Experiences, prerequisites and limitations of on-site sanitary systems used in northern Finland

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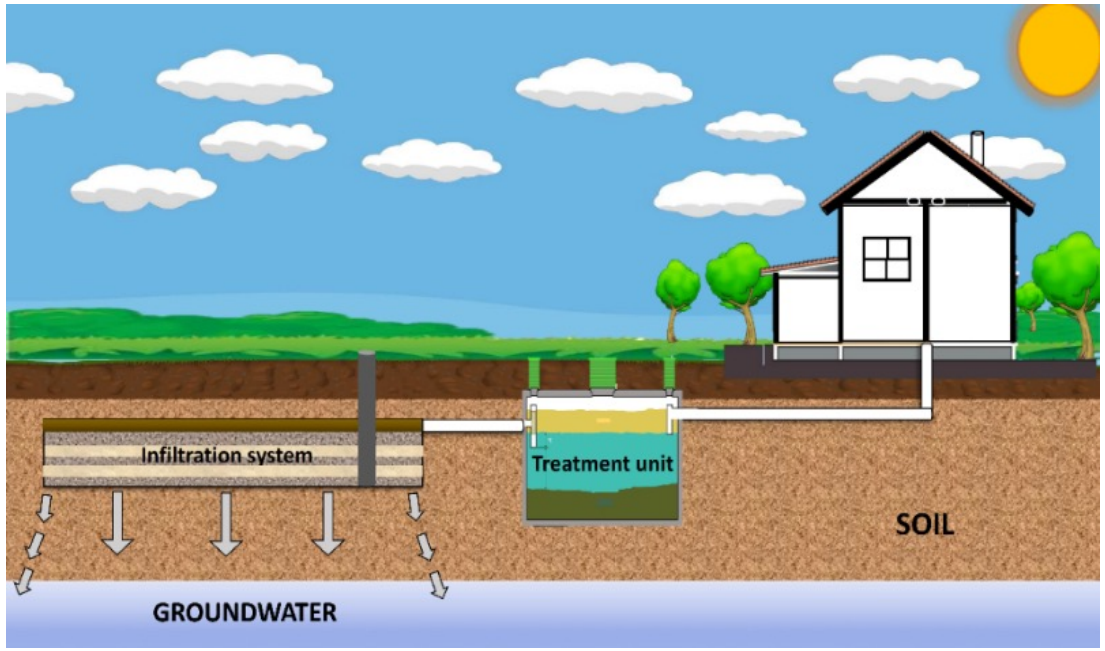
Content



- References
- Governance and management issues of On-Site systems in Finland
- Research results from cold climate study in Finland and Sweden

Source Vuokko Laukka, Juho Kinnunen, Elisangela Heiderscheidt

References

ON-SITE-project

Small-scale wastewater treatment systems: governance, efficiency, resources recovery, environment contamination risks and innovative solutions for processes optimization

- University of Oulu – UOULU, Oulu Finland
- Water Energy and Environmental Engineering
- Luleå University of Technology – LTU, Luleå, Sweden
- Department of Civil, Environmental and Natural Resources Engineering
- Finnish Environment Institute – SYKE, Laboratory Centre
- Freshwater Centre and Centre for Sustainable Consumption and Production, Finland

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Factors affecting effluent quality in on-site wastewater treatment systems in the cold climates of Finland and Sweden

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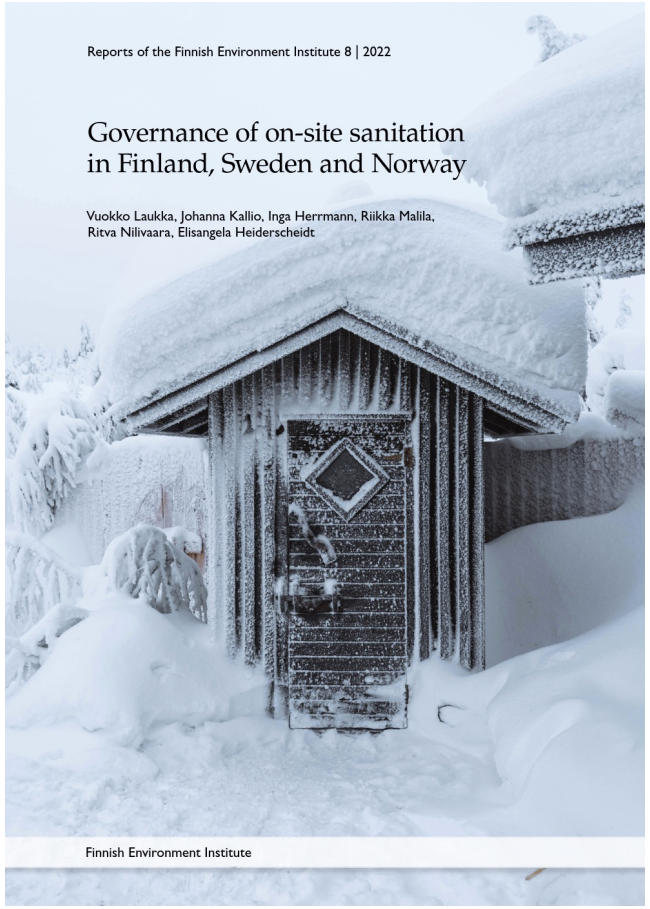


On-site systems in Finland and requirements (Laukka et al. 2022)

