Advancing Sustainability of Process Industries through Digital and Circular Water Use Innovations

AquaSPICE Final Conference

CS#3: Antwerp case

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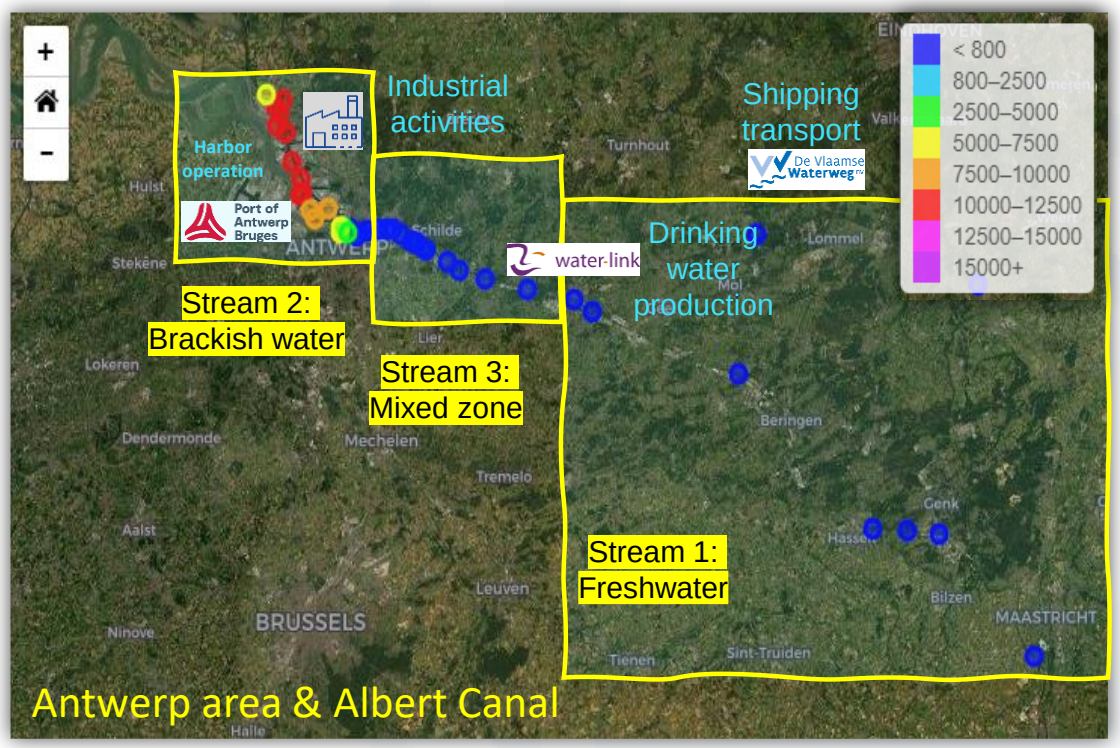
12/12/2024

The AquaSPICE project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958396.

Case Study 3 – Antwerp area

- Background

- Leading oil and chemical cluster in EU
- Complex ecosystem: different water use goals
- Different water streams & water qualities
- Climate-change: salinity, drought, flooding…
- ↘Freshwater resources, ↗increased use



SMART strategies & side wide approach for an efficient management of the water resources

Case Study 3 – Antwerp area

- Overview & Goals

Integrated approach

Strategy

Process innovation + digital innovation

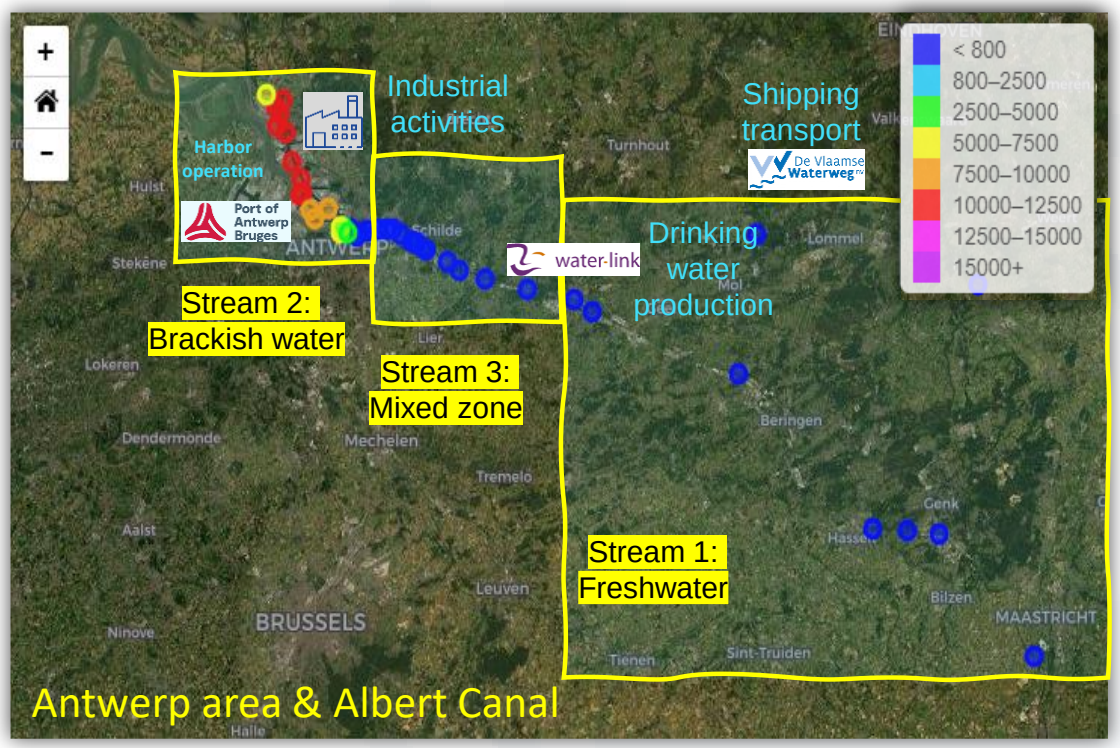
Methods & Tools

- Real time monitoring
- Modelling tools
- Pilot testing

Objectives

2 Application cases

1. Improve **water intake** management by stakeholders
2. Optimize **water sources** for industry



Stakeholders:

