SINTEF

River modelling in SHOP

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Technology for a better society

Motivation for the RIVER Module in SHOP

- Robustness of flow functions
- Introduce state-dependent time delay
- Verify new sensor measurements in watercourses
- Enable linking and merging river segments
- Ready for data-driven modelling

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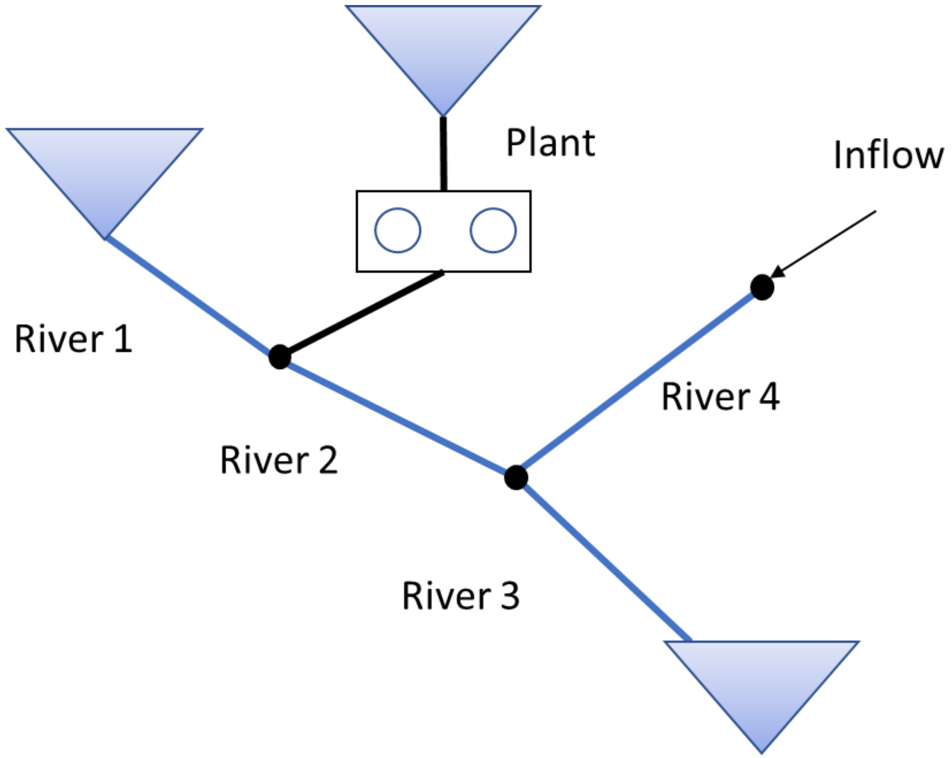
River topology



- Rivers can have multiple input objects, including other rivers
- Rivers can also have no input object, with only the river inflow flowing in the river
- Rivers can be joined, but not split

River flow functions

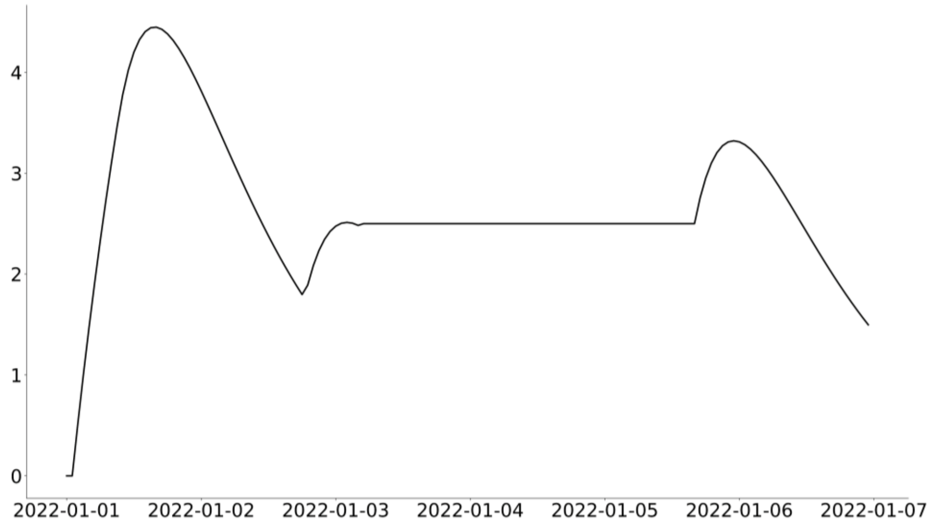
Different flow functions can be specified for rivers connected to an upstream reservoir:

