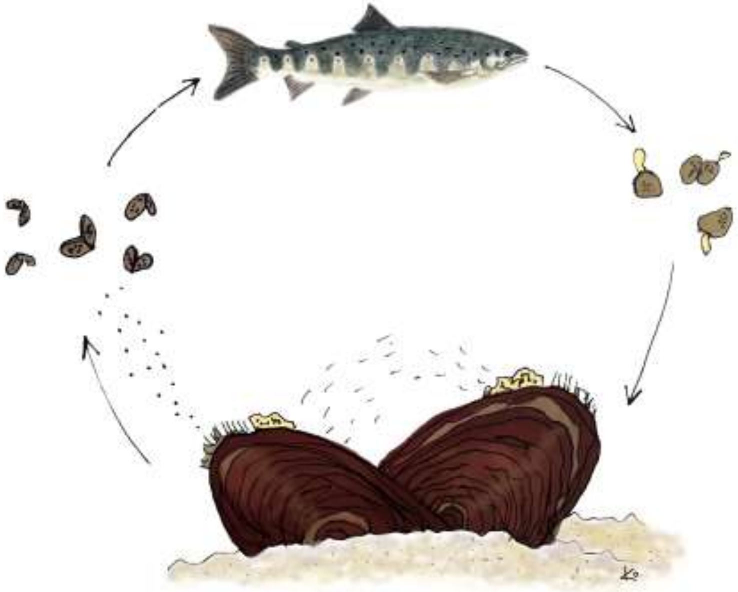
Expected effects of dam removals:

- Increase amount of spawning and recruitment areas
- Increased production of salmon and eels
- Increased eco- and sport fishing tourism
- Increase in local econmies

- Increased populations of host fish for mussels
- Increase in mussel recruitment
- Increase nutrient retention
- Increase in water quality

- More natural hydrological processes
- Increase in sediment transport to the sea
- Increased resilience for flooding and drought

- Increased biodiversity

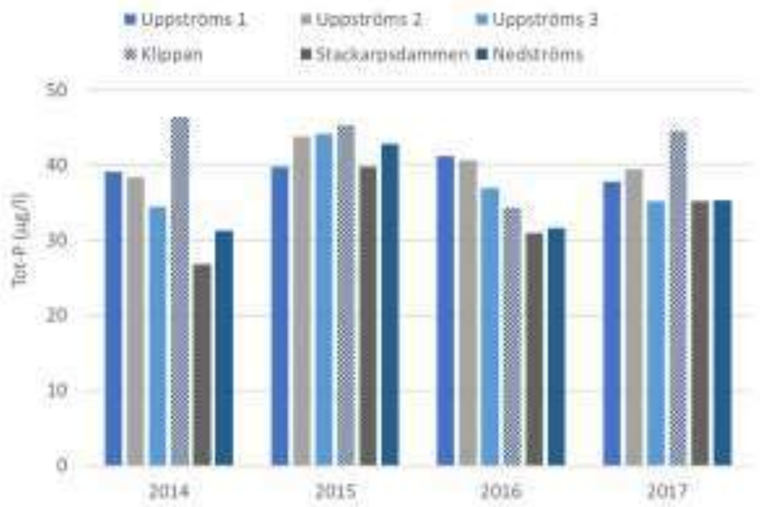


Ecosystem services assessments

Cost benefit analysis (CBA) and Spredsheet method for Rönne å

Data collection:

- GIS-analyses
- Data from scientific research
- Gathering of local knowledge of present salmon population, number of fishingdays, a.s.o.
- Estimations of recreational values, mussel filtration capacity, nutrient retention by mussel filtration, a.s.o. after dam removal and river restoration in Rönne å.



Ecosystem service	Effect	After restoration
Degradation of harmful substances		
Binding of toxins in mussels	Decreased concentrations in waterphase	0
Regulations of flowregim		
Stabilization of sediments	Decreased erosion	-
Natural flow regim	Decreased risk for flooding	+
Fireprotection	Decreased risk for spreading forest fire	0
Maintenance of habitat/genpools/lfecycles		
Seed dispersal	Conservation of biodiversity	+
Spawning/growing areas	Conservation of biodiversity	+
Free migration for aquatic organisms	Conservation of biodiversity	+
Waterservices		
Nutrient retention - nitrogen	Decreased transport to sea	0
Nutrient retention - phosphorus	Decreased transport to sea	0
Nutrient retention in reparian zone	Decreased transport to sea	+
Regulation of temperature	More natural temperature conditions	+
Atmospheric conditions		
Carbon storage in plants/phytoplankton and sediment	Decreased climate change	0

Ecosystem assessments

Before actions

How do we assess the baseline? Are the CBA and spreadsheet methods enough?

After actions

How do we assess the effects of restorations, dam removals, fish passages, mussel introductions and other project activities on ecosystem services? Is it enough to do a new CBA and spreadsheet after restoration?

What do you think?
Are there other methods that we should use?

LIFEConnects

THANKS

Rönne å River, 1817

Länsstyrelsen Skåne

KLIPPANS KOMMUN

uniper

SportFiskarna

Havs och Vatten myndigheten

Länsstyrelsen Kalmar län

Life

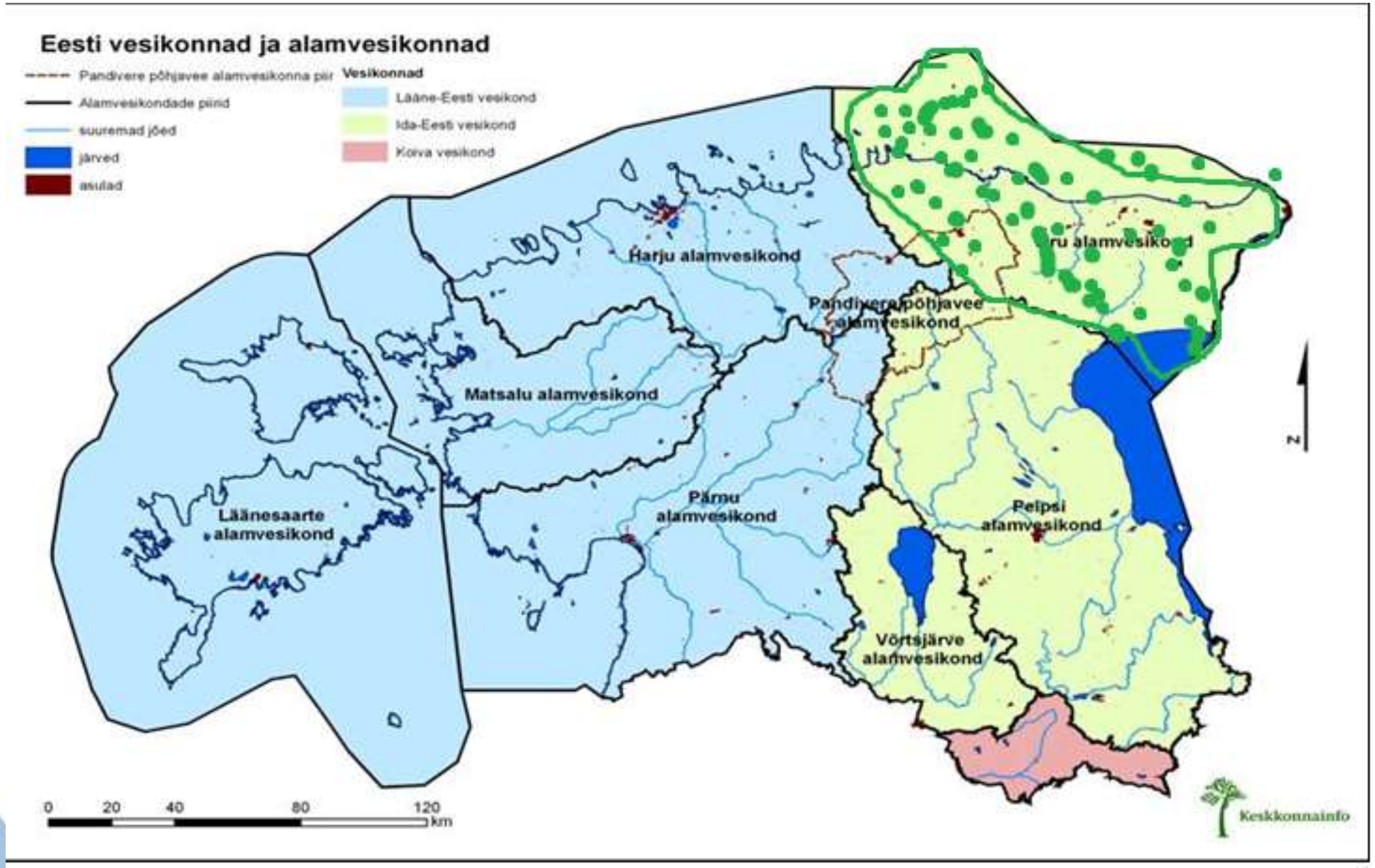
LIFE IP CleanEST project
Estonia

presentation in workshop on water ecosystems services assessment methodologies

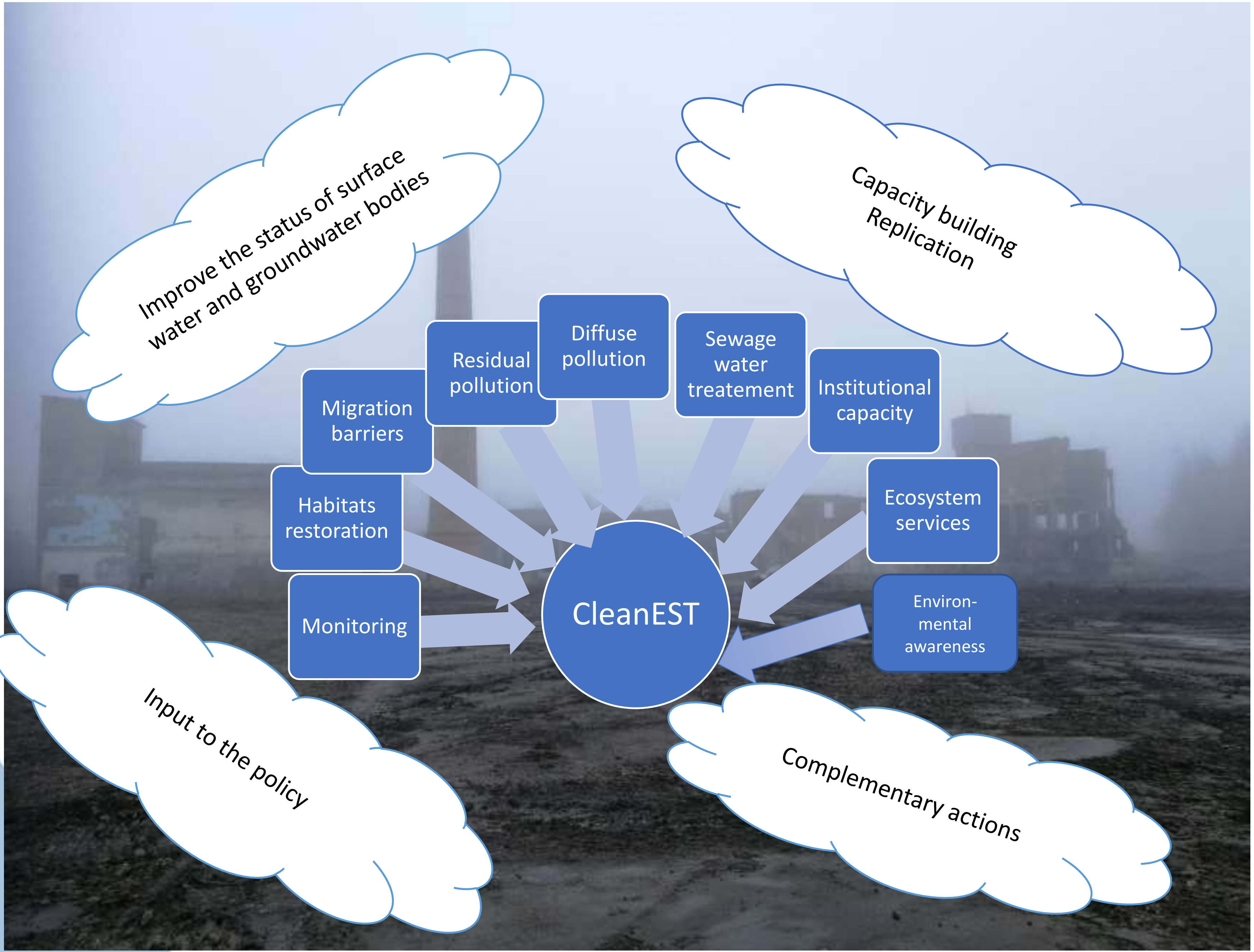
13.01.2022

Mari Sepp
Project Manager
Ministry of the Environment, Water Department

LIFE IP CleanEST

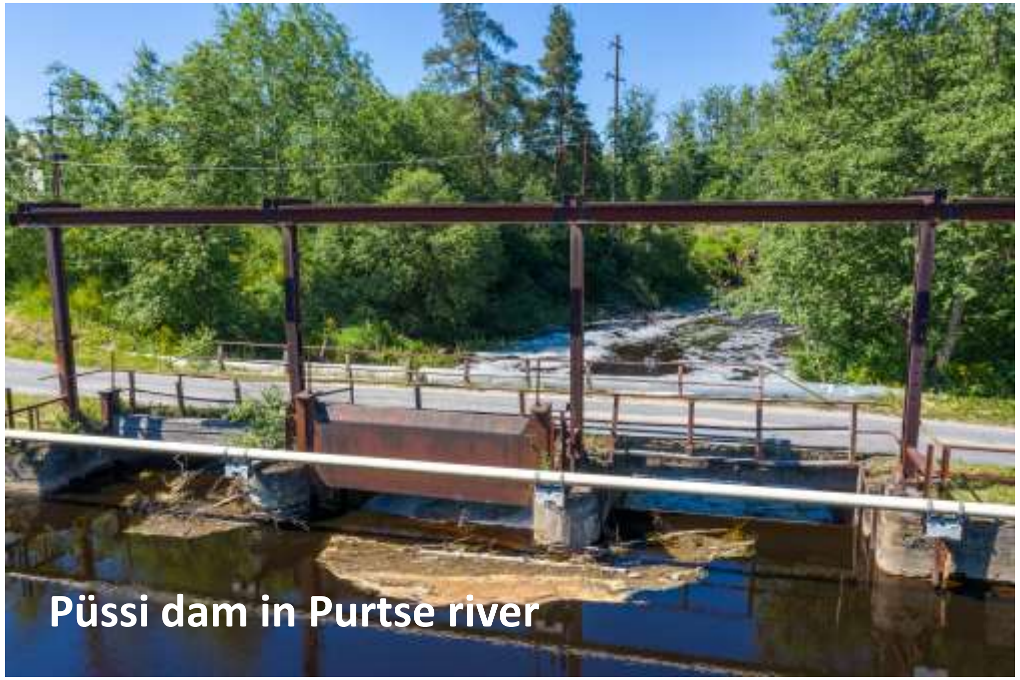


- East-Estonia River Basin Management Plan → Viru sub-basin
- Project duration 2019 – 2028
- Budget 16,7 million euros
- Included to the project: 36 surface water bodies, 7 groundwater bodies and 2 coastal water bodies.
- 23 partners



cleanest

Project topics


Püssi dam in Purtse river


Artificial waterbody in Aidu quarry


Restocking fish to Purtse river/ERR broadcast fiming


Fish camp for kids and youth


cleanest
Virumaa veed puhtaks!
Let's clean the waters of Virumaa!

EU LIFE Programme integrated project

"Implementation of River Basin Management Plans of Latvia towards good surface water status"

D2 MONITORING OF ECOSYSTEM SERVICES RESTORATION

Maija Fonteina Kazeka

maija.fonteina.kazeka@baltijaskrasti.lv

LIFE18 IPE/LV/000014 - LIFE GOODWATER IP

13.01.2022

EU LIFE Programme integrated project
"Implementation of River Basin Management Plans of Latvia towards good surface water status"

LIFE GOODWATER IP

Project implementation time: **01.01.2020.-01.12.2027**
Total budget: **14,568,050.00**
Coordinating Beneficiary: **Latvian Environment, Geology and Meteorology Centre (LEGMC)**

Partnership |19 partners | Public administration institutions | Scientific research institutions | Local and regional authorities | Companies managing the State property | Non-governmental organzations

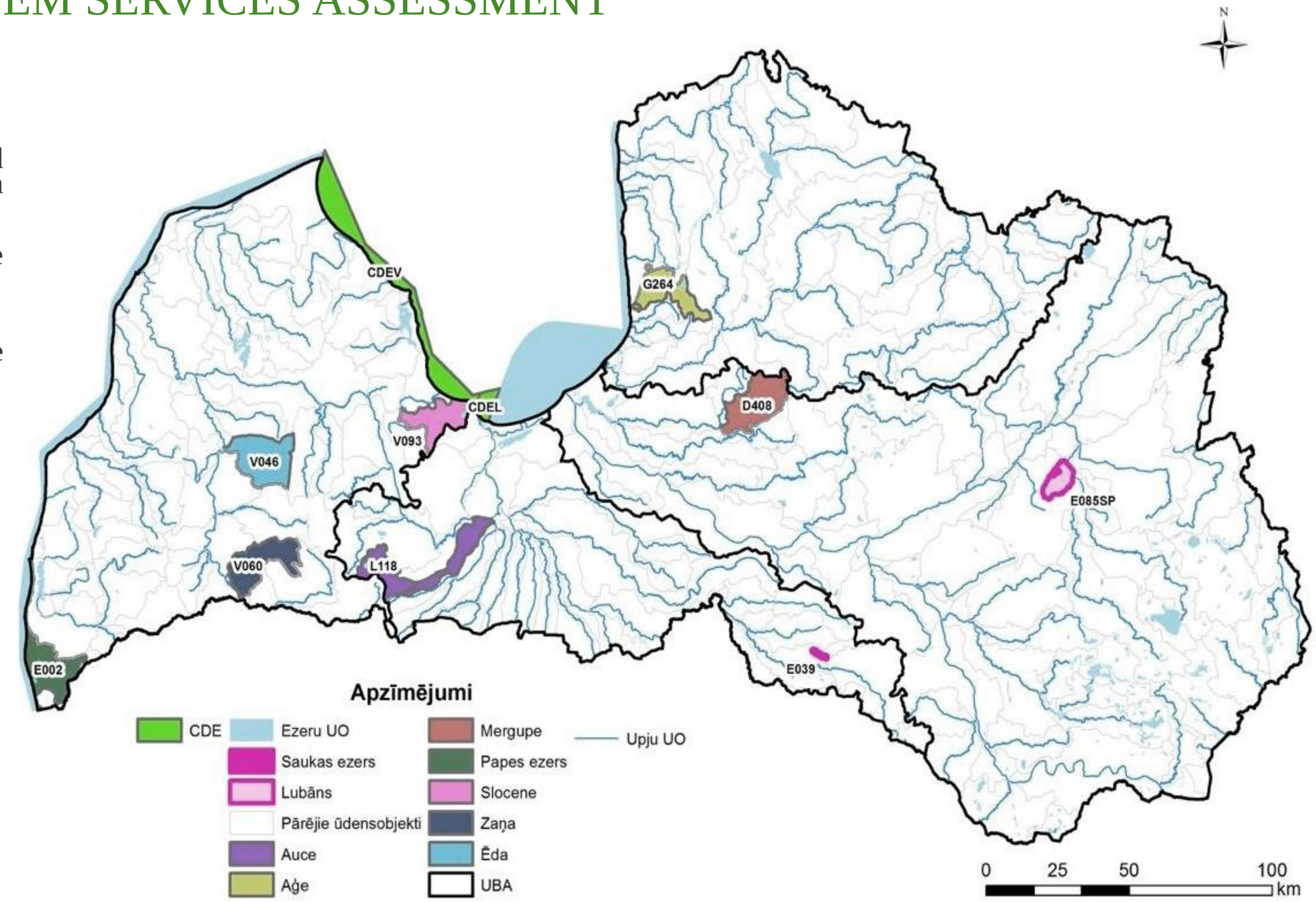
The objective | to improve the status of water bodies at risk in Latvia by means of the full implementation of the measures laid down in the Daugava, Gauja, Lielupe and Venta river basin management plans | to achieve the EU environmental objectives of the Water Framework Directive (2000/60/EC)

The specific objectives:

State Regional Development Agency Republic of Latvia
LVĢMC
Ministry of Environmental Protection and Regional Development Republic of Latvia
Ministry of Agriculture Republic of Latvia
ZMNĪ
LATVIJAS VALSTS MEŽI
Latvia University of Life Sciences and Technologies
SILAVA
UNIVERSITY OF LATVIA
BIOR
JELGAVAS NOVADS
LŪKA
Zemnieku Saeima
Pasaules Dabas Fonds
BALTIJAS KRASTI
BEF
LLKC
PAIC

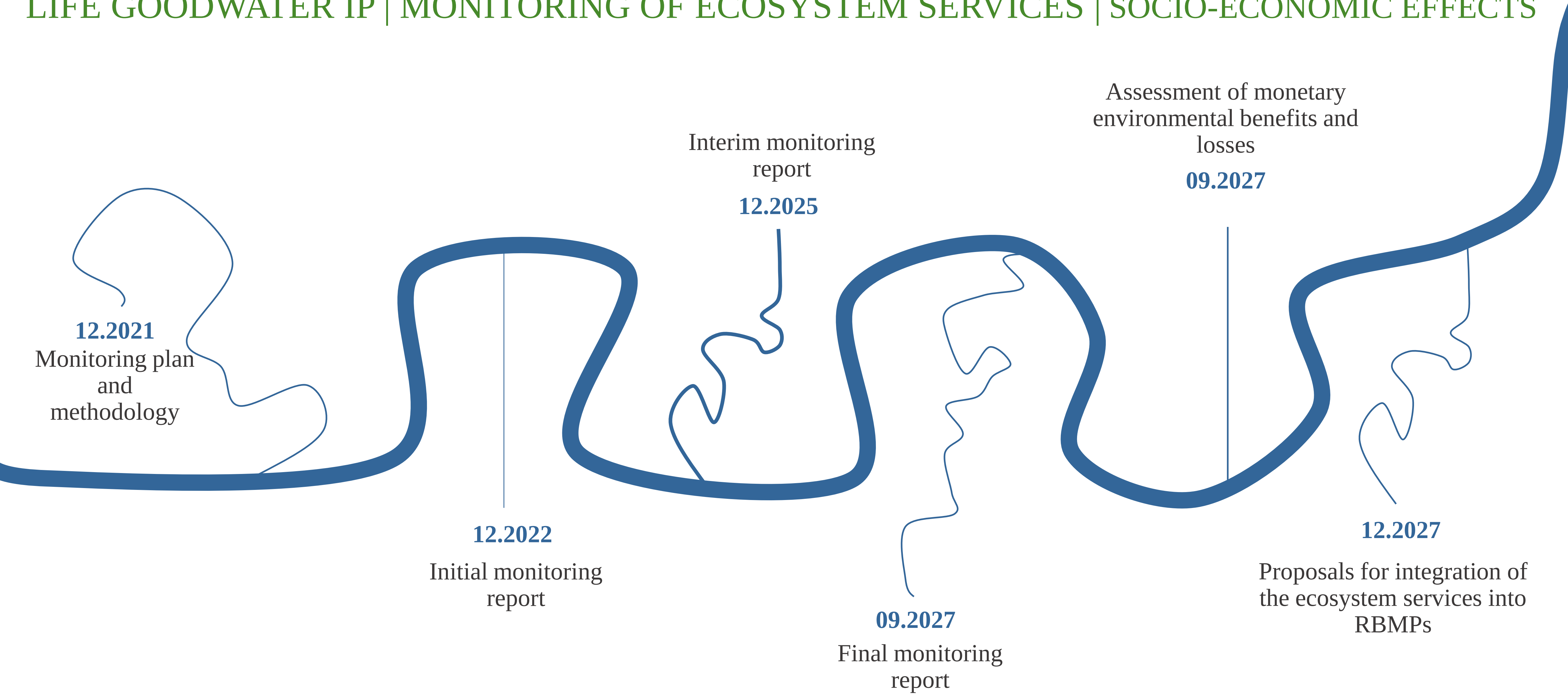
LIFE GOODWATER IP | ECOSYSTEM SERVICES ASSESSMENT

- 9 Demonstration sites
- D2 Monitoring of ecosystem services restoration:
  - D2.1. Development of methodology and indicators of ecosystem restoration in relation of concrete actions
  - D2.2. Monitoring of ecosystem services before and after implementation of concrete actions:
    - the baseline monitoring
    - monitoring after implementation of the demonstration activities
- Risk assessments of different scenarios on key habitats and species
- Assessment of monetary environmental benefits and losses for applied indicators using Ecosystem Services Valuation Database (ESVD) and The Economics of Ecosystems and Biodiversity (TEEB) database
- Documented methodologies and results on main ecosystem services
- Development of a documented model system for further use in other catchment areas in Latvia and elsewhere in Europe (integration on river basin management plans)