- Water-link → drinking water company
- Vlaamse Waterweg → activities on the Albert Canal
- Port of Antwerp/Bruges → activities on the Antwerp harbor
- Industries → industrial activities

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1 Application case 1: Water intake management

water-link vito

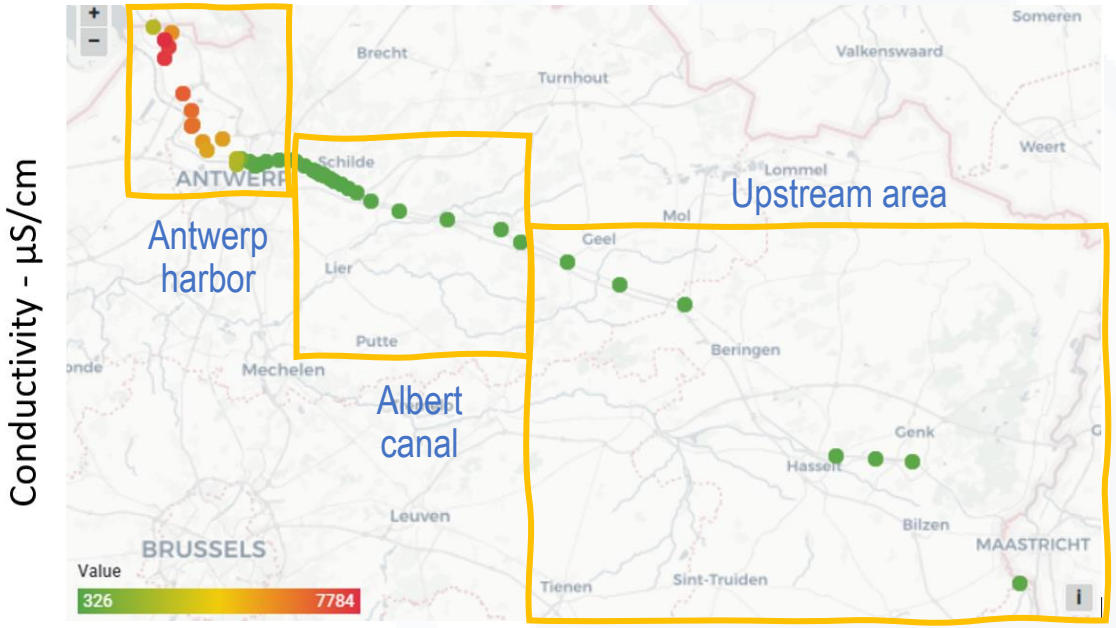
❖ Monitoring network

- 45 CTD online sensors (cond, temp & depth)
- Ad-hoc QA/QC maintenance procedures
- Performance within defined KPIs
- IoT infrastructure (LoRA)
- Data cloud platform & tailored dashboards
- Connection to AquaSPICE RTM & DataQA

Maintenance

Preventive	Corrective
•Biofilm registration •Deviation from references •Required maintenance frequency	•Infrastructure damages •Presence of biofilm

Real time monitoring network: area >120km



Operational since Summer 2021

Real time monitoring network

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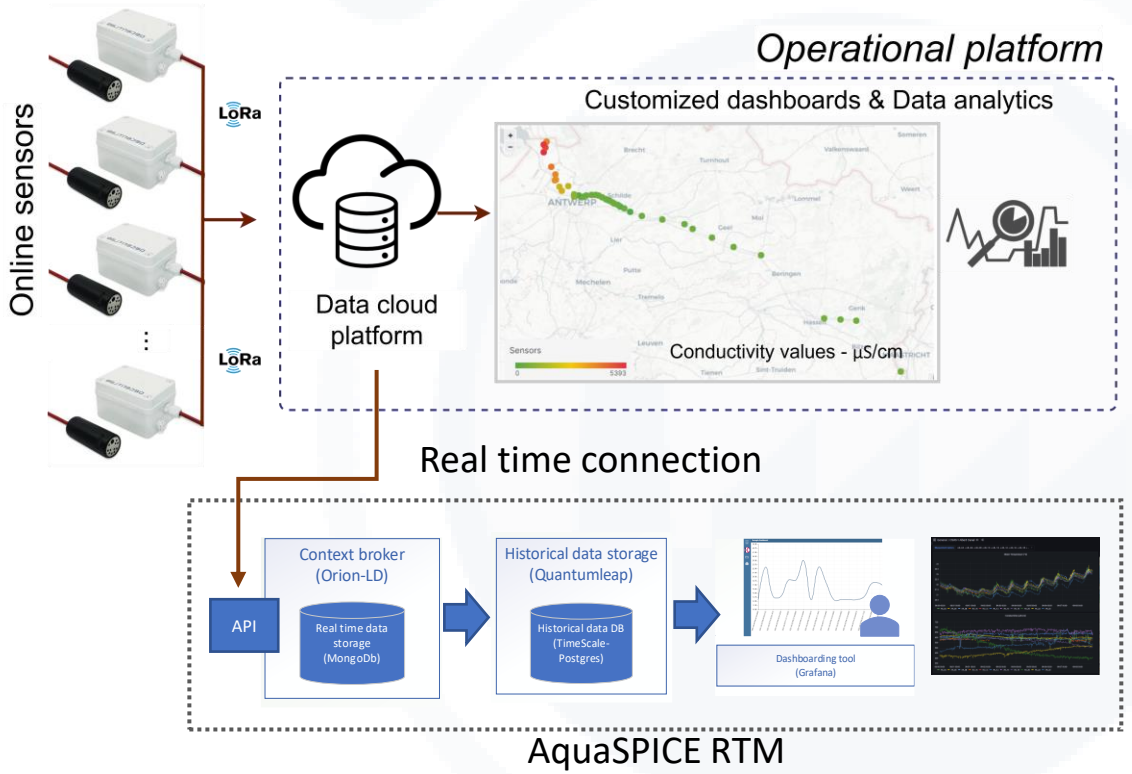

