Team 03 Presentation 3

Presentation 3: Results of 2nd Week

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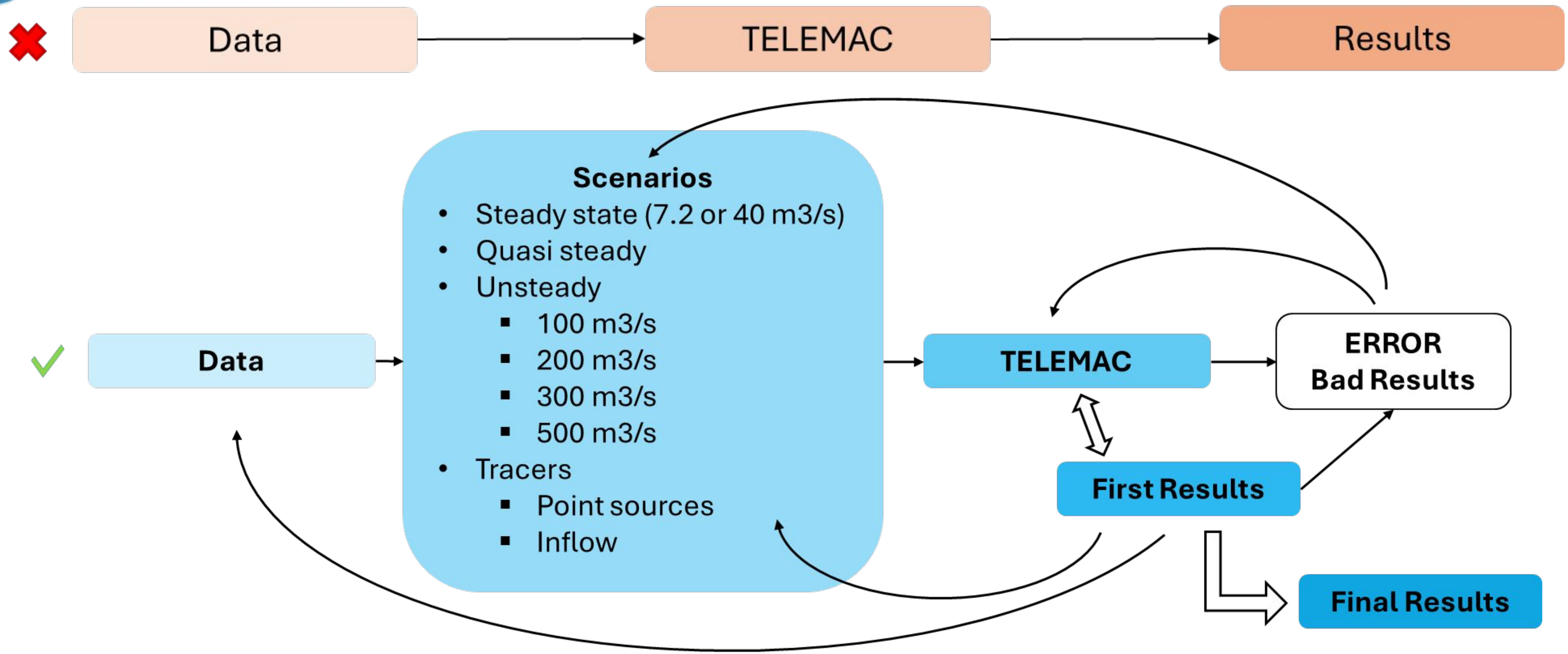
Accidental Water Pollution: Why?

- **Ahr Catchment is vulnerable to flooding & pollution transport**
- **Extreme rainfall & flash floods increase nutrient runoff & pollutant spread**
- **Pollutant runoff impacts water quality and damages the environment**
- **Fine-scale analysis is needed to understand how pollution moves during different hydrological conditions**

Accidental Water Pollution: What do we want to know?

- **How does pollution spread under different hydrological conditions?**
- **How do different flow rates (40, 100, 300, 500 m³/s) impact pollution transport?**
- **What patterns emerge when moving from large-scale modeling to fine-scale analysis?**

Methodology



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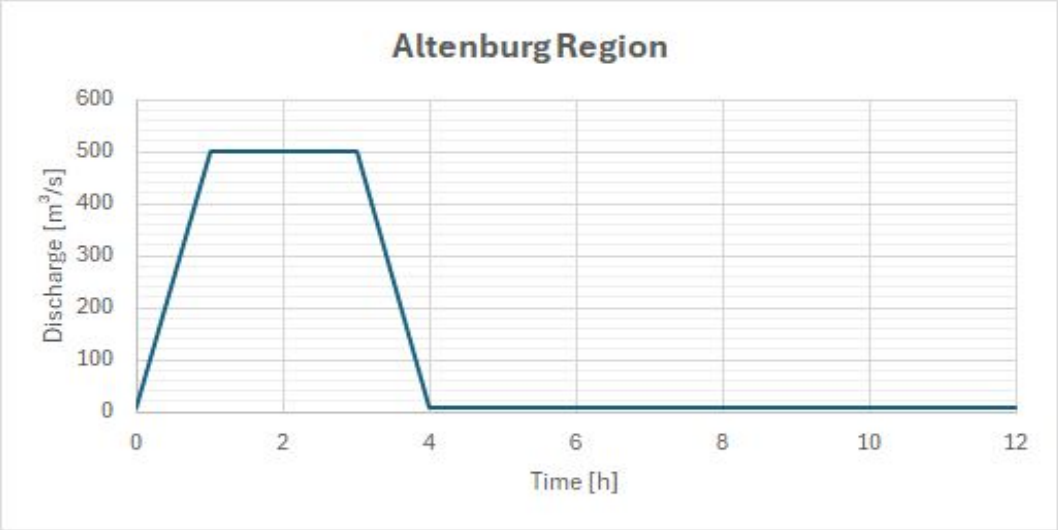
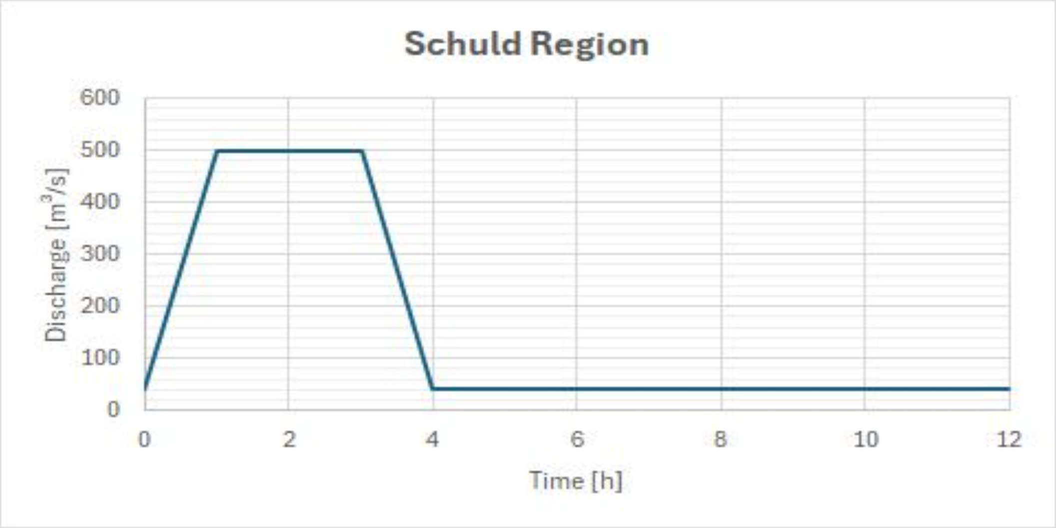
Flash flood scenarios