EU LIFE Programme integrated project
"Implementation of River Basin Management Plans of Latvia towards good surface water status"

LIFE GOODWATER IP | MONITORING OF ECOSYSTEM SERVICES | SOCIO-ECONOMIC EFFECTS



EU LIFE Programme integrated project

“Implementation of River Basin Management Plans of Latvia towards good surface water status”

LIFE GOODWATER IP | ECOSYSTEM SERVICES | STEPS OF METHODOLOGY DEVELOPMENT

1. Feasibility study: ES concept, publications, similar experience

2. Evaluation: adoption/ transferability of similar methodology (Benjemin Burkhard; Joachim Maes)

3. Identified the services provided by aquatic ecosystems (CICES V5.1)

4. Identified group of potentially involved experts (internal / external for indicator evaluations and rating (scientifically justified)

5. Development: potentially identified ecosystem services, characteristic indicators and their units of measurement, created support material for experts

6. Communication/workshops: identified ecosystem services, characteristic indicator (internal / external experts)

7. Identification of data source availability; communication with data holders; assessment of data quality and applicability

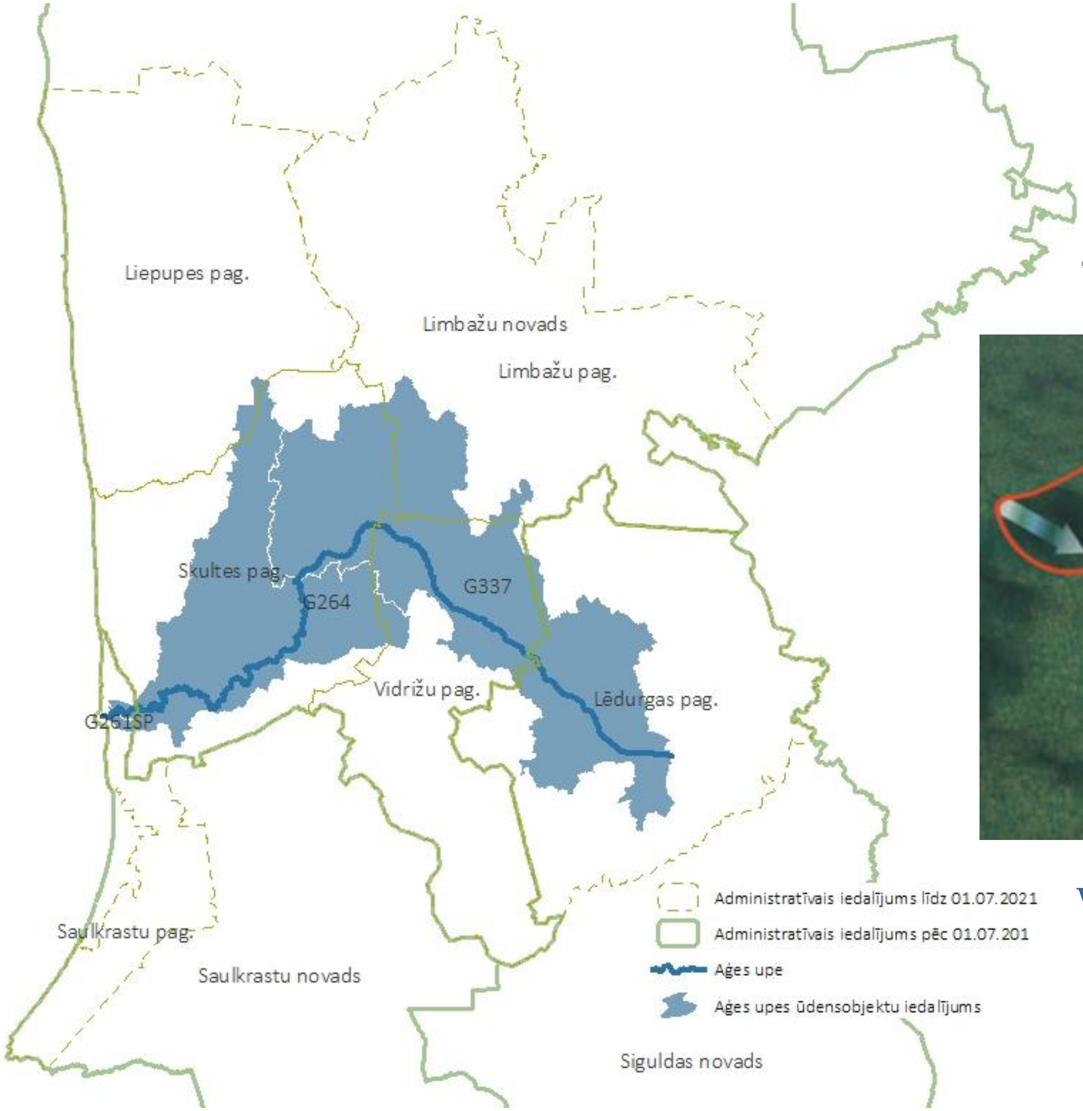
8. Individual communication with experts on the development of an indicator data sheet

9. 7 workshops to calibrate methodologies among groups of experts with similar ecosystem services/indicators/ calibration (*still in the process*)

10. Individual communication with experts on the development of an indicator data sheet

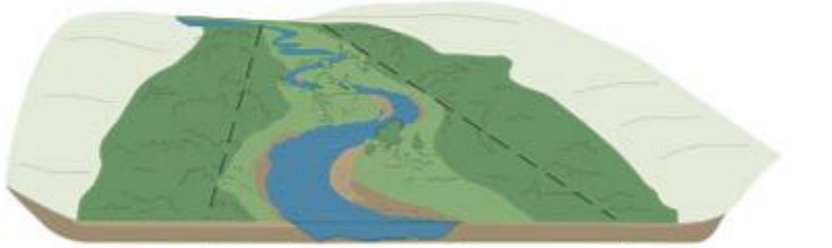
EU LIFE Programme integrated project
“Implementation of River Basin Management Plans of Latvia towards good surface water status”

LIFE GOODWATER IP | ECOSYSTEM SERVICES ASSESSMENT | SPATIAL UNIT



RIVER **LAKE**

WATER BODY BORDER / CATCHMENT AREA

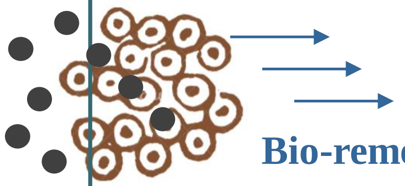


50% PROBABILITY OF FLOODING (FLOODS WITH RECURRENCE EVERY 2 YEARS)

LIFE GOODWATER IP | ECOSYSTEM SERVICES | SCALE OF METHODOLOGY

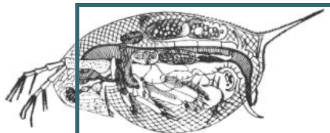
INDICATORS | An indicator is a quantitative measure which represents a complex system or phenomenon

ECOSYSTEM SERVICE FLOW



Bio-remediation

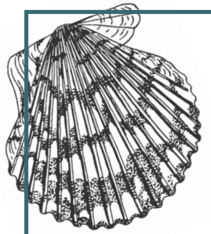
BIOPHYSICAL INDICATOR



Concentration of micro - organisms

Score 0-5 (indicator data sheet)

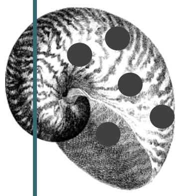
BIOPHYSICAL INDICATOR



Mollusc population

Score 0-5 (indicator data sheet)

BIOPHYSICAL INDICATOR



Concentrations of priority and harmful substances in biota

Score 0-5 (indicator data sheet)

Involved expert opinions assigning a weight to each factor/indicator

SCORE 0-5

0	ES not provided
1	ES very low value
2	ES low value
3	ES medium value
4	ES high value
5	ES very high value

EU LIFE Programme integrated project
"Implementation of River Basin Management Plans of Latvia towards good surface water status"

LIFE GOODWATER IP | ECOSYSTEM SERVICES | INDICATORS

4 PROVISIONING SERVICES | 10 REGULATING SERVICES | 6 CULTURAL SERVICES (CONSOLIDATE)

| ABOUT 46 INDICATORS | 22 EXPERTS | 18 SPATIAL UNITS | 3 DEVELOPMENT SCENARIOS

PROVISIONING ES

Class	CICES V5.0 (2018) Code	INDICATOR	Measurements
Fibres and other materials from wild plants for direct use or processing (excluding genetic materials)	1.1.5.2	Volume of reeds (*Phragmites australis*) harvested in lakes (lake)	t/ha -1 (dry matter)
Wild animals (terrestrial and aquatic) used for nutritional purposes	1.1.6.1	Diversity of fish species of interest to fisherman (lake/ river)	Sum of points
		Fishing limits (lake)	Licenses (threshold value)
		Fisheries productivity (lake)	Kg/ha
Surface water used as a material (non-drinking purposes)	4.2.1.2	Water consumption for livestock / farm needs (lake/river)	Number (surveys)
Freshwater surface water used as an energy source	4.2.1.3	Amount of energy produced (river)	kWh/ha per year

EU LIFE Programme integrated project

"Implementation of River Basin Management Plans of Latvia towards good surface water status"

LIFE GOODWATER IP | ECOSYSTEM SERVICES | INDICATORS

REGULATION & MAINTENANCE ES |

Class	CICES V5.0 (2018) Code	INDICATOR	Measurements
Bio-remediation by micro-organisms, algae, plants, and animals	2.1.1.1	**Density and composition of the zoobenthos (lake/river)**	LMI index (for rivers) and LLMMI index (for lakes) on a scale from 0 -1
		Composition, occurrence and biomass of the phytoplankton (lake)	Biomass mg / l, species diversity (number of taxa), chlorophyll a concentration µg / l
		Composition, occurrence, biomass of the zooplankton (lake)	Biomass mg / l, species diversity (number of taxa)
		Composition, occurrence, biomass and structure of the macrophyte (lake/river)	Shannon diversity index
Filtration/sequestration/storage/accumulation/regulation by micro-organisms, algae, plants, and animals	2.1.1.2/2.2.5.1	**Proportion of "filters" of the macrozoobenthos ecological group (lake/river)**	%
		Composition, occurrence and biomass of the phytoplankton (lake)	Biomass mg / l, species diversity (number of taxa), chlorophyll a concentration µg / l
		Composition, occurrence, biomass of the zooplankton (lake)	Biomass mg / l, species diversity (number of taxa)
		Composition, occurrence, biomass and structure of the macrophyte (lake/river)	Shannon diversity index
Control of erosion rates	2.2.1.1	Coastal vegetation structure (land use) (lake/river)	Proportion / score
		Swell (lake)	
Hydrological cycle and water flow regulation (Including flood control, and coastal protection)	2.2.1.3	**Floodplain area (lake/river)**	
		Flow rate and dynamics (river)	
		River continuity (river)	Index
		Water exchange rate (lake/river)	

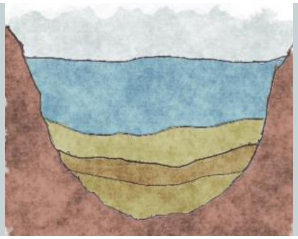
LIFE GOODWATER IP | ECOSYSTEM SERVICES | INDICATORS

REGULATION & MAINTENANCE ES ||

Class	CICES V5.0 (2018) Code	INDICATOR	Measurements
Seed dispersal	2.2.2.2	Floodplain area (lake/river)	Proportion / score
		River continuity (longitudinal, lateral) (lake)	
Maintaining nursery populations and habitats (Including gene pool protection)	2.2.2.3	Diversity of amphibian species (lake)	Specimens / km
		Summarized occurrence of protected water bird species and umbrella species (lake/river)	Bird species according to nesting reliability characteristics
		Abundance and diversity rate of the zoobenthos (lake/river)	H ’value of the Shannon-Wiener diversity index
		Abundance and diversity rate of the phytoplankton (lake)	Biomass mg / l, species diversity (number of taxa)
		Abundance and diversity rate of the macrophyte (lake/river)	Shannon diversity index
		Abundance and diversity rate of the zooplankton (lake)	Shannon diversity index
		Abundance and diversity of the fish and certain fish species/ specially protected fish species, Directive species (lake/river)	Sum of points

LIFE GOODWATER IP | ECOSYSTEM SERVICES | INDICATORS

REGULATION & MAINTENANCE ES |||



Class	CICES V5.0 (2018) Code	INDICATOR	Measurements
Dilution by freshwater and marine ecosystems	5.1.1.1	Dilution capacity of pollution (defined substances) in the river, presence of oxygen in lakes (abiotic indicator); electrical conductivity, pH (the acidity or basicity); range of water quality standards (lake/river); winding opportunities (lake)	
		River continuity (river)	
		The width/depth (W/D) ratio (lake/river)	
		Water exchange rate (lake/river)	
Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	5.1.1.3	Differences in the concentration of priority substances and/or hazardous substances in the sediments of a water body. The predominant composition of the bed substrate - hazardous substances in sediments (lake/river)	
		Soil potential (lake/river)	
Decomposition and fixing processes and their effect on soil quality	2.2.4.2	Ability of the soil to absorb, accumulate nutrients (lake/river)	
Regulation of temperature and humidity, including ventilation and transpiration	2.2.6.2	Surface albedo of land cover type (lake/river)	
		Shading coverage (lake/river)	
		Evaporation and transpiration of the reeds (lake)	

LIFE GOODWATER IP | ECOSYSTEM SERVICES | INDICATORS

Cultural ES

Class	CICES V5.0 (2018) Code	INDICATOR	Measurements
Characteristics of living systems that that enable activities promoting health, recuperation or enjoyment through **active** or immersive interactions	3.1.1.1	Suitability for boating, swimming, fishing; boat bases and sites; swimming areas; pathways; boating and excursion routes; the value of building social relationships; memories, life-changing values	Data and survey
Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through **passive** or observational interactions	3.1.1.2	suitability of boating (ecess); visual accessibility (from shores); boat bases and sites; swimming areas; pathways; camping and tent possibilities; picnic areas, watching towers for landscapes and birds; therapeutic value; the value of building social relationships; memories, life-changing values	Data and survey
Characteristics of living systems that enable **scientific/education** investigation or the creation of traditional ecological knowledge	3.1.2.1/3.1.2.2	Specially protected nature territories (proportion); informative nature trails and sights; scientific projects; scientific publications; popular scientific publications; involvement and interaction with nature; knowledge of local ecologies; memories, life-changing values	Data and survey
Characteristics of living systems that are resonant in terms of **culture or heritage**	3.1.2.3	historical population area and road network; transformation degree; archeological, architectural and industrial monuments; cultural heritage infrastructure, local guides; water-related cultural heritage objects; cultural and artistic objects; knowledge of locals about historical events, practices, environmental changes; identification regarding the history and culture of the place; memories, life-changing values	Data and survey
Characteristics of living systems that enable **aesthetic experiences**	3.1.2.4	**Aesthetic quality of the landscape based on structural diversity, naturalness, uniqueness and views (which includes accessibility)**	Number/area of landscape elements with expressed value Data and survey
Elements of living systems that have **symbolic/sacred** meaning	3.2.1.1/3.2.1.2	narrative, symbolic, sacred places; natural monuments of symbolic or sacred meaning; nature tourism objects with a symbolic or sacred meaning; knowledge of places, natural elements with symbolic and / or sacred meanings; spiritual values; place identity (and uniqueness); memories, life-changing values	Data and survey

LIFE GOODWATER IP | ECOSYSTEM SERVICES | THE CHALLENGES

- Heterogeneous data availability for different demonstration water bodies
- Differences in indicator character (flow /potential)
- Difficult to define final aquatic ecosystem services / lack of experience in complex assessment of aquatic ecosystem services provision
- Obstacles simultaneously to achieve the objectives of the method: to assess the project impacts at the same time ensuring the transferability and integration of the method/indicators in river basin management plans
- Ecological responses to restoration or new methods of recurring management are generally slow and difficult to predict, therefore might be challenging to interpret the results

PURE WATER IS THE WORLD'S FIRST AND FOREMOST MEDICINE

Maija Fonteina Kazeka
maija.fonteina.kazeka@baltijaskrasti.lv

LIFE GOODWATER IP

Actions for better water!

Rich Waters

Life

Swedish Agency for Marine and Water Management

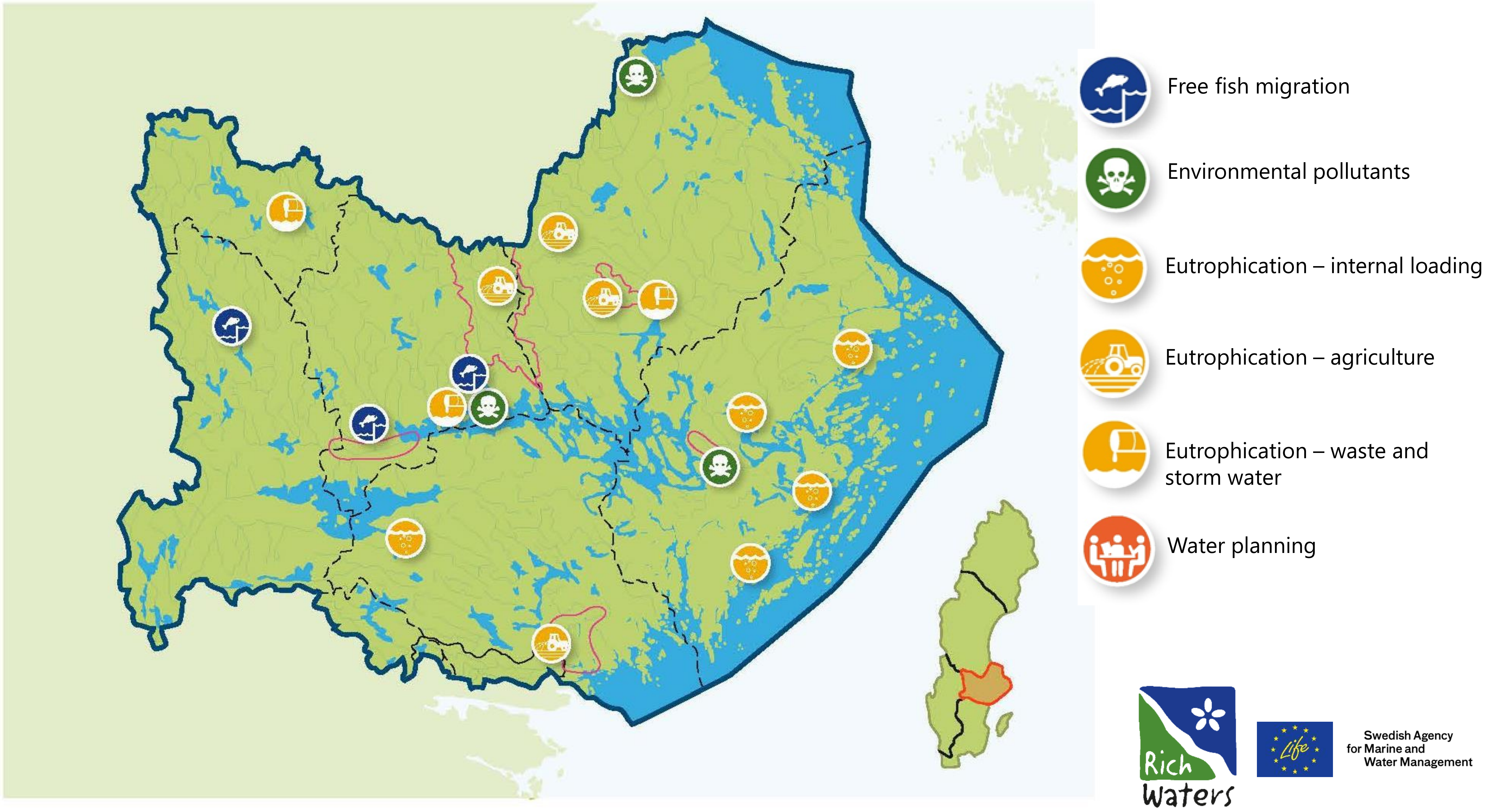
The first LIFE IP project in Sweden

Project start and stop: 2017 - 2024

Total budget: 30 Million EURO

Goal: to implement the EU Water Framework Directive

Swedish Agency
for Marine and
Water Management


Free fish migration
Environmental pollutants
Eutrophication – internal loading
Eutrophication – agriculture
Eutrophication – waste and storm water
Water planning
Rich Waters
Life
Swedish Agency for Marine and Water Management

Climate adaptation and eco-system services
-a subproject in Life IP Rich Waters

Aim

1. How water ecosystem services will be affected by climate change in terms of overflow
2. case studies in two different drainage basins in the larger Stockholm area, River Arbogaån and River Bällstaån

3. develop a method to locate appropriate areas to channel overflow
4. minimize flood risks –thereby contribute to the achievement of good water status and stimulate ecosystem services.