Real time monitoring network

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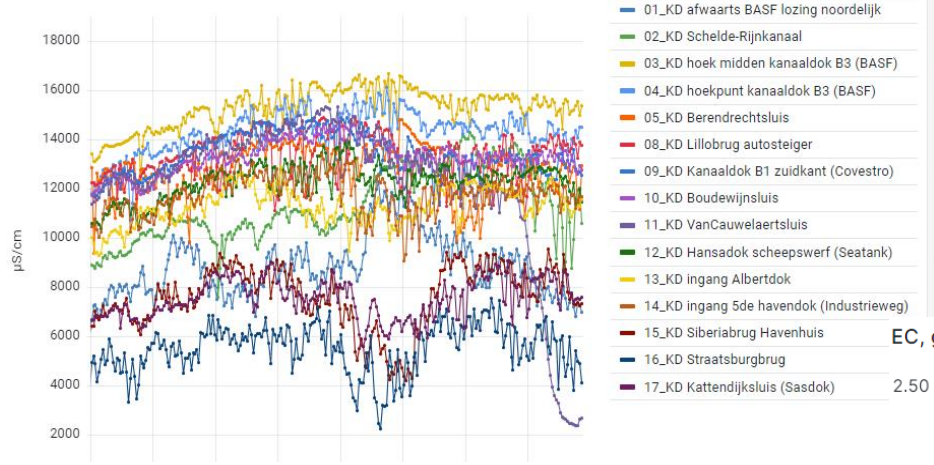
1 Application case 1: Water intake management

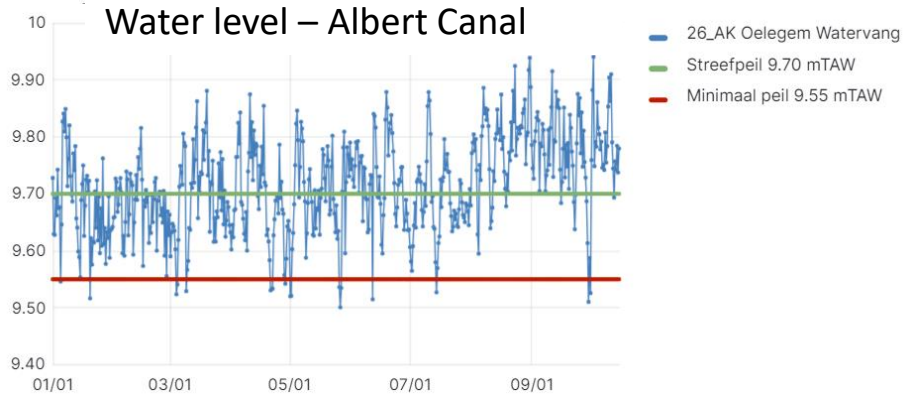
❖ Monitoring network

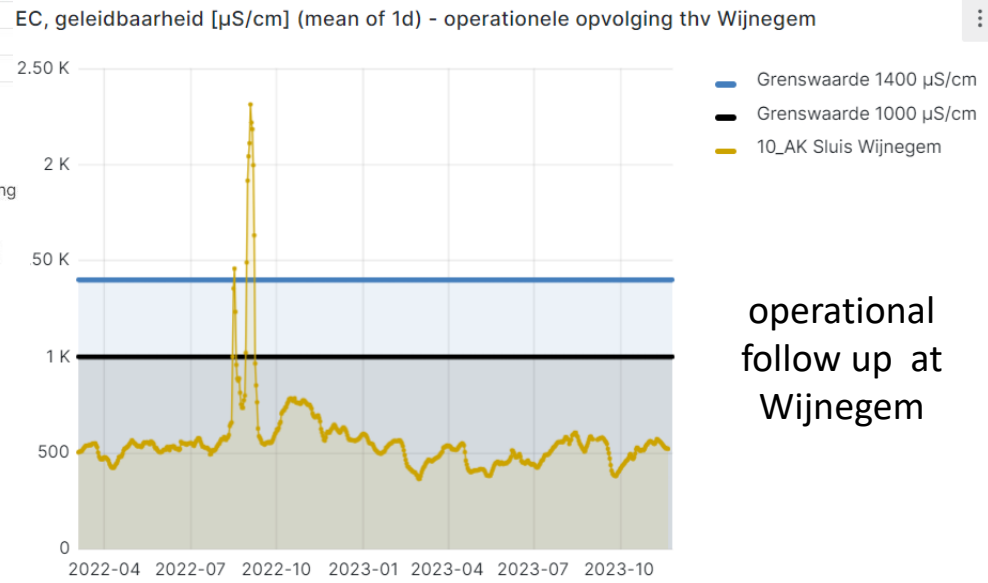
- Improve understanding
- Follow-up:
  - ✓water quality
  - ✓Salinity
  - ✓Patterns
  - ✓Climate change events