Peak discharge 500 m³/s





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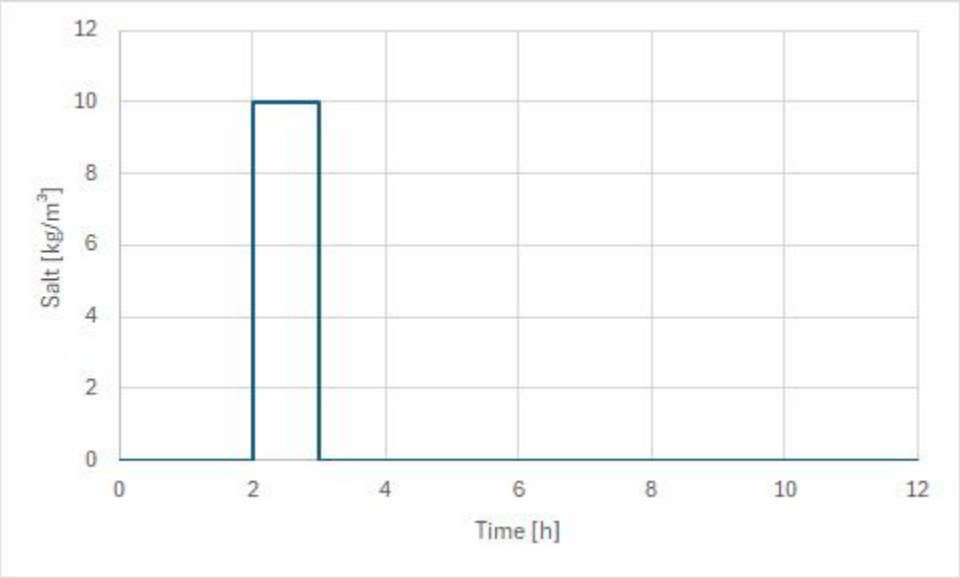
Pollutant Scenarios

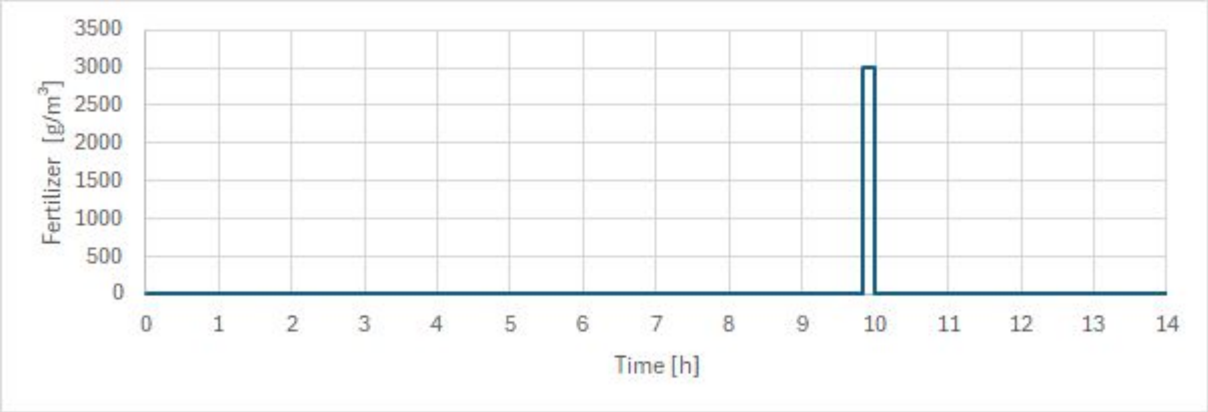
Altenburg region

Salt
point source (upstream)