LÄNSSTYRELSEN VÄSTRA GÖTALANDS LÄN · SLU · LÄNSSTYRELSEN I STOCKHOLMS LÄN · Länsstyrelsen Västmanlands län · Havs och Vatten myndigheten · Life

Background to our subproject

Challenges

Climate change

↓

Increased flood risk

↓

Affected water quality

LÄNSSTYRELSEN VÄSTRA GÖTALANDS LÄN · SLU · LÄNSSTYRELSEN I STOCKHOLMS LÄN · Länsstyrelsen Västmanlands län · Havs och Vatten myndigheten · Life

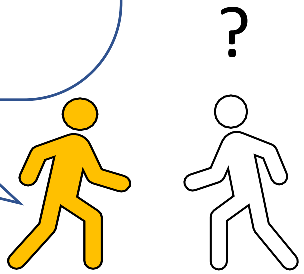
Nature based solutions

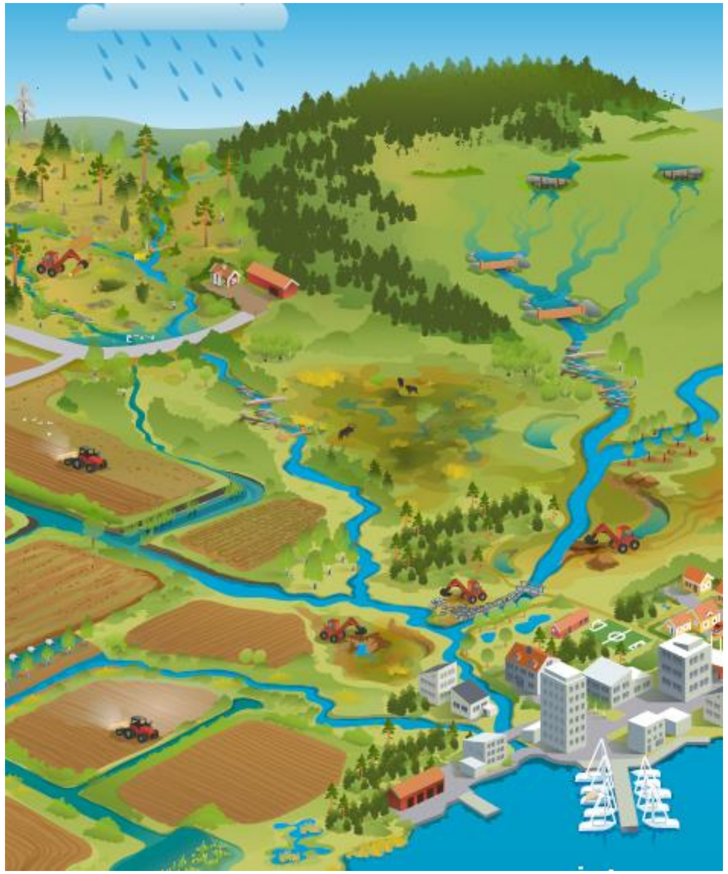
using the landscape to improve water quality and reduce flood risk

Role play of 2022-01-13

We, the city council of Floodville, have raised the question on how to reduce flood risk and improve water quality

You, head officer, are due to report suggestions





LÄNSSTYRELSEN VÄSTRA GÖTALANDS LÄN

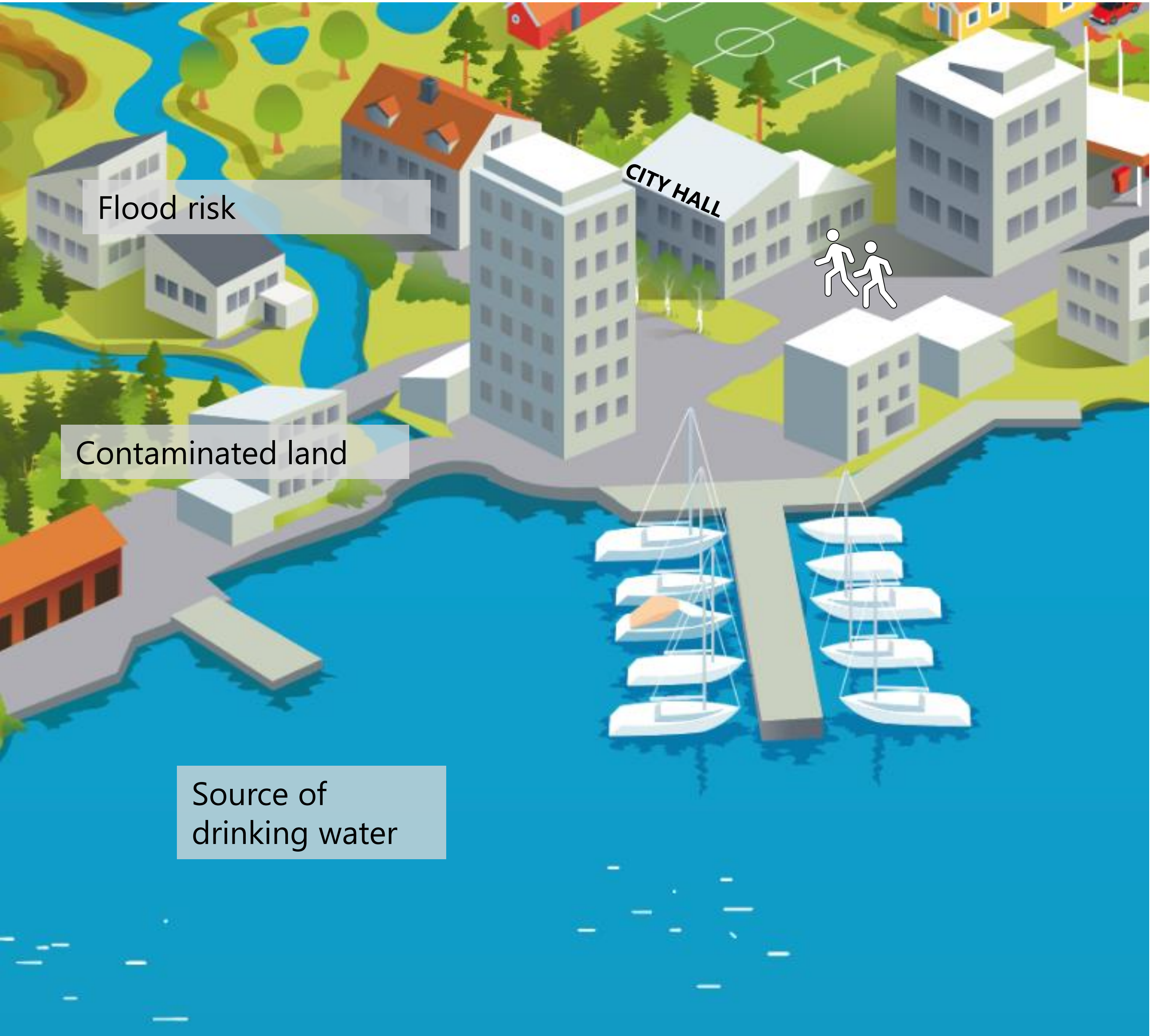
SLU

LÄNSSTYRELSEN I STOCKHOLMS LÄN

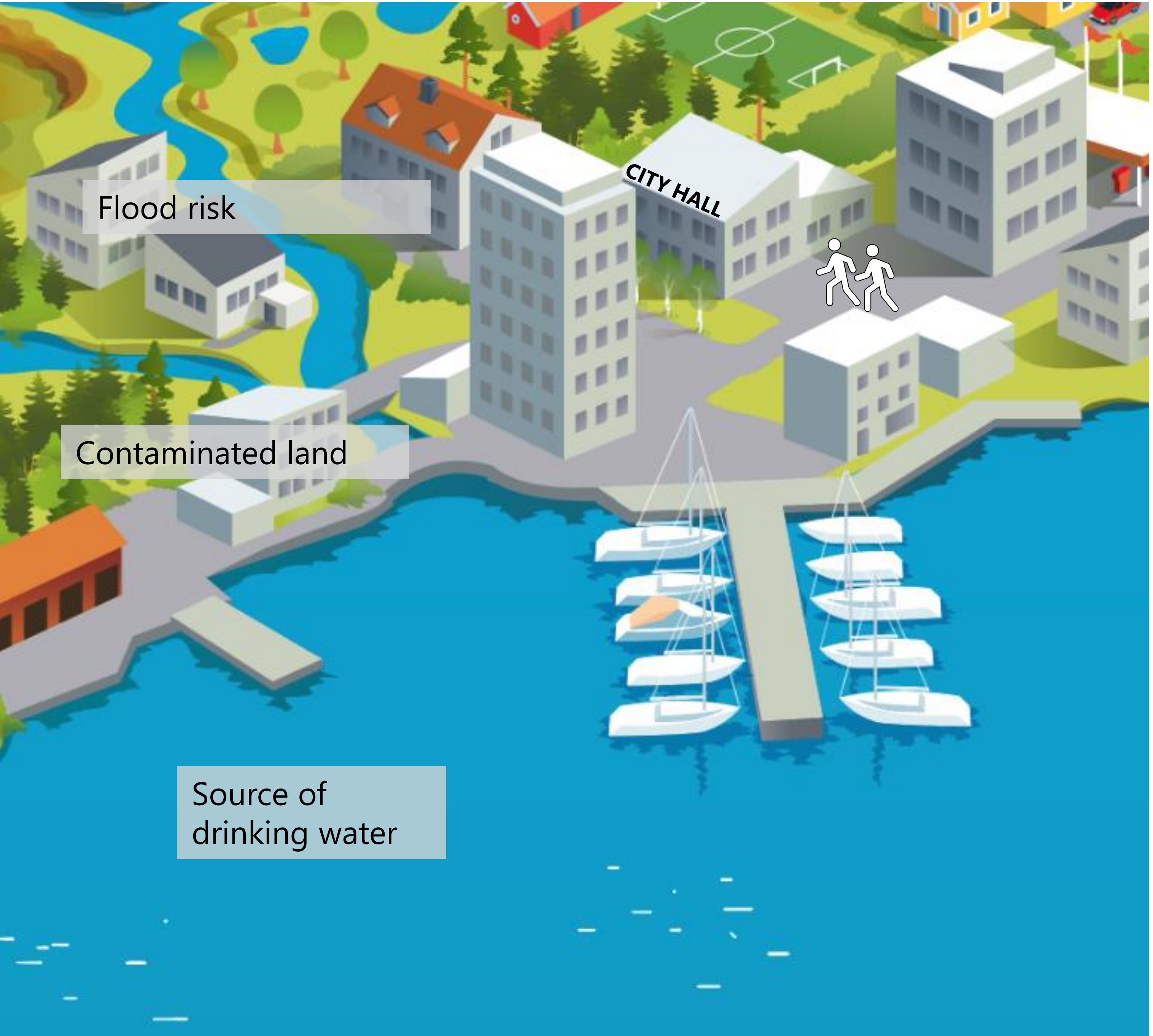
Länsstyrelsen Västmanlands län

Havs och Vatten myndigheten

Life


Flood risk
CITY HALL
Contaminated land
Source of drinking water

Floodville



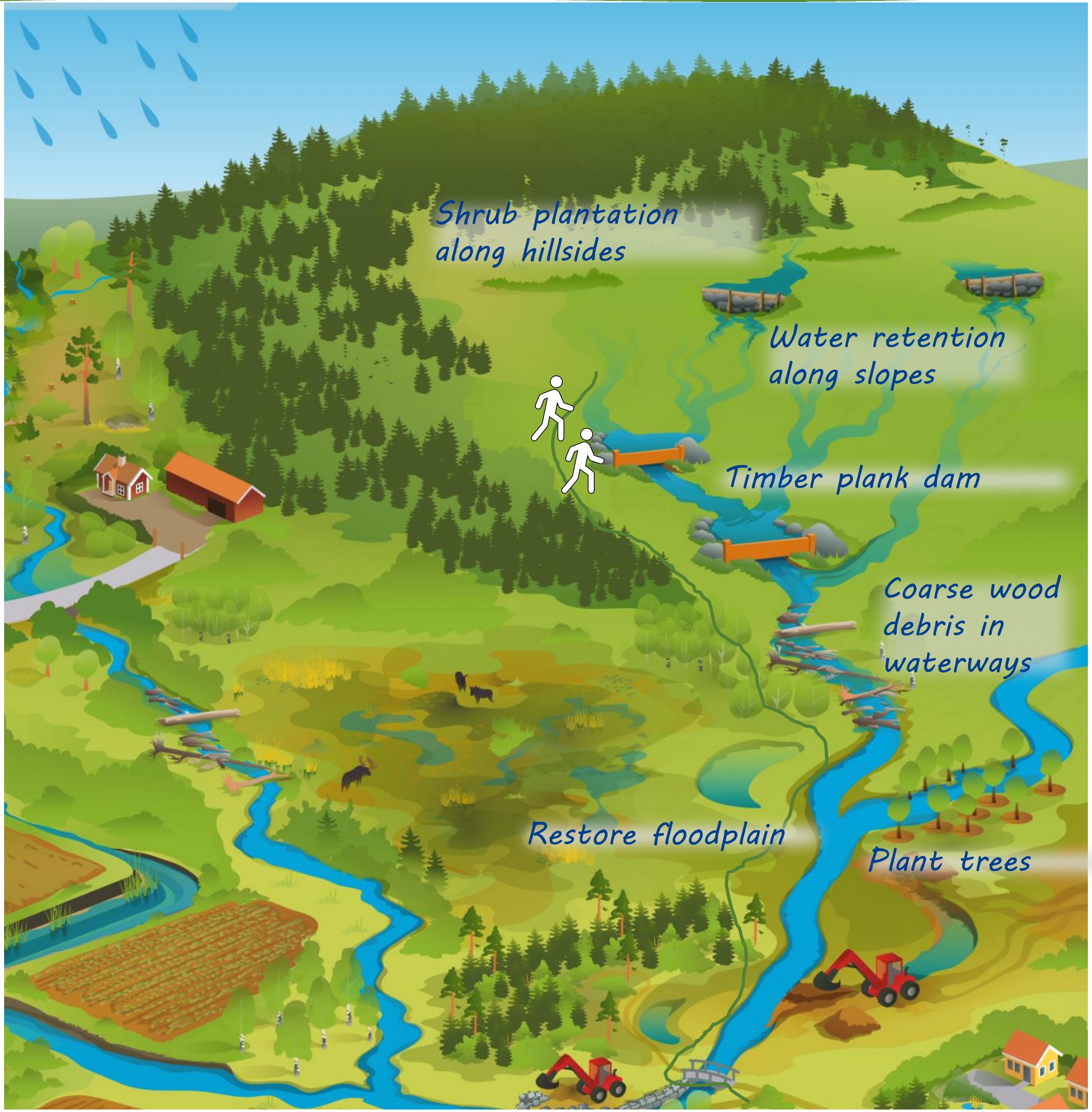
Floodville

Thus
We will undertake a field tour to examine the possibilties offered by the landscape

<u>Assumptions</u>
-Economical
-Eco-system based
-Synergies

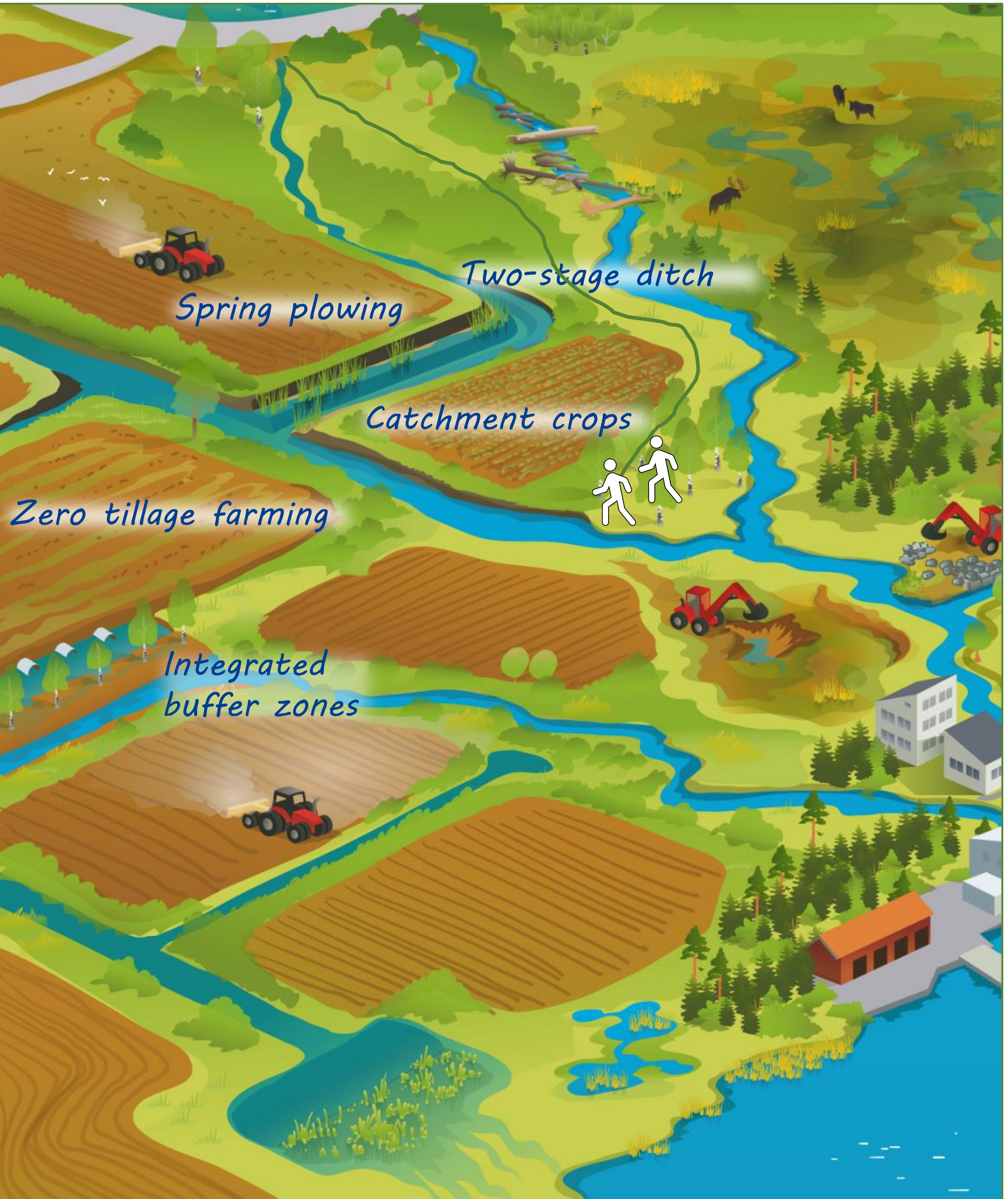
Question

What other benefits than flood management will restoring wetlands give?


Shrub plantation along hillsides
Water retention along slopes
Timber plank dam
Coarse wood debris in waterways
Restore floodplain
Plant trees

Question

What kind of obstacles can you see when implementing these kind of measures?

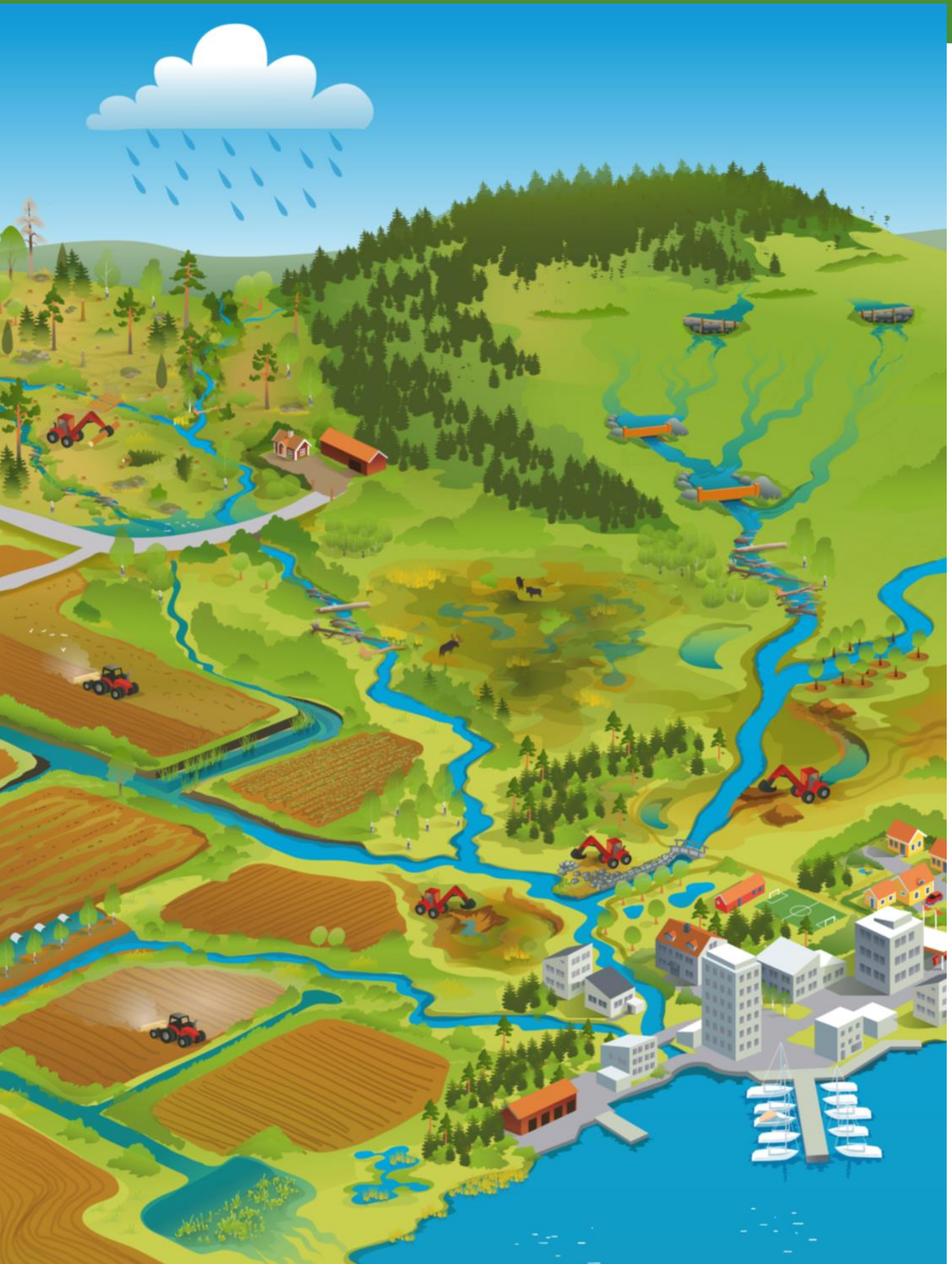


Life
Rich Waters

Reporting to city council

<u>We, the officers, advocate</u>

- Wetland restoration
- Away with ditches
- *And many more measures*



Sharing of experiences

1. Do you have any experience of implementing nature based solutions to solve challenges with flooding or water quality?

2. Introducing nature based solutions as introduced during the field tour –what are the main obstacles to overcome considering the context of your home environment and how can these be solved?

Rich Waters

Thank you!

- Samuel Karlström – County administrative board of Stockholm
- Måns Enander – County administrative board of Västmanland
- Zandra Camber – County administrative board of Västmanland

Länsstyrelsen Västra Götalands län | Länsstyrelsen Stockholm | SLU | Länsstyrelsen Västmanlands län | Havs och Vatten myndigheten | Life