Customized dashboards

- Recent values
- Time series graphs, maps color
- Aggregated volumes







operational follow up at Wijnegem

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1 Application case 1: Water intake management

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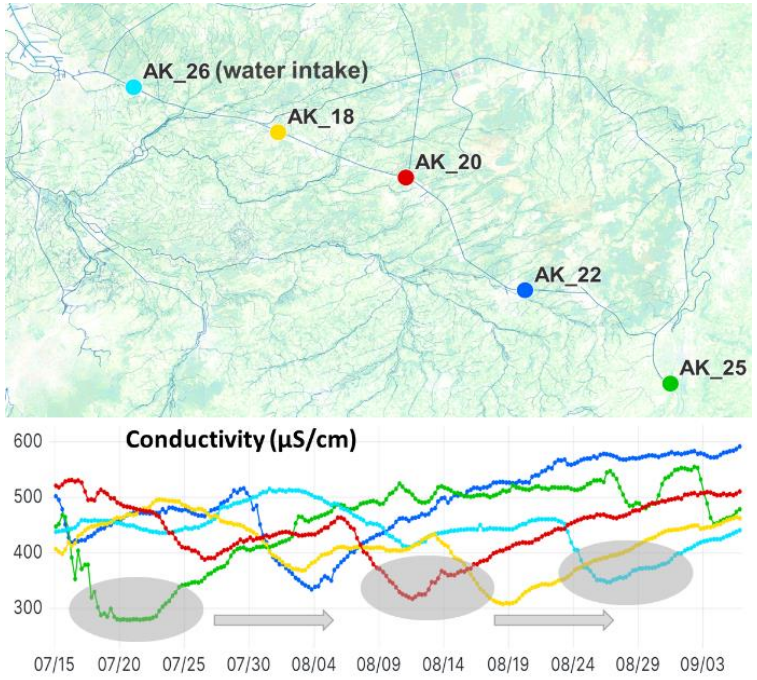
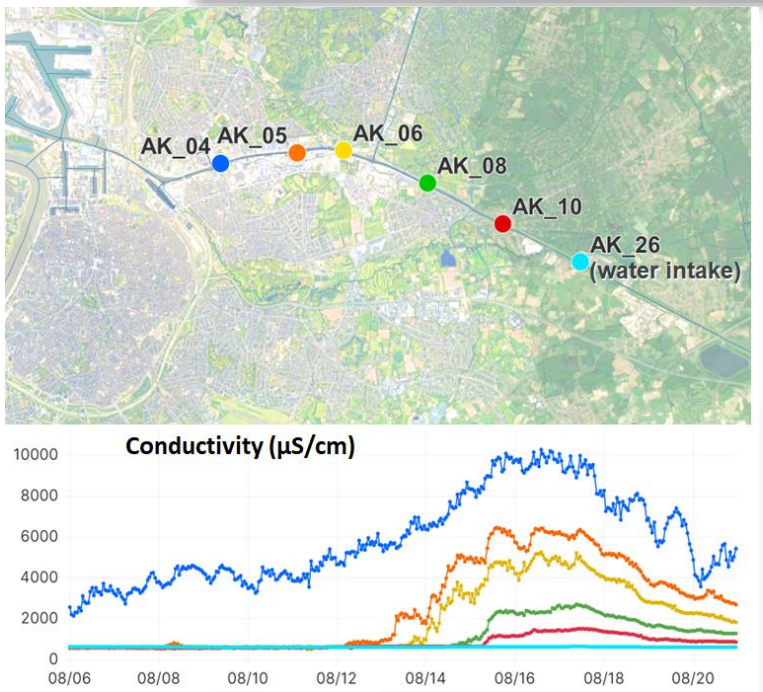


Monitoring flood event (Summer 2021)



Monitoring salinity intrusion (Summer 2022)