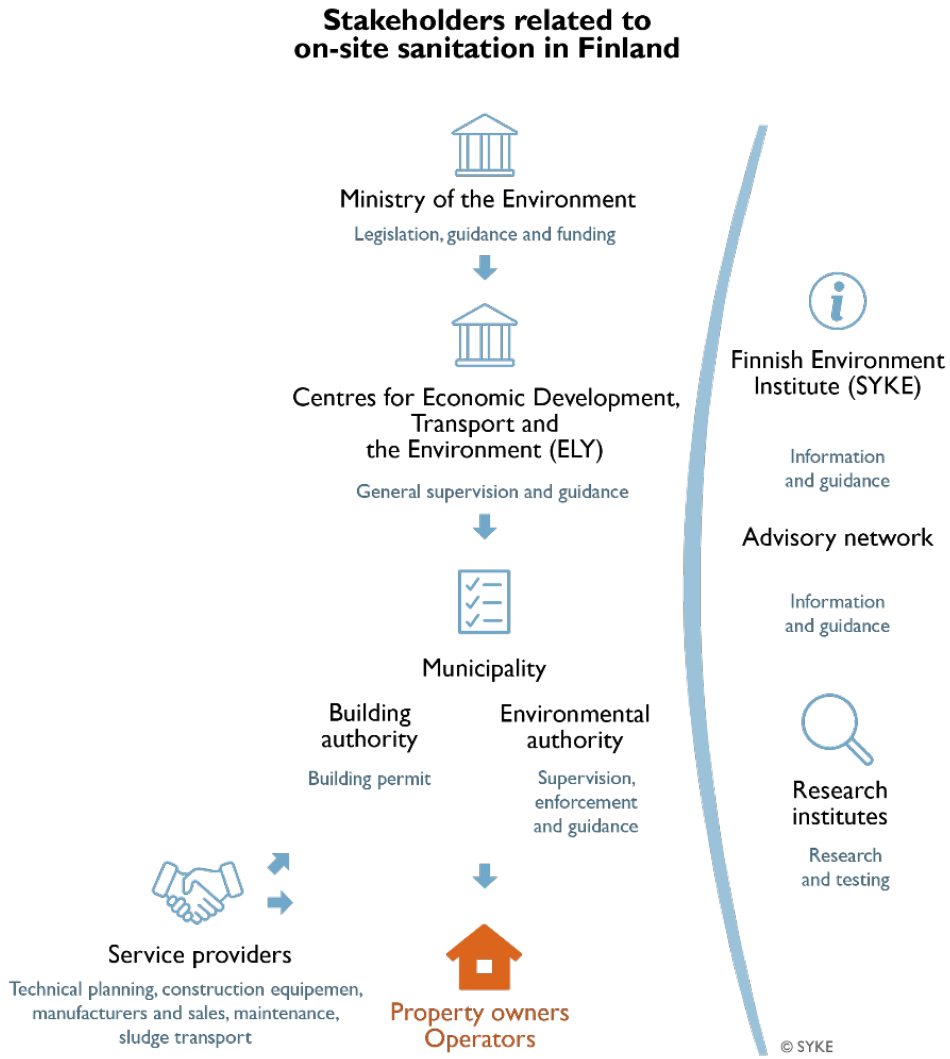
- **In general, all single property owners having a wastewater treatment system at the site are considered operators of an on-site sanitation system**
- **Also systems of several properties, holiday resorts, schools etc. up to 100 PE**
- **Most common system septic tank (common solution from previous decades during prior legislation)**
- **Current treatment requirements similar to Sweden and Norway**
- **Note: distances can be long, but road network broad**

	Level of requirement	BOD_7 [a] (%)	P_{tot} (%)	N_{tot} (%)
Finland	Standard	80	70	30
	High	90	85	40
Sweden	Standard	90	70	not regulated
	High	90	90	50
Norway	Less sensitive [b]	-	-	not regulated
	Normal	70	60	not regulated
	Sensitive [c]	70 / 90	90	regulated according to location [d]

	Finland
Population in 2020 (millions)	5.53
Average population density (persons/km^2) [a]	18.1
Population living outside sewer network (%)	15
Number of properties (permanent habitation) outside sewer network	286,000 [b]
Number of leisure homes	441,000 [b]
Proportion of treatment units not fulfilling the treatment requirements (%)	55–67 [c]
Most used treatment systems (%)	Permanent habitation
Septic tanks with no secondary treatment	42
Sand filter	13
Infiltration system	
Package plant	5
Holding tank	2
Others / not specified	38

Finnish management system and legislation

- Original legislation from 1960s and update in 2004
- So-called “faeces-law”, where requirements for On-Site systems were tightened
- Somewhat unsuccessful implementation: became a target for populistic political discussion
- Requirements for updated on-site systems were seen expensive in rural region, legislation was watered down (e.g. only for new houses, renovated houses, houses 100 m from lake or river)
- Management under ministry of environment, implementation by municipalities
- Issues with monitoring: permits from building authorities (municipal), supervision from environmental authorities (more regional)



