Enhancing Ribasim for Reservoir Operations

Validation with Canteen & Application to the Drammen Basin

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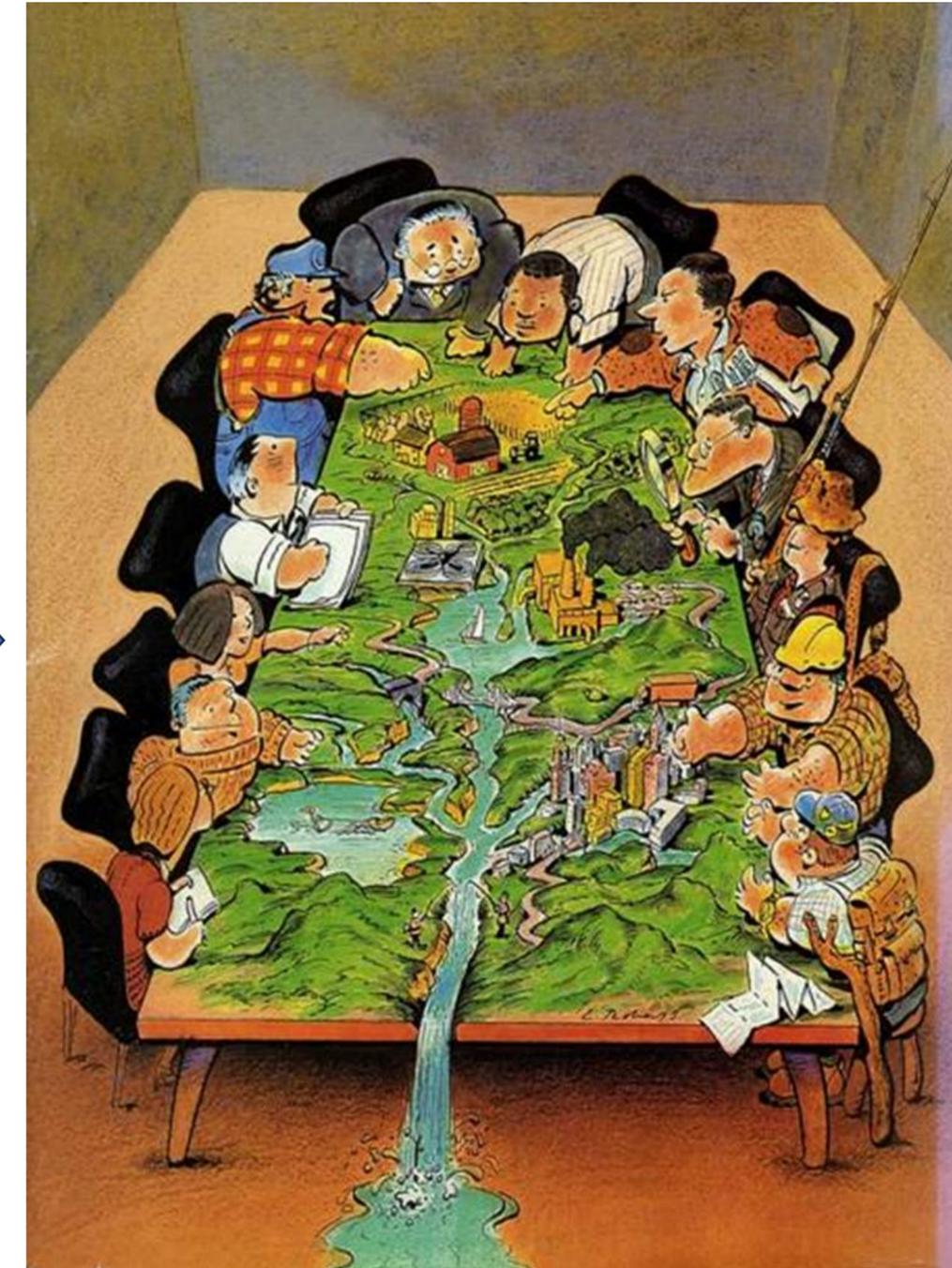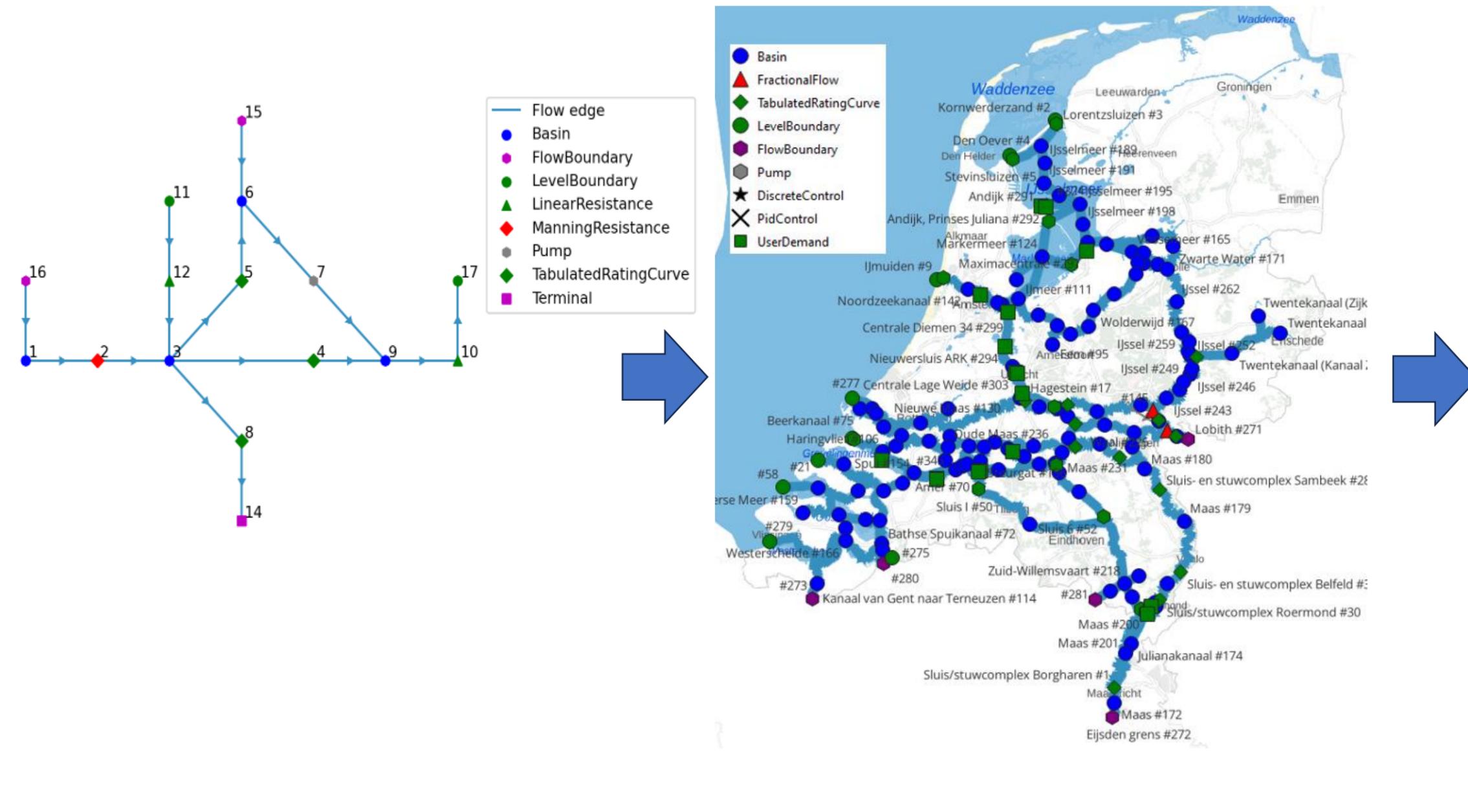
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[2] *The Norwegian Water Resources and Energy Directorate (NVE)*

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Ribasim

Ribasim = is a **water resources model** to simulate the physical behaviour of a **managed open water system** based on a set of control rules and a prioritized water allocation strategy (www.ribasim.org)

# Motivation and context

Why this matters:

- The **Drammen Basin** is densely developed for **hydropower**, with many reservoirs and complex operations.
- This makes it a great test case to see if **Ribasim** can support **real-world reservoir and hydropower management**.