What started as a POC is now a daily operational tool

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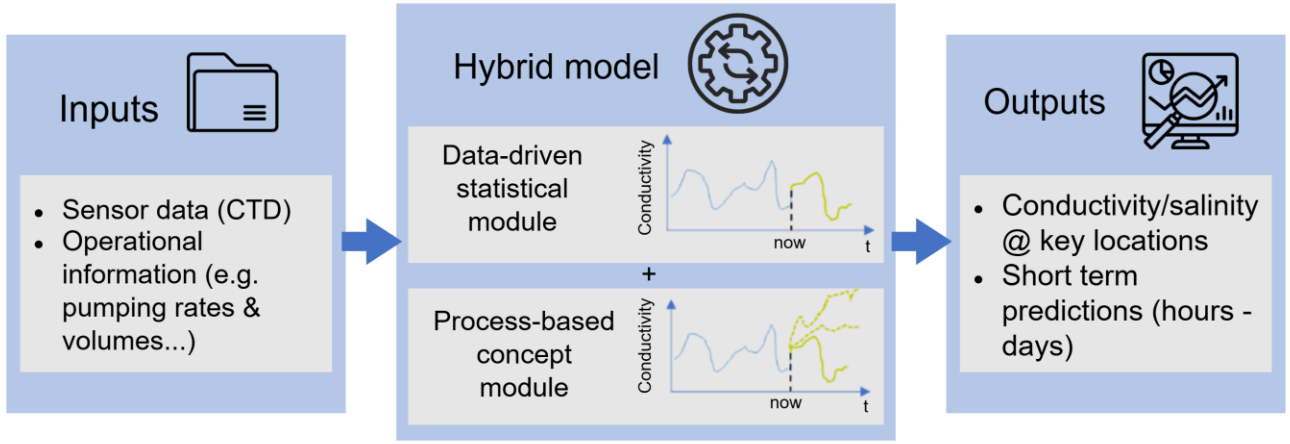
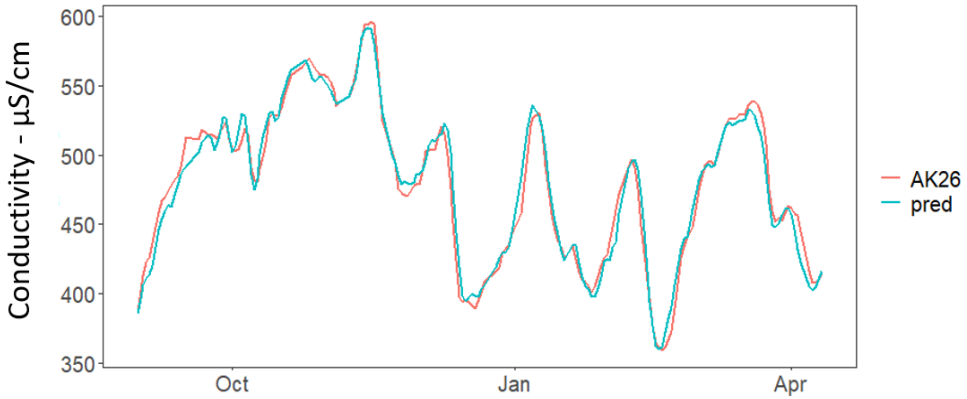
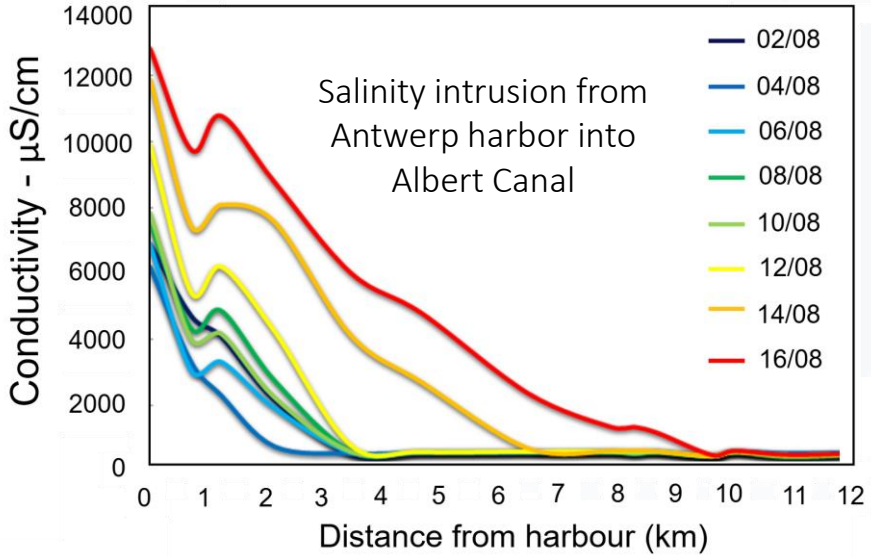
1 Application case 1: Water intake management

❖ Operational model

- Evaluate effect of operational actions
- Prediction of conductivity/salinity levels







Insights on water quality dynamics, support decision making & optimization (e.g. intake, pumping)

Key model outputs incorporated in RTM platform for scenario analysis

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1 Application case 1: Water intake management

❖ Stakeholder involvement

- Involvement of stakeholders since the beginning to define requirements and scope
- Important efforts towards ensuring the continuity after AquaSPICE

- ✓ **Contracts** between partners being drafted
- ✓ **Adding** new locations (Nete canal) for estimation of residence time in calamity events

De Vlaamse Waterweg nv — Operational Activities on the Albert Canal

Port of Antwerp Bruges — Operational Activities on the Antwerp harbor

Sensor network and operational model (service) will continue running after AquaSPICE

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2 Application case 2: cooling water & water reuse

1. Investigate potential reuse of wastewater streams & alternative water sources
2. Increase knowledge about water treatment cost-effective solutions

