



Hydrology-Controlled Pollution Pathways in Vantaanjoki under Climate Change

DIWA Webinar

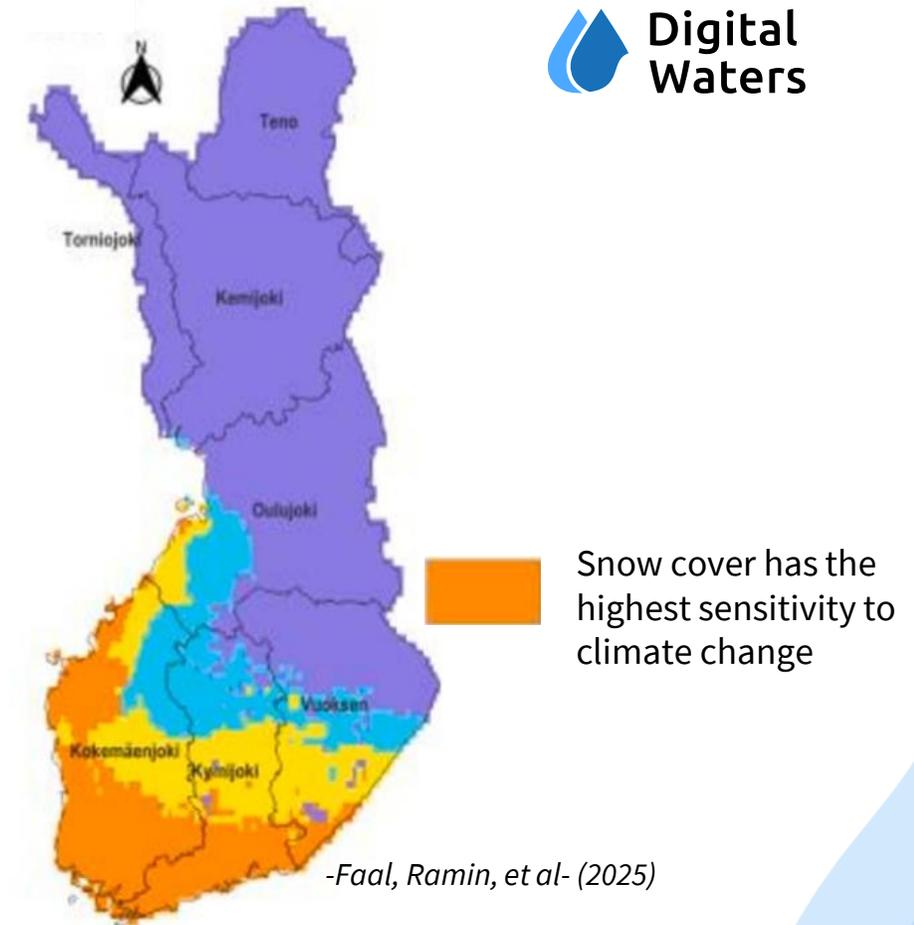
06-Feb-2026



A rapidly changing risk landscape

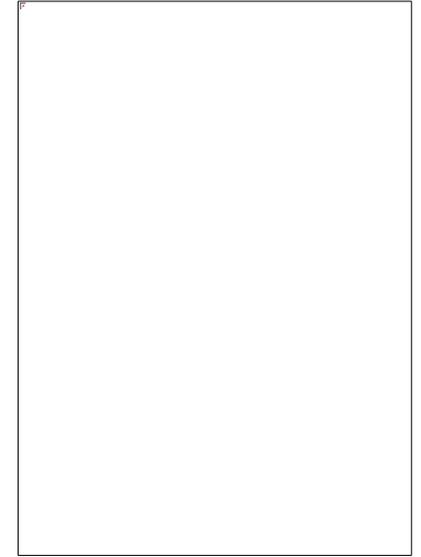
- Southern Finland = snow-rain transition zone
- Winters: warmer, wetter, more rain-dominated
- Long wet periods are increasingly common

The implications for water quality in vulnerable catchments, e.g., Vantaanjoki?



Catchment Management: Strong foundations already exist

- Long-term joint monitoring (water quality, flow, biology)
- Action & Practical mitigation (retention, wetlands, sewer upgrades)
- PFAS pilots and stormwater management.



But ...