Current situation:

- Operational tools like **EOPS** are in use, but focus on a single stakeholder (the hydropower producer)
- The model doesn't explicitly combine **routing and allocation** in a transparent, flexible framework
- → Limits broader water system perspective

Part of **STARS4Water** (EU Horizon)
→ supports improved climate-resilient basin-scale water management
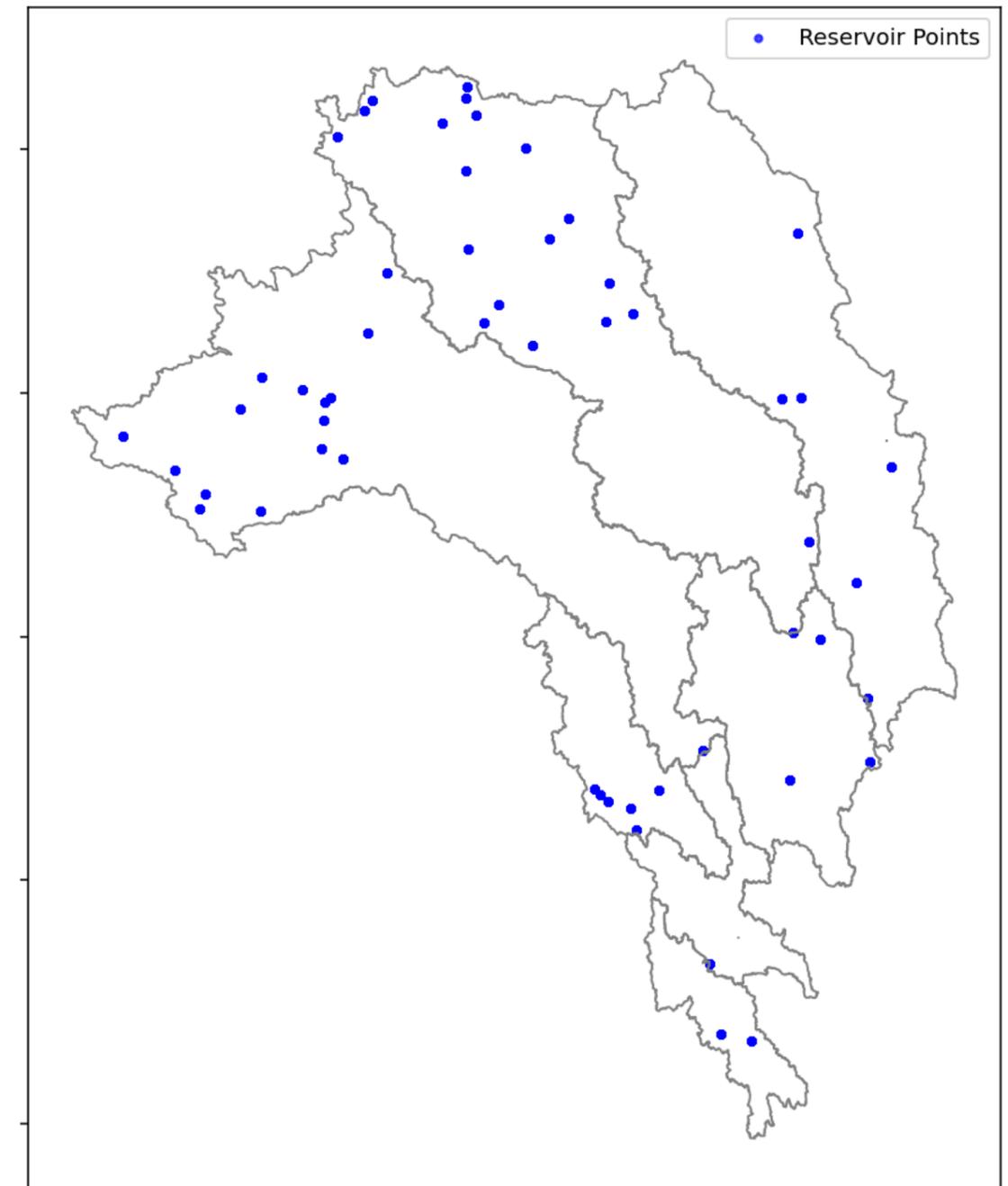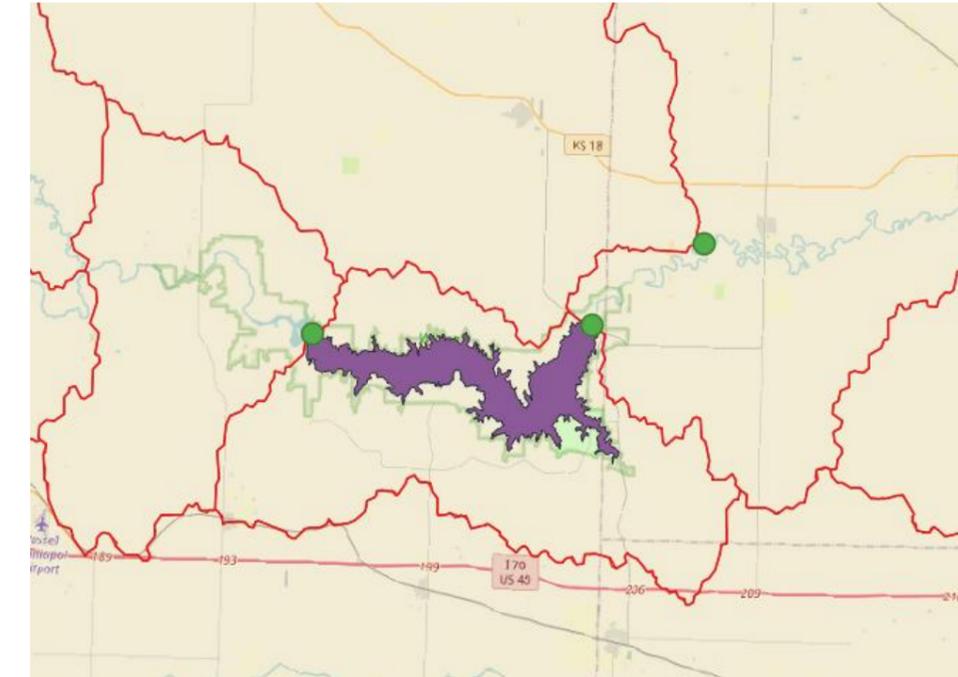
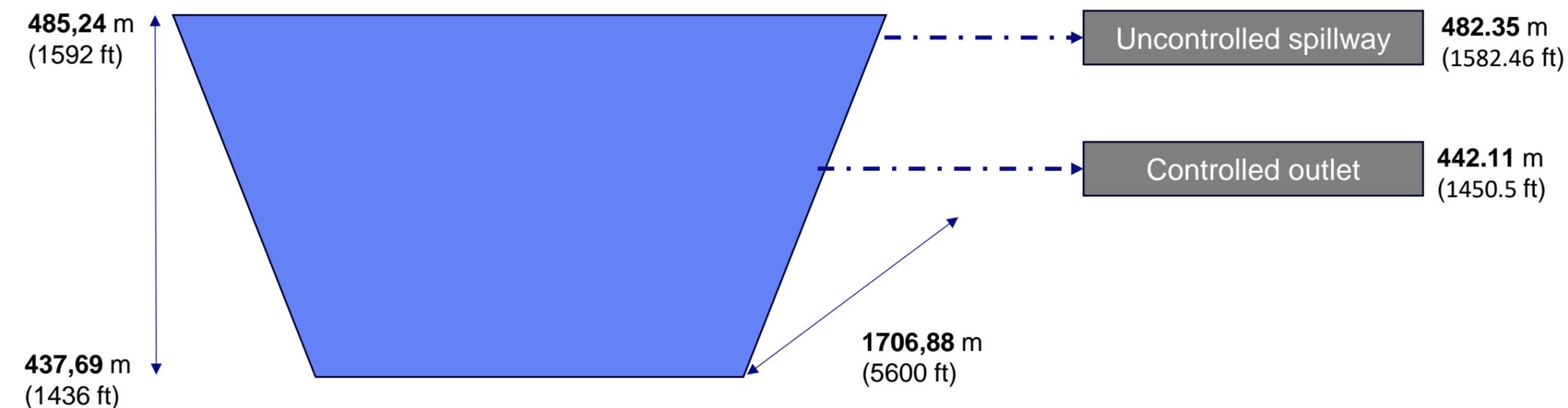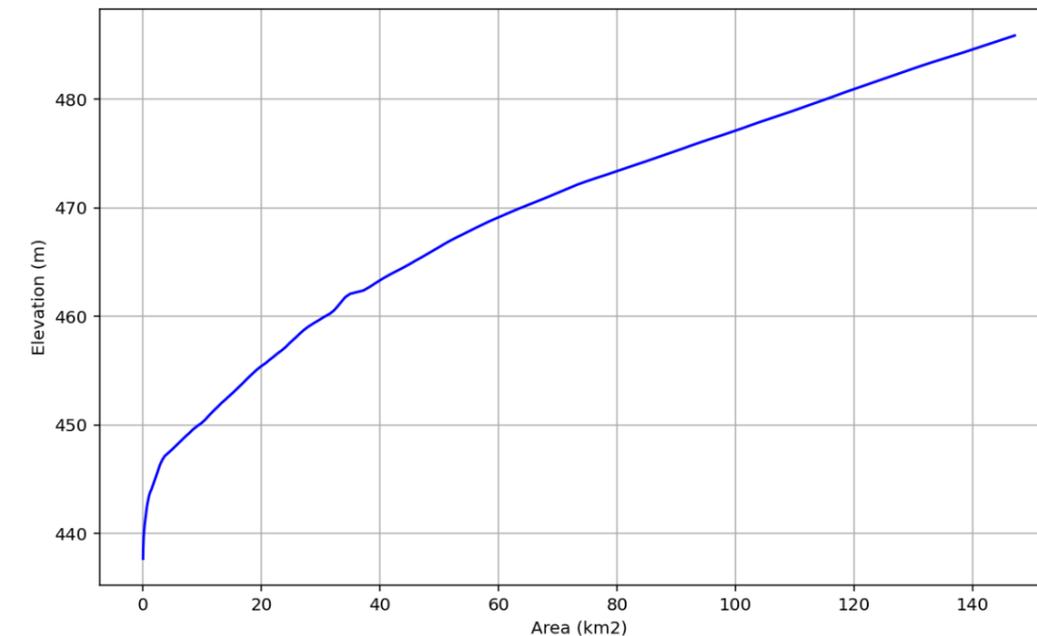**Canteen** = Python Package is used to model reservoirs and reservoir operations in water resource systems (JohnRushKucharski/canteen)