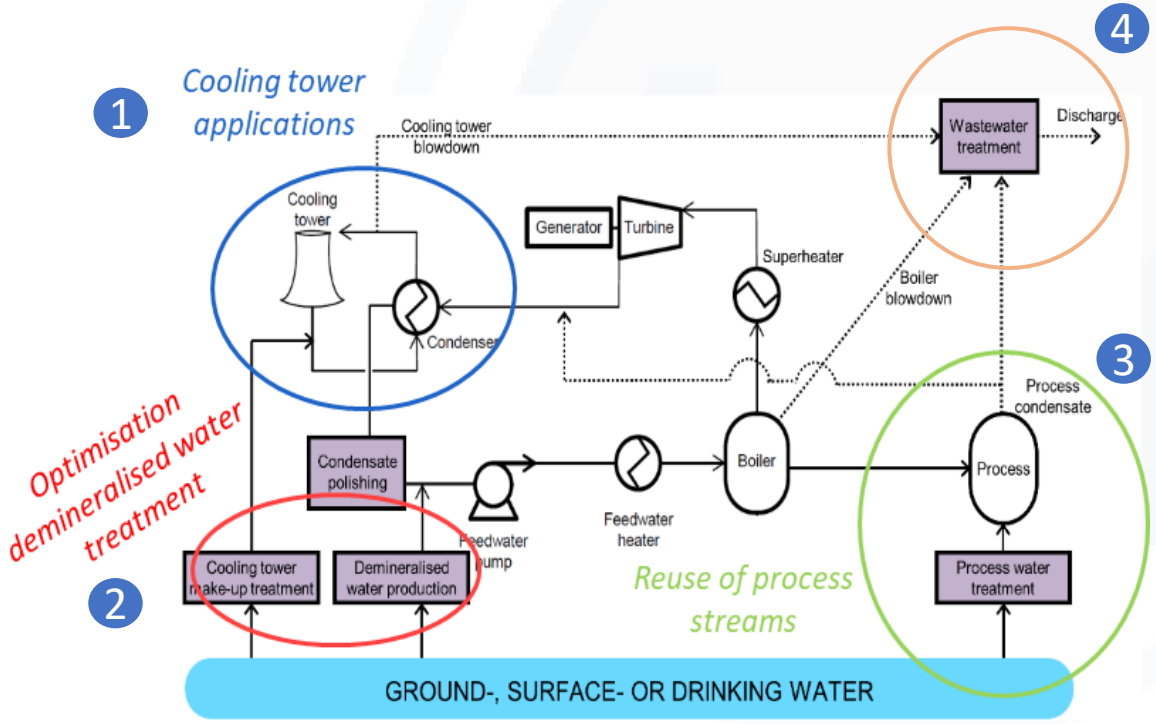
Water streams (BASF)

Cooling water — MERADES pilot

1 Cooling system → *Effect of enhanced recirculation*

Water reuse — IMPROVED pilot

2 Demin plant
3 Cracker site
4 Effluent WWTP → *Feasibility treatment technology*



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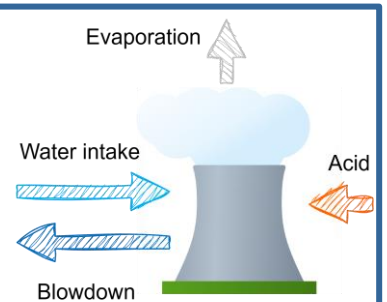
2 Application case 2: cooling water & water reuse

- MERADES pilot

1

- Effect enhanced recirculation
- Effects (scaling, fouling, corrosion)

Instrumented pilot

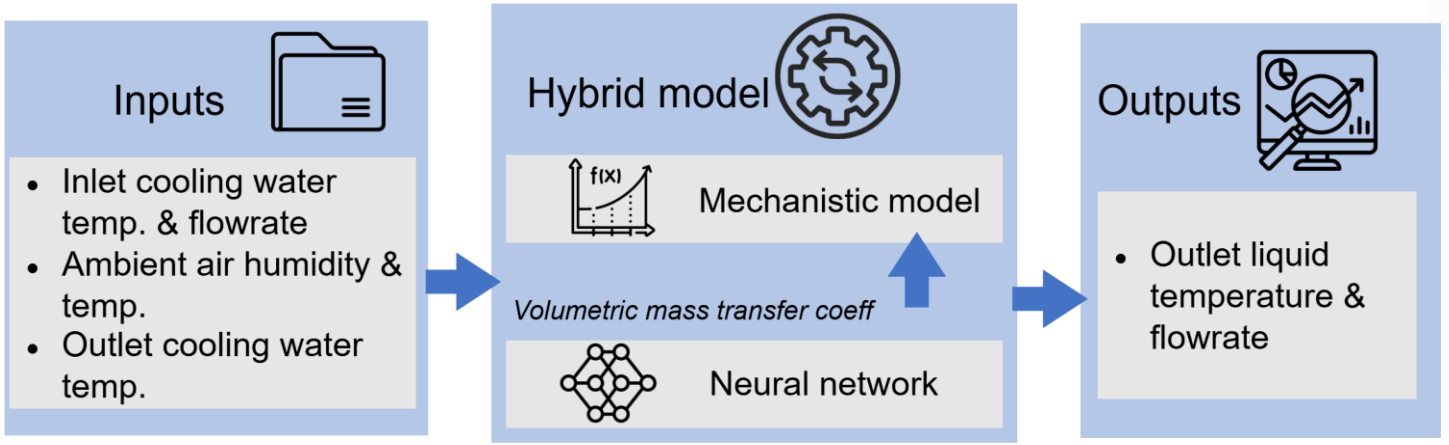


Cooling water

- ↘cooling water use by minimum **30%**
- Current installation: high investment
- New: ↗CoC by **1.3**, no chemicals

Cycle of Concentration (CoC) = intake flow/blowdown flow

- Model closed loop



Hybrid model for prediction of outlet conditions

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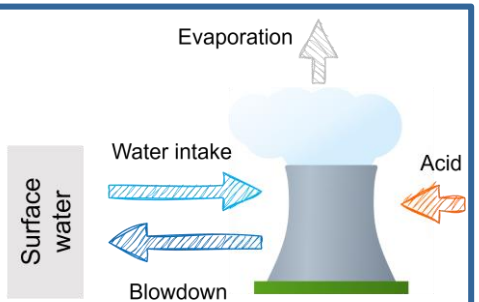
2 Application case 2: cooling water & water reuse

- MERADES pilot

1

- Effect enhanced recirculation
- Effects (scaling, fouling, corrosion)