The next generation

Lena Allthin
Swedish Forest Agency
Communications Manager


Sweden ♥ forests

Elementary schools

Classrooms in the forest

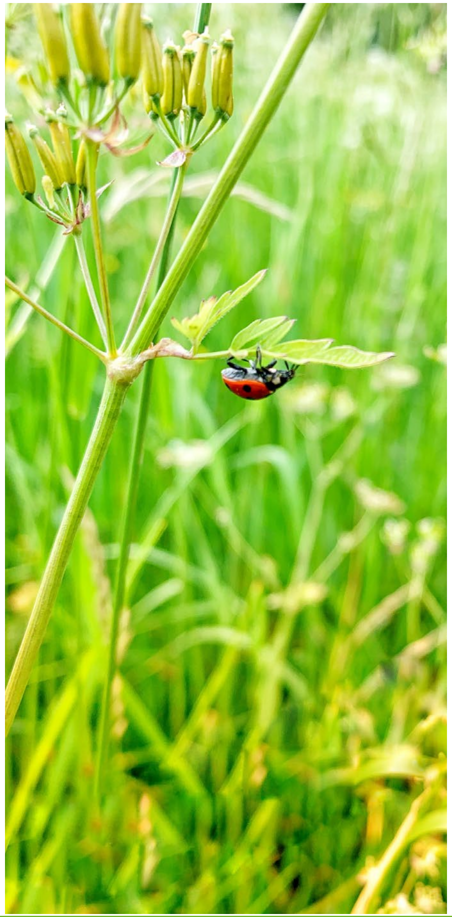
GRIP on LIFE

NATURA 2000

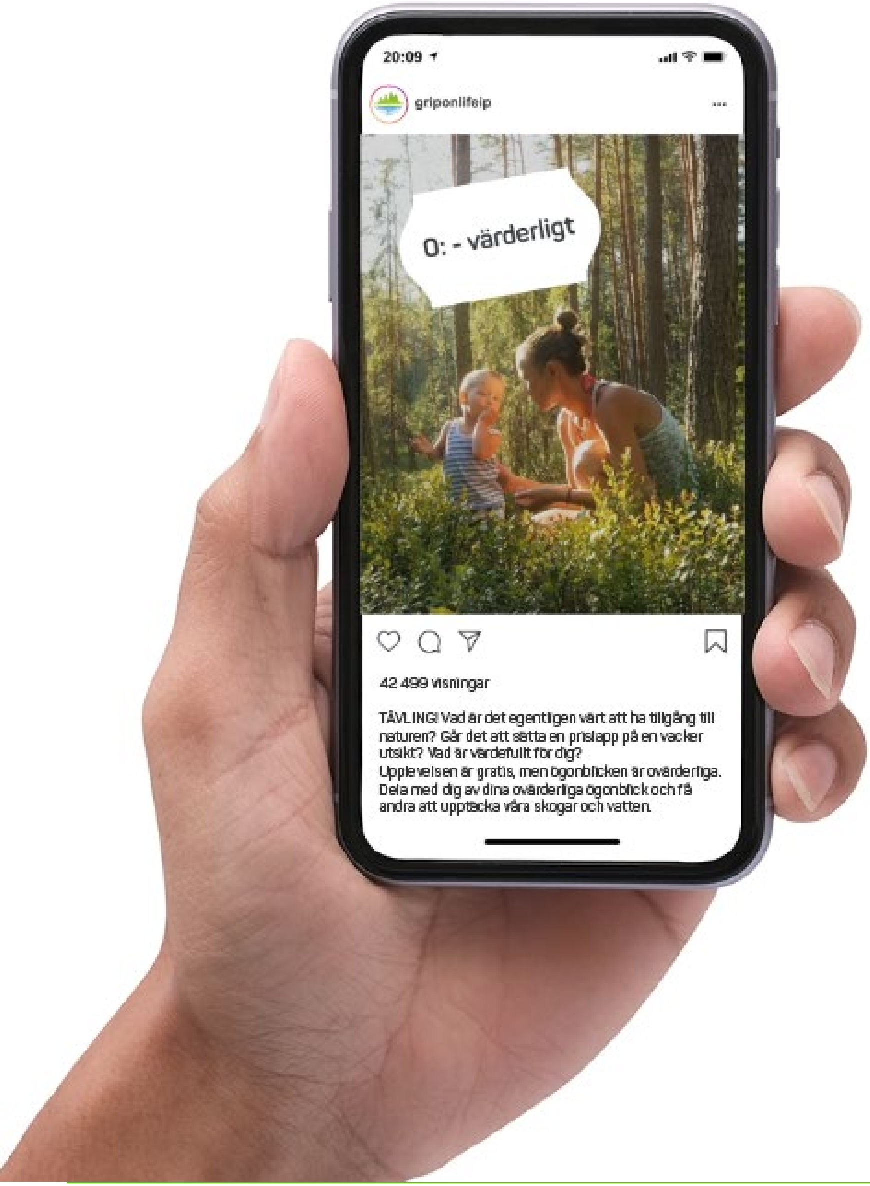
Families with children



Easy access adventure

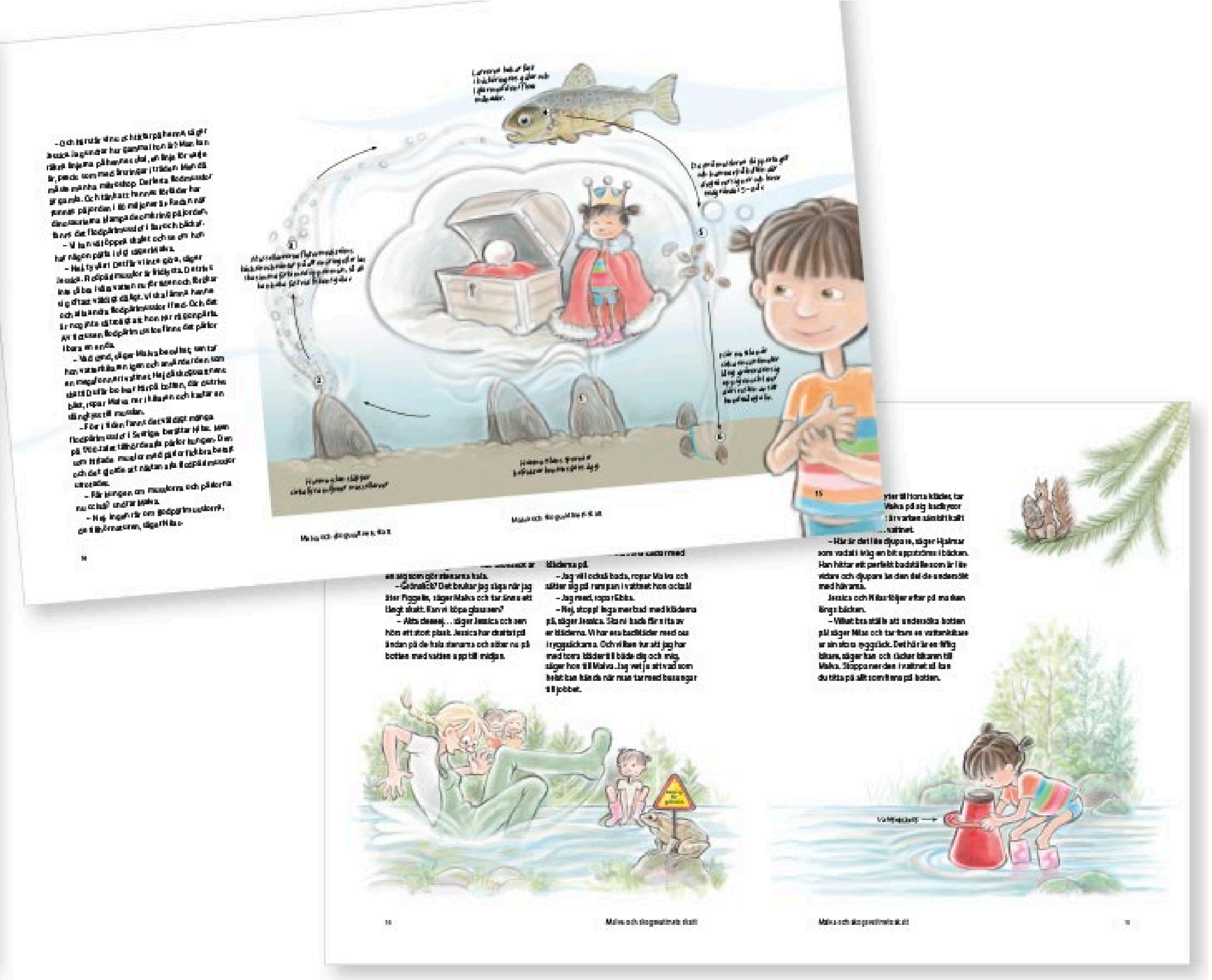
Invaluable


20:09
griponlifeip
0: - värderligt
42 499 visningar
TÄVLING! Vad är det egentligen värt att ha tillgång till naturen? Går det att sätta en prislapp på en vacker utsikt? Vad är värdefullt för dig?
Upplevelsen är gratis, men ögonblicken är ovärderliga.
Dela med dig av dina ovärderliga ögonblick och få andra att upptäcka våra skogar och vatten.


Upplevelsen är gratis
ögonblicken är ovärderliga.
0: - värderligt
GRIP on LIFE

Share and win

“Malva and the forest water treasure”



A long-term relationship

GRIP on LIFE

www.griponlife.se

With contribution from the LIFE programme of the European Union

LIFE IP CleanEST project - actions and support to implement the RBMP measures in Viru sub-basin

Mari Sepp, LIFE IP CleanEST project manager
Ministry of the Environment
Water Department

08.09.2022

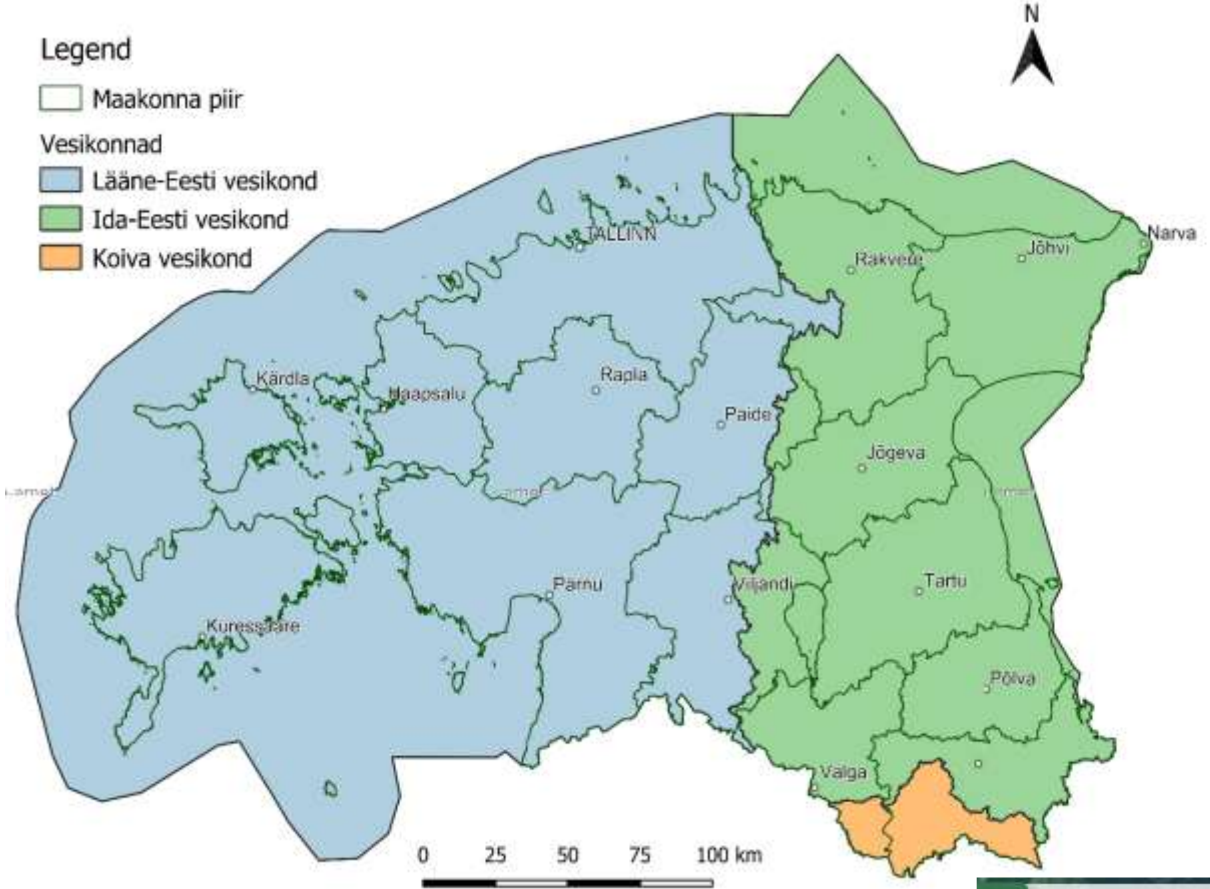
LIFE IP CleanEST project

- Duration is 10 years 01.01.2019 – 31.12.2028
- The overall budget is 16,7 million euros
  - EU LIFE Programme 10 million
  - National co-financing 6,7 million
- The aim of the project is to implement the measures of the Viru sub-basin foreseen within East-Estonian river basin management plan (RBMP)
  - ➢ to improve the status of the waterbodies in Viru sub-basin
  - ➢ to build the institutional capacity for RBMP governance
  - ➢ to prepare the proposals for RBMP cycle IV 2027 – 2032
  - ➢ To raise environmental awareness

Project partners

- Governmental organisations
- Universities
- NGOs
- Awareness
- Municipalities
- Technical

Project area – Viru sub-basin in East-Estonia



Waterbodies included to the project

- The total number of waterbodies in Estonia is 744
  - ➢ 53% are in good condition
- The total number of groundwaterbodies is 31
  - ➢ 76% are in good condition
- 574 km of waterbodies are involved to the project
  - ➢ 36 surface water bodies
  - ➢ 6 groudwater bodies
  - ➢ 2 coastal water bodies
  - ❖ Artificial waterbodies

Project actions

Pressures:

- Residual pollution
- Diffuse pollution from agriculture
- Migration barriers, restoration of riverine habitats
- Local sewage water systems

Policy, governance, tools:

- Proposals to RBMP
- Administrative capacity
- IT tools
- Remote sensing feasibility study

Communication:

- Stakeholder involvement
- Awareness raising
- Broadcasts
- Science theatres
- Youth engagement

Monitoring, impact assessment, mapping of ecosystem services

Removal of residual pollution in Erra river

15 000 m3 of polluted soil will be removed during 2022 and 2023

Situation on 26 June 2022

Erra river after removal of residual pollution

07.09.2022

Soolikaoja floating islands

Quarries – artificial waterbodies

Aidu quarry in former excavated area

Ecological status – migration barriers, restocking of salmon, communal works

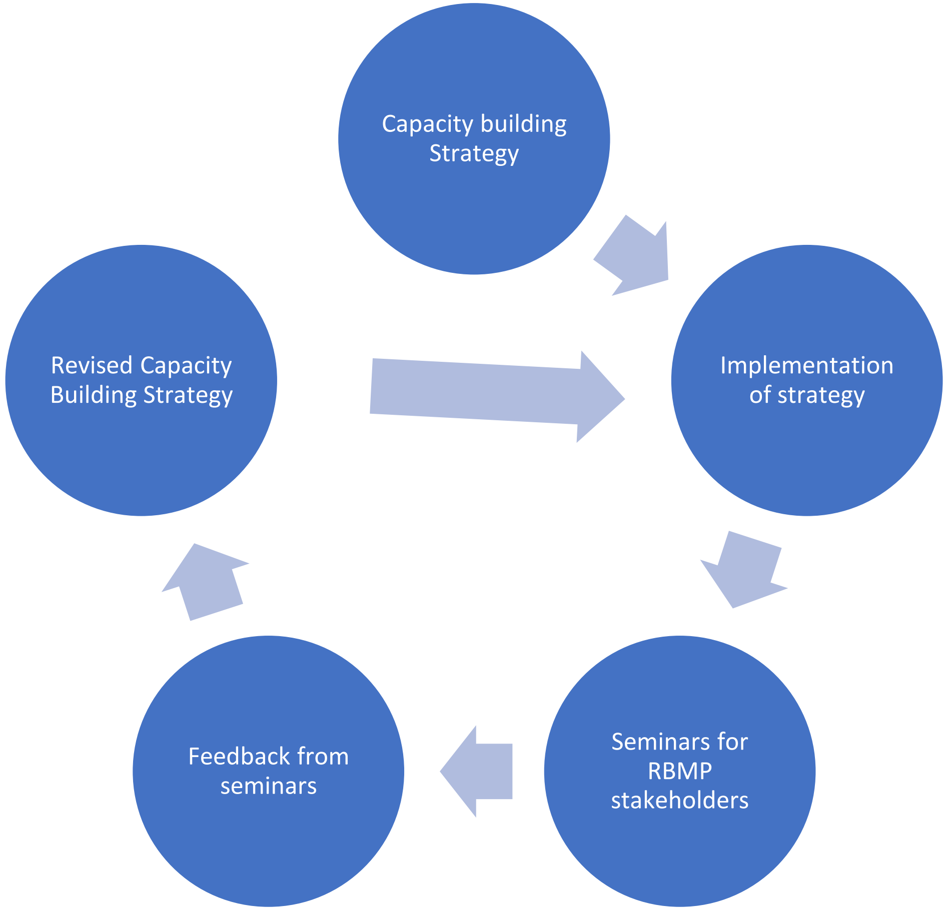
•

Püssi dam in Purtse river

Restocking fish to Purtse river/ERR broadcast fiming

Institutional capacity building

- Implementers are not aware of the RBMP aims, obligations and possibilities
- Stakeholder engagement is unregular or there is no engagement
  - Sub-basin coordinaator
  - Seminars for implementers



LIFE IP CleanEST RBMP III cycle measures

- RBMP III cycle measures in 3 river basins:
  - 2860 surface water measures
  - 73 gorunwater measures
  - 214 overall measures for all 3 catchment areas

650 million euros

- 552 measures in project area, Viru sub-basin
  - 42 measures in LIFE IP CleanEST project
    - 16,7 million euros


cleanest
Virumaa veed puhtaks!
Let's clean the waters of Virumaa!

GEOLOGICAL SURVEY OF ESTONIA

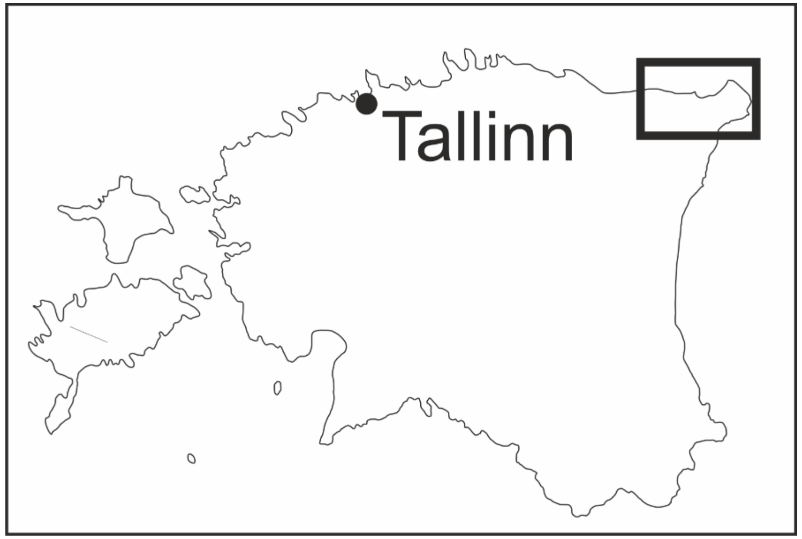
cleanest

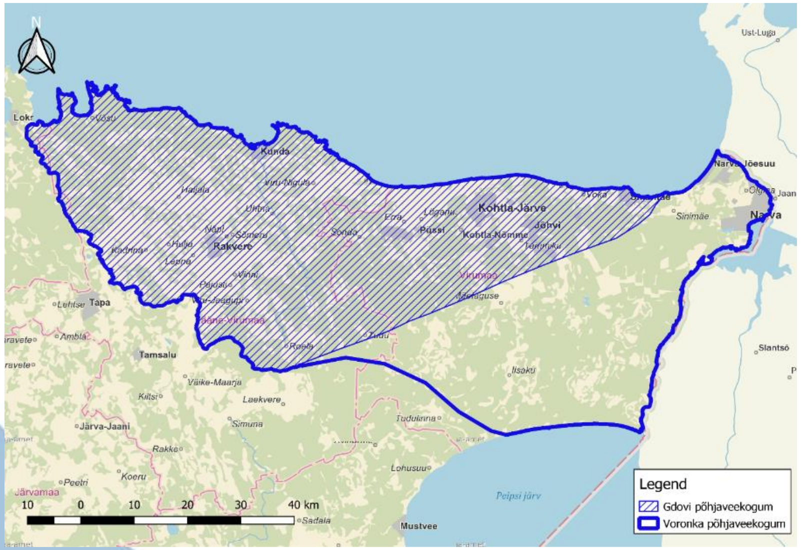
Problems related to national groundwater monitoring network and groundwater-surface water interaction in groundwater bodies of the Viru-subbasin, Estonia

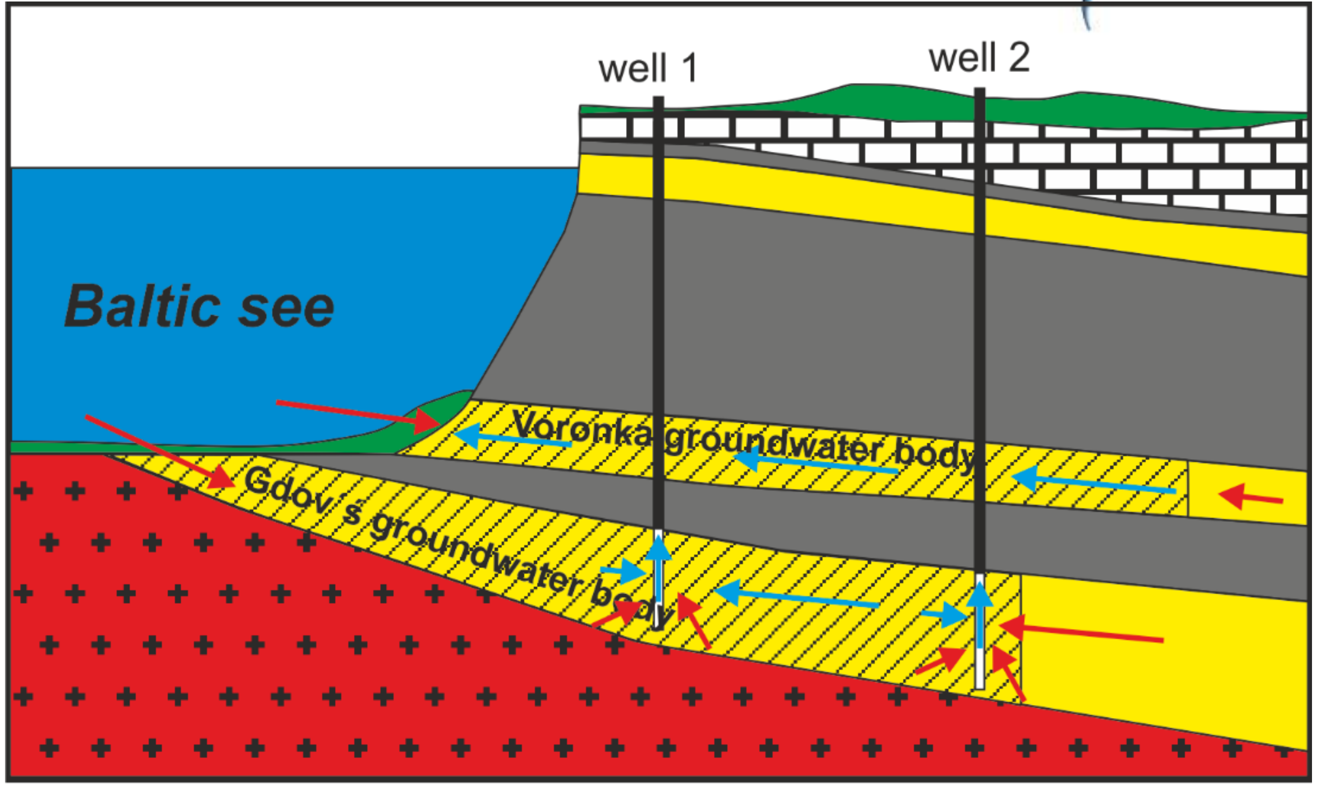
Valle Raidla, Merle Truu

2022

Prologue: Gdov’s groundwater body





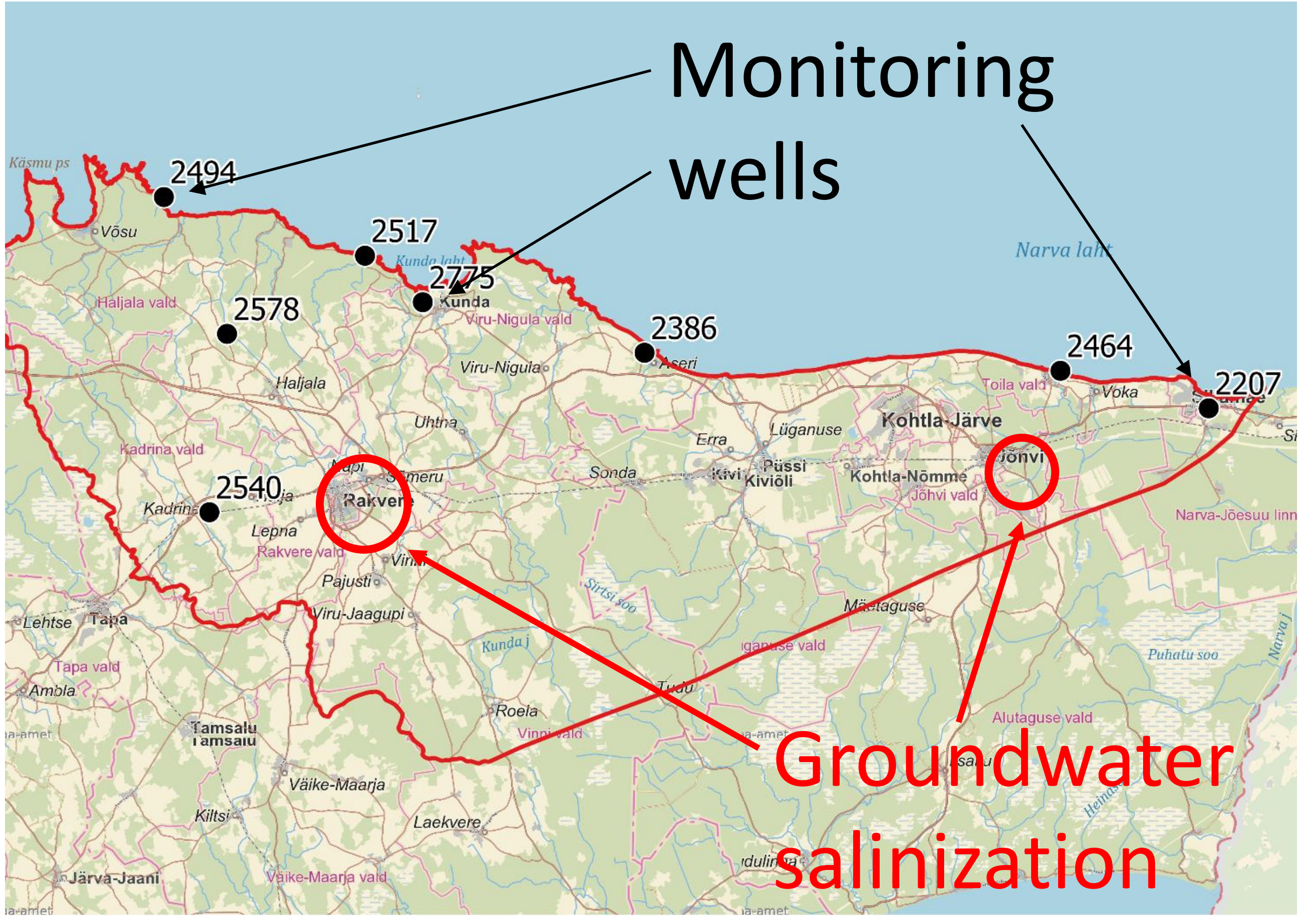


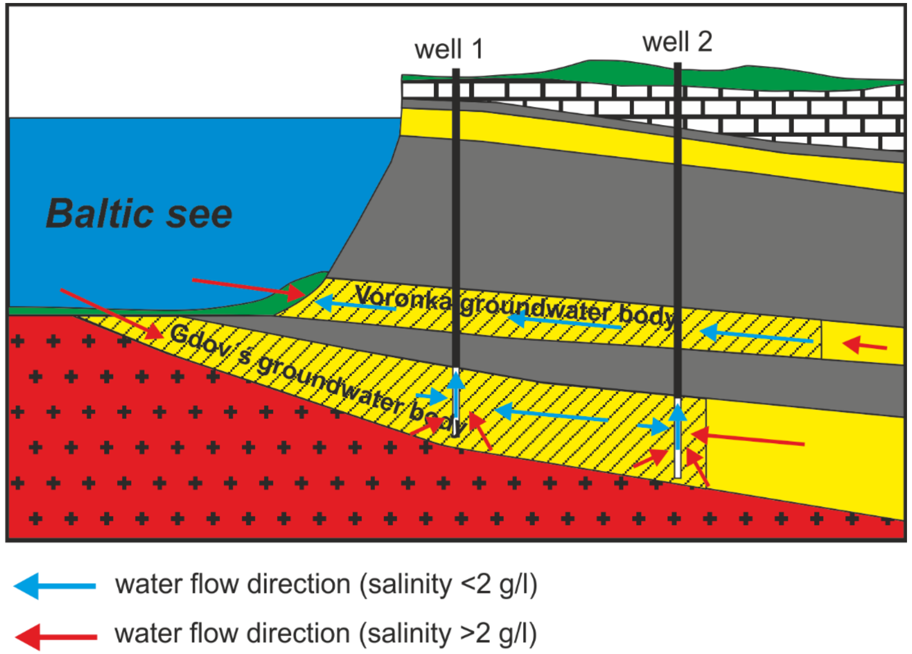
water flow direction (salinity <2 g/l)

water flow direction (salinity >2 g/l)

Fresh water body between two salt water basins.