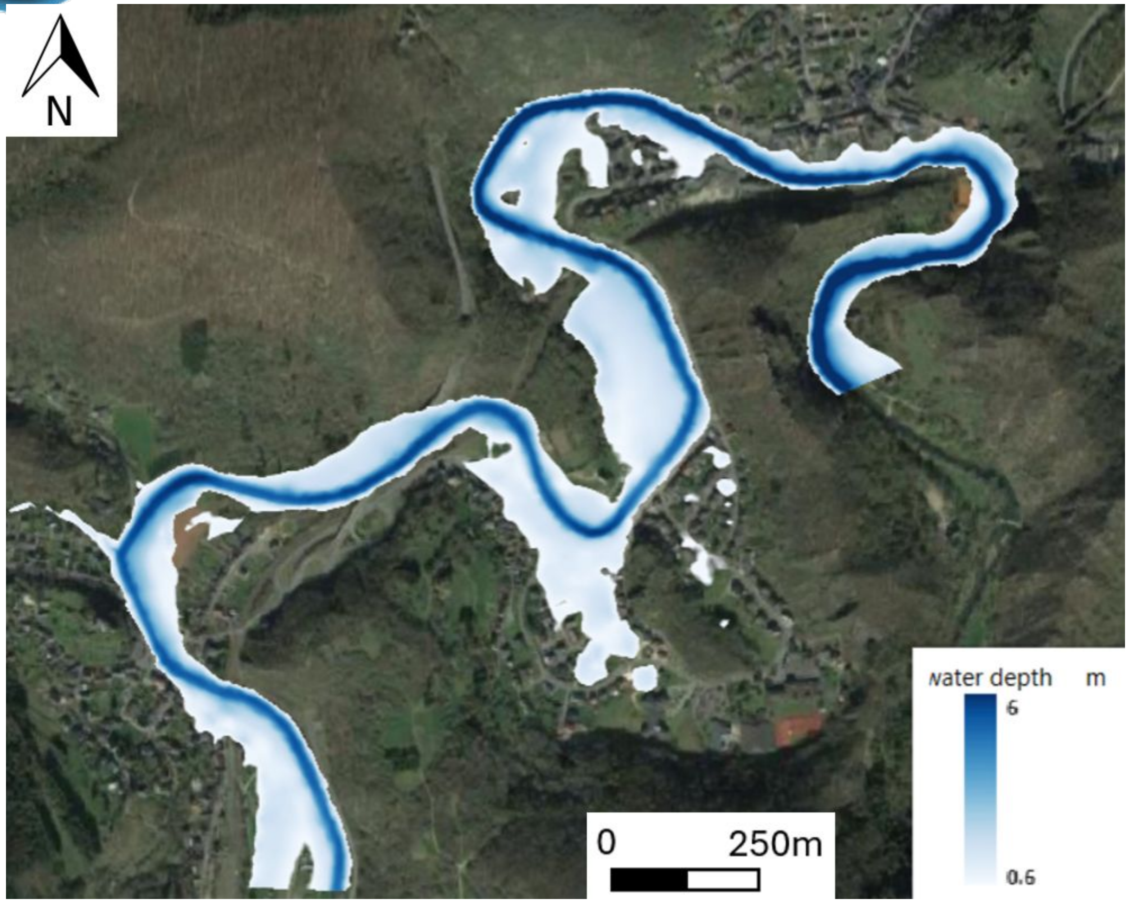


Schuld region

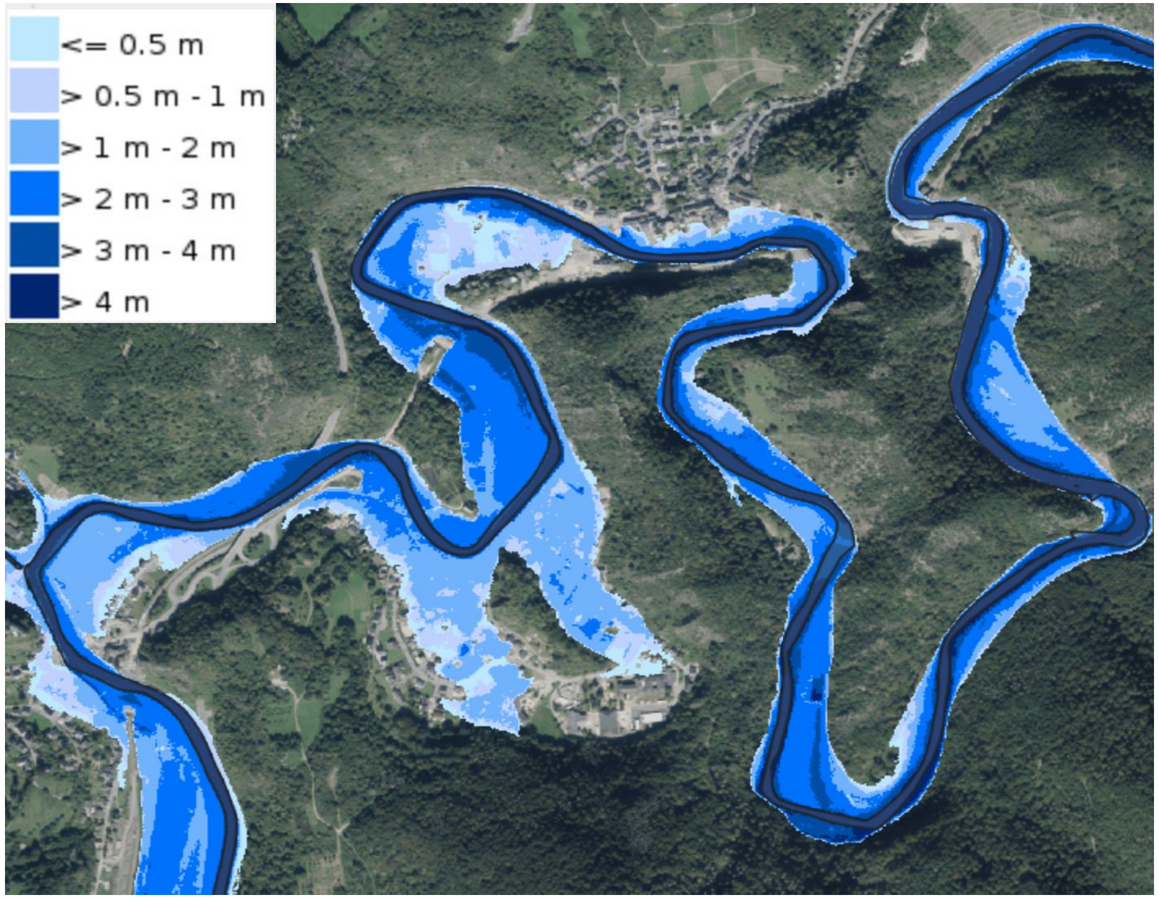
Fertilizer
point source



Flood modeling results and validation (Altenberg)