Background

- Wilson reservoir (Kansas US)
- Model run: 2010
- Compare outputs from Ribasim and Canteen
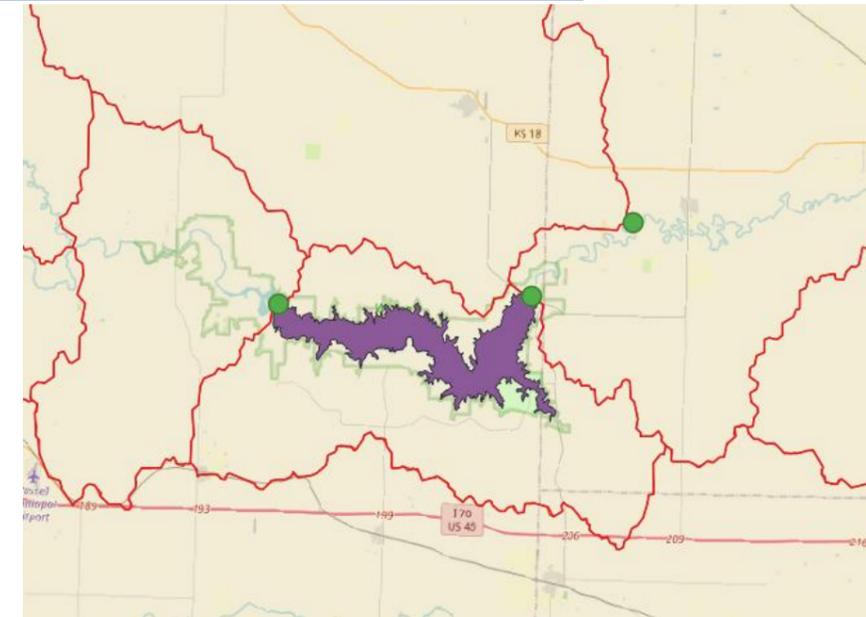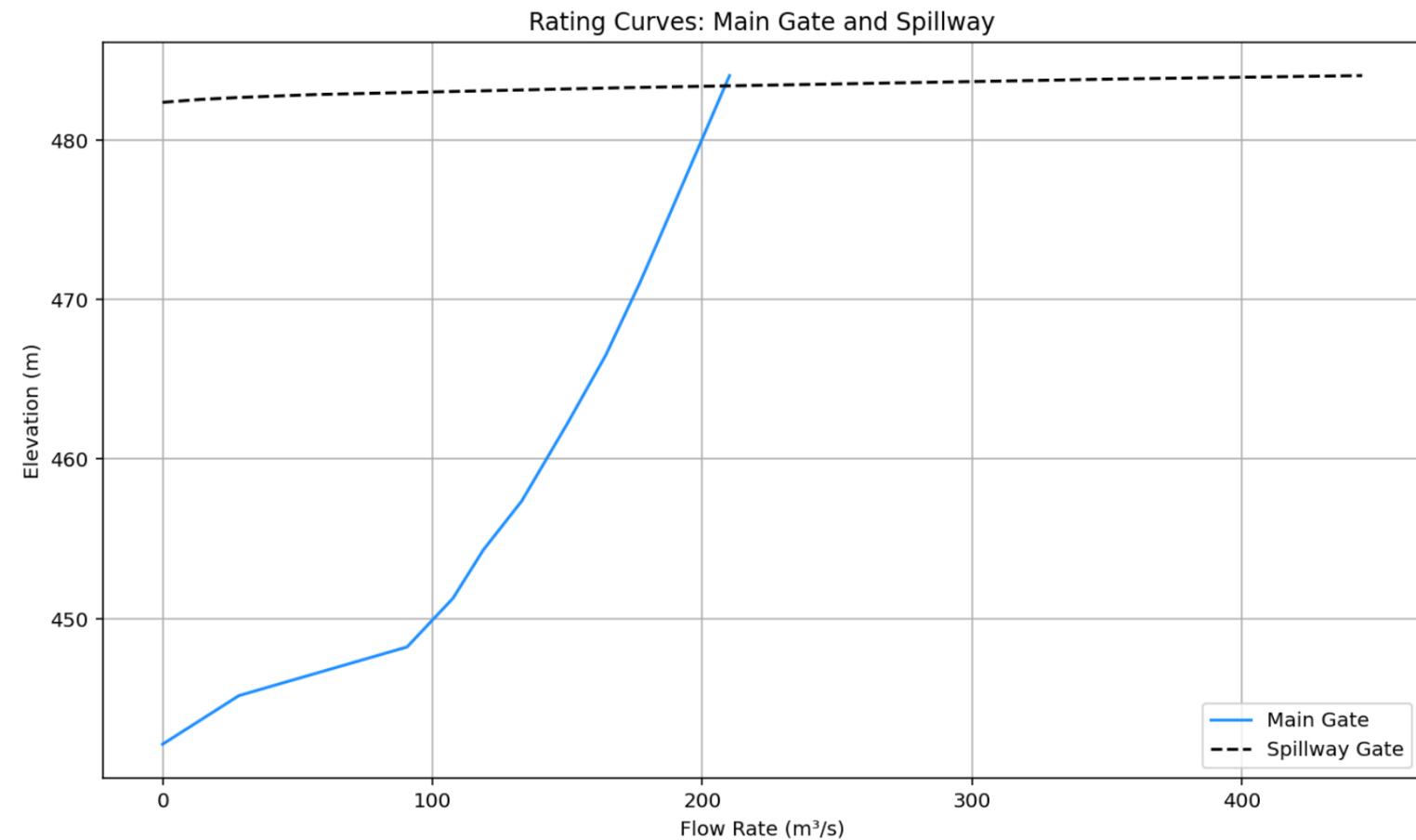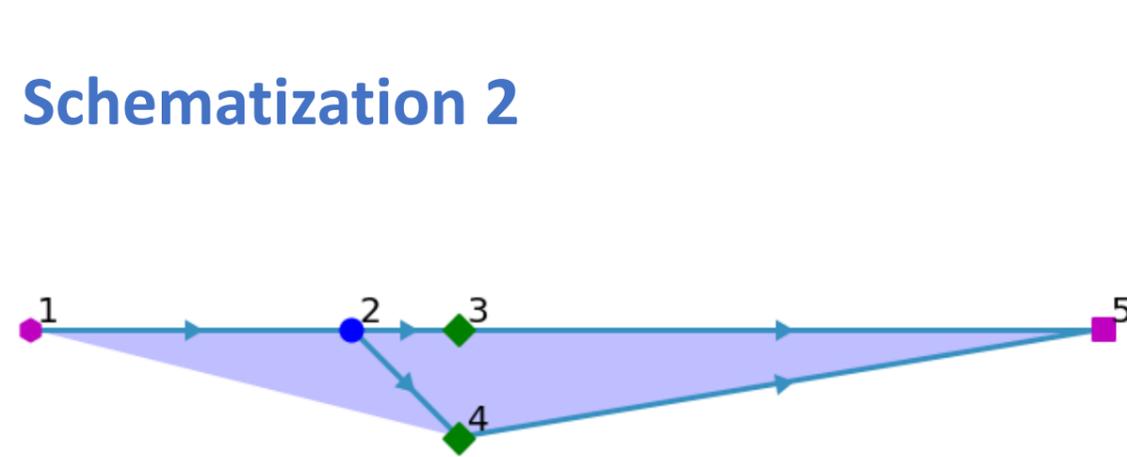- Ensure Ribasim can replicate established reservoir dynamics

Wilson Profile

485,24 m
(1592 ft)