- **Monitoring explains what happened**
- **Climate change demands insight into what is about to happen**



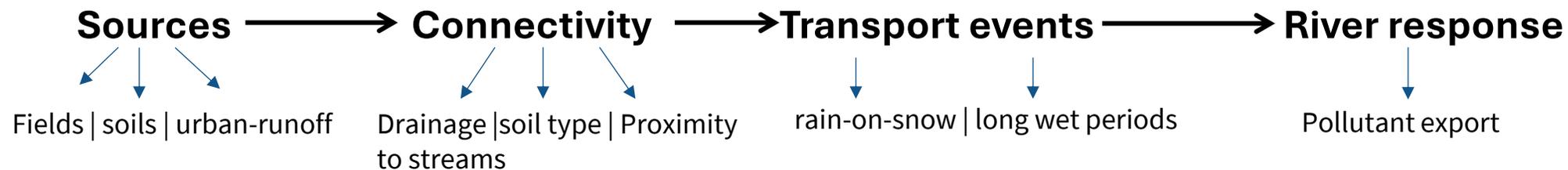
Yesterday



**Next
72-Hours?**

To anticipate risk, we must understand pathways – not just sources

How pollution actually reaches the river:



Research questions:

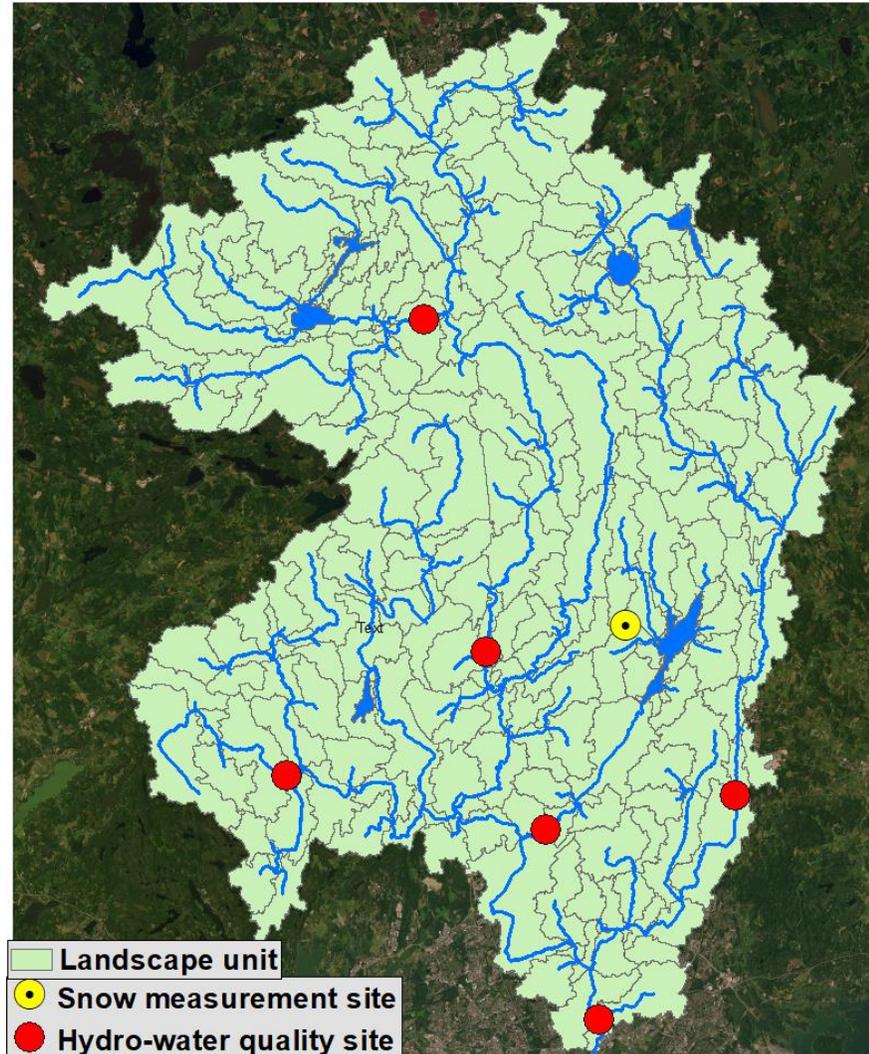
- Does climate change only change how much nutrients are exported?
- Or does it fundamentally change when and where export occurs?

What we did

Sub-catchment: 1.5– 18 km²

Landscape unit: 1.5– 3 km²

Hydrologic unit: 0.01 – 1.0 km²



- Catchment model: SWAT⁺
- Calibrated/validated for:
 - Snow dynamics
 - River flow
 - Water quality proxies
- Climate Scenarios (2026 – 2087):
 - Sustainable (SSP1–2.6)
 - Middle (SSP2–4.5)
 - Extreme (SSP5–8.5)
- Statistical analysis
 - Regression
 - Correlation

Key hydrological shifts expected in Vantaanjoki

- ↓ • Snow storage decreases, and earlier melt are project
- ↑ • More winter rainfall than snow is expected
- ↑ • Increases in winter and autumn runoff

New transport windows will be created

The new transport windows shift nutrient export into winter and autumn

- Nutrient inputs to the Gulf of Finland will likely be shifted from melt-driven toward rainfall-driven mobilization, with spring contributions declining from about 33% to 23–28%.
- While winter and autumn inputs rise from 21–25% to 28–31% and from 28–31% to 36–40%, respectively.