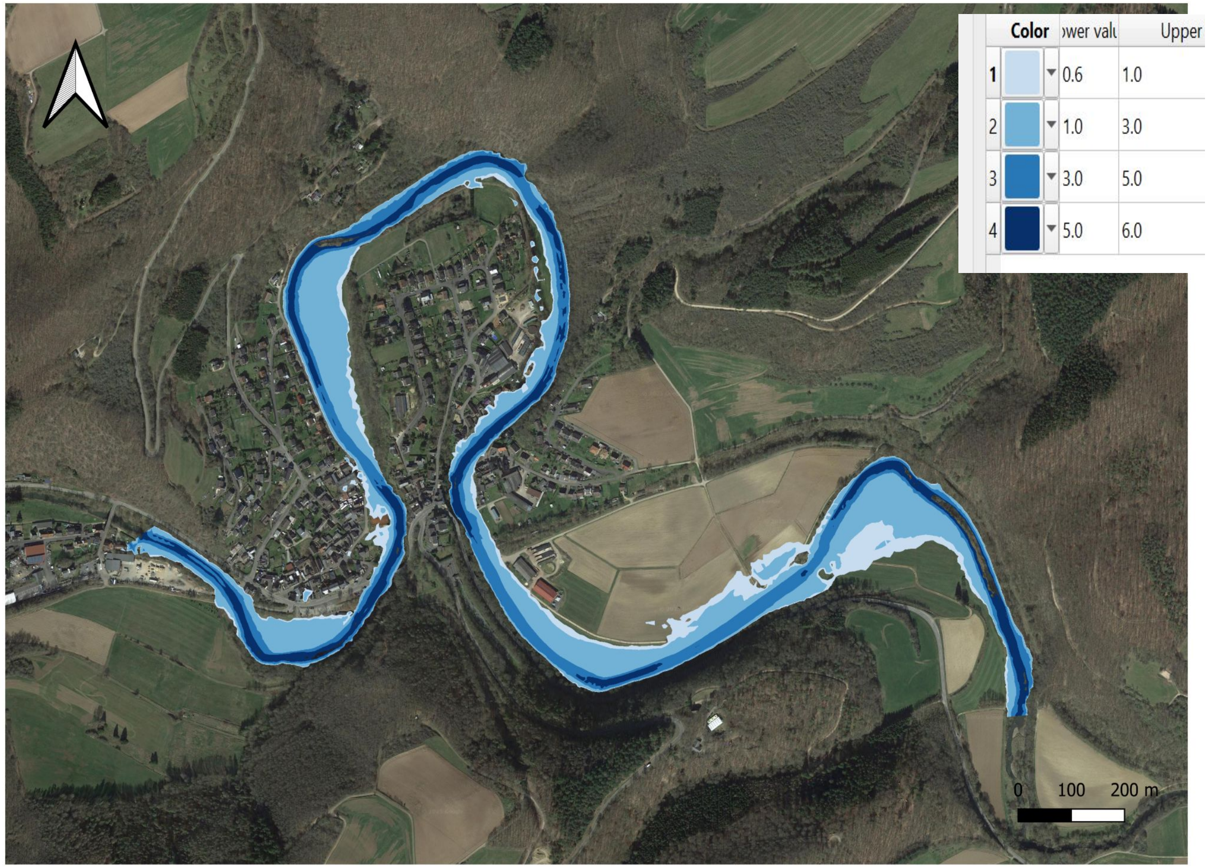


Simulated Q500 m^3/s floodmap (Altenberg)

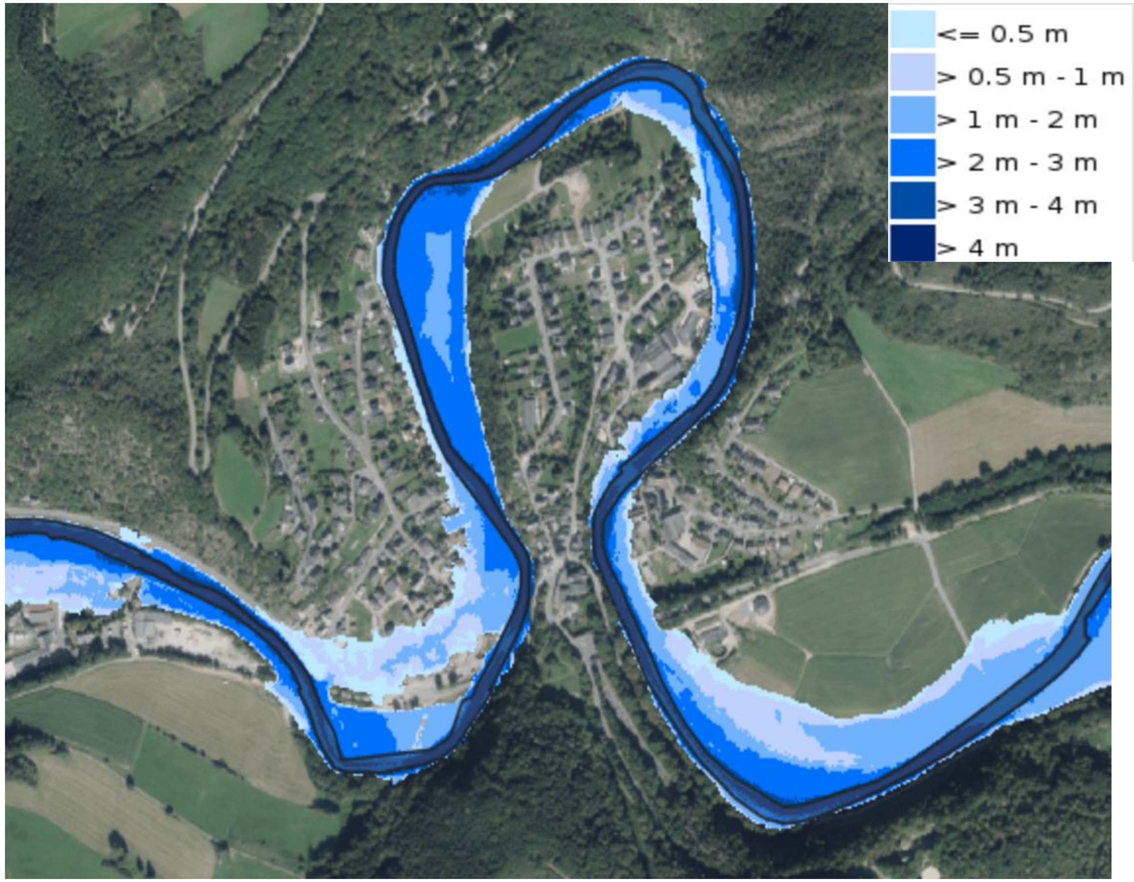


2021 Floodmap (Altenberg)

Flood modeling results and validation (Schuld)



Simulated Q500 m^3/s floodmap (Schuld)