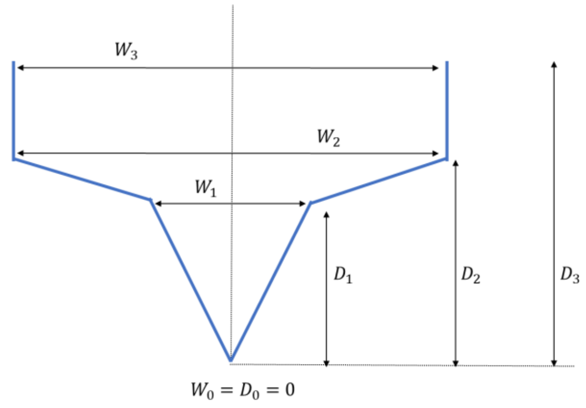
1. A table connecting reservoir level with flow

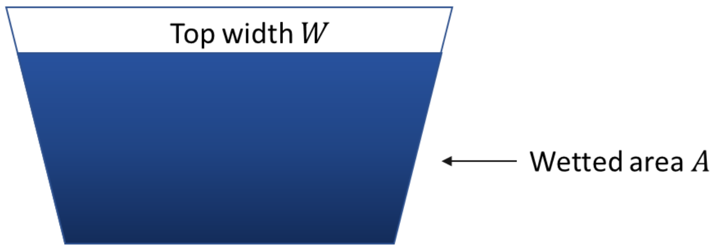
2. "Deltameter" flow functions for two-way flow between two reservoirs