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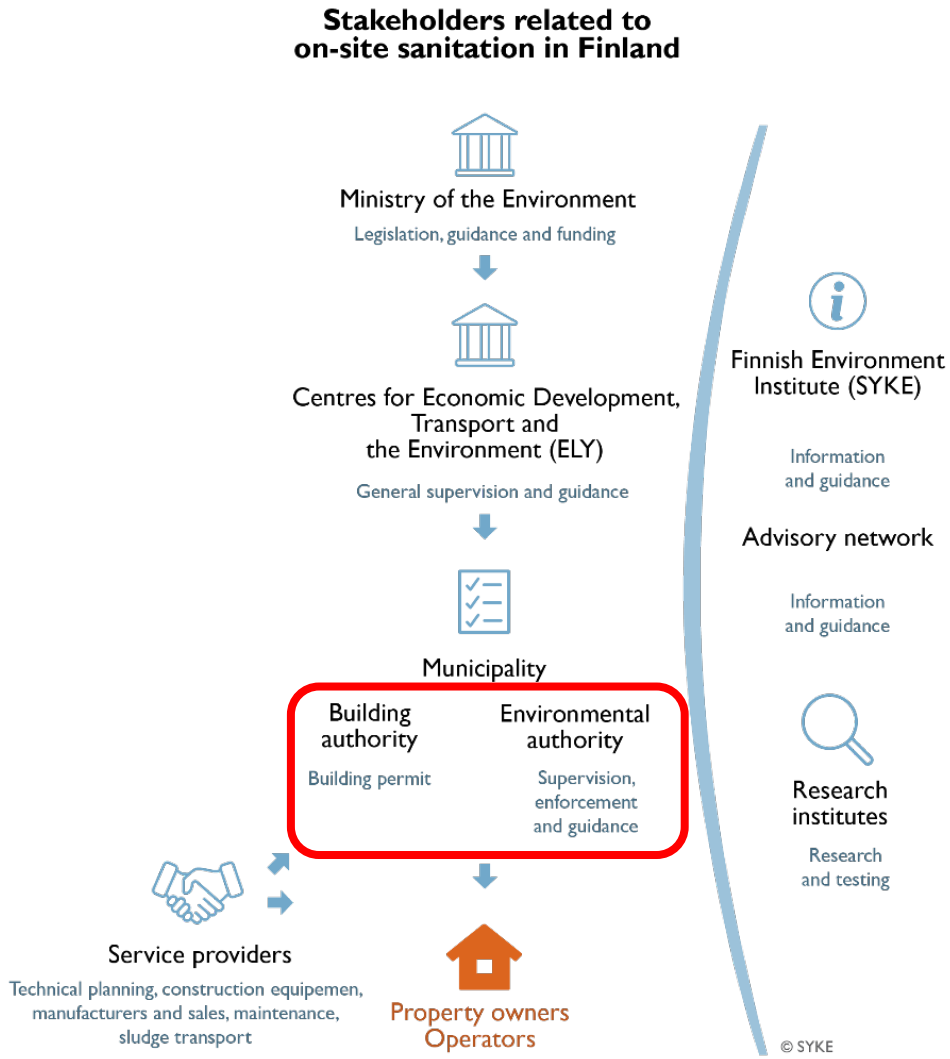
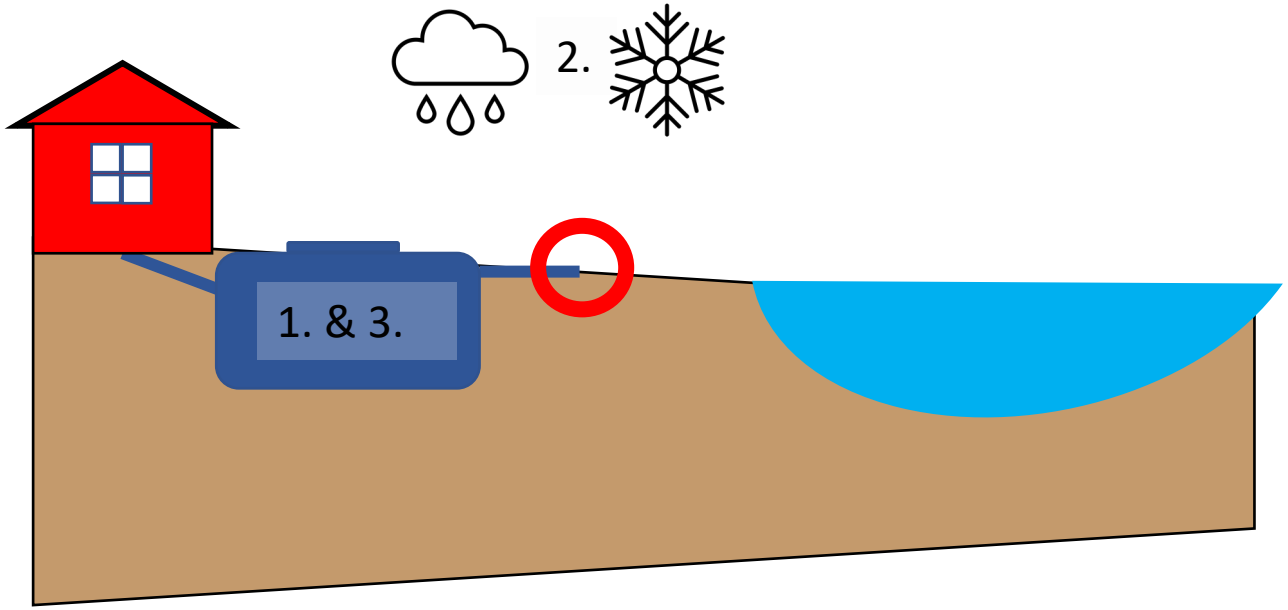