2021 Floodmap (Schuld)

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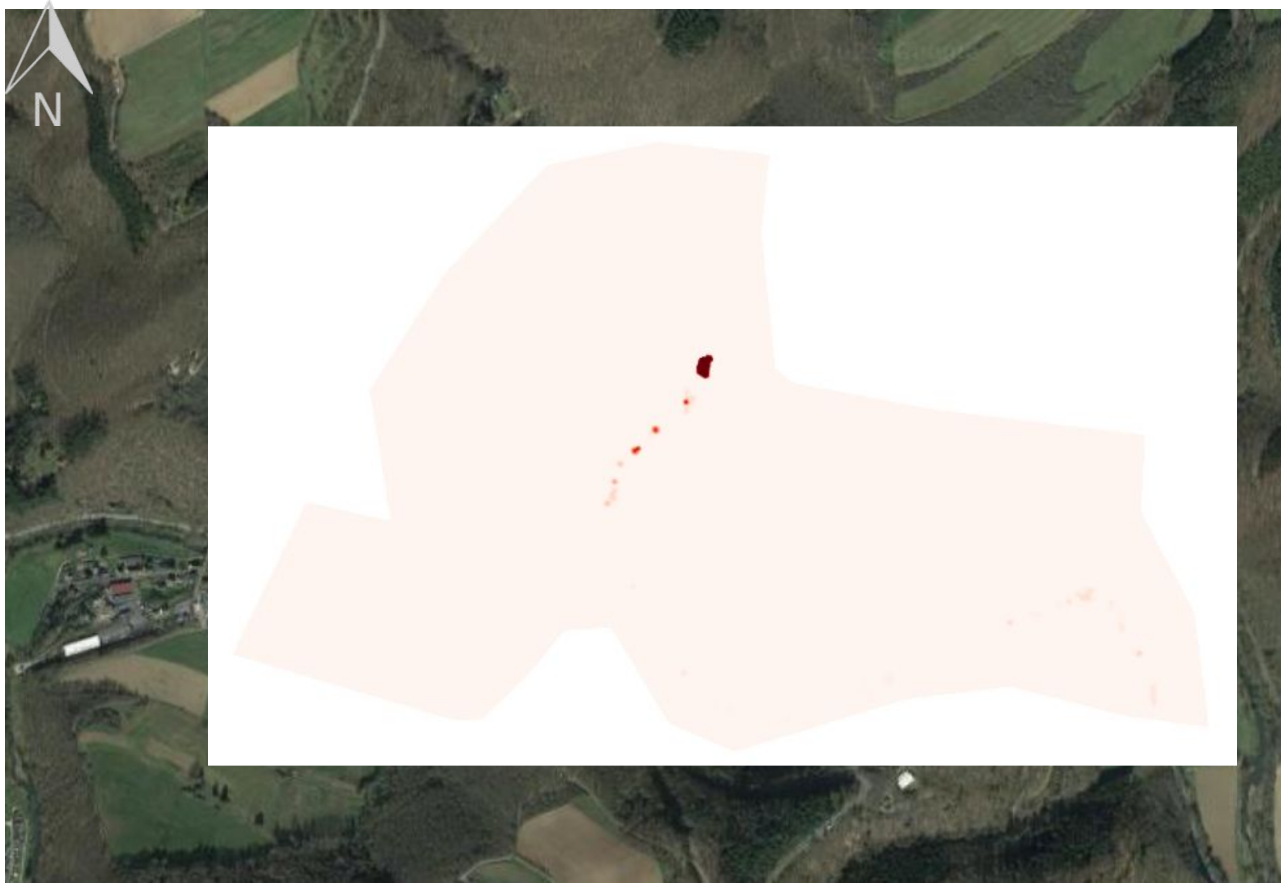
Tracers modeling results

Scenario : 500 m³/s & upstream boundary pollutant

Scenario : 500 m³/s & point sources pollutant



Pollutant distribution (kg/m³) during 500 m³/s event (Altenberg)

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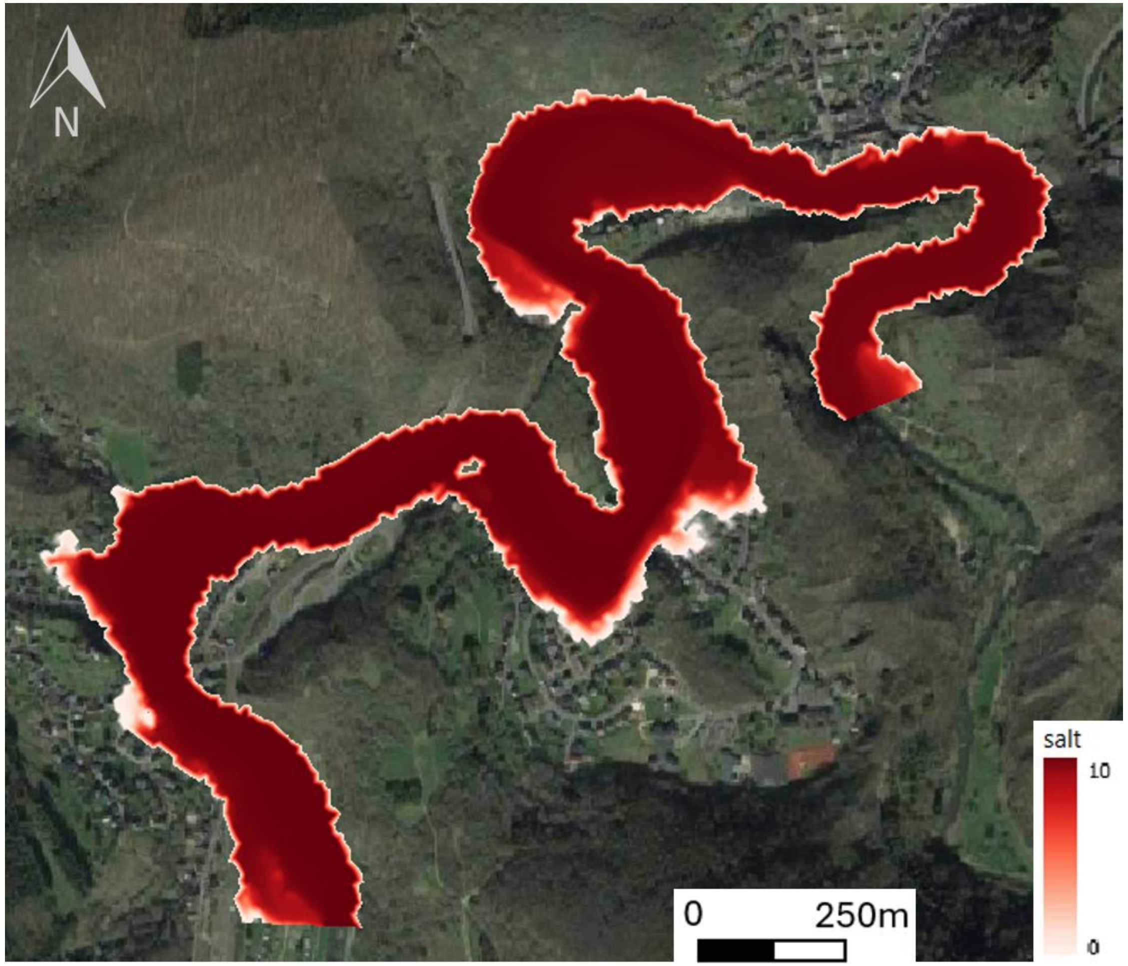
Tracers modeling results