3. A width-depth curve describing the geometry of the river opening

$$q^2 = g \cdot \frac{A^3(h)}{W(h)}$$







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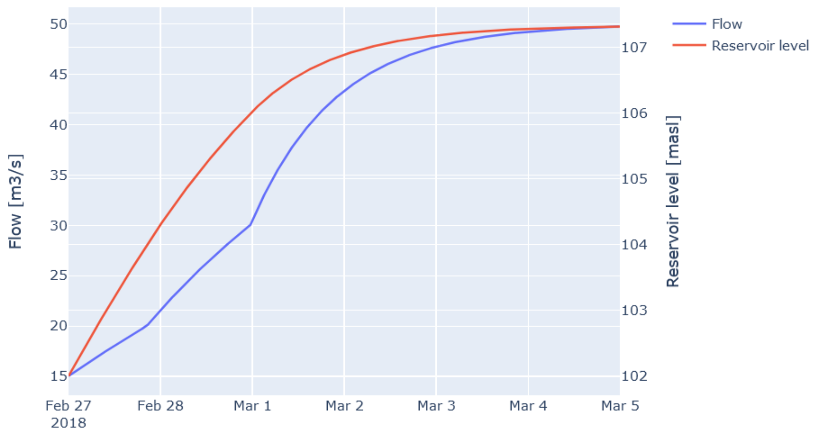
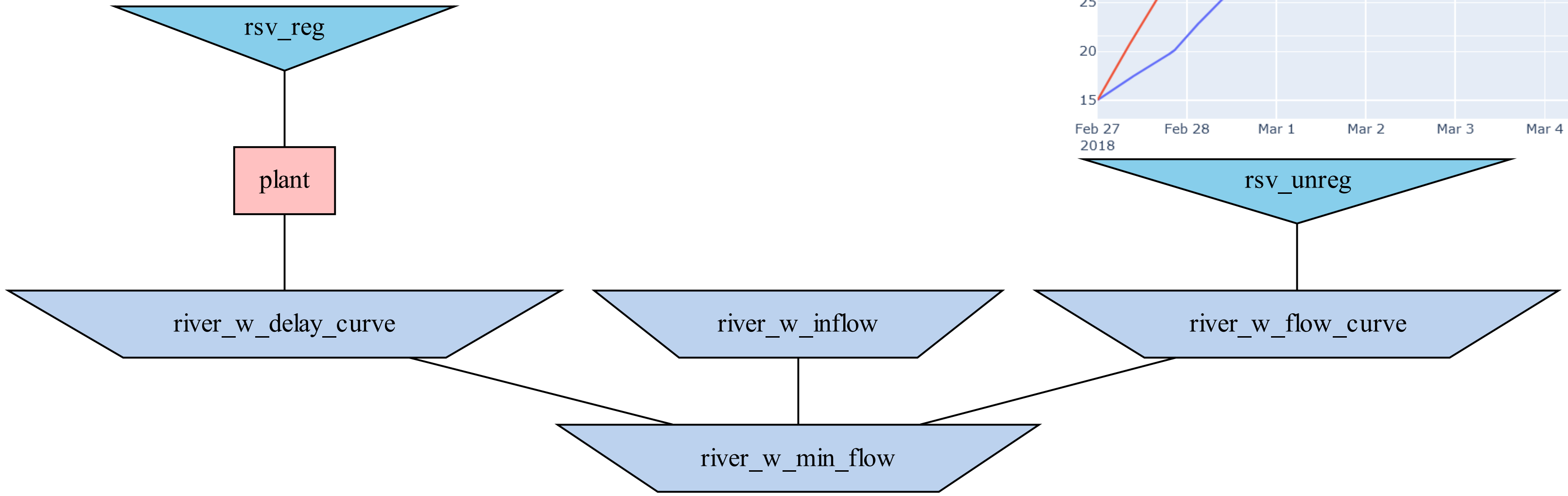
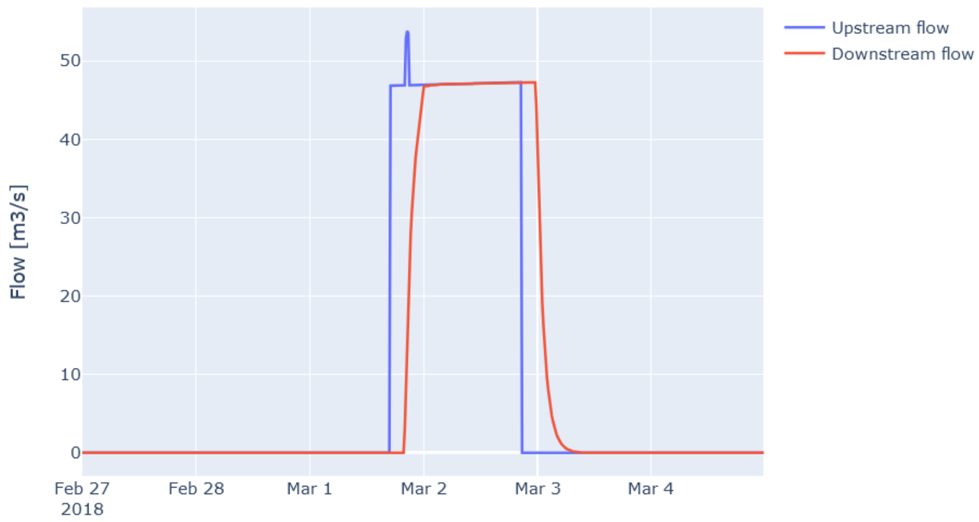
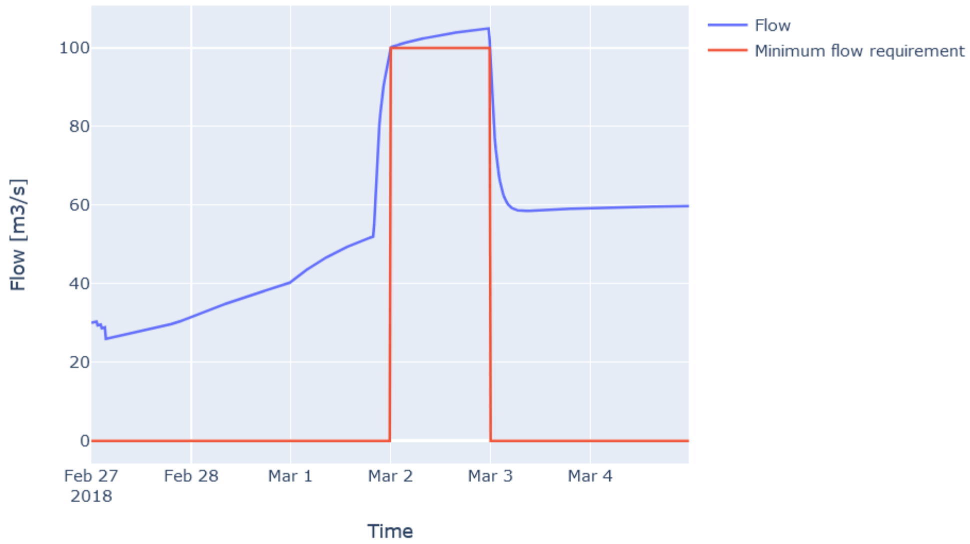
Minimum flow example