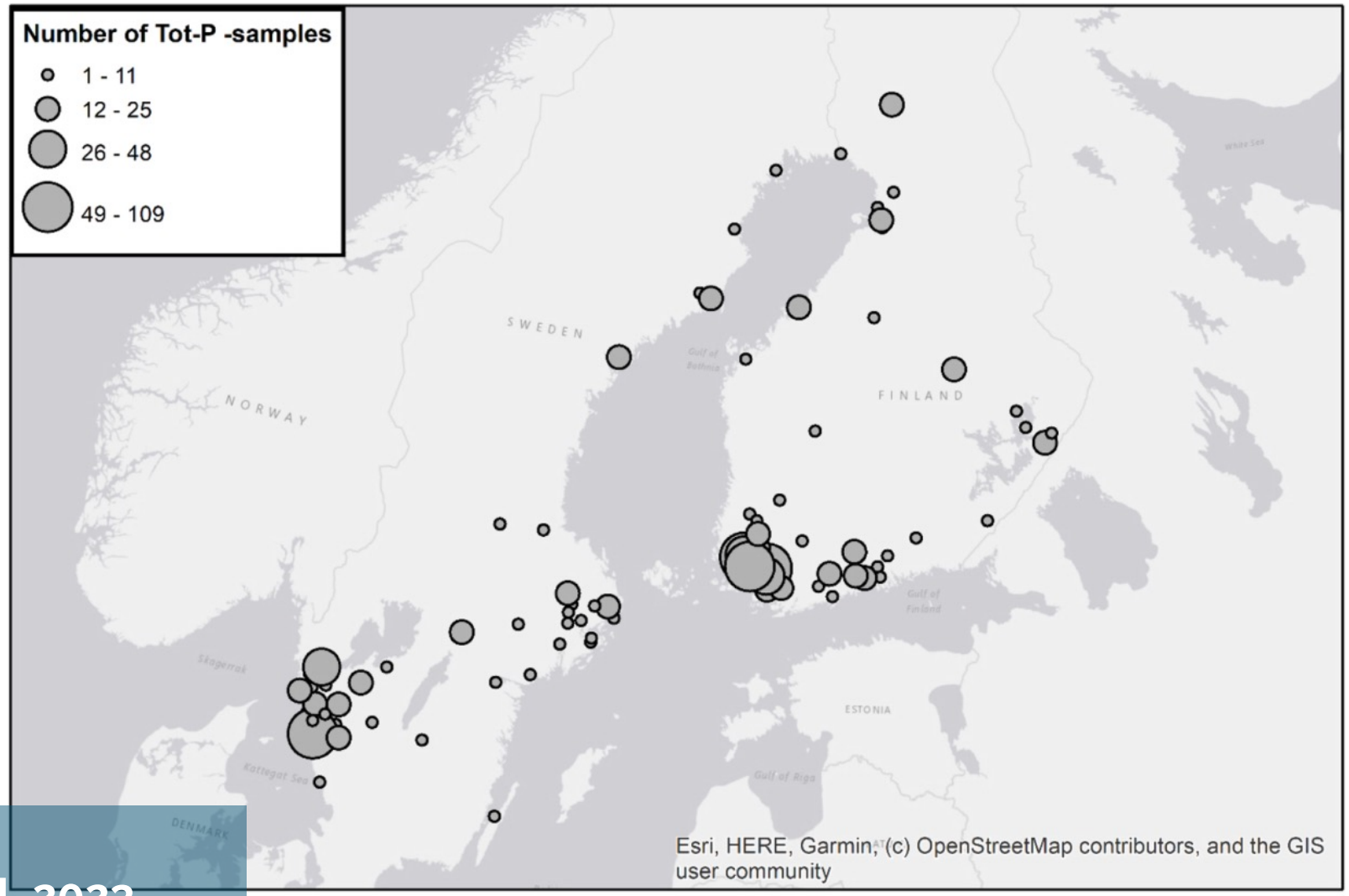
Factors Affecting Effluent Quality In On-site System: Research questions



1) How does effluent water quality vary across system and process types and how does it compare to regulated discharge limits?
2) Does unit age, load and local climate conditions affect effluent water quality of soil-based systems and package plants differently?
3) Does the type of biological and P-targeting processes used significantly affect effluent water quality?

Dataset

- **9 different scale National projects**
- **1300 sampling occasions**
  - >300 units
  - Emphasis in Southern parts of countries

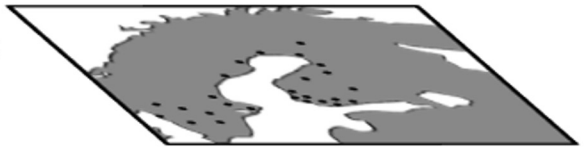


Source: Kinnunen et al. 2023

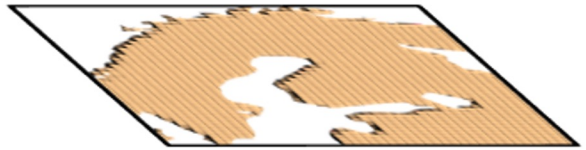
Dataset

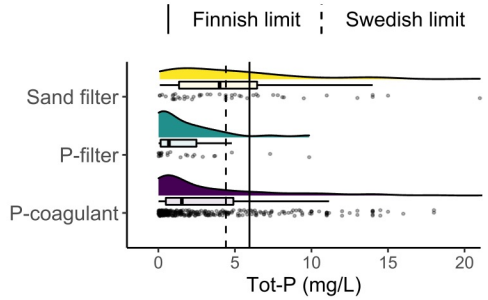
Data collection and compilation	Statistical analysis