Scenario : 500 m³/s & upstream boundary pollutant

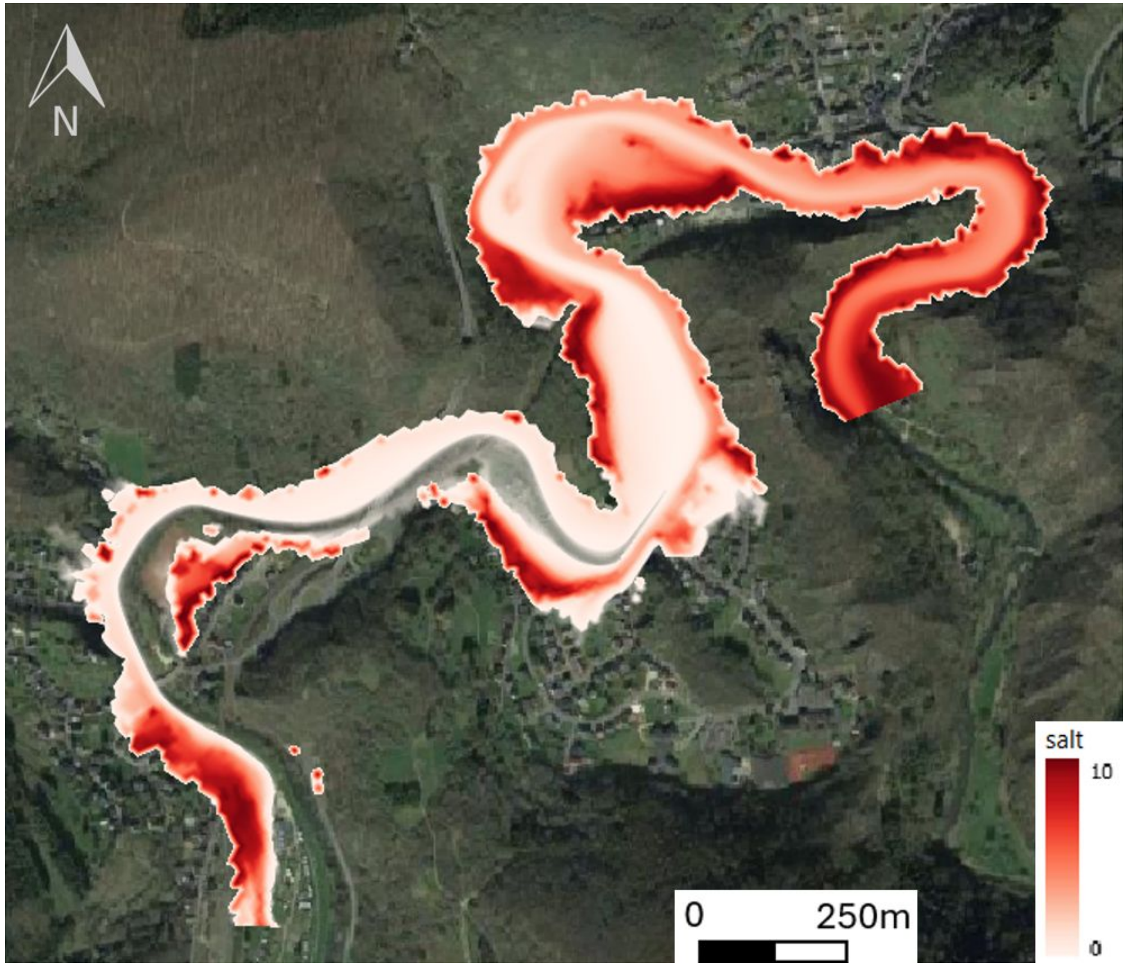


Pollutant distribution at the peak of 500 m³/s event (Altenberg)

Scenario : 500 m³/s & point sources pollutant

Tracers modeling results

Scenario : 500 m³/s & upstream boundary pollutant

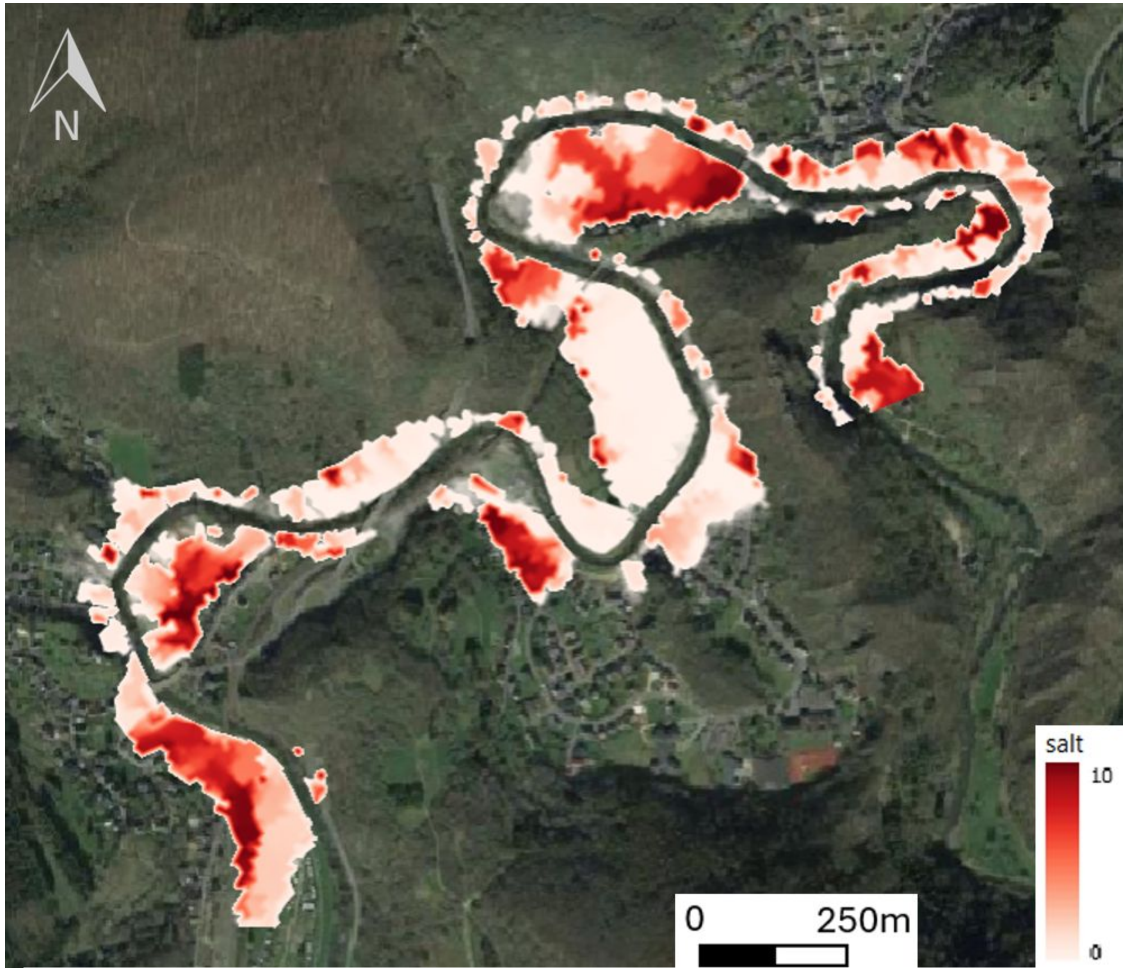


Pollutant distribution after stopping the entry of the pollutant, 500 m³/s event (Altenberg)