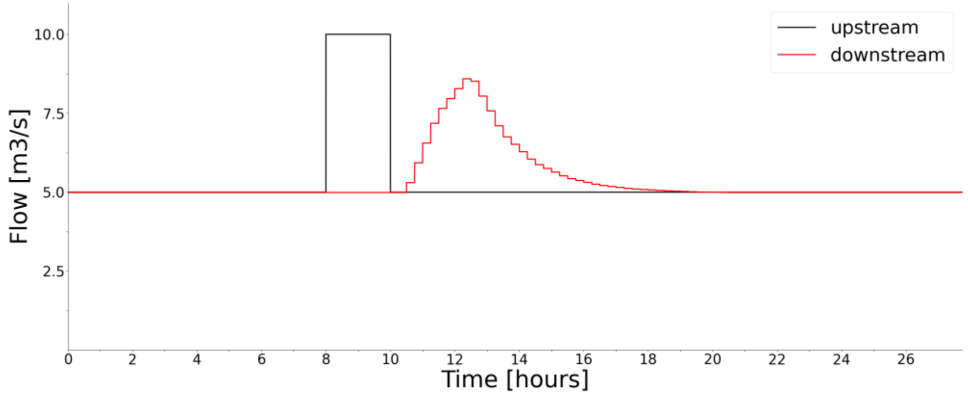








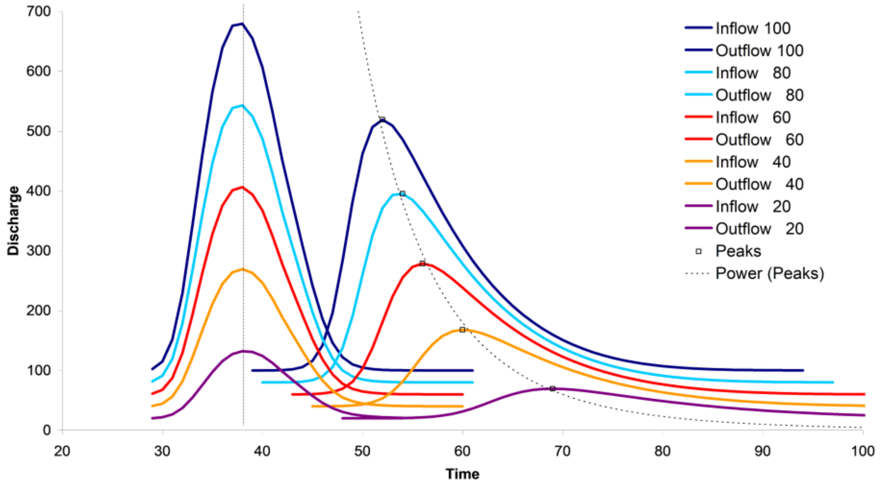
River time delay



- Rivers can have constant time delay or time delay according to a wave shape curve