Uncontrolled spillway — 482.35 m (1582.46 ft)

Controlled outlet — 442.11 m (1450.5 ft)

437,69 m
(1436 ft)

1706,88 m
(5600 ft)

Validation with Canteen

Daily Outflows: Canteen vs Ribasim
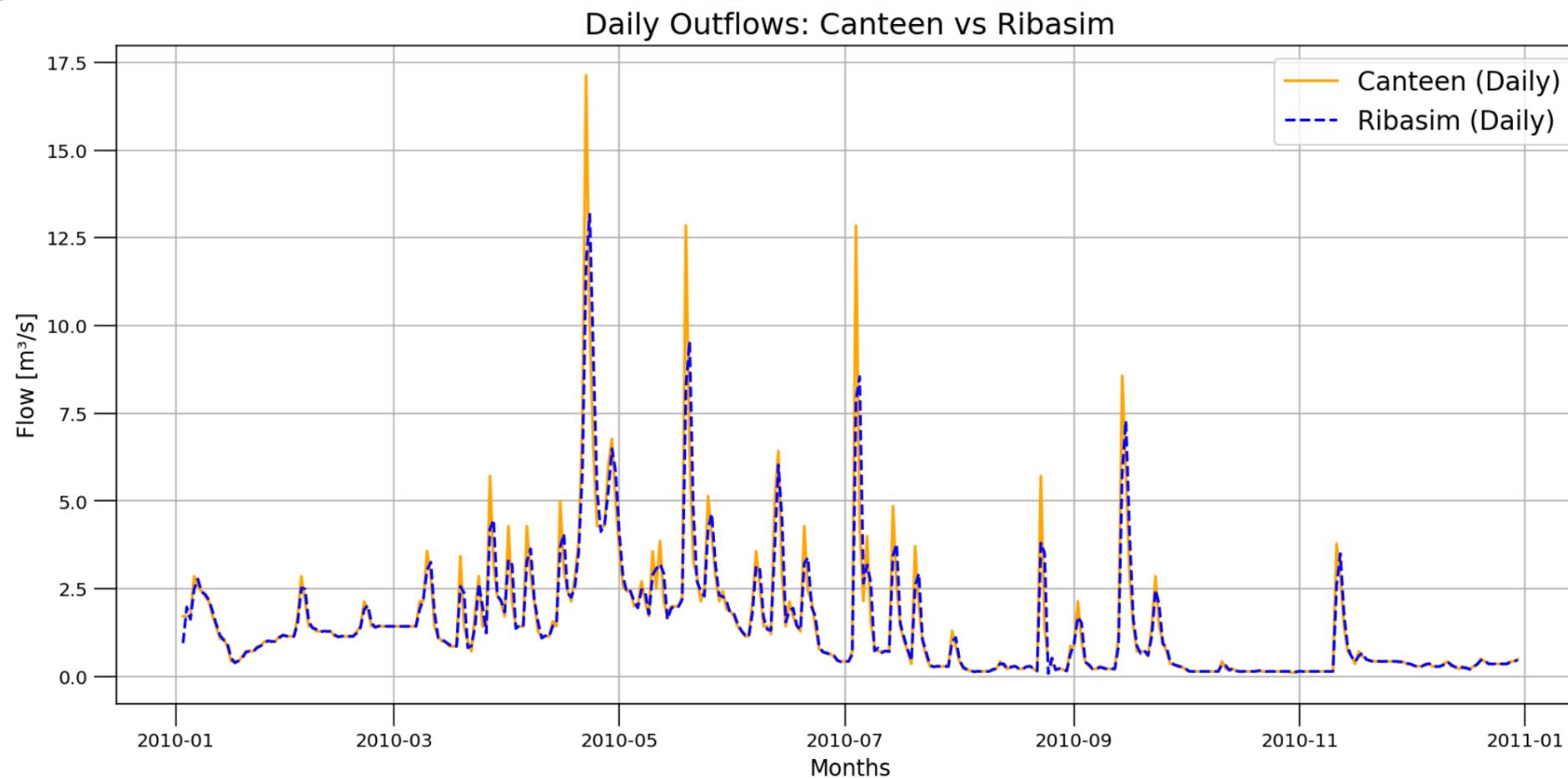
Observations
- Outflows show similar timing and trend
- Ribasim peaks are lower than Canteen in most high-flow events