Scenario : 500 m³/s & point sources pollutant

Tracers modeling results

Scenario : 500 m³/s & upstream boundary pollutant



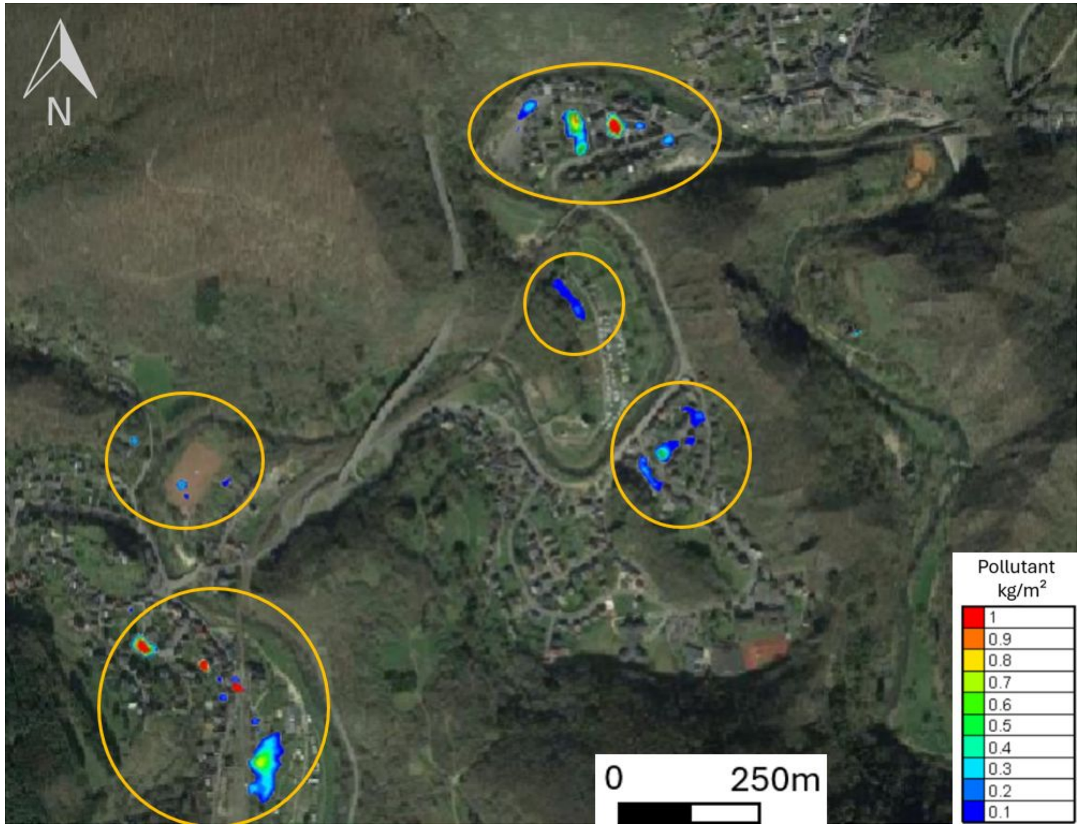
Pollutant distribution (kg/m³), steady state : 7.15 m³/s, 500 m³/s event (Altenberg)

Scenario : 500 m³/s & point sources pollutant

Tracers modeling results

Scenario : 500 m³/s & upstream boundary pollutant

Pollutant (kg/m³) * Water depth (m) = Pollutant (kg/m²)



Pollutant distribution (kg/m²), steady state : 7.15 m³/s, 500 m³/s event (Altenberg)

Scenario : 500 m³/s & point sources pollutant

Central risk area

Eastern risk area

Conclusion

How Does Pollution Spread Under Different Hydrological Conditions?

- Low flow keeps pollutants near their source.
- High velocity spreads pollutants far and wide.
- **Flash floods = fast & messy** → Sudden surges deposit contaminants in floodplains and groundwater.

Key takeaway: The more extreme the conditions, the harder pollution is to control.

How Do Different Flow Rates Impact Pollution Transport?

- **Slow flow (40–100 m³/s):** Pollutants stay put, dispersing gradually.
- **Mid-range (300 m³/s):** Carried further, dilution increases, but hotspots remain.
- **Extreme floods (500 m³/s):** Rapid transport + widespread deposition → long-term contamination risks.
- **Bottom line:** Higher flow doesn't just wash pollution away—it spreads the contamination.