- The wave shape curve can also be flow dependent

- The value of water in transition at the end of the horizon can be specified for each river object



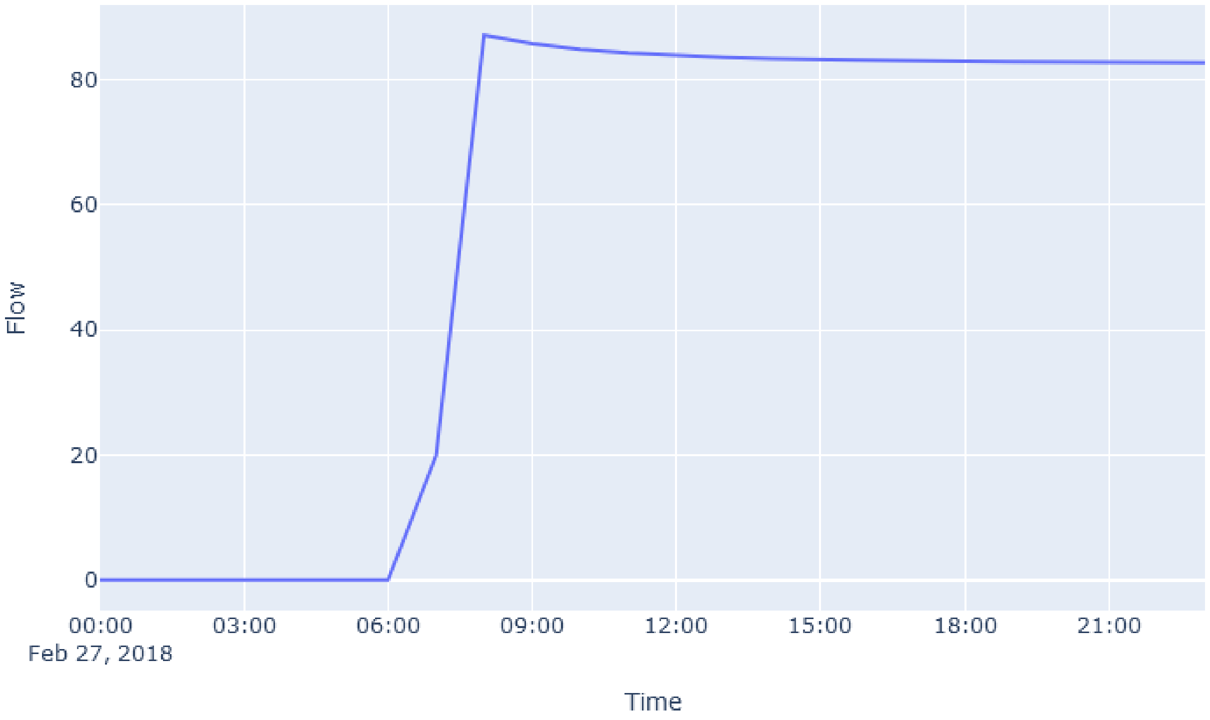
https://ec-jrc.github.io/lisflood-model/3_05_optLISFLOOD_kinematic-wave/