Prologue: Gdov's groundwater body

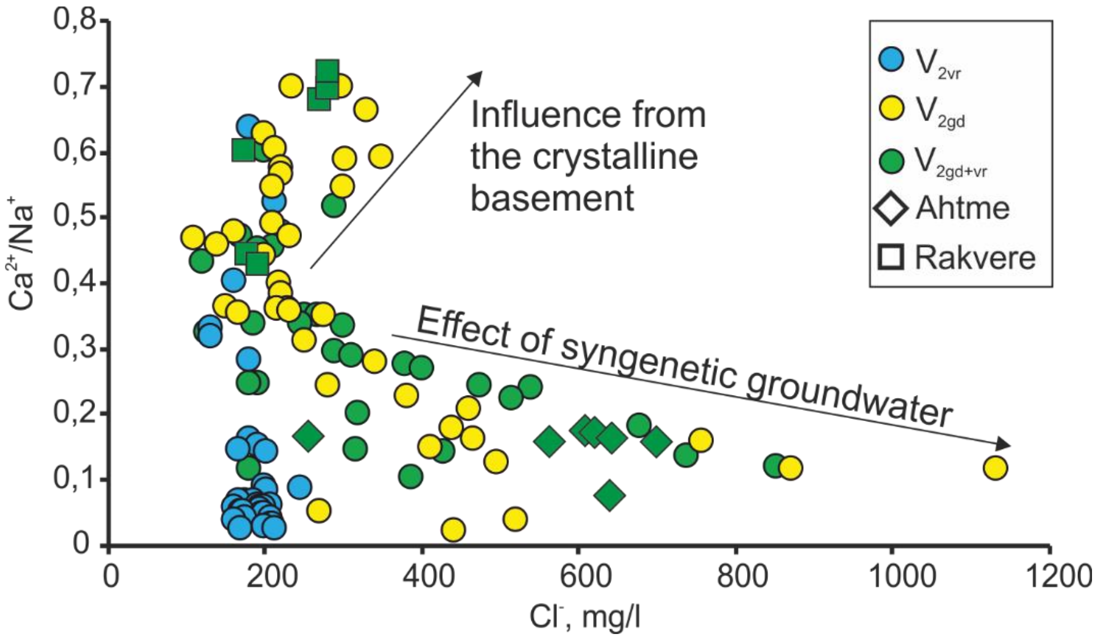


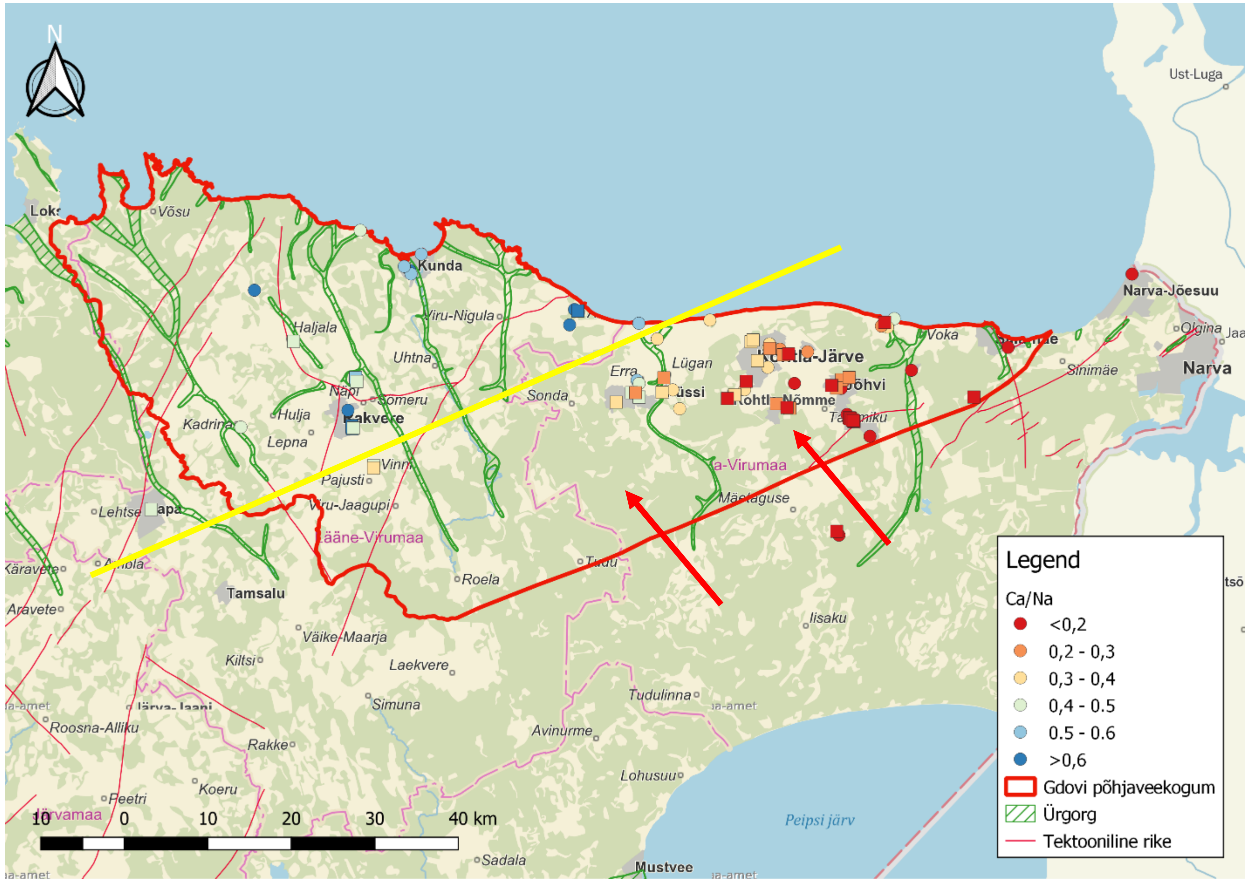


Water salinization (increased Cl and Na) became a problem for the groundwater body, but not on the coast but inland.

Prologue: Gdov's groundwater body

cleanest

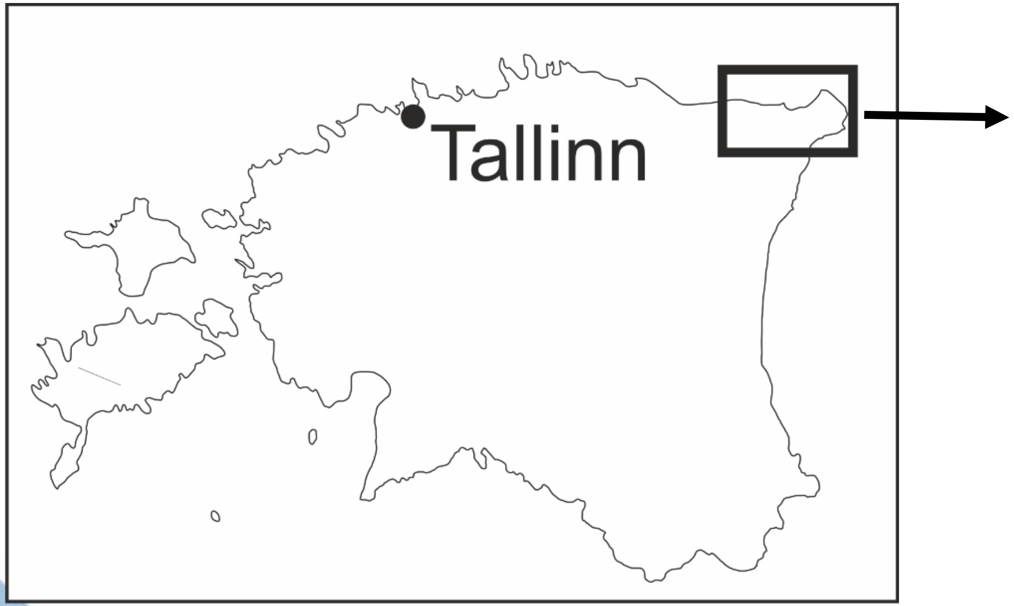


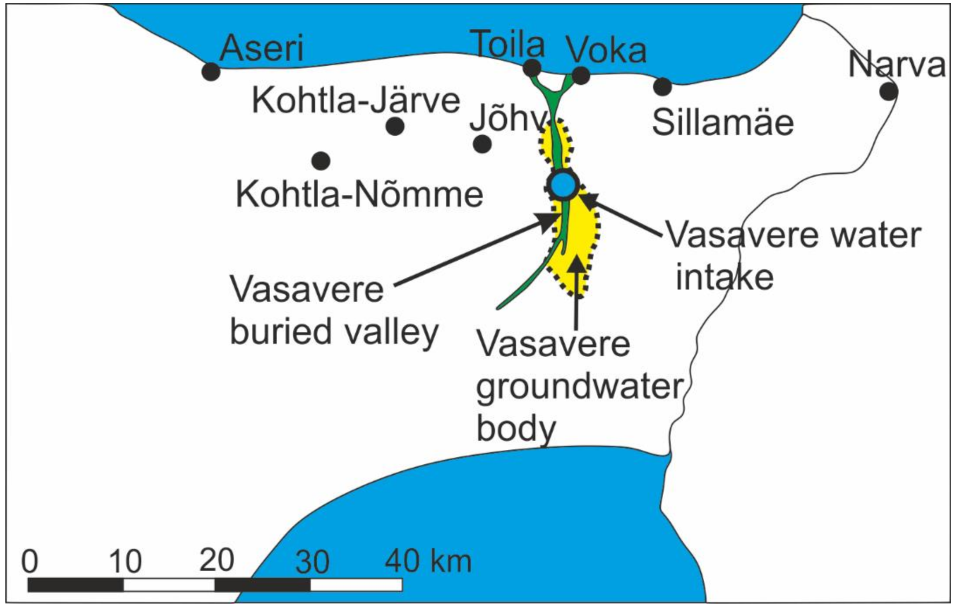


It turned out that almost half of the groundwater body was affected by the southern mineral water.

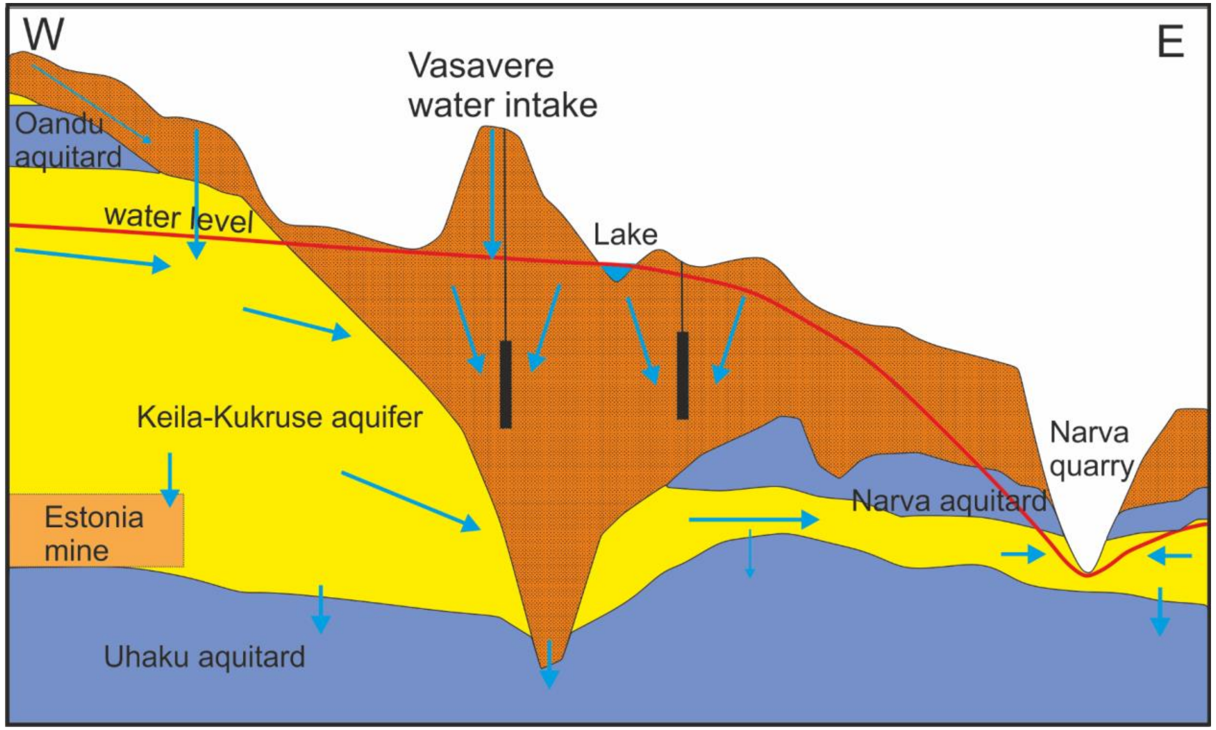
Problem: Vasavere groundwater body

- According to the status assessments of the groundwater bodies carried out in 2014 and 2020, the chemical status of the Quaternary Vasavere groundwater body was found to be poor due to the upward trends of COD_{Mn} (chemical oxygen demand), NH_4^+ and NO_3^- values.
- It is essential to understand the causes of the trends because the groundwater body is used as an important source of water supply for the surrounding areas.
- Given the above, a study was performed within the LIFE IP CleanEST project in 2019–2021.

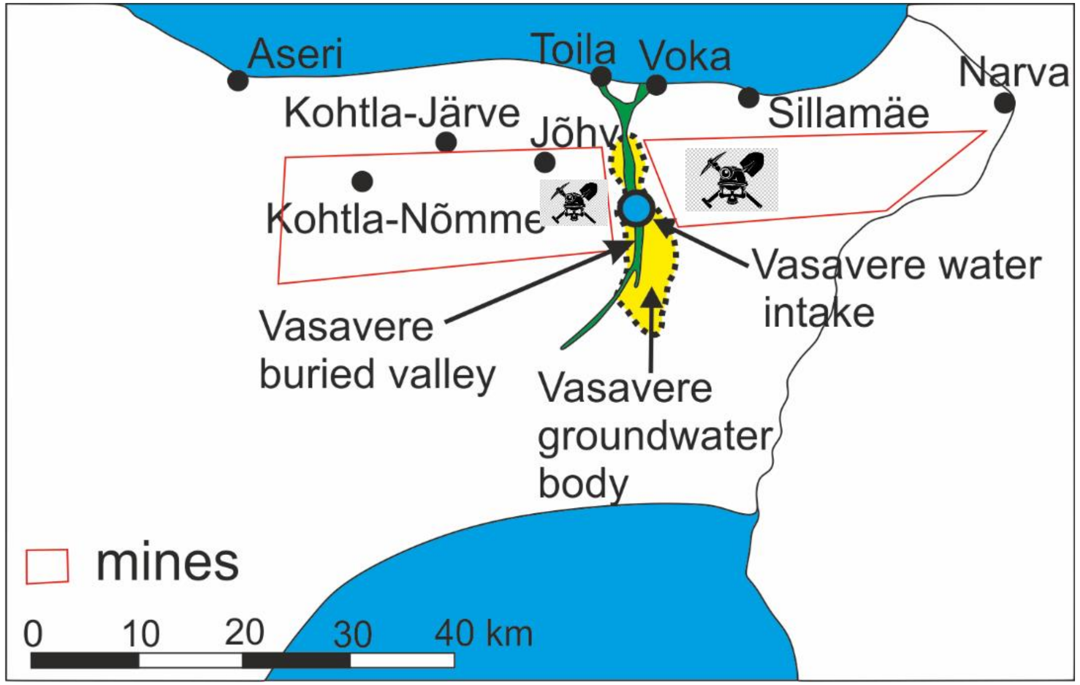




Site description: Vasavere groundwater body

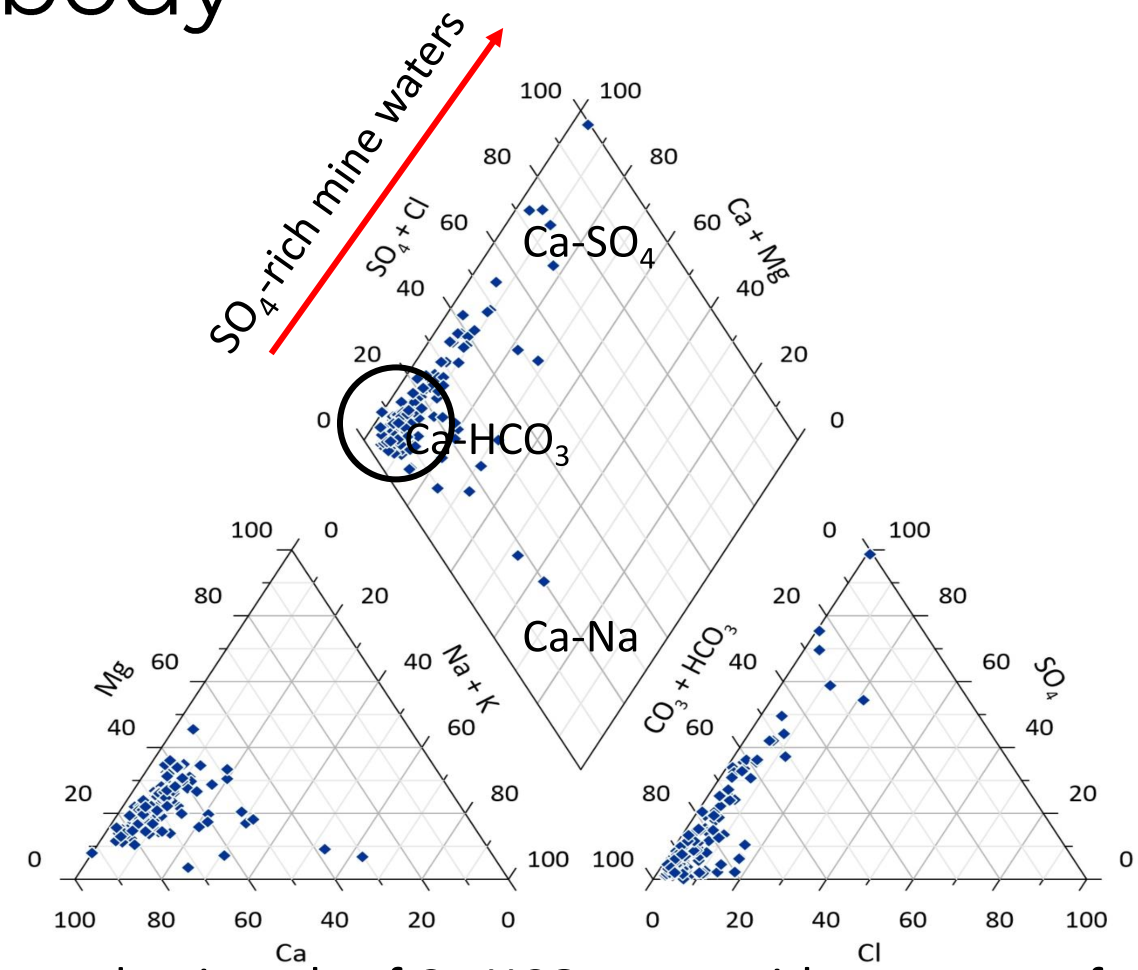


The majority of the groundwater body is located in the buried valley of Vasavere, which is filled with fluvioglacial sand.



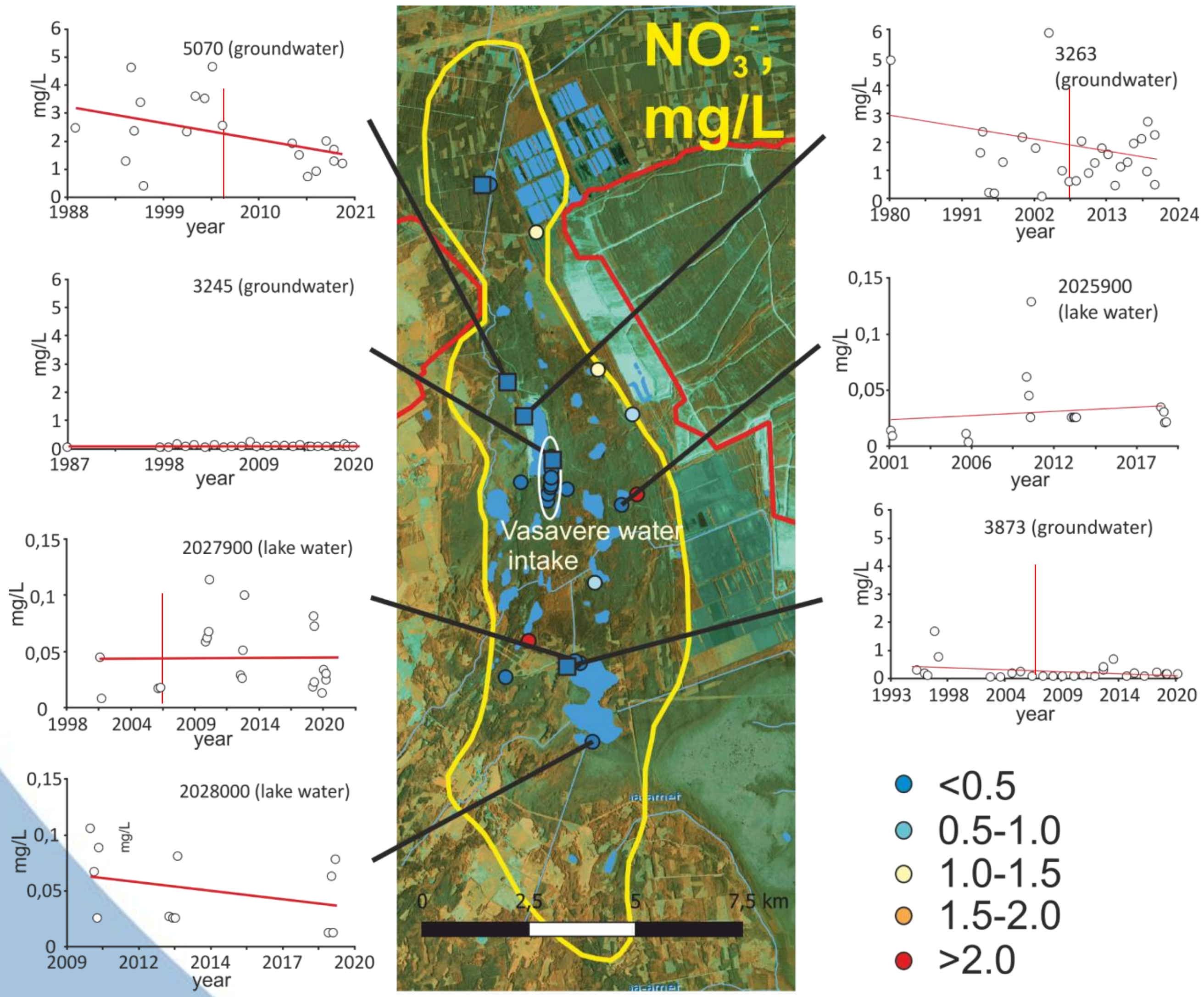
The groundwater body and local surface water ecosystems are affected by the adjacent oil-shale mines, the water abstraction, peat cutting and forest drainage.