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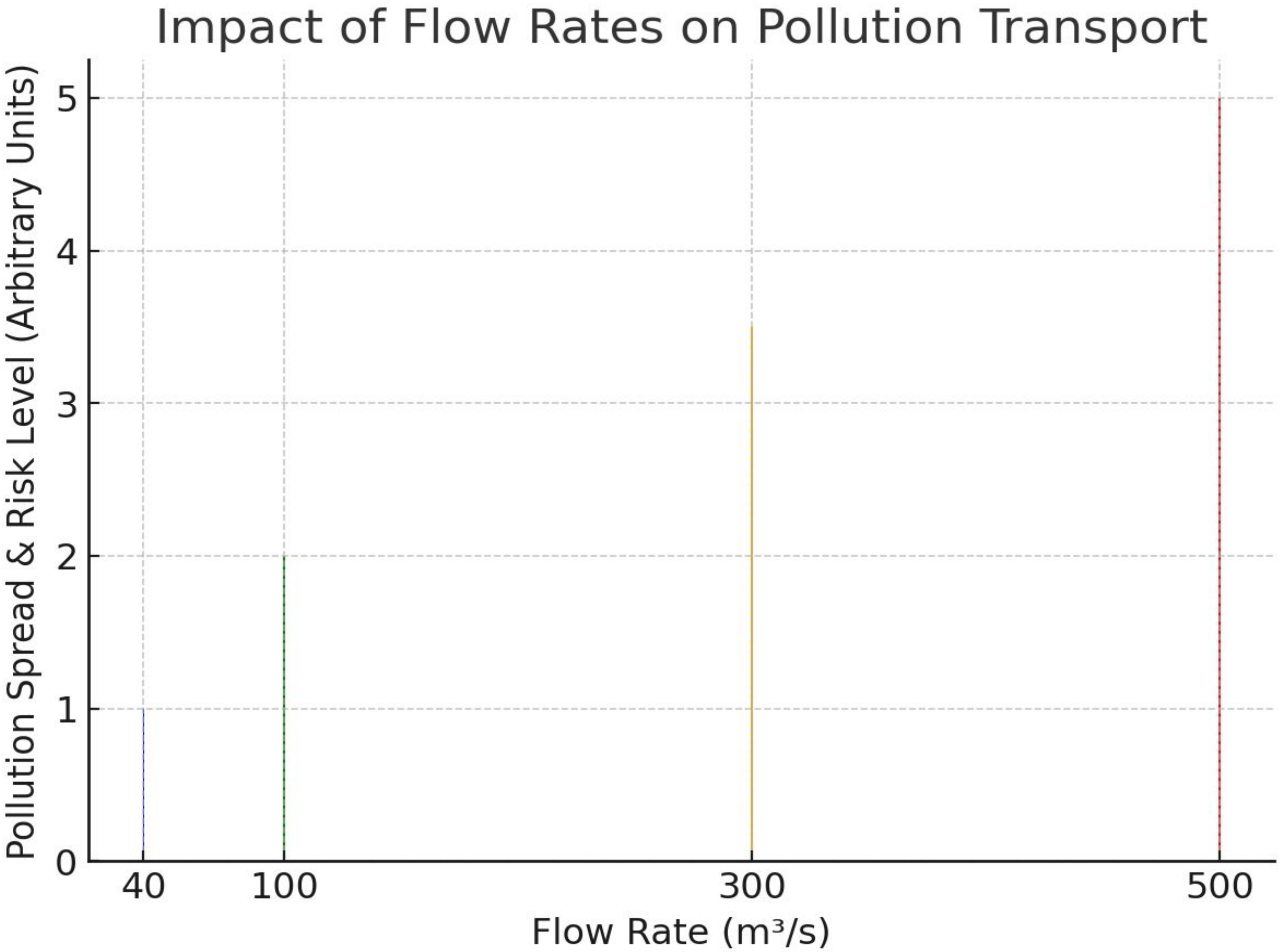
How pollution spread increases with flow rate.

The color gradient from **blue (low impact)** to **red (high impact)** visually highlights the risk escalation.



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What Patterns Emerge from Large-Scale to Fine-Scale Analysis?

- **Big models = big picture** – Shows general pollution trends but lacks precision.
- **Zooming in = real insights** – Fine-scale analysis reveals hidden hotspots and risk zones.
- **Why it matters:** Localized pollution pockets can be missed without detailed modeling.

Key takeaway: A combined approach leads to more effective pollution control and prevention.

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Beyond the Project: Future Perspectives

✅ What We Achieved

- Developed **hydrodynamic models** to simulate flood behavior and pollutant transport.
- Validated our models using real-world data from the **2021 Ahr Valley floods**.
- Identified **high-risk pollutant zones**, providing actionable insights for mitigation.
- Overcame challenges in **TELEMAC simulations**, refining our approach for accuracy.

🔎 Applying This Work to Other Case Studies

- The **Ahr River model** serve as a reference for flood-prone areas with **steep valleys and rapid runoff**.
- **3D Pollutant Transport Models:** To capture subsurface infiltration and long-term environmental impacts.
- **Climate Change Considerations:** Assessing **future flood scenarios** under extreme weather conditions.

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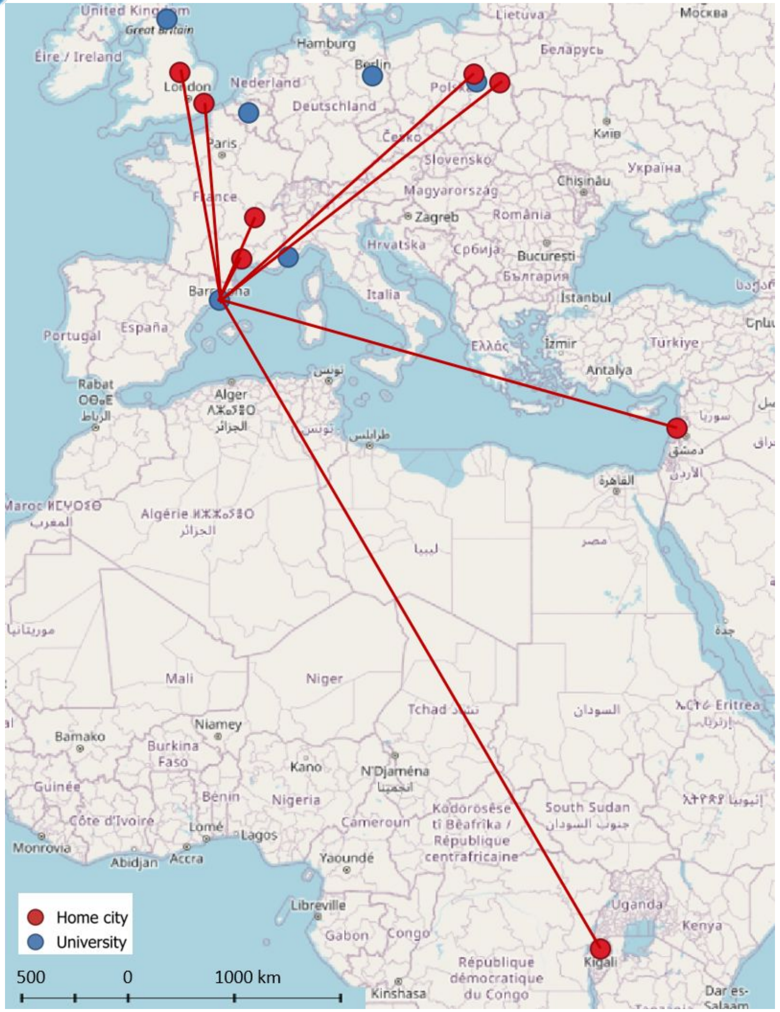
Team work



Merci

Danke

Gracias

HYDROEUROPE
Flood Risks Management and Resilience in Europe

Thank You

Dziękuję

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