Overflow modelling

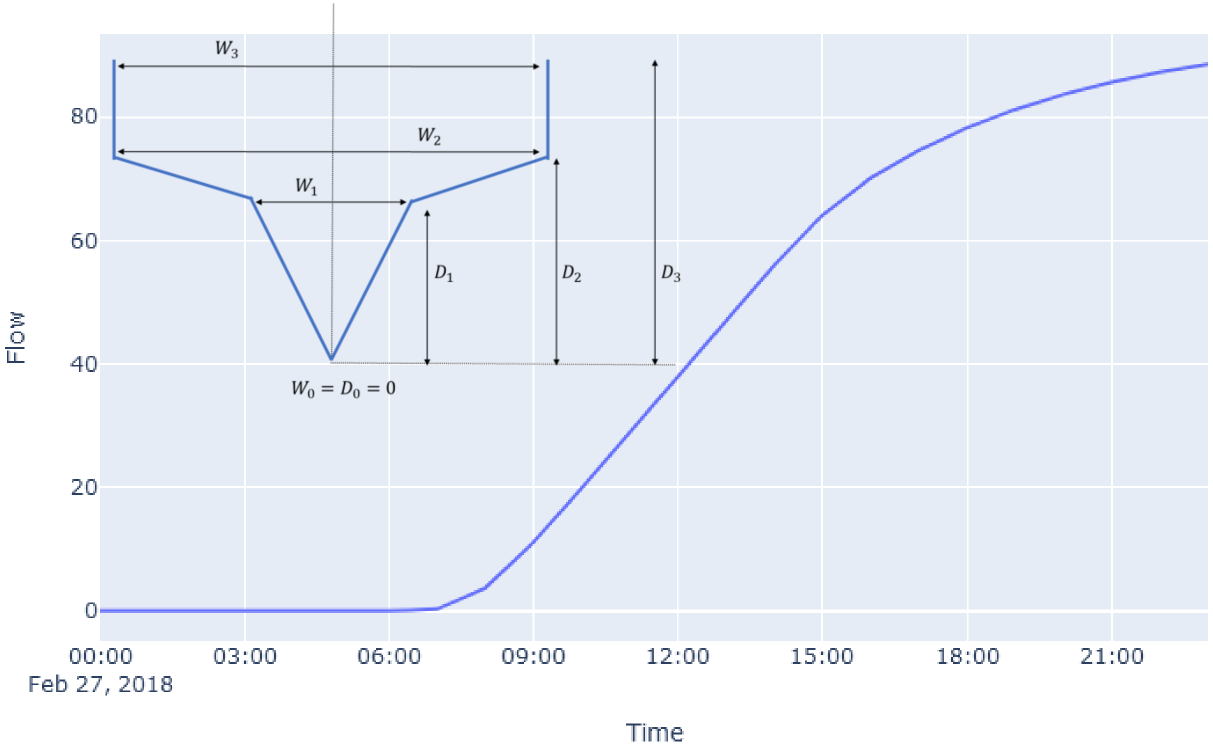
- River is a physical object, not a logical object
- *Upstream elevation* must be defined when a river revieves water from a reservoir
- This replaces traditional overflow modelling, and allows multiple spillways, both controlled and uncontrolled

Overflow modelling with flow functions

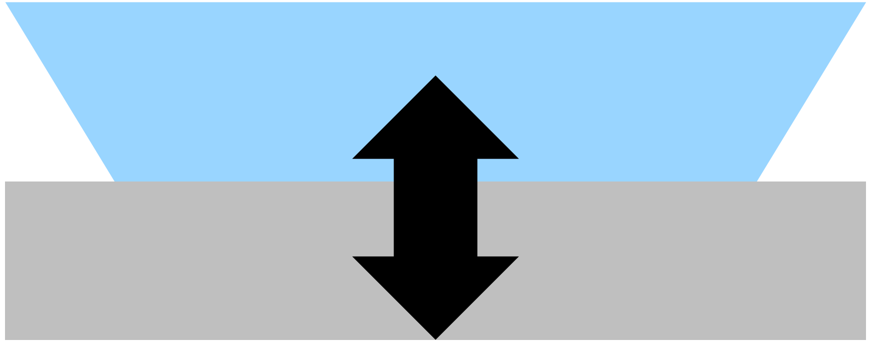
Instant spill



Physical weir model (width/height xy-curve)