Likely cause of peak
- Canteen: Outflow is constant all day at $Q(h_0)$, like a staircase (Stepwise interpolation)
- Ribasim (applied Euler Algorithm):
  - Updates the basin level based on linearly interpolated inflow
  - Recomputes $Q(h)$ based on the updated level
  - This causes a gradual ramp-up in flow during the day
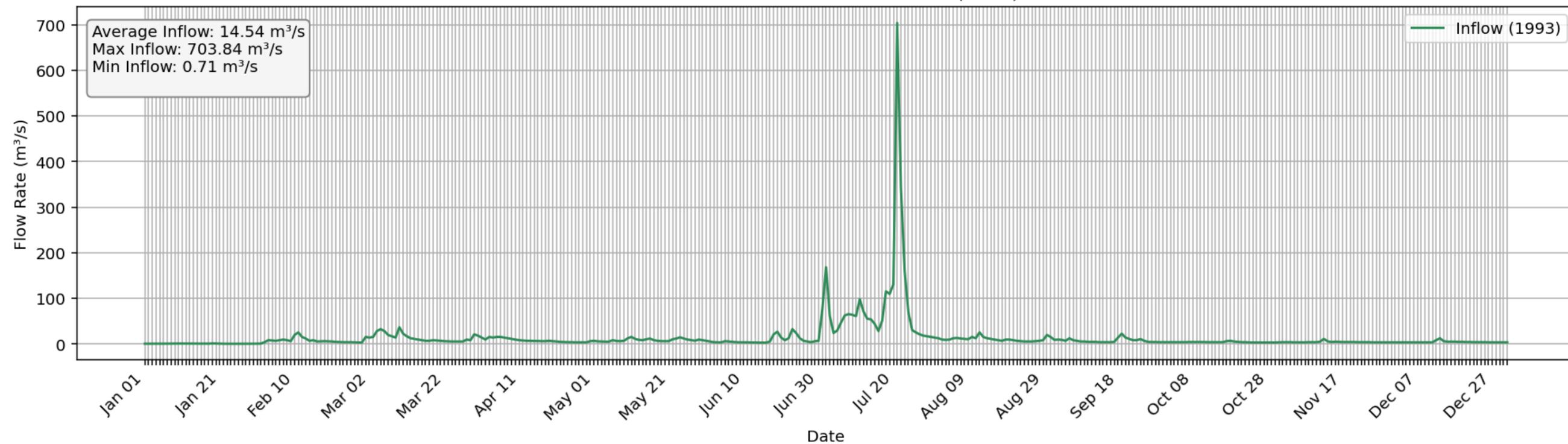- As a results, Ribasim daily average outflow is lower than Canteen's peak

Zone-based outlet modelling

Peak inflow is in 1993

Wilson Dam Inflow - Full Time Series
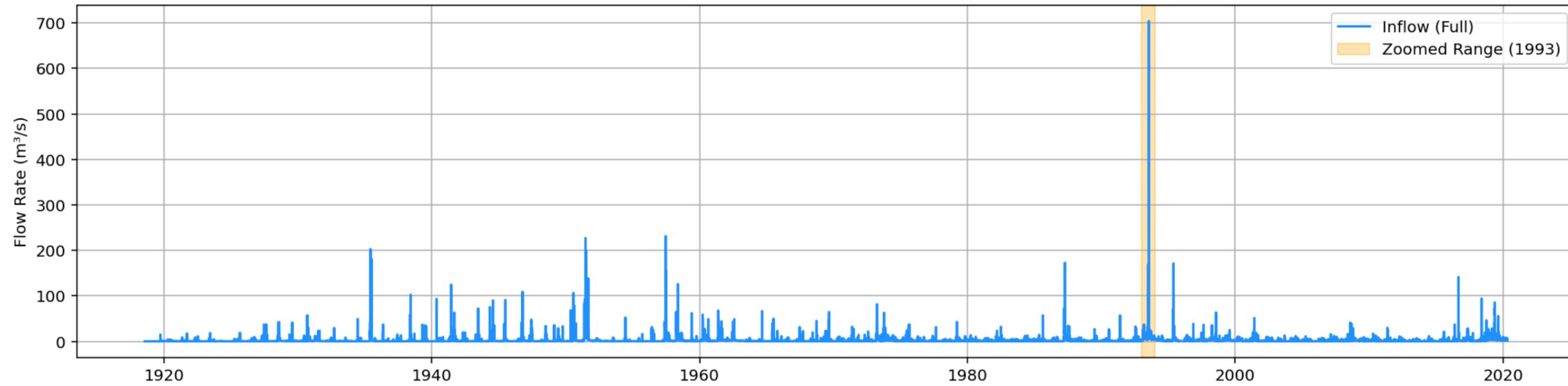
Zoomed View: Wilson Dam Inflow (1993)

Average Inflow: 14.54 m³/s
Max Inflow: 703.84 m³/s
Min Inflow: 0.71 m³/s

Zone-based outlet modelling

Set-up

- 7 operational zones defined:
  1. Inactive (no discharge!)
  2. Conservation
  3. Priority 1 [PI]
  4. Priority 2 [PII]
  5. Priority 3 [PIII]
  6. Surcharge
  7. Top of the dam