Effluent data with unit locations combined from several studies

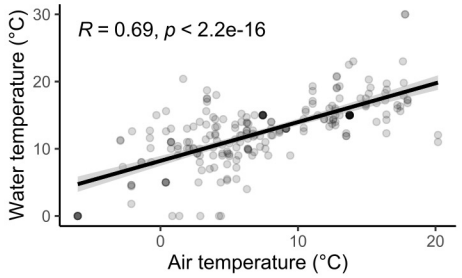


Gridded historical weather model data to generate time series for each location prior sampling date





Comparing wastewater treatment system types



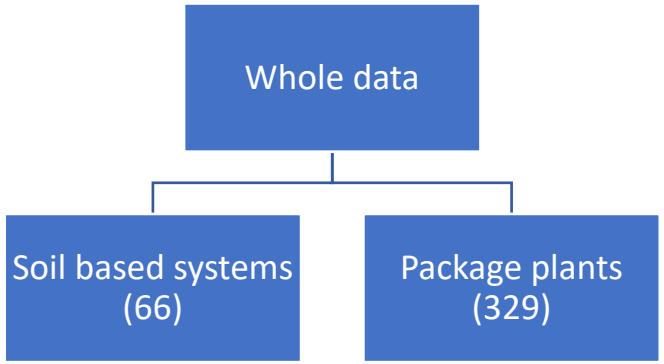
Searching correlations with weather factors

- **UERRA regional reanalysis for Europe on single levels from 1961 to 2019, 11 km x 11 km**
- **Temperature, Precipitation, Snow water equivalent**
  - What was weather like prior sampling? (7 & 30 days)