Instrumented pilot



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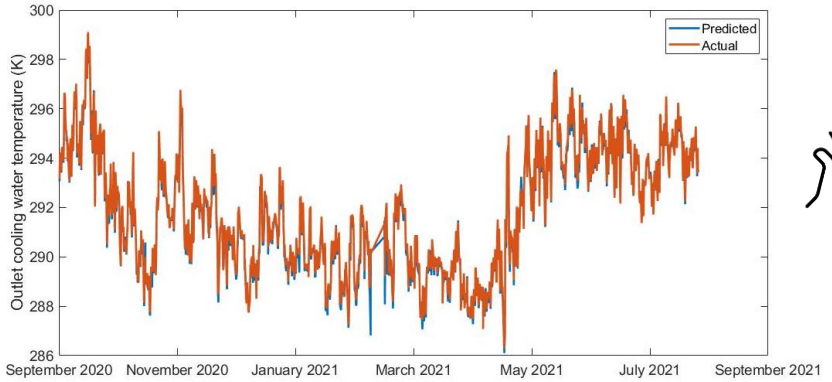

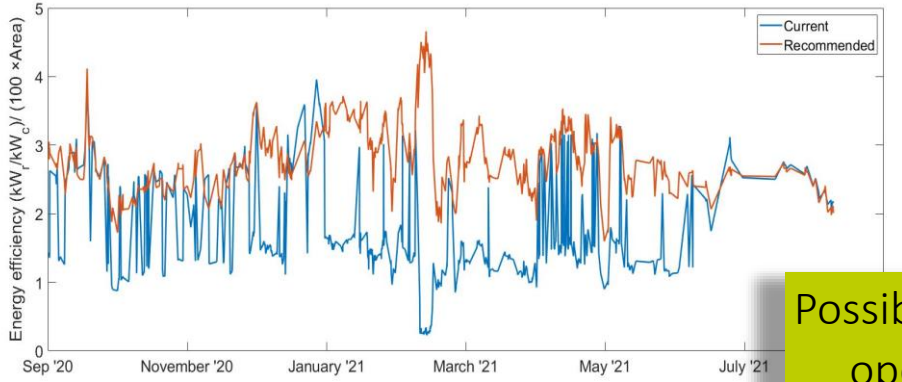

Possible tool to optimize fan operation to maximize energy efficiency

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2 Application case 2: cooling water & water reuse

- IMPROVED pilot

Water reuse

- Evaluation of treatment technologies (lab & on site)

Instrumented pilot

GHENT UNIVERSITY

High potential for reuse and effective technology

Full implementation
WaterCPS platform

	Location	Stream	Tested technology	Main results
2	New demin plant	Reuse RO concentrate	• RO, CCRO	≥ 80% recovery with CCRO 12% intake water savings, ↘ 12%NaCl in softener
3	Cracker site	Process condensate	• IEX-GAC-RO • RO-GAC • RO • 2RO-MB	TOC too high to reuse Biological treatment recommended
		Boiler blowdown	• EDI	EDI (Electrodeionization): 90% recovery & high-quality water, reuse as boiler feed water
		NTBA-tank	• CCRO • UF+CCRO • CCRO+EDI	Boiler feed water production (CCRO+EDI) →low energy consumption
4	WWTP	Effluent	• RO • CCRO	UF+CCRO stable operation → reuse as process water & boiler feed water production.

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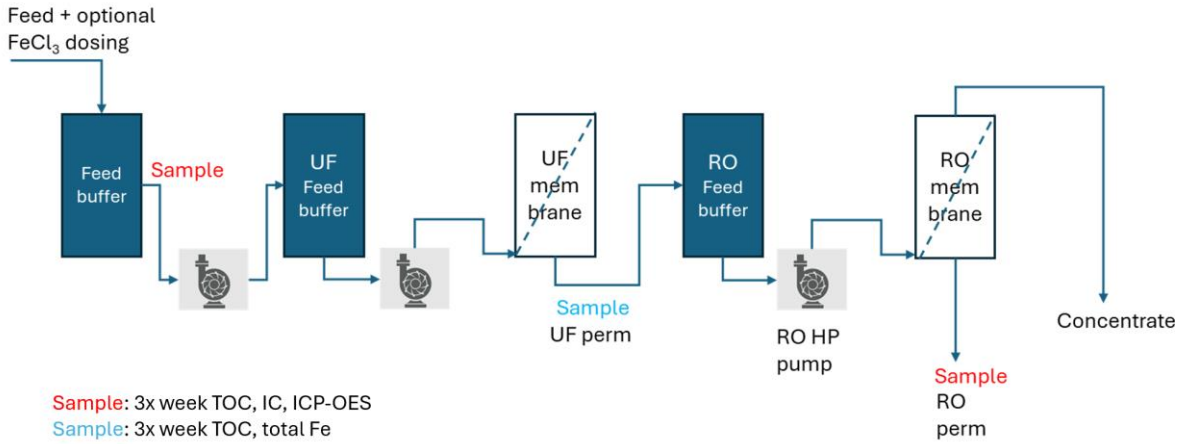
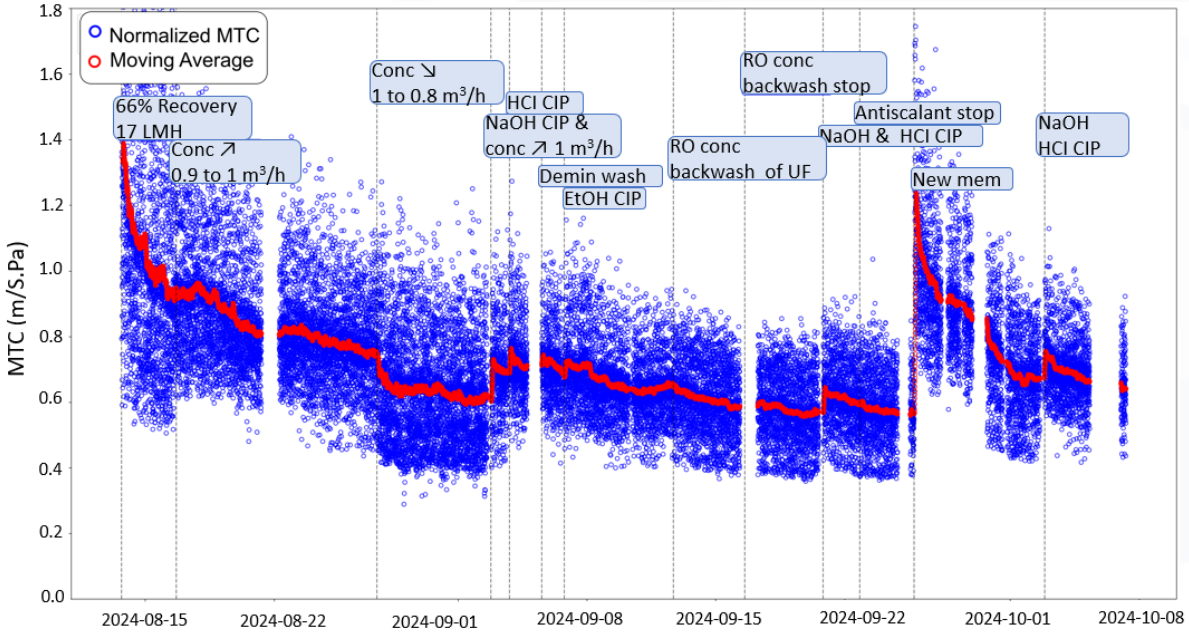
2 Application case 2: cooling water & water reuse