- Each zone linked to separate outlet node
- Flow rules set by min. reservoir level and fixed zone-specific discharges
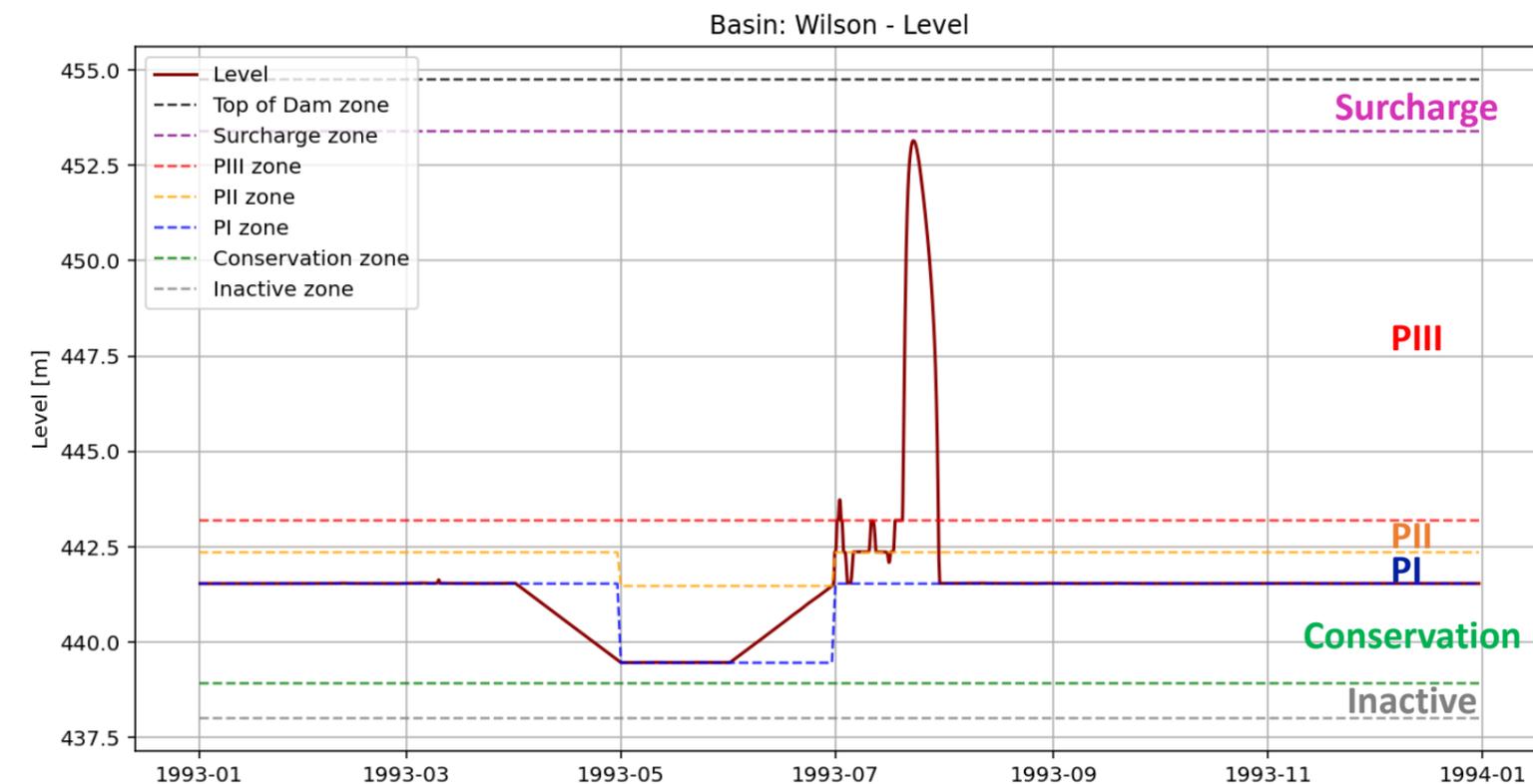- Flow rules change over time