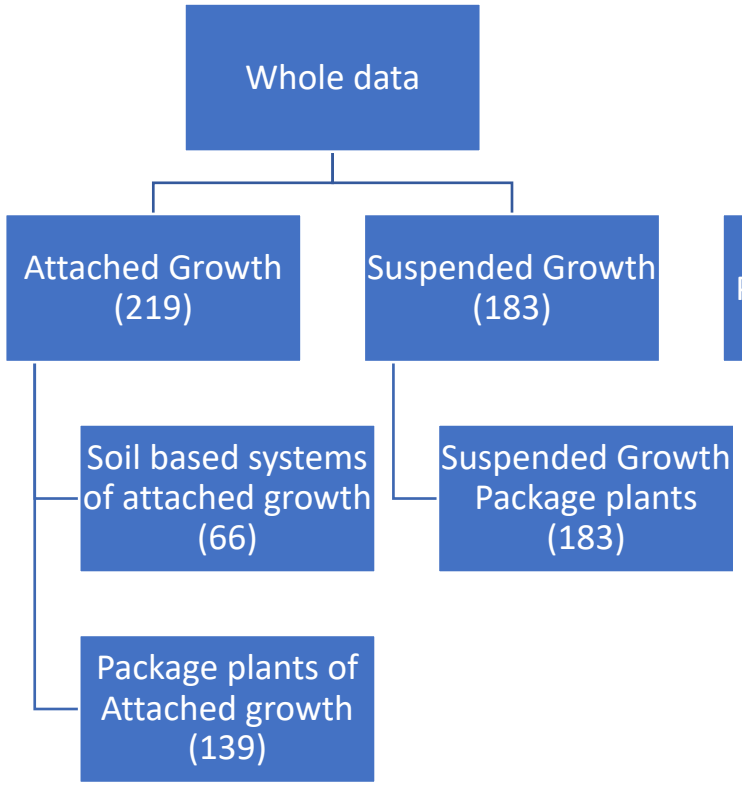
Source: Kinnunen et al. 2023

Dataset

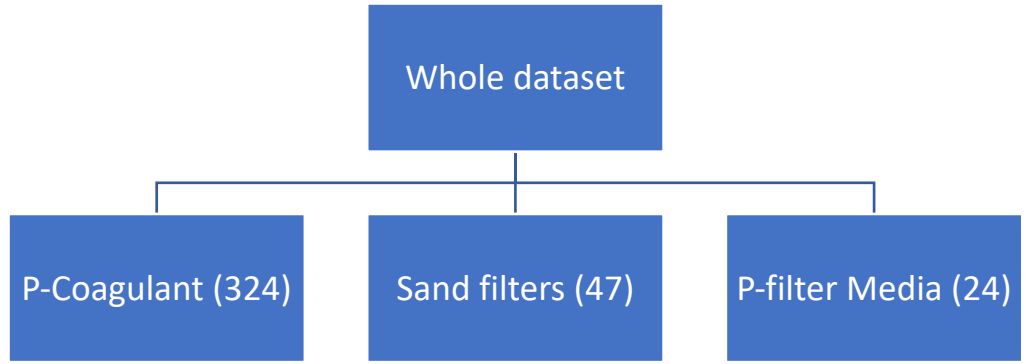
Effect of Weather, Age and Load



Biological BOD & Nitrogen

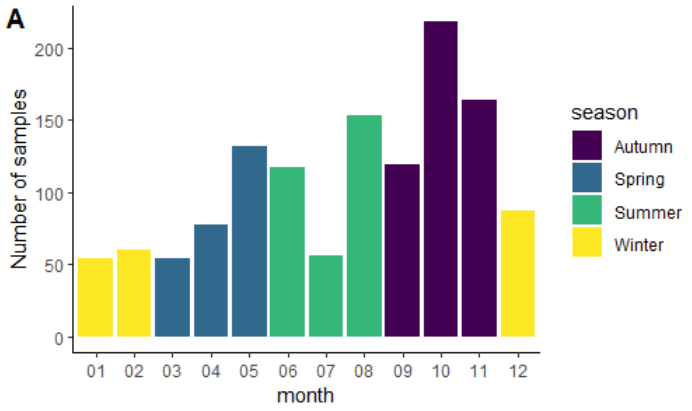


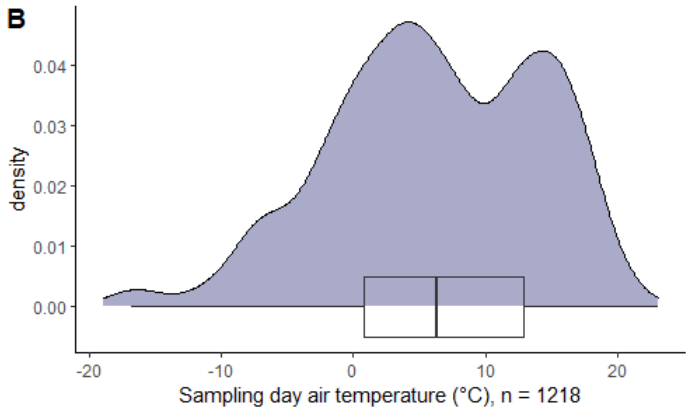
Physical-chemical Phosphorus