- IMPROVED pilot
  - BASF WWTP effluent

1 Feasibility of reuse as process water



- UF-RO ≈ 2 weeks
- UF-CCRO > 5 weeks, more stable, no antiscalants)
- Persistent fouling on RO (membrane autopsy)



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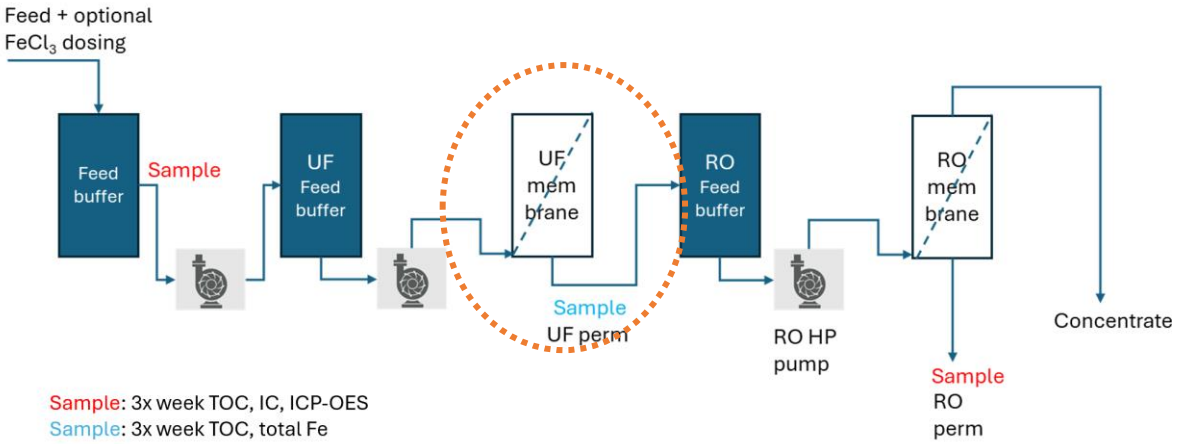
2 Application case 2: cooling water & water reuse

- IMPROVED pilot
  - BASF WWTP effluent

2 Full implementation of WaterCPS concept



Improve performance UF unit

WaterCPS

Applications

1. UF permeability performance
2. Determination of critical flux

Functionalities

- Online data to **RTM platform**
- Online connection to **WaterCPS services:** calculations, alarms, optimization loop)

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- Summary main achievements

Application case 1: Water intake management

- ✓ Real time monitoring network
- ✓ Customized dashboards for daily operation
- ✓ Insights on water quality dynamics
- ✓ Operational model to support decision making
- ✓ Key model outputs incorporated in RTM platform
- ✓ Ensuring continuity after AquaSPICE

Application case 2: Cooling water & water reuse

- ✓ Feasibility of water reduction in cooling towers
- ✓ Hybrid model for prediction of outlet conditions
- ✓ Possible tool to optimize fan operation
- ✓ Feasibility potential for water reuse & effective technology
- ✓ Full implementation WaterCPS concept

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- Add possible slide on dissemination

Take home message

- The adopted water-smart strategies highlight the potential of data and data-based tools to support decision making at several levels
- Pilot testing supports decision making regarding the feasibility of reducing water consumption & reuse industrial water streams
- The sensor network is providing crucial real-time insights on the status of the water system and main drivers for salinization
- Models are powerful tools to assess operational scenarios for water management, reducing water consumption and improve process efficiency

AquaSPICE

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Thank you

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CS#3 team

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