Site description: Vasavere groundwater body



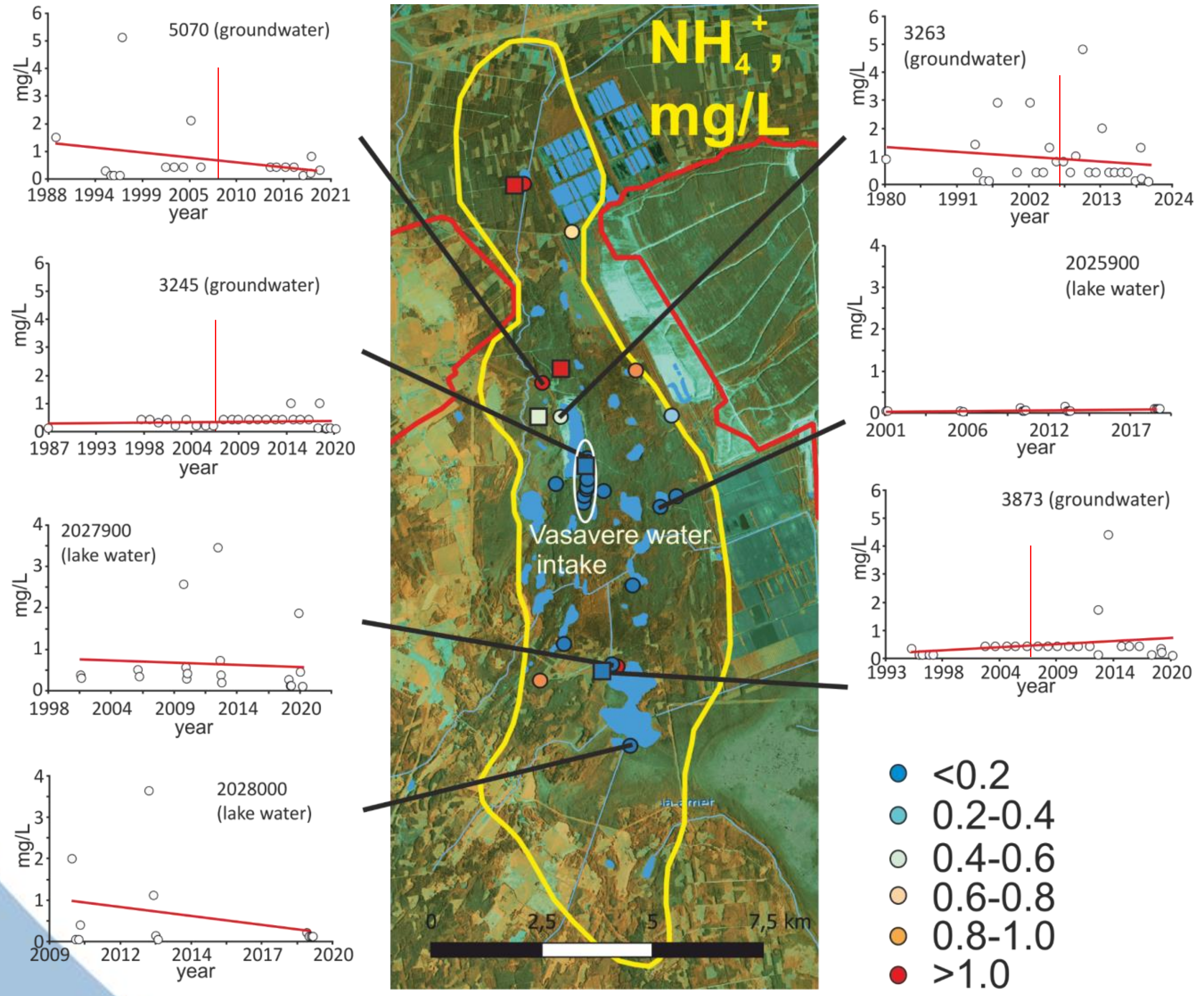
Water in the groundwater body is predominantly of Ca-HCO_3 type, with a content of total dissolved solids of 0.2–0.5 g/L.

Results



- Nitrate concentrations were below 2.2 mg/L in all wells, and the detected growth trends can be considered statistically insignificant.
- An increasing trend of NO_3^- observed in the four boreholes in years 2007 to 2014, however, it occurs at very low concentrations.

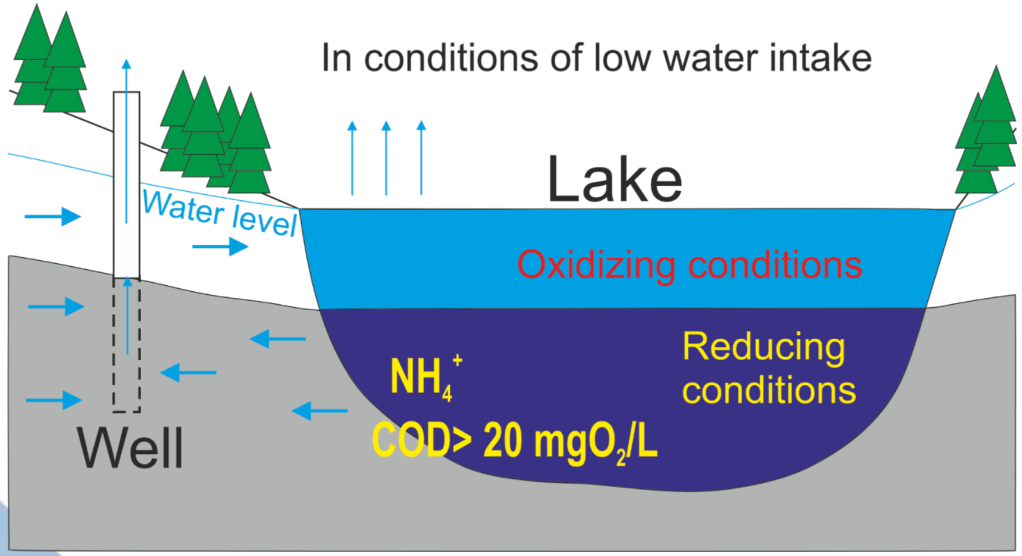
Results

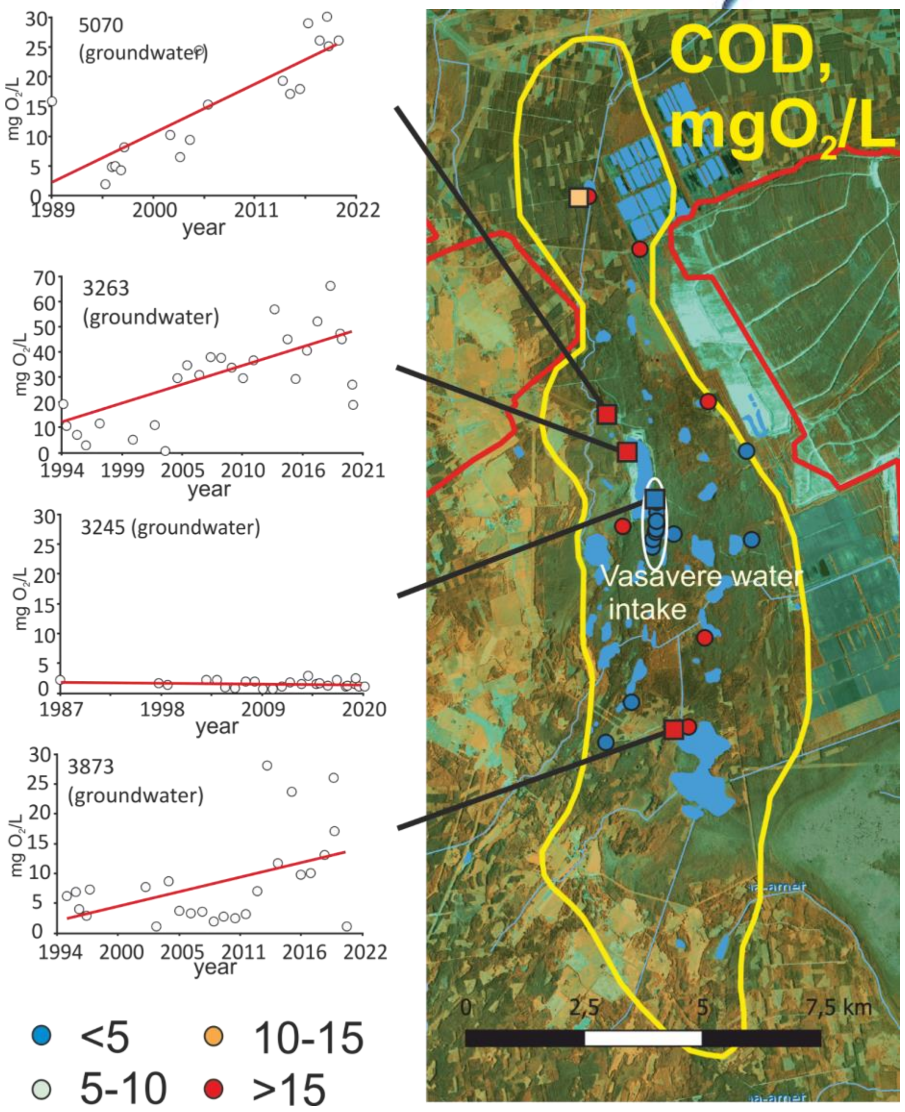


Elevated NH_4^+ levels (0.92–1.85 mg/L) were detected in four wells, but statistically the increasing trends are unreliable.

Results

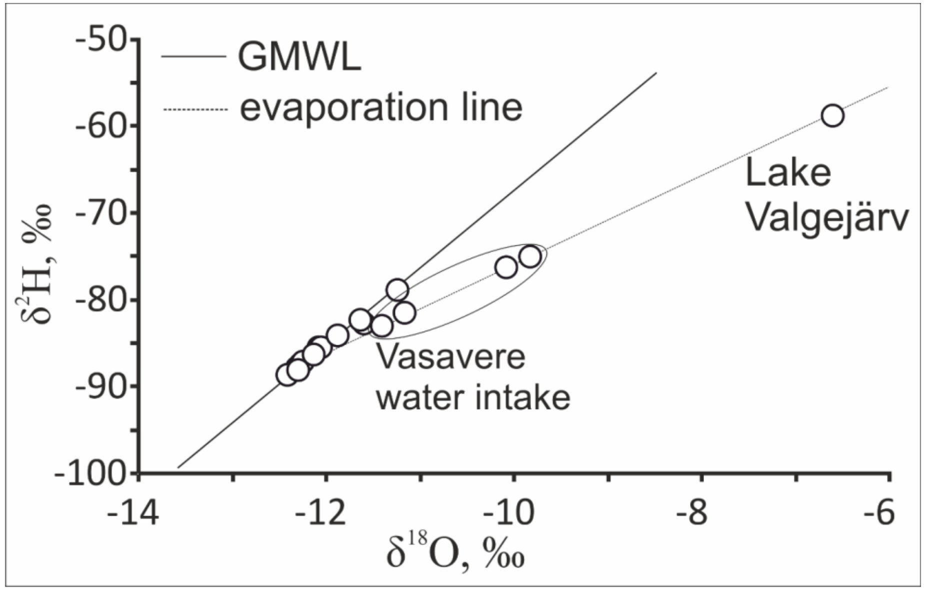
- The COD values vary widely, and in 8 wells the results ranged from 22 to 42 mgO_2/L.
- A clear increasing trend of COD content was detected in three wells.
- Higher NH_4^+ and COD_{Mn} values are more characteristic of wells which are located near wetlands.

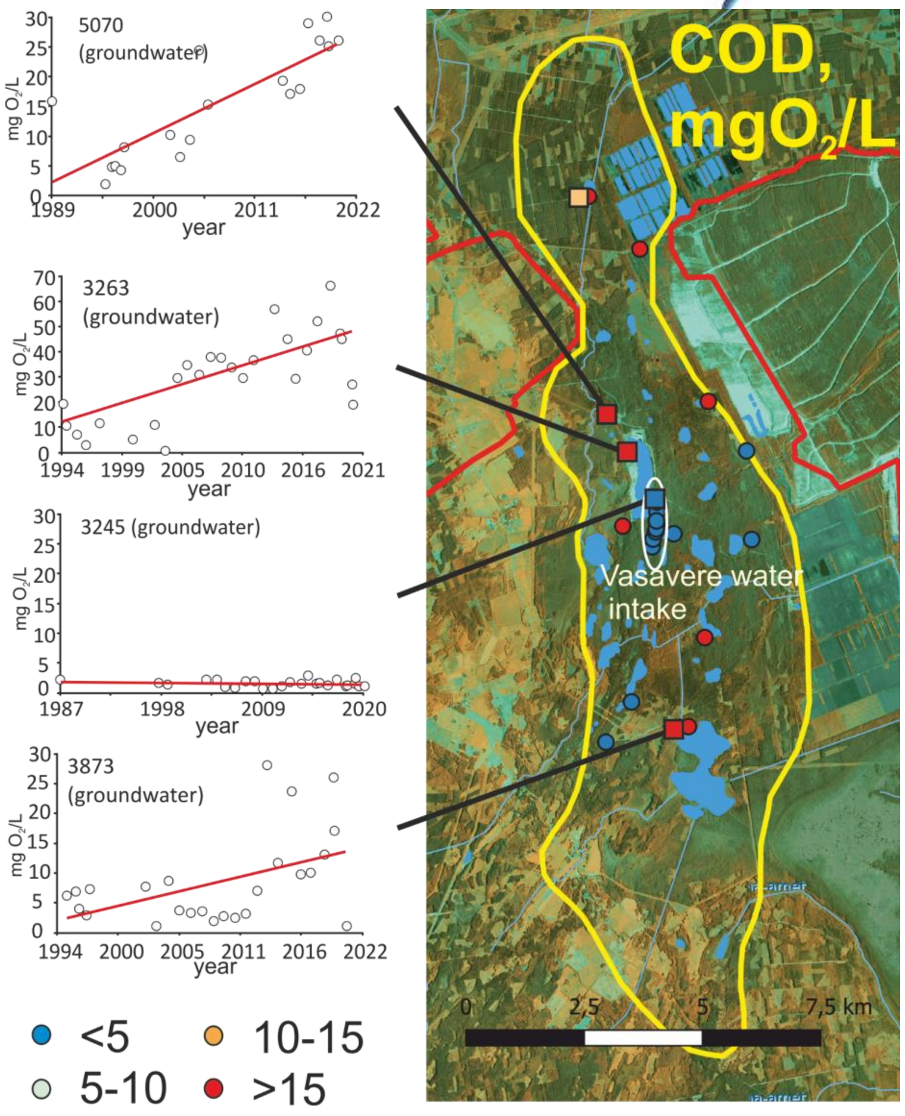




Results

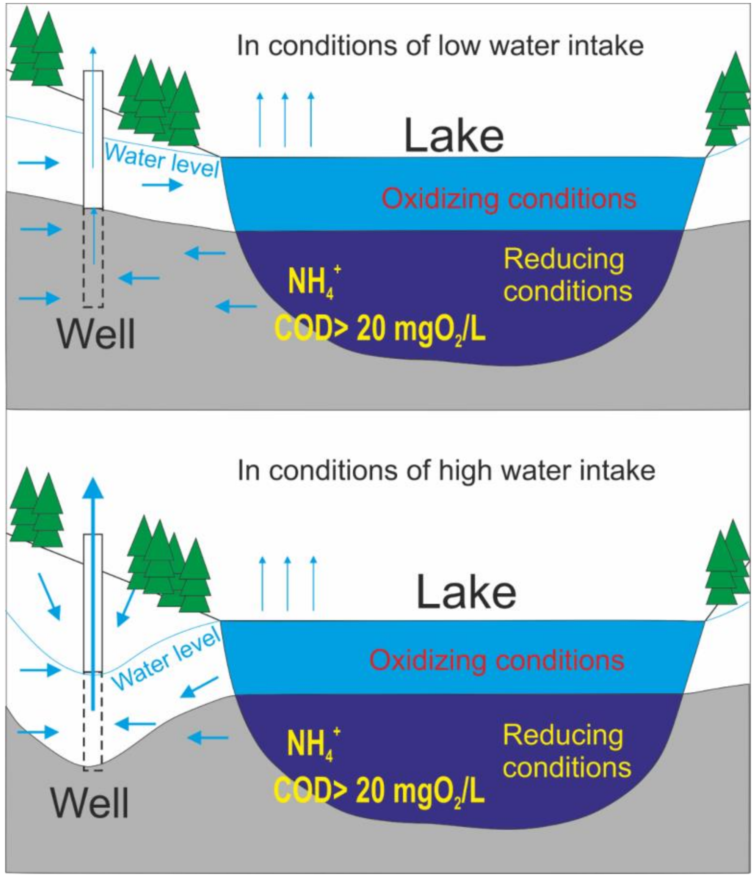
At the same time, high COD values are not found in the wells of the Vasavere water intake, which is located among the lakes.

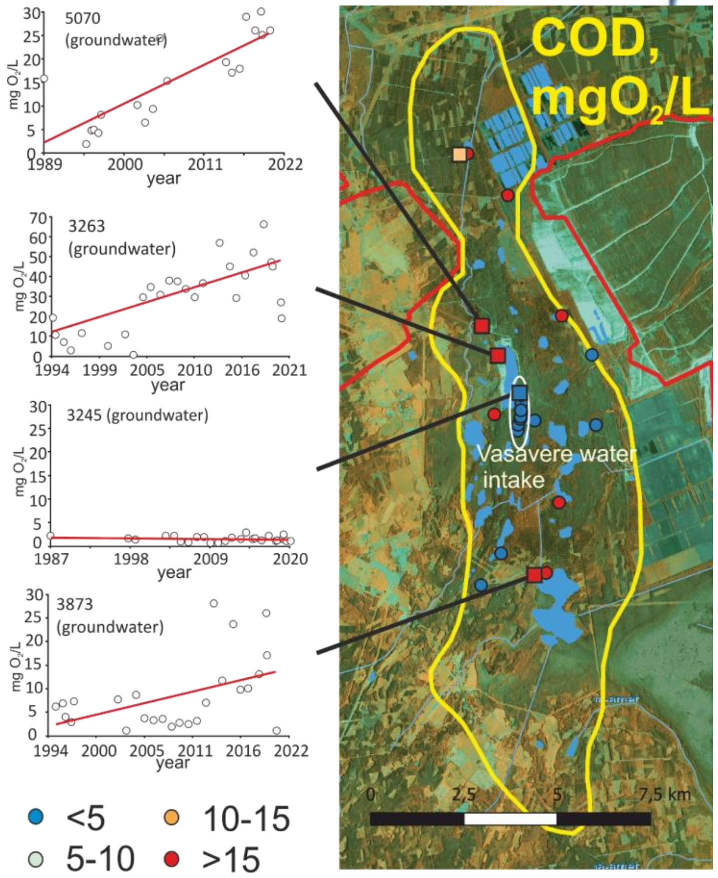




The isotopic composition of the water in the wells in that area indicated a significant evaporation effect.

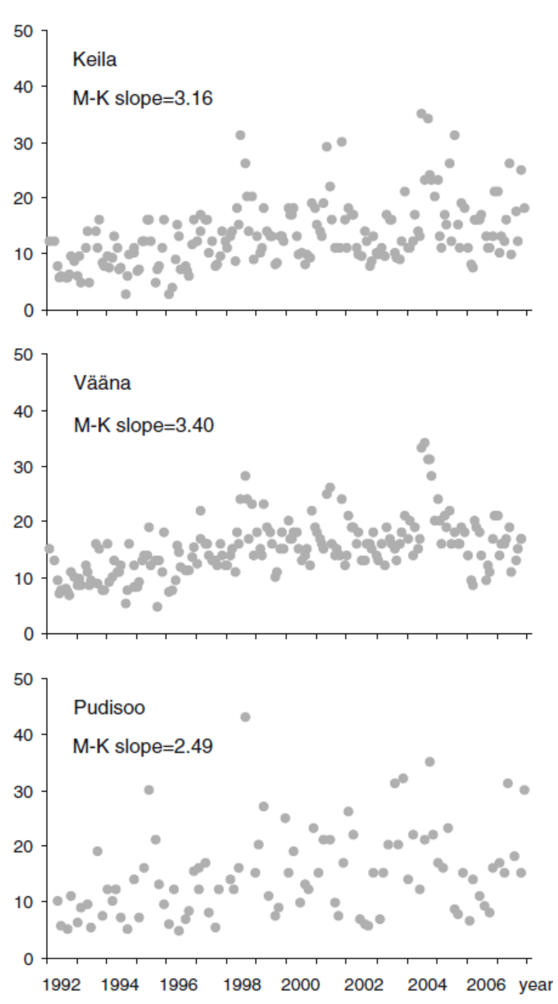
Discussion



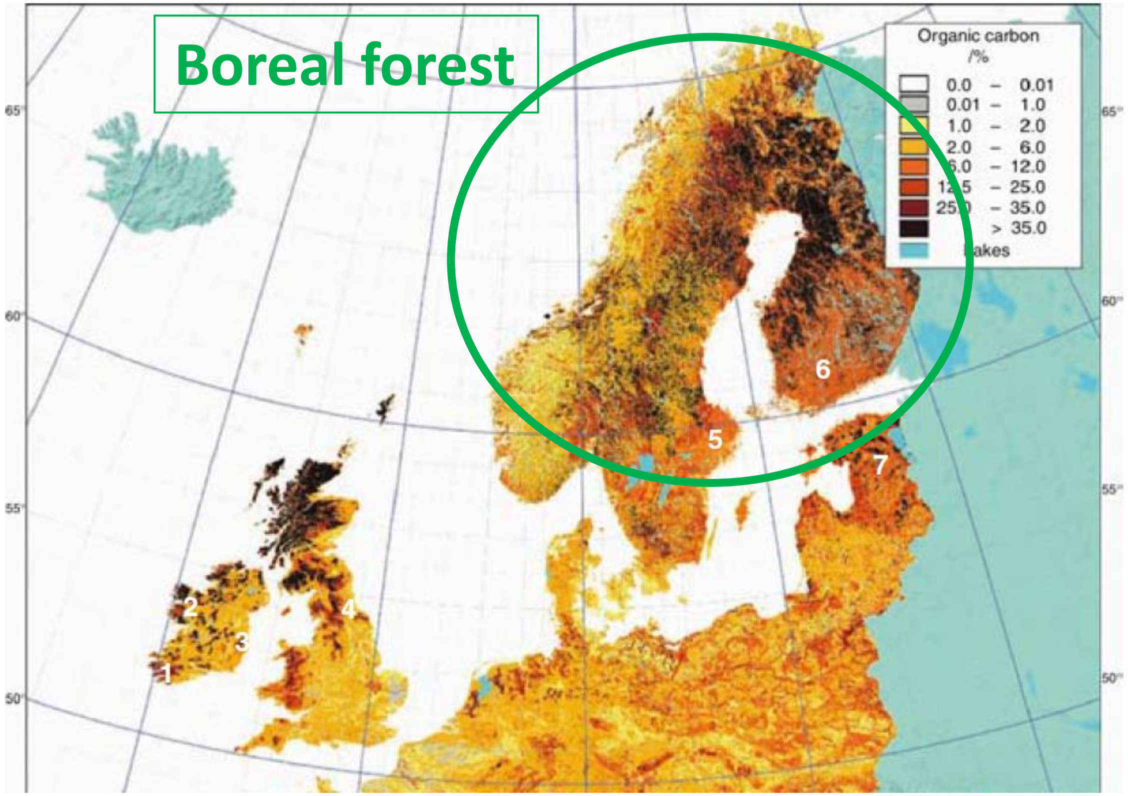


Apparently, water of the Vasavere water intake mainly originates from the surface layer of the nearby lake(s). This would also explain the presence of oil products and phenols in the wells in the vicinity of the Pannjärve quarry.