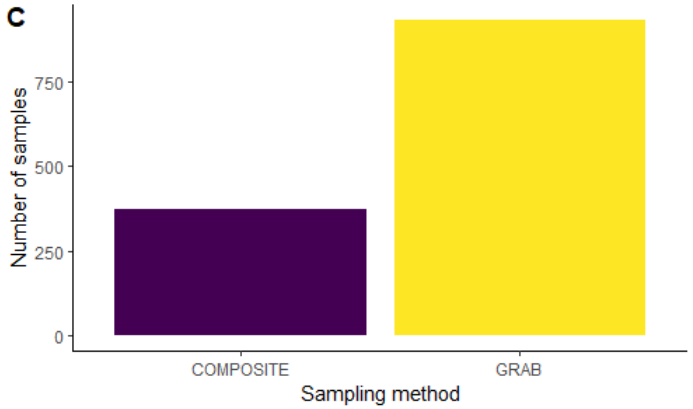


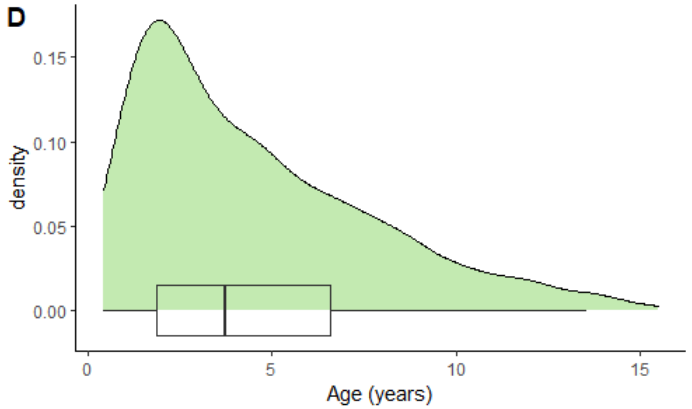
Source: Kinnunen et al. 2023

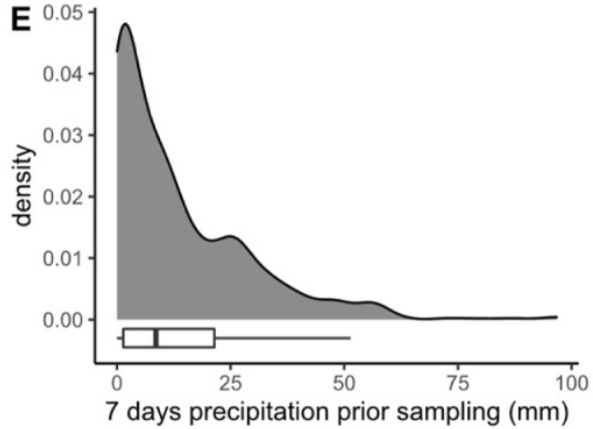
Dataset







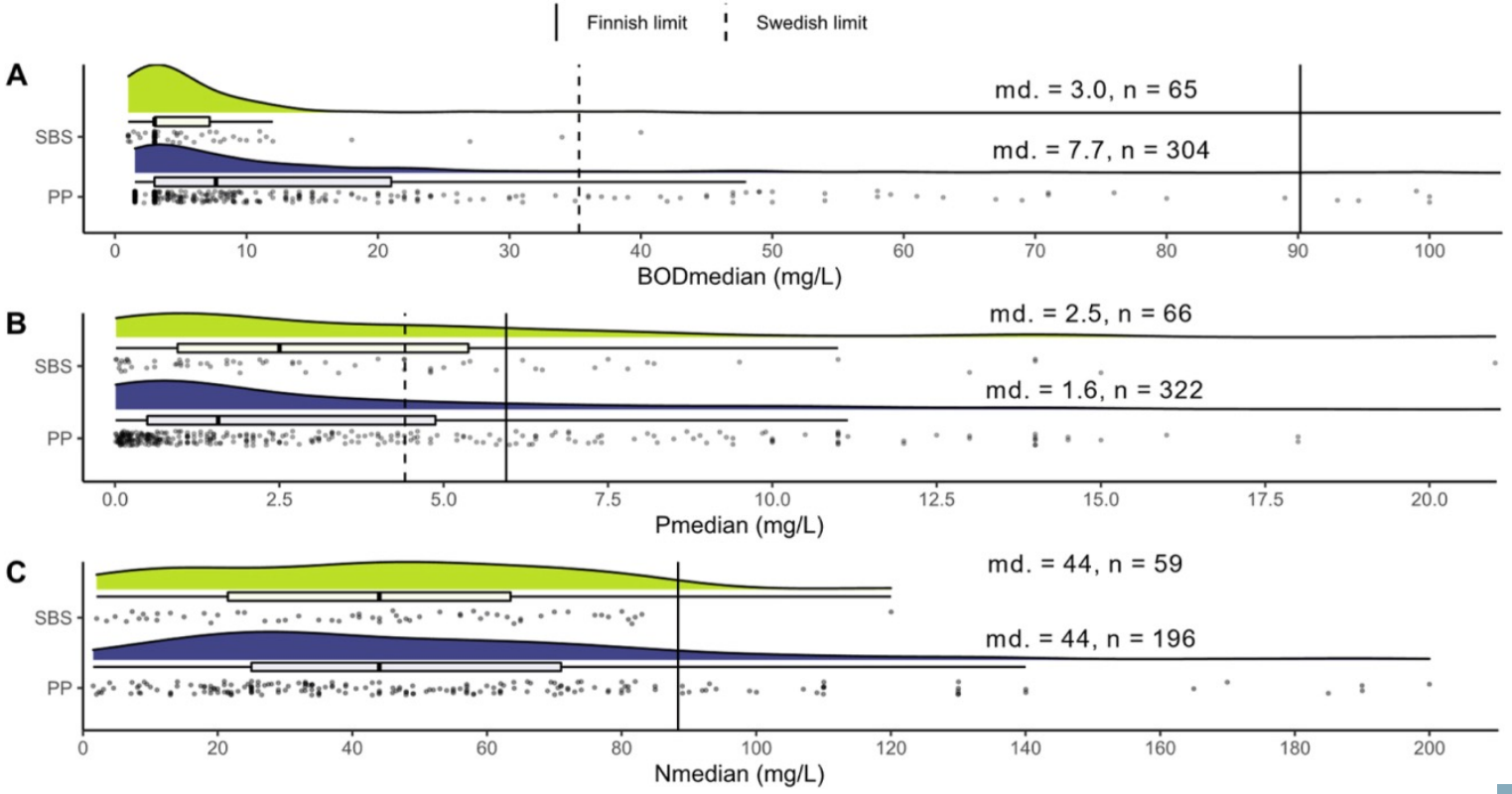




- Autumn most sampled
- >75% sampling days >0 ˚C
- semi-new, working units (75% less than 6 years old)