- Spring: ↓
- Winter: ↑
- Autumn: ↑

Export occurs when:

- Plant uptake is minimal
- Many mitigation measures operate at reduced efficiency

When timing shifts, spatial risk reorganizes

- Under climate change scenarios, Expansion of hotspots is expected to occur in:

- Low-lying areas
- Runoff-sensitive soils
- Intensively managed agriculture

- Hotspots are:

- Dynamic
- Event-driven
- Climate-sensitive

Static hotspot maps are no longer enough?

From understanding pathways to anticipating risk

What we have learned:

- Climate change is shifting nutrient transport toward event-driven, off-season pathways.
- These shifts lead to seasonal decoupling between transport, uptake, and mitigation.
- As a result, risk emerges dynamically in time and space

Implications for water protection

- Annual/monthly loads alone are no longer sufficient indicators of risk.
- Water-quality impacts increasingly depend on:
 - * **When** high flows occur
 - * **Where** hydrologic connectivity is activated

Managing pathways, not just sources, becomes critical

Why current tools struggle to anticipate the risk

Structural limits

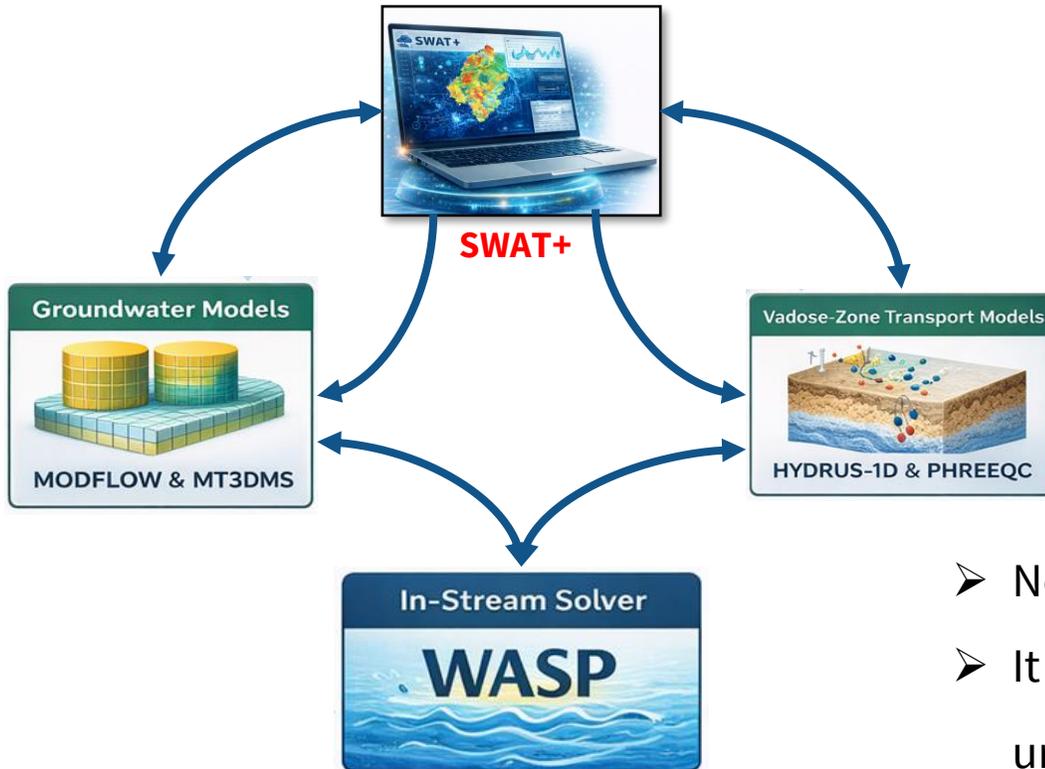
- Retrospective
- Monthly/annual resolution
- Weak event sensitivity
- No early-warning capacity

A new risk forecasting system (CLIMHOT-Next)

- Near-real-time meteorological, soil–crop, hydrological, and water-quality data are integrated into a climate-aware hydrology–water quality model to produce short-term nutrient risk forecasts, dynamic hotspot probability maps, and early warnings for high-risk periods.

Beyond nutrients: PFAS & emerging pollutants

Pathway thinking extends beyond nutrients:



PFAS Fate and Transport Diagram - @usgs.gov

- Not replace monitoring or treatment.
- It explains when and where PFAS risk emerges under changing hydrologic conditions.

What CLIMHOT-Next offers

Municipalities & ELY

- Early warnings before winter/autumn events
- Better timing of sewer & retention management

Farmers & advisors

- Risk-based timing of field operations

VHVSY

- Smarter monitoring placement
- Stronger justification for targeted measures

From research to co-development

- Co-develop CLIMHOT-Next with practitioners
- Pilot: Vantaanjoki → Keravanjoki → Palojoki
- Complement — not replace — national models



Your feedback highly appreciated 😊

Thank you

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