Discussion

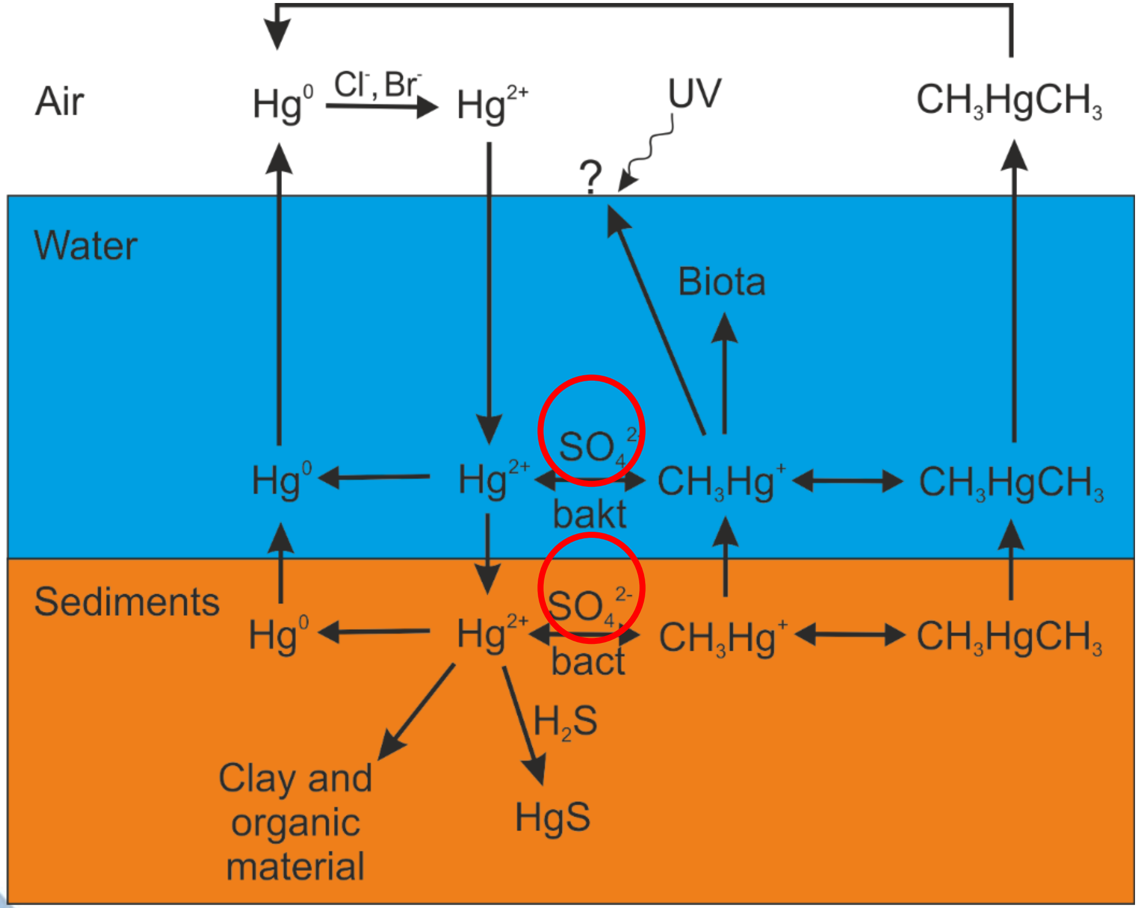


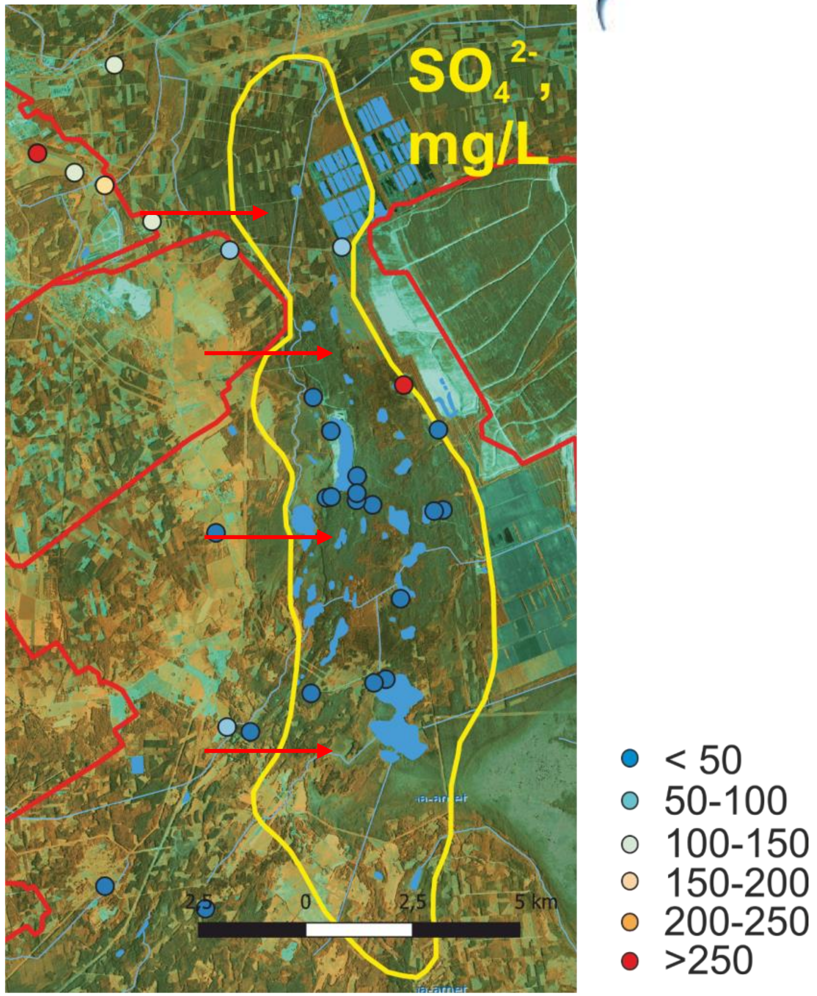
Pärn, J., Mander, Ü., 2012.



The global warming has become more obvious in Estonia, causing the replacement of the boreal, organic matter accumulating system with a much faster decay cycle.

Discussion

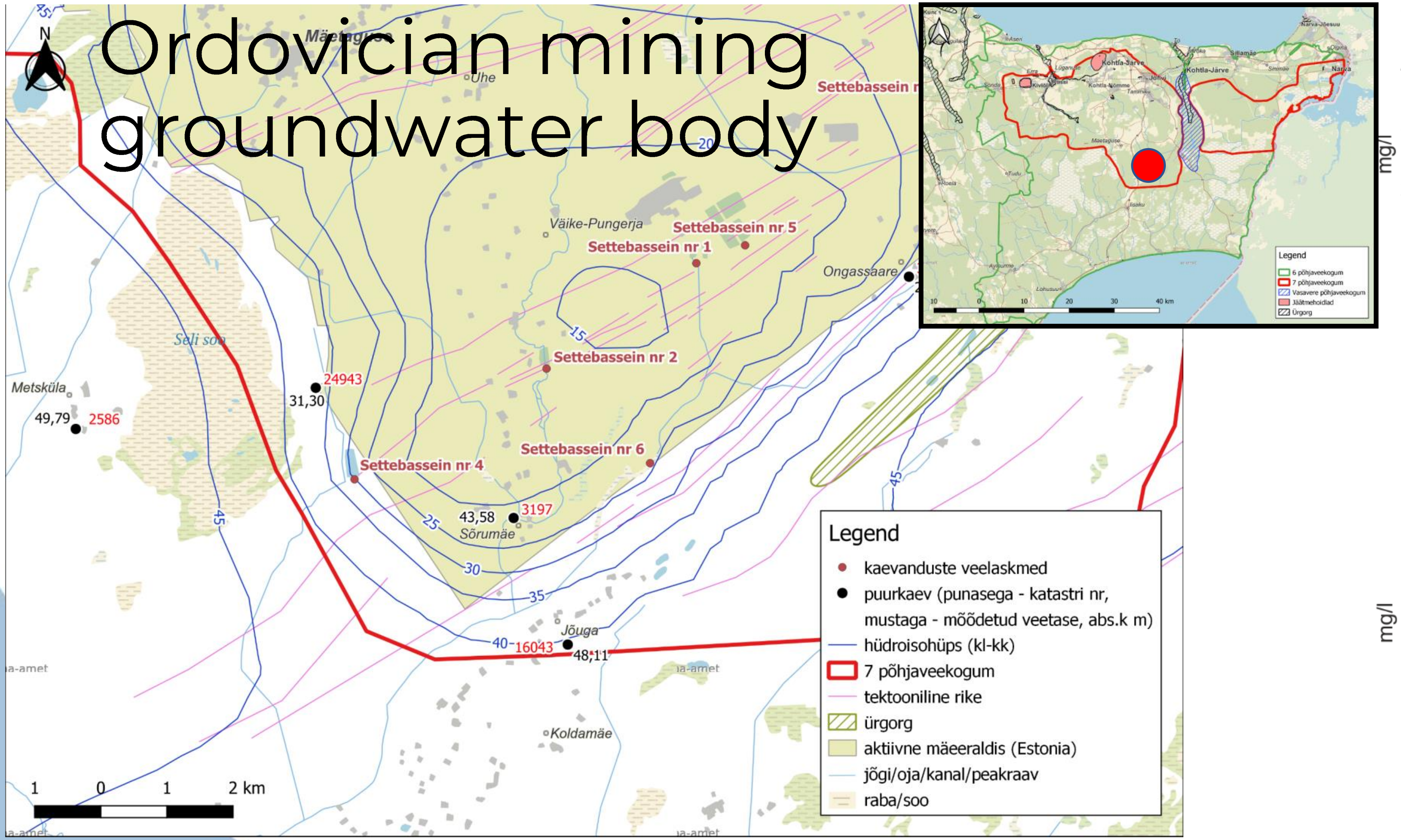


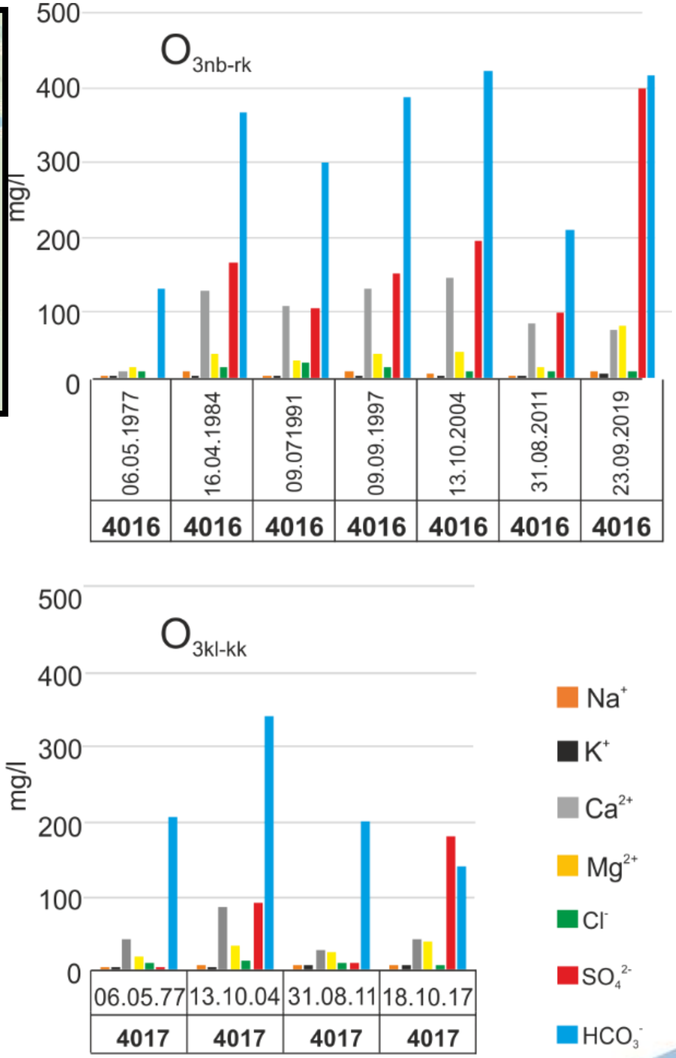


Degradation of organic material could release heavy metals

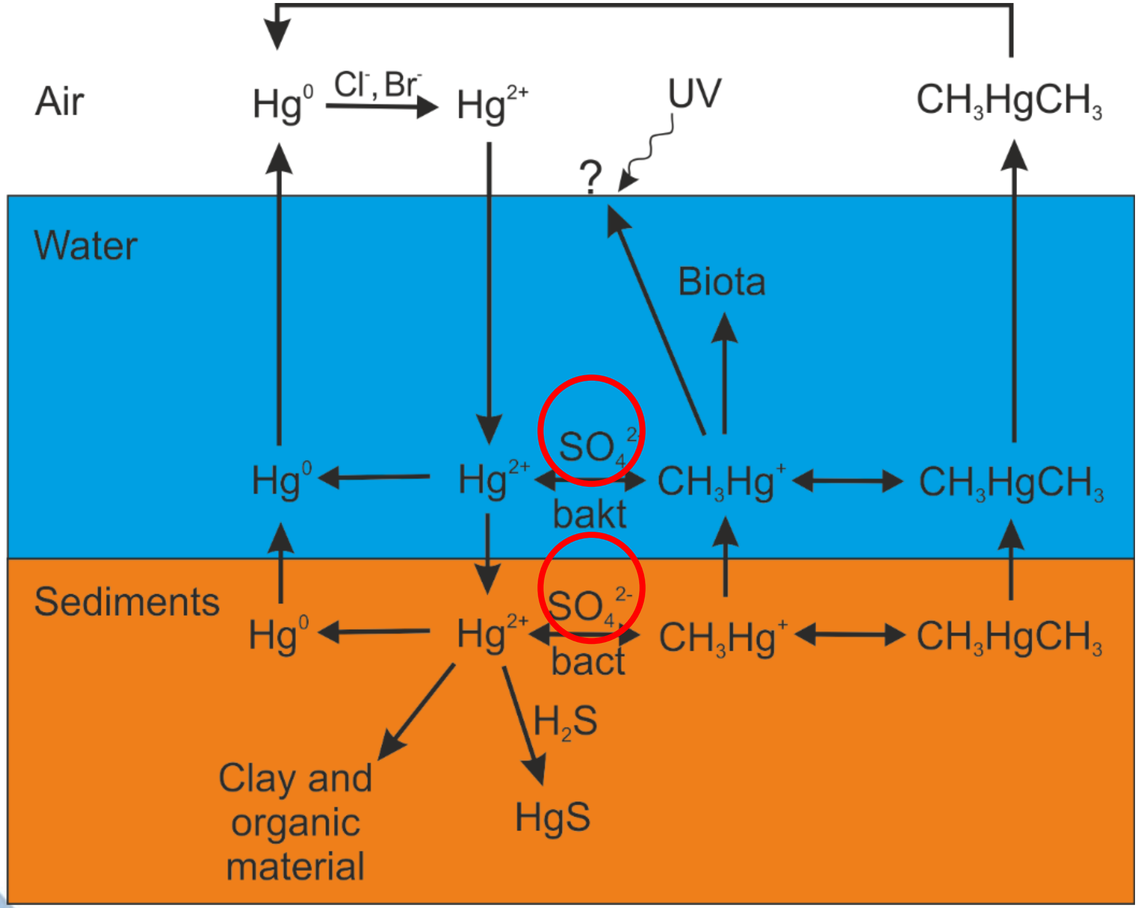
Discussion

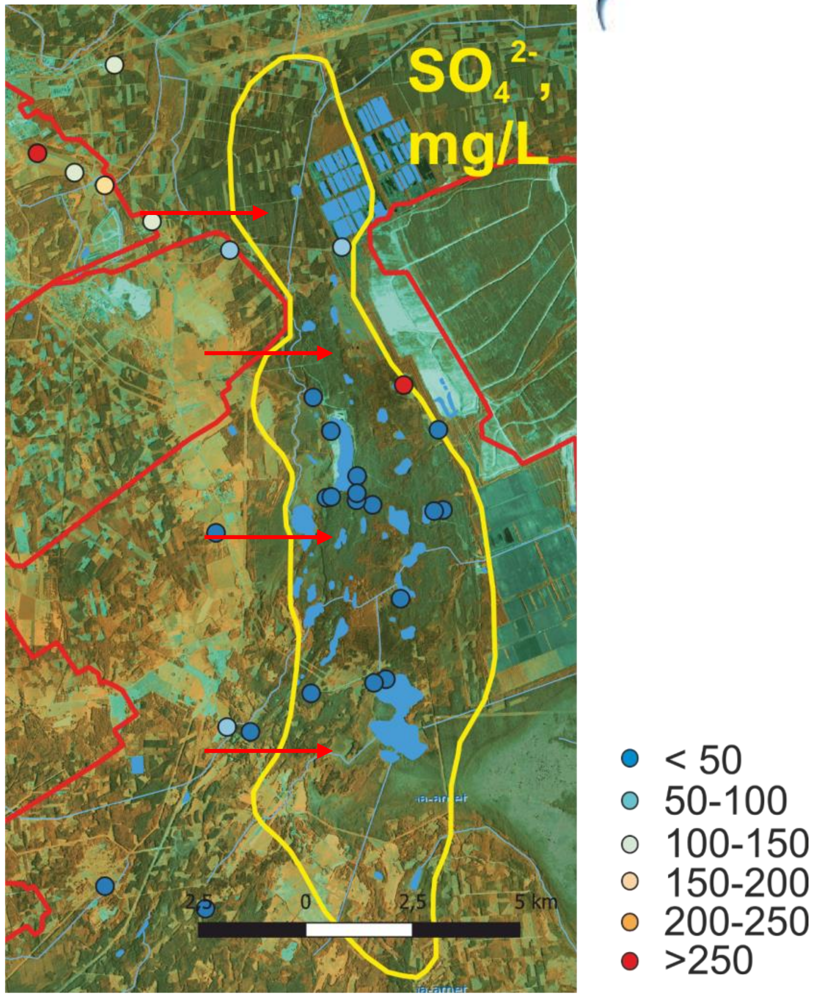
Ordovician mining groundwater body





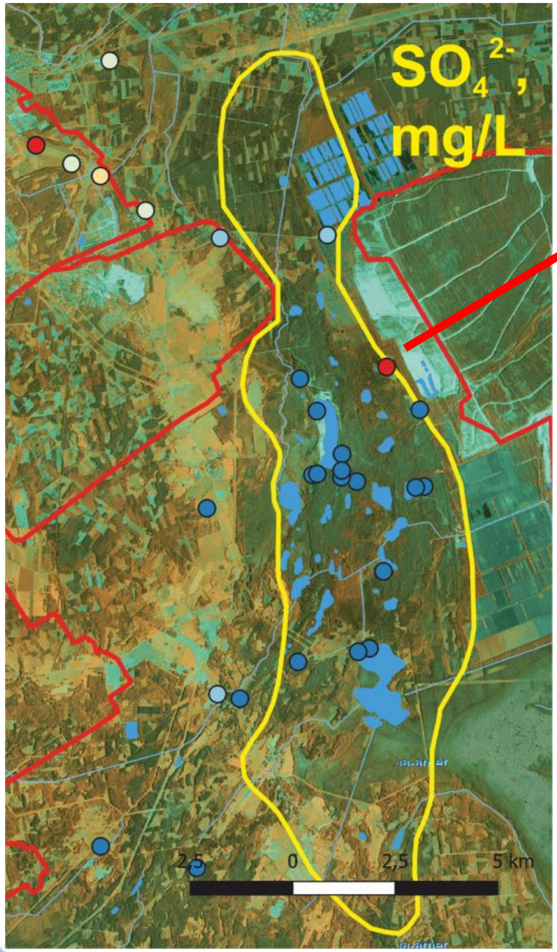
Discussion





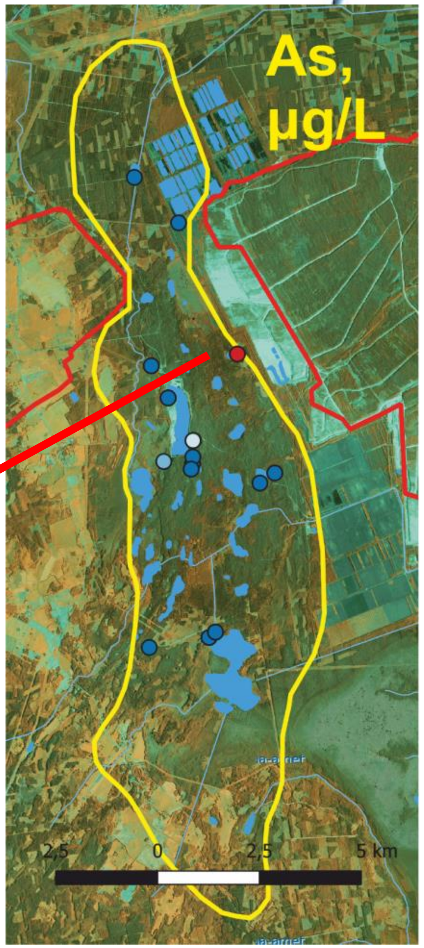
Degradation of organic material could release heavy metals

Discussion



- < 50
- 50-100
- 100-150
- 150-200
- 200-250
- >250

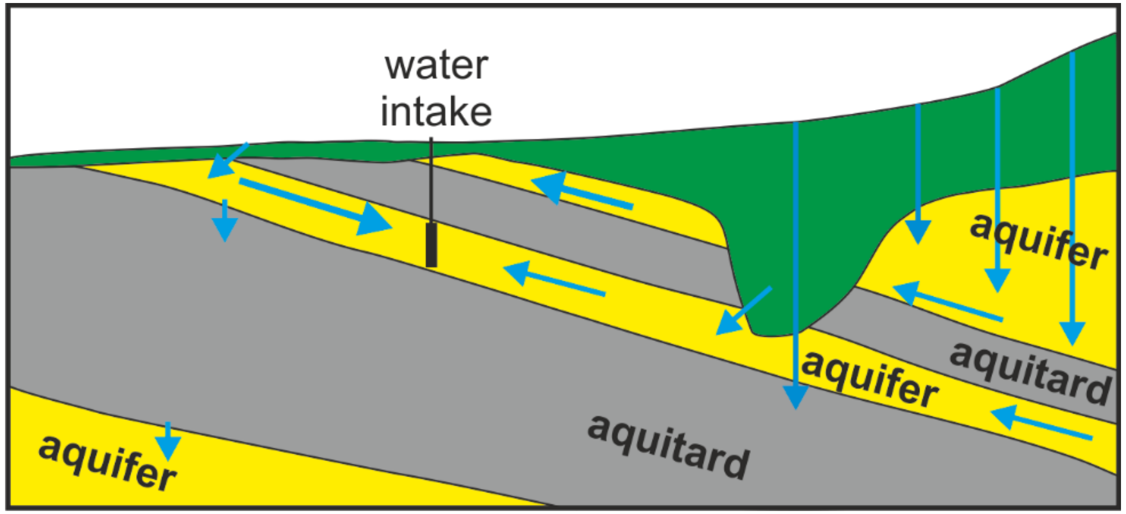
$$FeAsS + 2H_2O + 2O_2 \rightarrow$$
$$FeOOH + SO_4^{2-} + As^{5+} + 3H^{+}$$

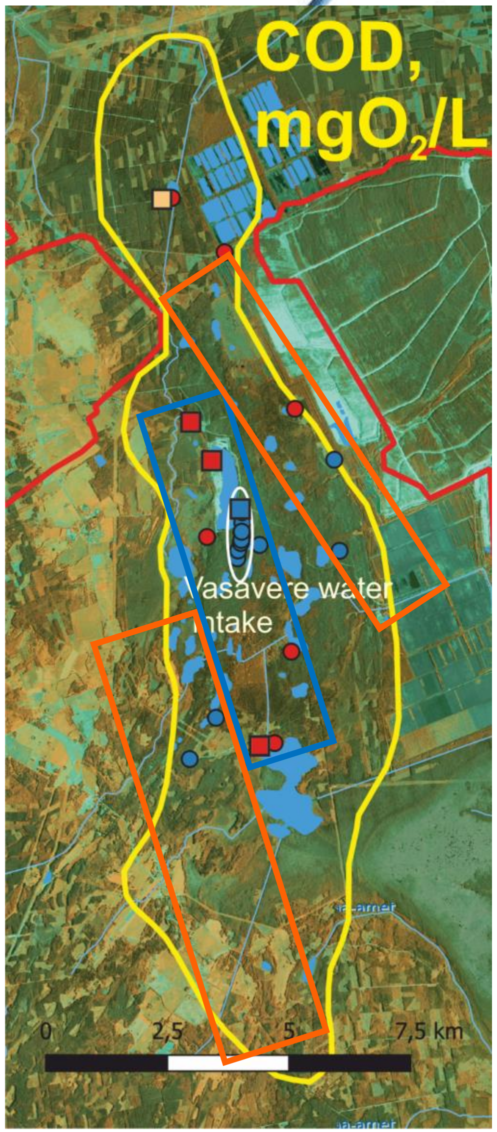


- <2
- 2-4
- 4-6
- 6-8
- 8-10
- >10

A long drought and a strong storm events could stimulate oxidation of sulphide minerals and release heavy metals.