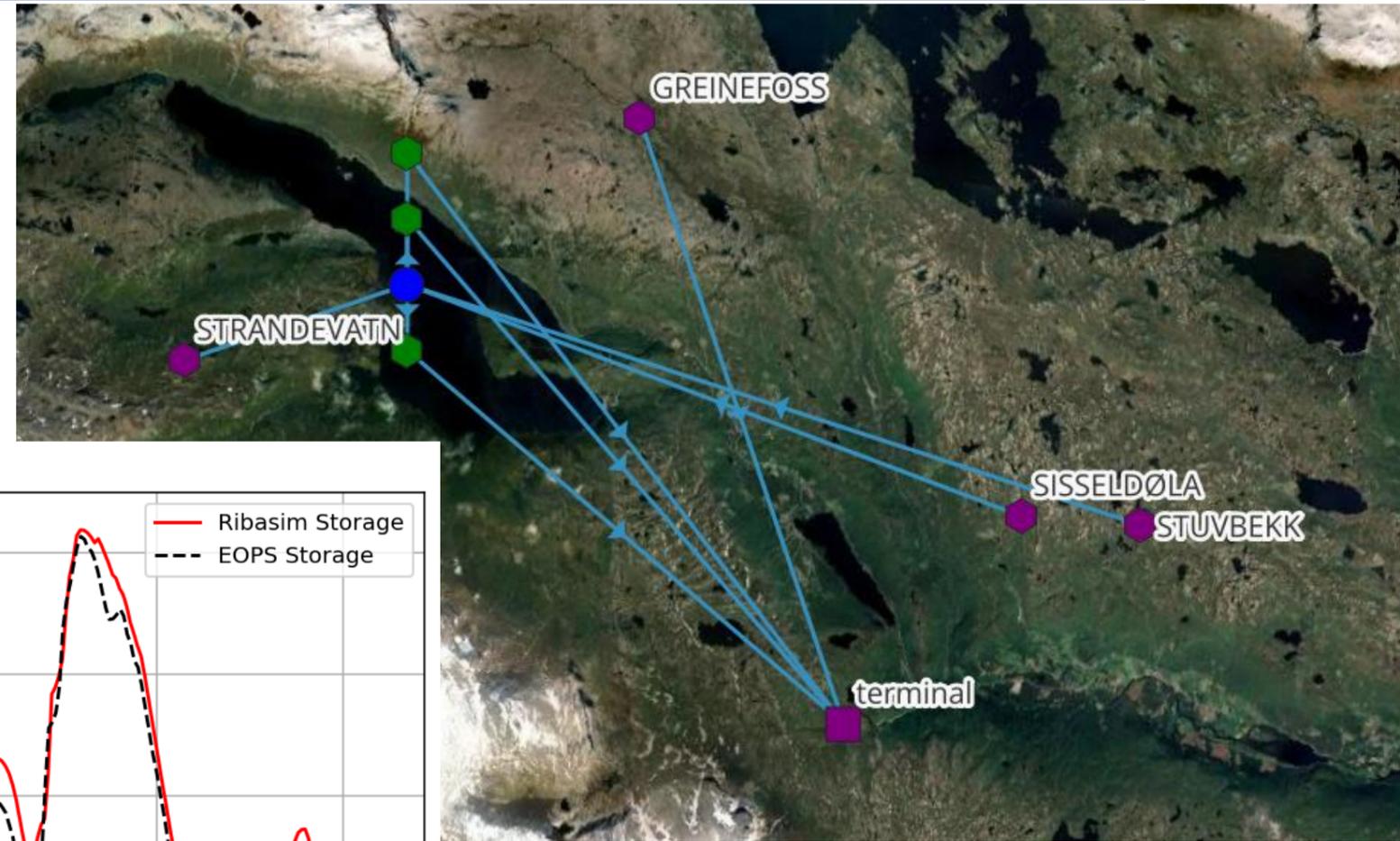Schematization 3
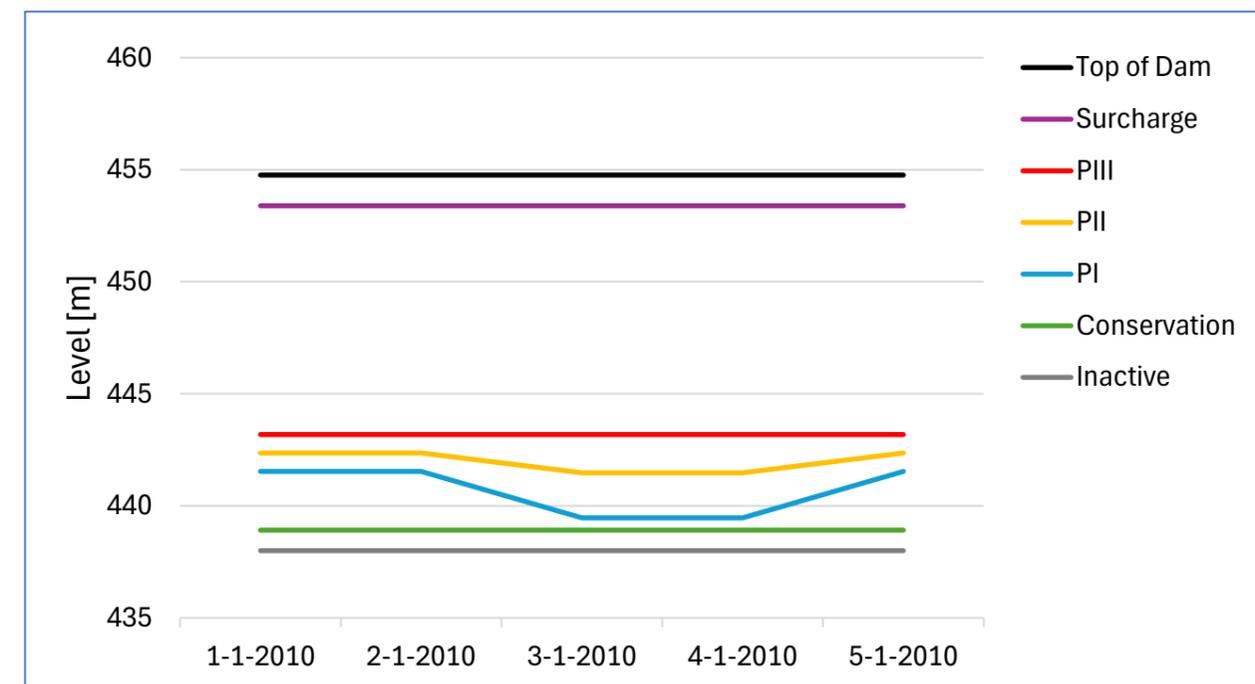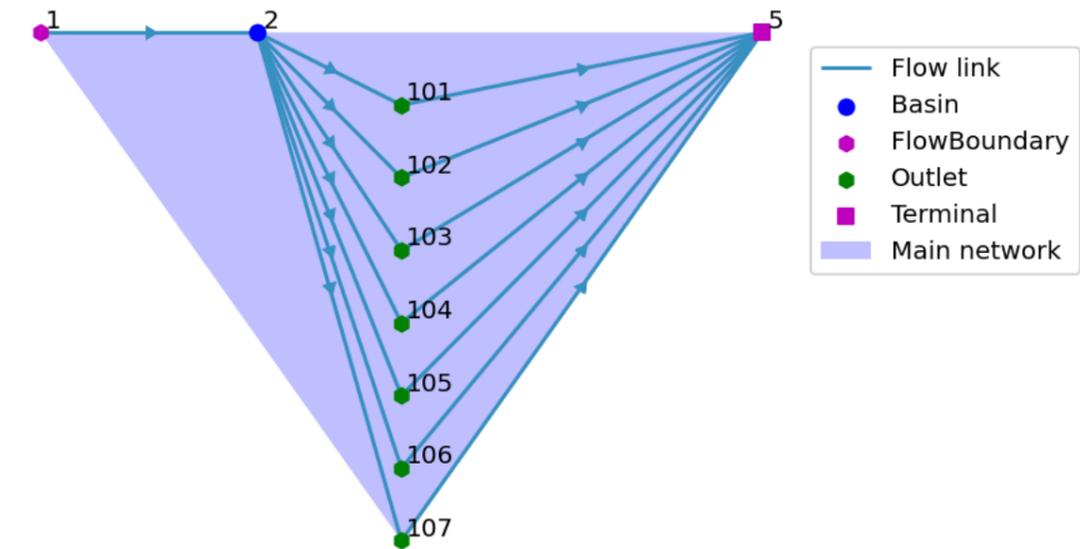
Zone-based outlet modelling
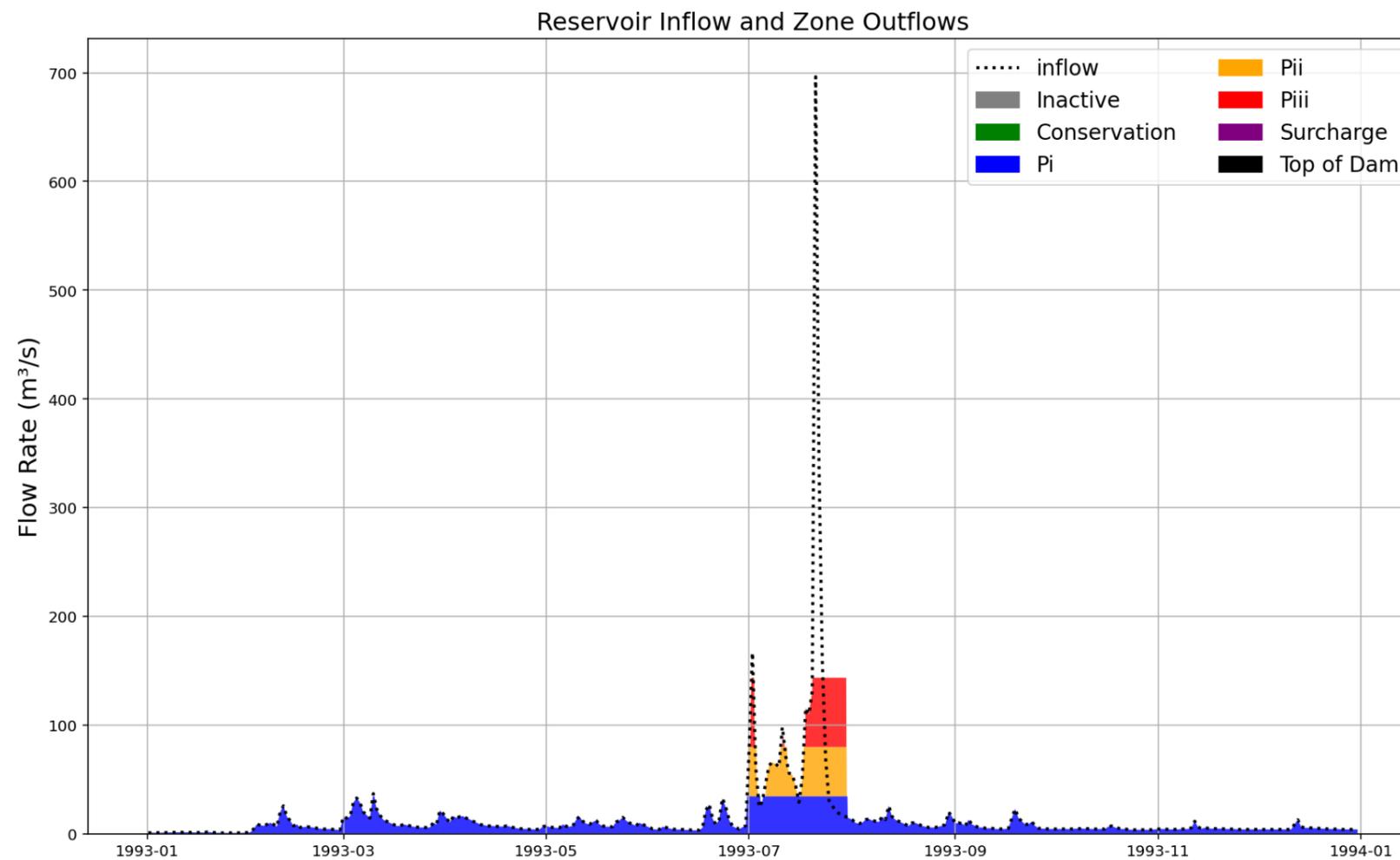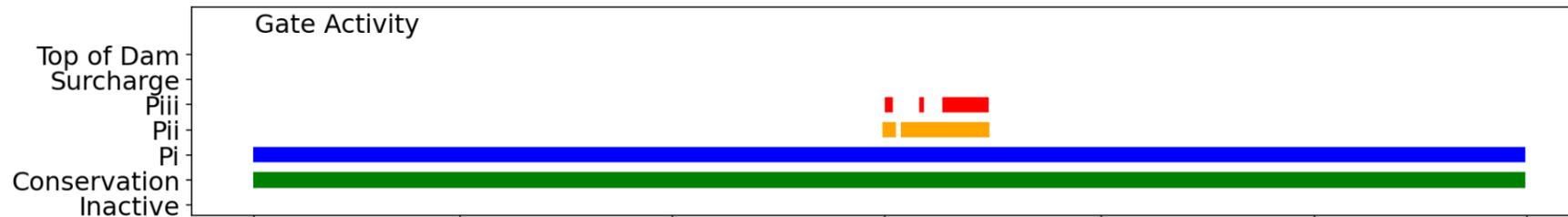
- Gates switch dynamically as reservoir level crosses zone thresholds
- Higher zones (PII and PIII) only triggered during peak inflow events
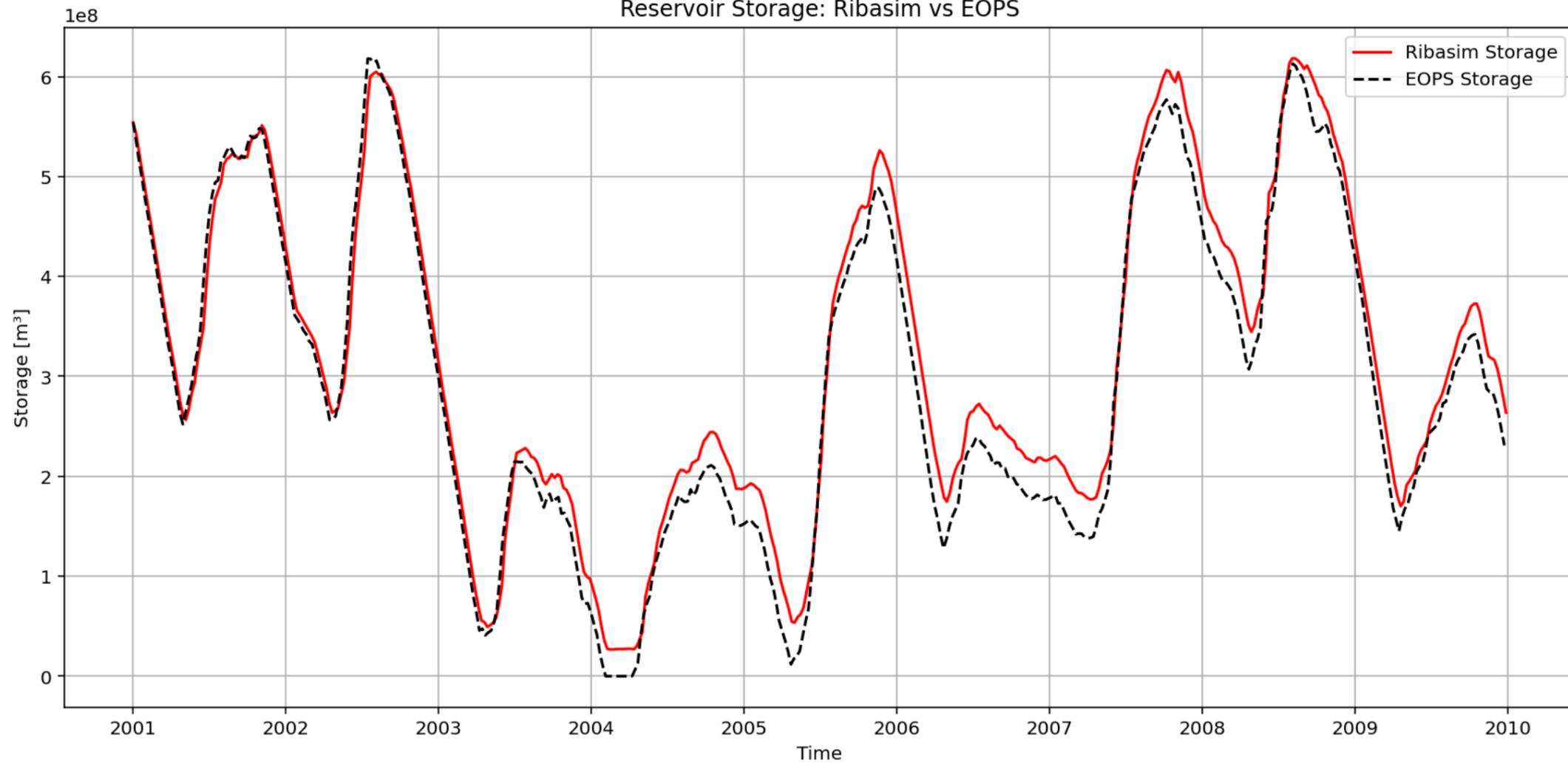- Model structure is transparent, interpretable, and policy-aligned

Drammen

Reservoir Storage: Ribasim vs EOPS

Conclusions and next steps

- Ribasim can help planners, hydropower managers, and policy stakeholders evaluate trade-offs and risks more effectively
- Aligns with STARS4Water goals: supporting water security under climate change at basin level
- Not just a model, but a decision-support tool that can integrate real operations, priorities and water needs
- Early results show Ribasim can mimic key behaviours, even with a simplifies structure
- More refinement needed, especially with control rules and allocation features.

Next steps
- Validation with observed values
- Drammen case expands Ribasim's use to hydropower-driven systems
- Focus on building realistic but understandable setups that support planning for different stakeholders in Drammen basin
- Further enhancements: energy-water trade-offs

Thank you!

More information

- ribasim.org (free open source https://github.com/Deltares/Ribasim)

- www.stars4water.eu

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