Source: Kinnunen et al. 2023

Results: Weather factors

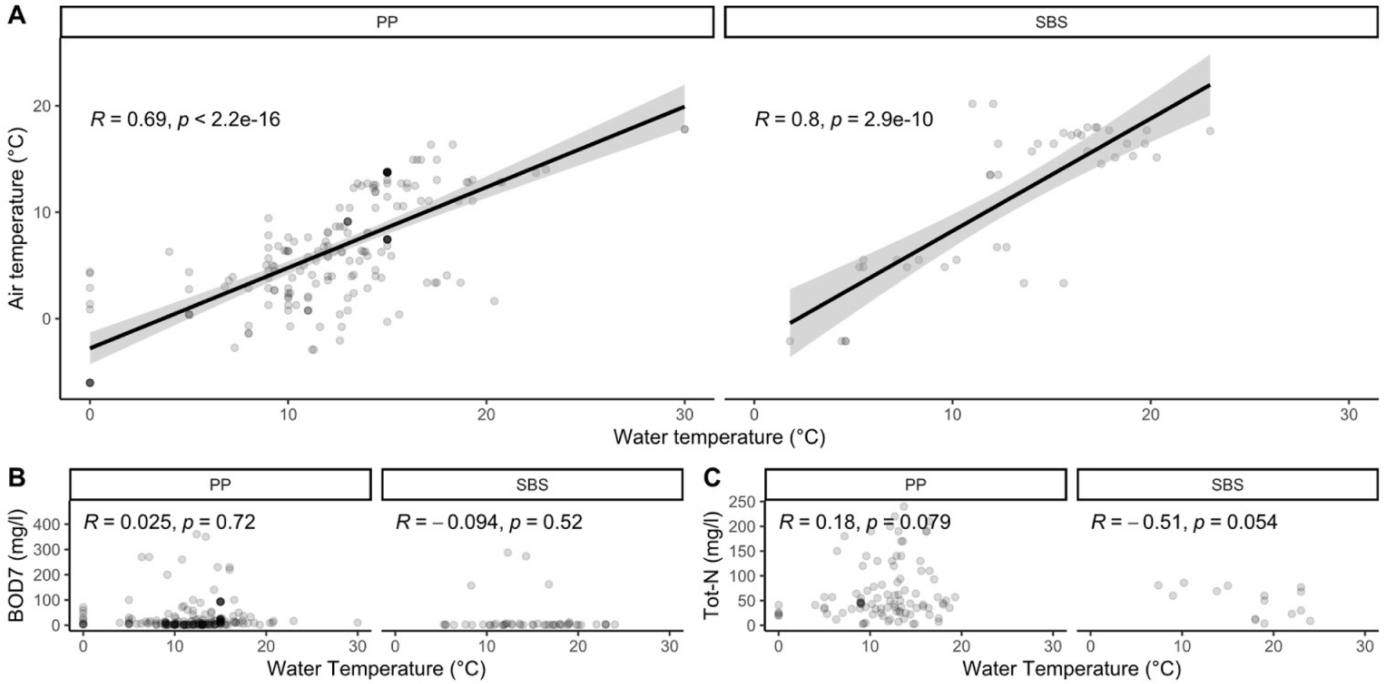


Autumn most sampled

- >75% sampling days >0 ˚C
- semi-new, working units (75% less than 6 years old)
- BOD_7 was removed well
- Tot-P regulations were not met by 28% and 25.4% of Finnish and Swedish units

Source: Kinnunen et al. 2023

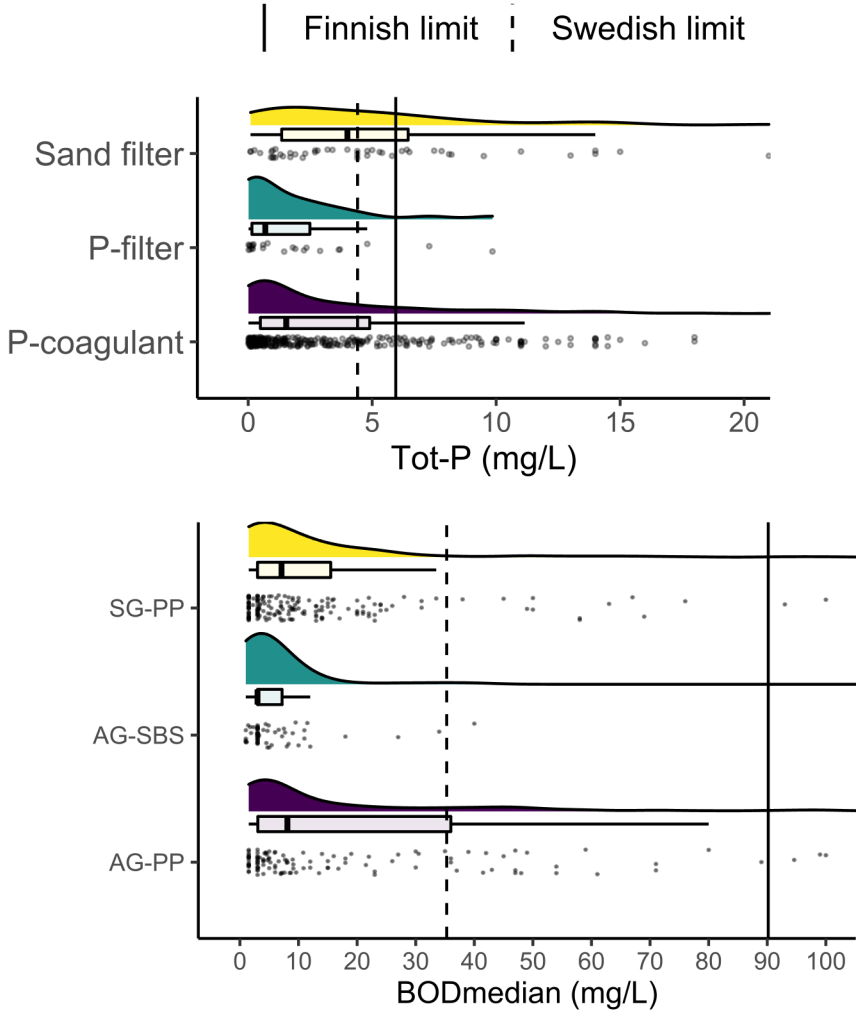
Results: Biological process



- No significant effect of temperature or dilution due to precipitation was found either on PP or SBS
- Correlation of air and water temperature
- Not much data on very cold conditions
- Age was a factor in effluent P increase in SBS but not in PP

Source: Kinnunen et al. 2023

Results: Biological process



- P-coagulant and P-filters had lower P concentration in effluents in contrast to sand filters
- SBS had more stable BOD_7 removal (narrower distribution)
- Type of biological process did not have a significant effect on N-removal

Source: Kinnunen et al. 2023

Conclusions

- **Lessons learnt from management structures and how they can effect e.g. on surveillance and data collection**
- **Importance of legislation work and risks**
- **Weather factors (air temperature, precipitation, and snowmelt) in either soil-based systems (SBS) or package plants (PP) did not correlate with effluent quality**
- **Found biases in data which can affect conducted tests and conclusion**
    - Selection of units
    - Seasonality of sample collection
    - Geographical distribution
- **More data on cold conditions and a more random snapshot campaign of any given system for more realistic results of the current condition?**

Thank you!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