Conclusions





- Groundwater affects the surface water bodyes, but the surface water also affects the groundwater.
- In the light of global climate changes, it becomes more critcal to predict what will happen next.
- The monitoring network must be dynamic, both spatially and methodically.
- The problem. Resources.

Geological Survey of Estonia

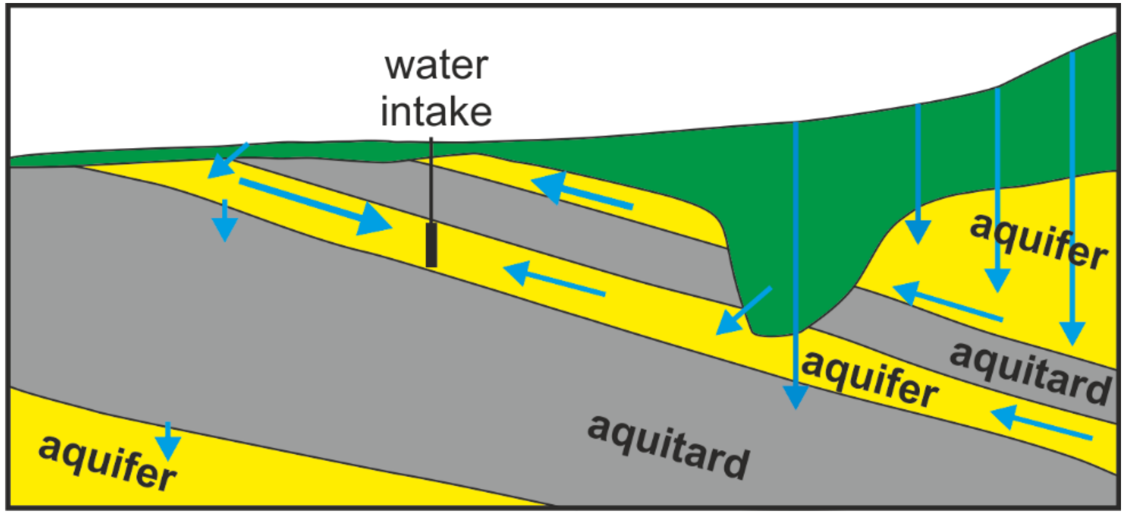
Greater flexibility and inventiveness could help to avoid problems in the future.

Thank you for your attention!

Valle.Raidla@egt.ee

Conclusions

Conclusions



- Groundwater affects the biota, but the biota also affects the groundwater.
- In the light of global climate changes, it becomes important to predict what will happen next.
- The monitoring network had to be dynamic, both spatially and methodically, in interaction with new knowleges.
- The problem. The more we know, the more expensive it becomes to acquire new knowledge. Where is the critical degree of knowledge?

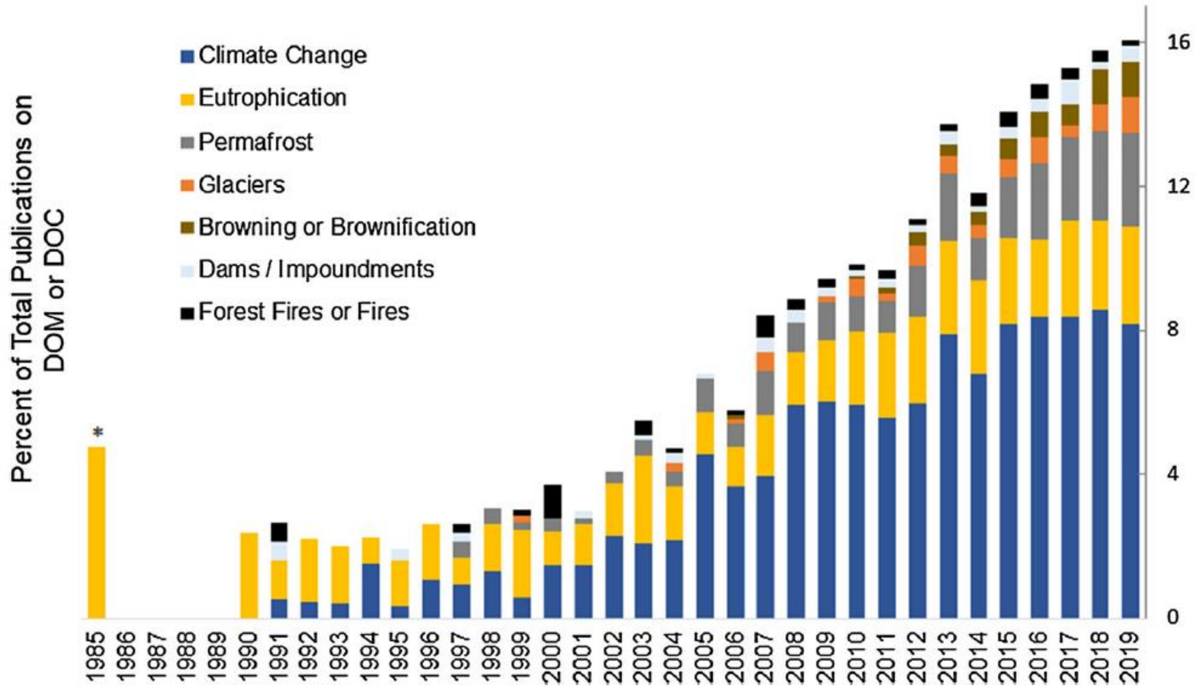
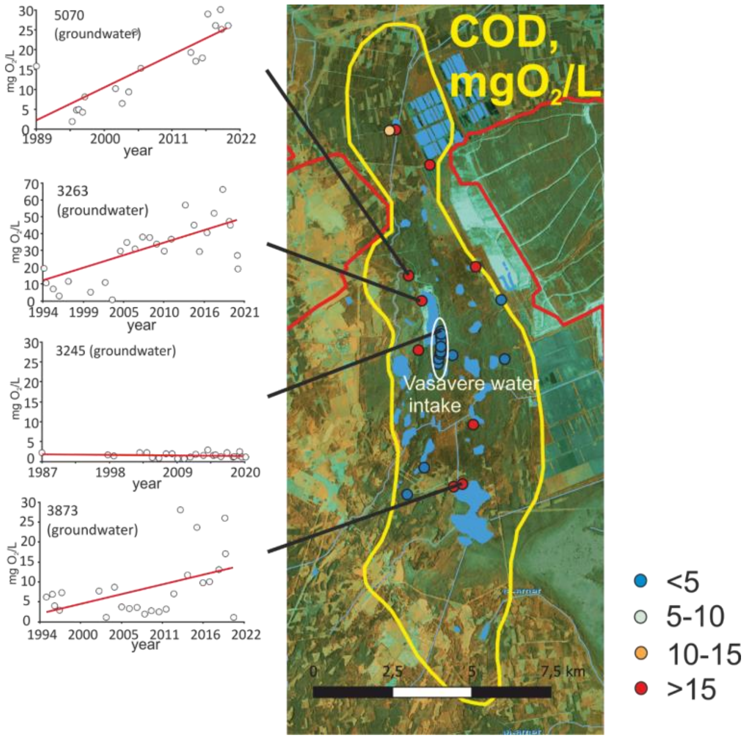


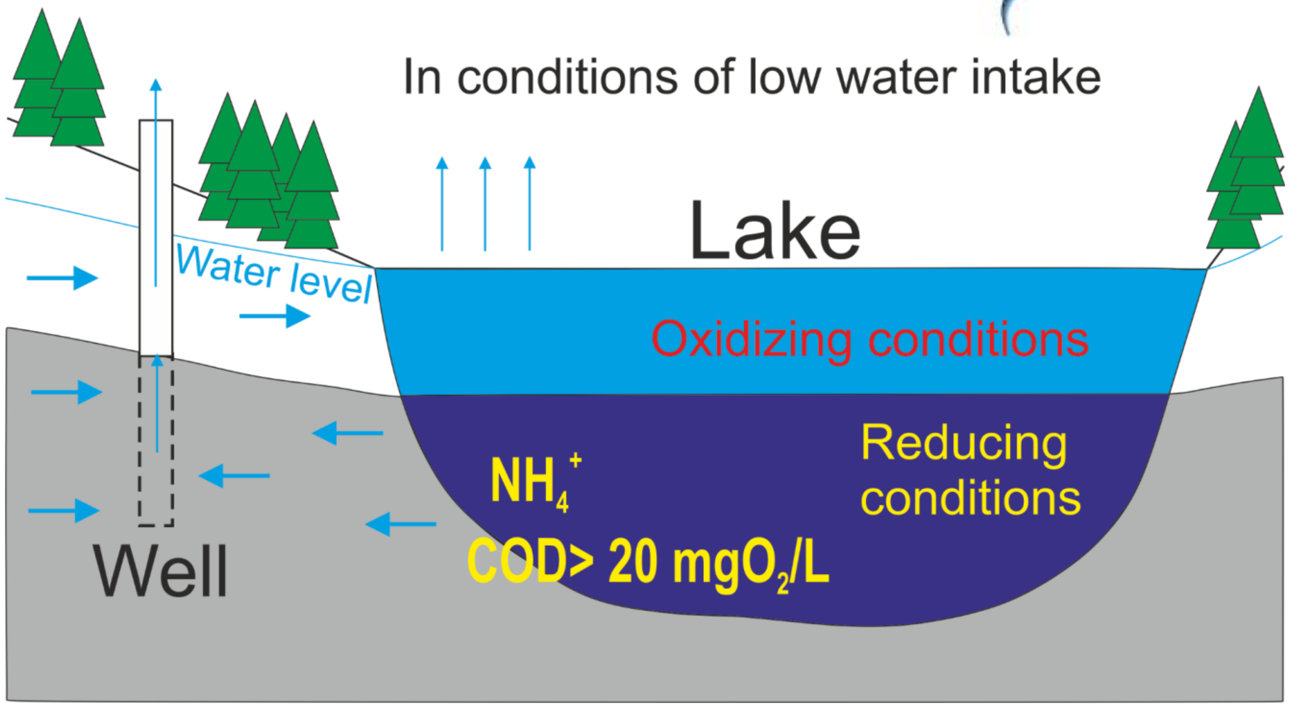
Fig. 1 Evaluation of the percentage of publications with "dissolved organic matter" (DOM) or "dissolved organic carbon" (DOC) and selected global changes over time, starting in 1985, the year *Biogeochemistry* began publishing. Data is based on searches performed in Web of Science (August 6, 2020). Raw data and search details are available in the supplemental information. *In 1985, 1/25 (or 4.8%) of publications on DOM or DOC were on eutrophication

Kokkuvõte

- Kõrgemad PHT ja NH_4^+ väärtused on iseloomulikud märgalade läheduses asuvatele puurkaevudele ning PHT kasvutrendid võivad olla põhjustatud intensiivsemast järve vee valgumisest puurkaevudesse või/ja globaalsest soojenemisest tulenevast kiirenenud aineringest.
- Põhjus tagajärg seoste ja nende ulatuse hindamine saab kriitiliseks globaalsete muutuste valguses. Oluline on mõista protsesside dünaamikat mitte statistiliste näitajate pime kasutamine.
- Seirevõrk peab olema dünaamiline (seda ka metoodika osas) täiendades teadmisi ja tagasisidestusega seirevõrku.
- Probleem. Mida rohkem me teame seda kallimaks muutub uute teadmiste hankimine. Kus asub kriitiline teadmiste määr.
- Ökosüsteemidest tulenev signaal põhjavees on üheltpoolt loomulik kuid läbi veebilansi muutuse võib see kujuneda väga tugevaks.

Discussion

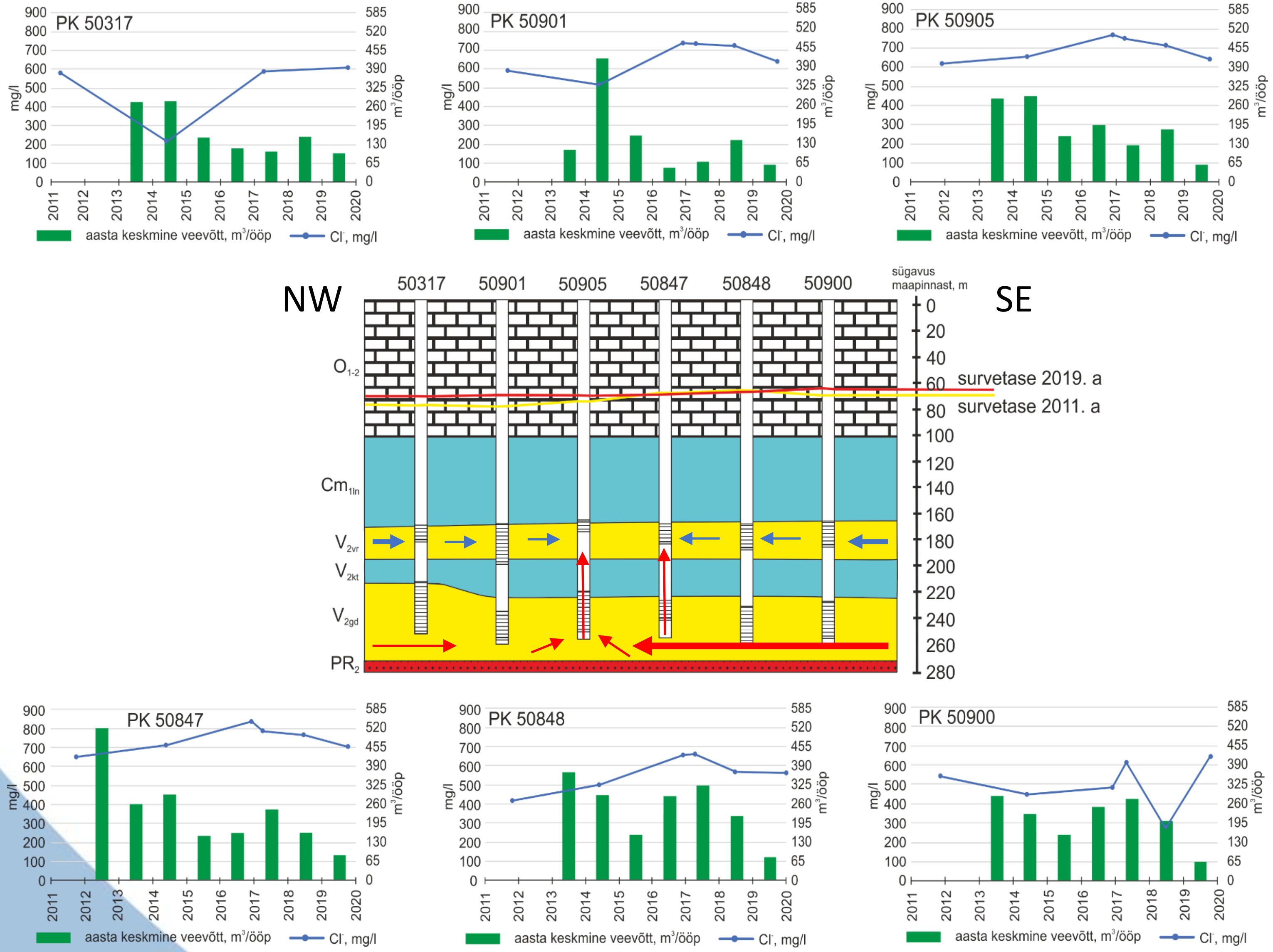




The large fluctuation of ammonium ion values indicates that high NH_4^+ contents and COD values in the groundwater body are of local origin and primarily related to the proximity of wetlands.
Several groundwater monitoring wells are also located near lakes or bogs.

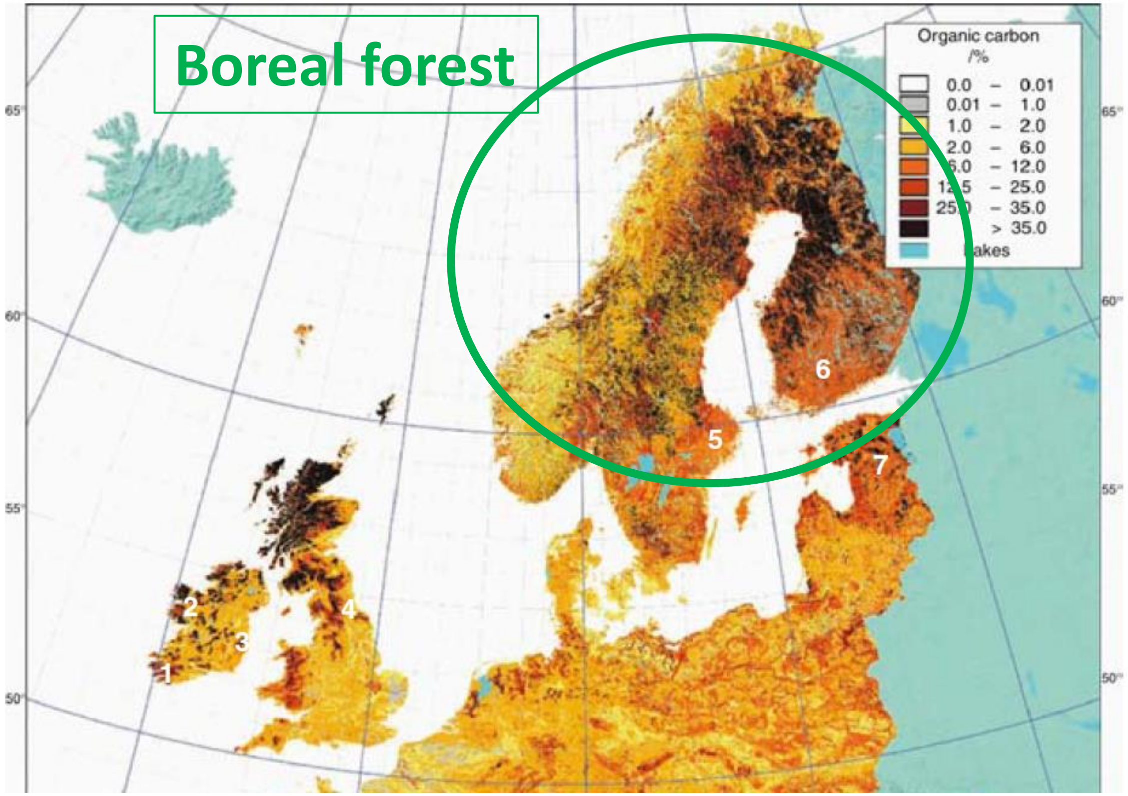
it could mean water from deoxygenated lake(s) infiltra the well. Increasing trends in COD may be caused b intensive lake water intrusion into wells, increased hum on lakes and/or accelerated circulation due to global wa

Gdov’s groundwater body



Due to the construction of the wells, the salinization of the upper Voronka water body will take part, which normally is unfeasible.

Discussion



The upward trends of COD_{Mn} values may be caused by more intense infiltration of lake water into monitoring wells, increased human pressure on lakes and/or accelerated nutrient circulation due to global warming.

In the course of the Life project, it has become clear that several "problems" often result from the lack of a monitoring network.

Actions for better water. Our action - Measures for emission reduction of pollutants.

https://www.richwaters.se/category/en/

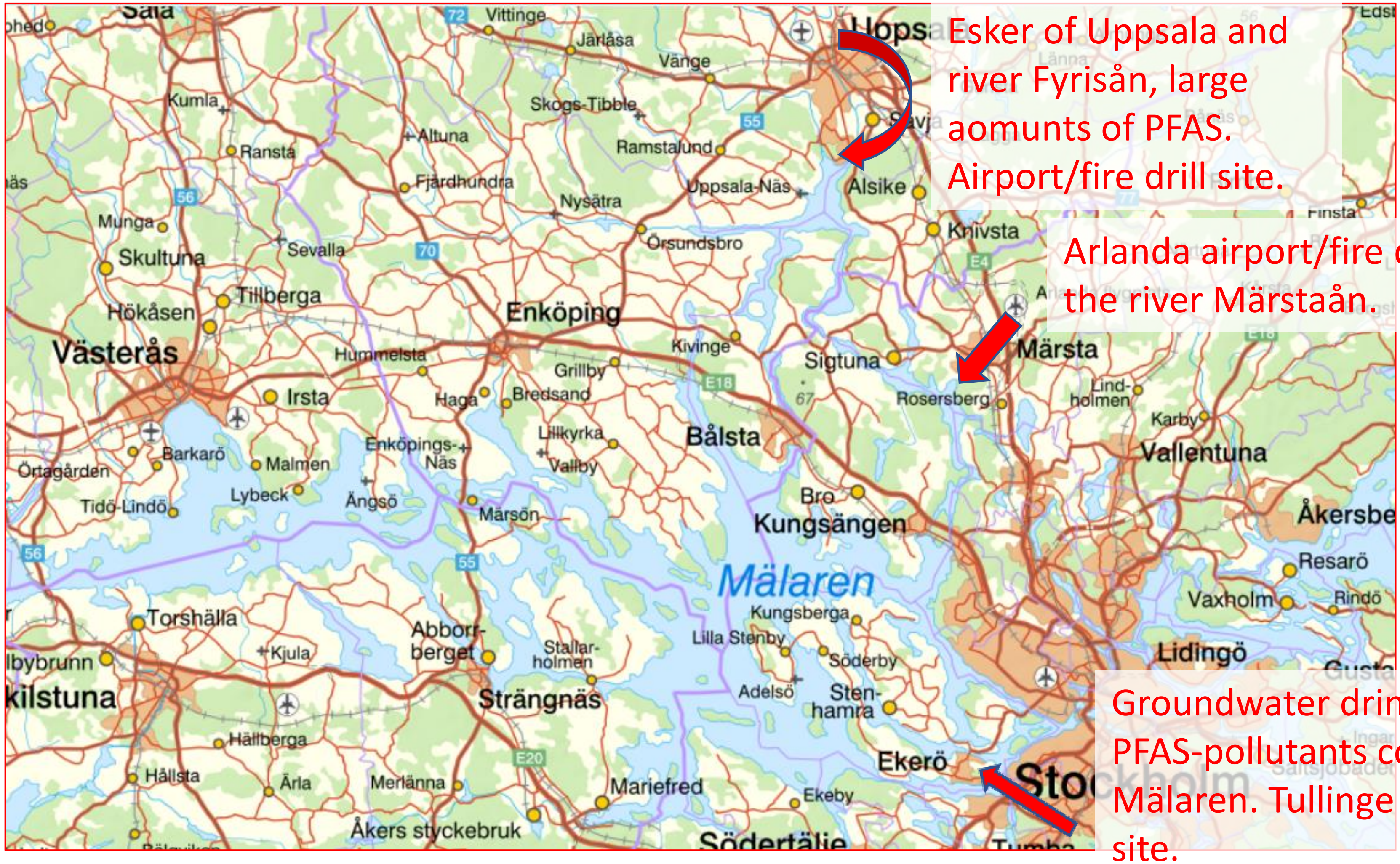
Our long term goal – reduce the load of environmental toxins to surface and groundwater waterbodies.

We will achieve our goal by increasing our knowledge about pollutants and where they occur. This knowledge will trigger actions to remediate pollutants, mainly through the legal requirements of the Water Framework Directive.

A variety of industrial activities and thousands of known and unknown pollutants. How to go about?

A large challenge for the drinking water producers is how to handle PFAS. So we choose to focus on PFAS combined with a variety of common environmental pollutants, substances to trace sources and screening for less measured pollutants in groundwater such as tinorganic substances.

Known pressures of PFAS via ground and groundwaters to Lake Mälaren.



Esker of Uppsala and river Fyrisån, large aomunts of PFAS. Airport/fire drill site.

Arlanda airport/fire drill site. Via the river Märstaån.

Groundwater drinking plant closed, PFAS-pollutants continue to lake Mälaren. Tullinge airport/fire drill site.

Who we are.

Five County Administrative Boards, City of Stockholm, Water conservation associations of lakes Mälaren and Hjälmaren.

https://www.richwaters.se/category/en/

Storymap about PFAS;
https://ext-geoportal.lansstyrelsen.se/arcgis/apps/storymaps/collections/abce4974a5ce4e74882b5284154ecfaf