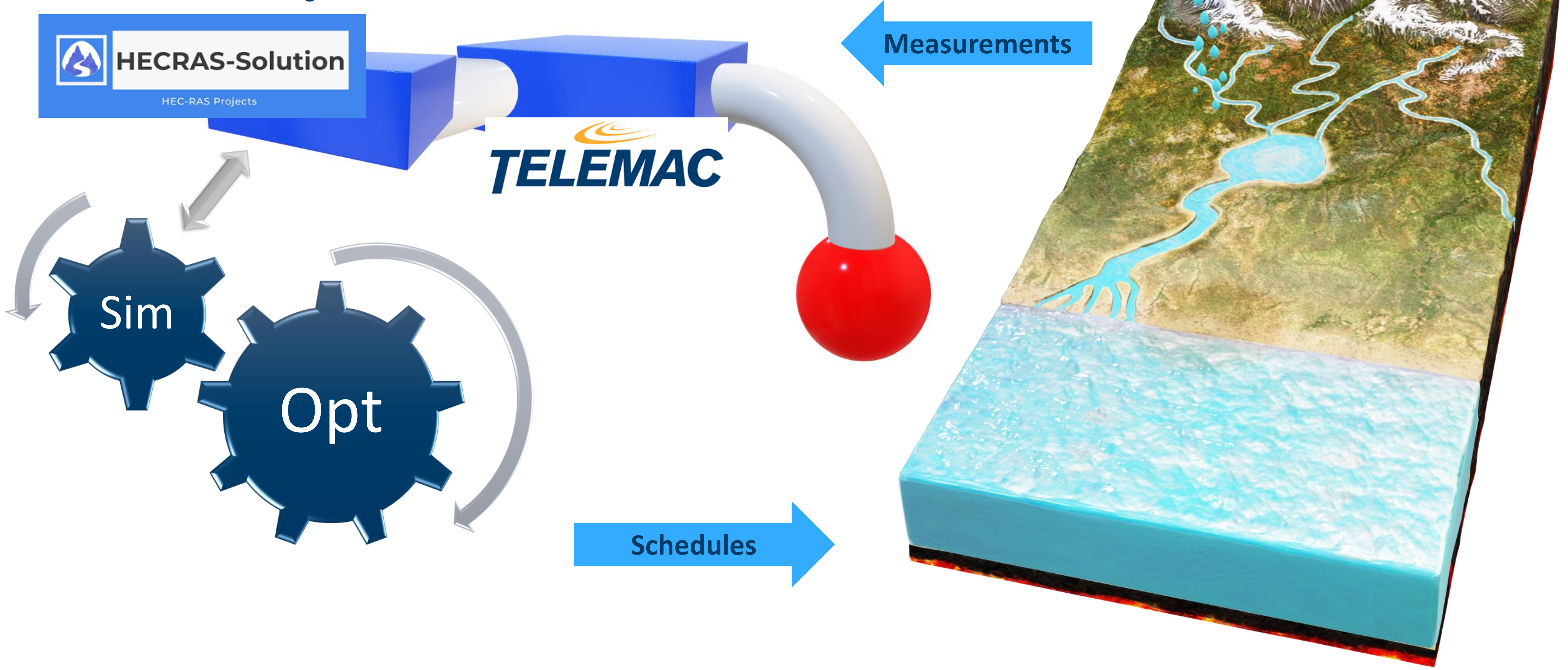
Gate optimization in rivers



- Assumes water flows freely above the gate
- If water flows under the gate, a tunnel object should be used
- Optimizes physical position of the gate
- A time-dependent adjustment cost can be used to get realistic gate schedules
- Initial gate opening makes the connection to the current system state
- Flow function can be given as an XY-curve, or a geometric description of the cross-section

$$q = \sqrt{g \cdot \frac{\left(A(h) - A_g(h_g)\right)^3}{W(h)}}$$

Data-driven modelling and digital twins coupled to optimization



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