Digital Water City

In situ measurement system of faecal indicator bacteria

Machine learning based Early Warning System for bathing water quality

Mobile application to communicate bathing water quality with citizens

digital-water.city
digitalwater_eu

digital-water.city has received funding from the European Union's H2020 Research and Innovation Programme under Grant Agreement No. 820954.

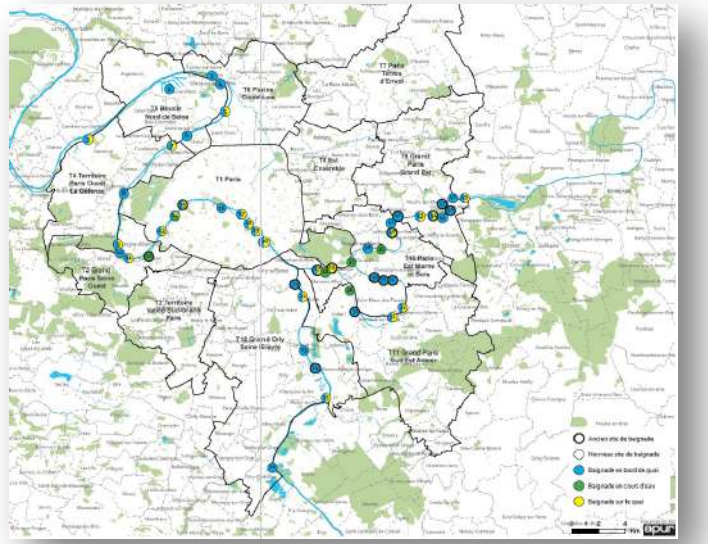
Digital Water City – Paris area

Early Warning System

Prediction tool + **Mobile Applications**

Olympic and Paralympic games of 2024

Legacy : Safe and sustainable urban river bathing



Developments axis

- Modelling of the bathing water quality (PhD P. Dupain)
- Prediction tool of the bathing water quality
- Sociological issues linked to the dissemination of the water quality
- Measurement system (ALERT) of Fecal Indicator Bacteria (E. coli and intestinal enterococci)

The deliverables

Measurement tool ALERT

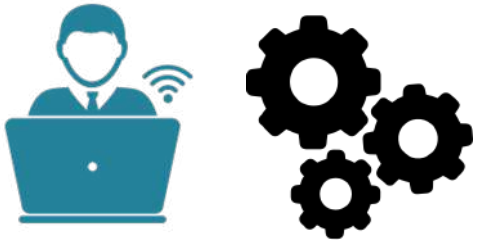
fluidion
fluidic intelligence

Prediction tool

SIAAP
Service public de l'assainissement francilien

SORBONNE UNIVERSITÉ

KOMPETENZZENTRUM Wasser Berlin



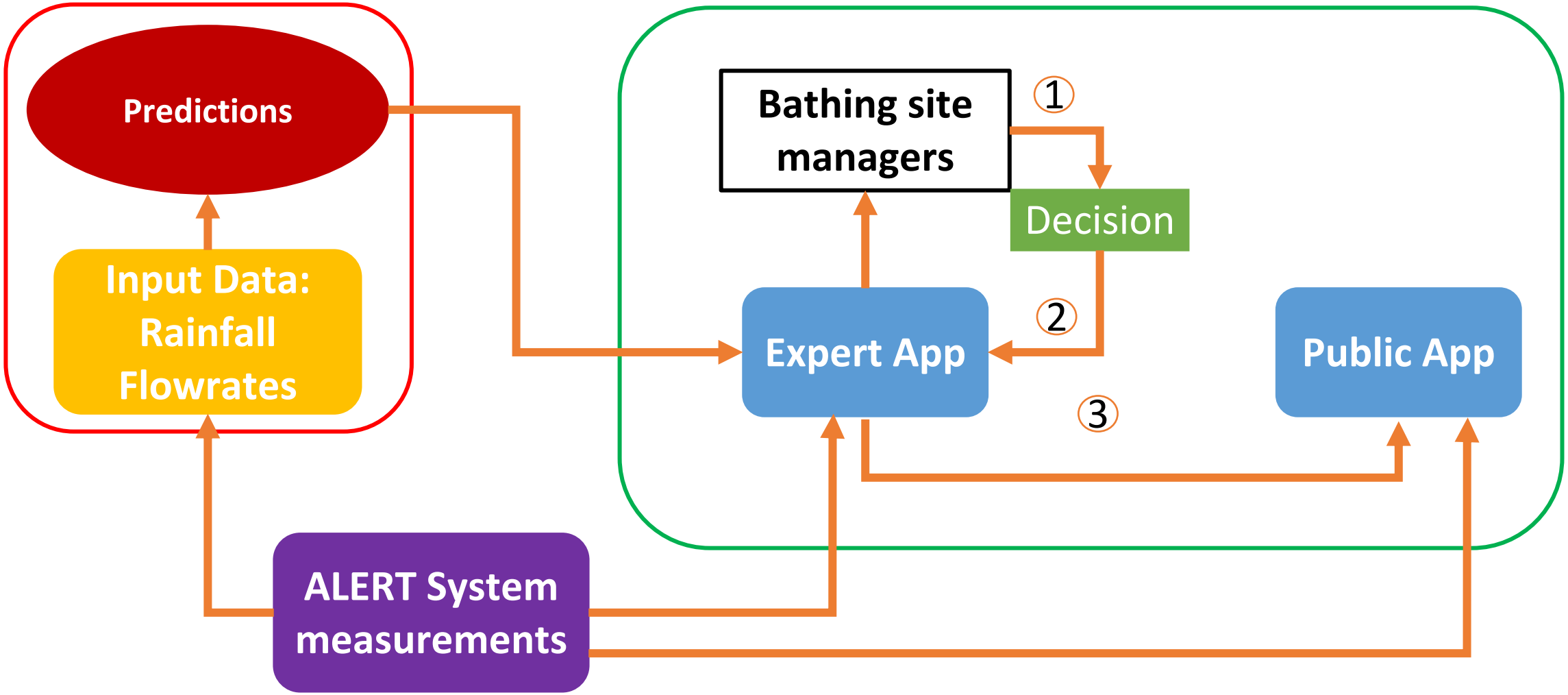
« Expert » App « Public » App

SIAAP
Service public de l'assainissement francilien

Via un prestataire

Mockup: Technologiestiftung Berlin

Daily functioning of the Early Warning System

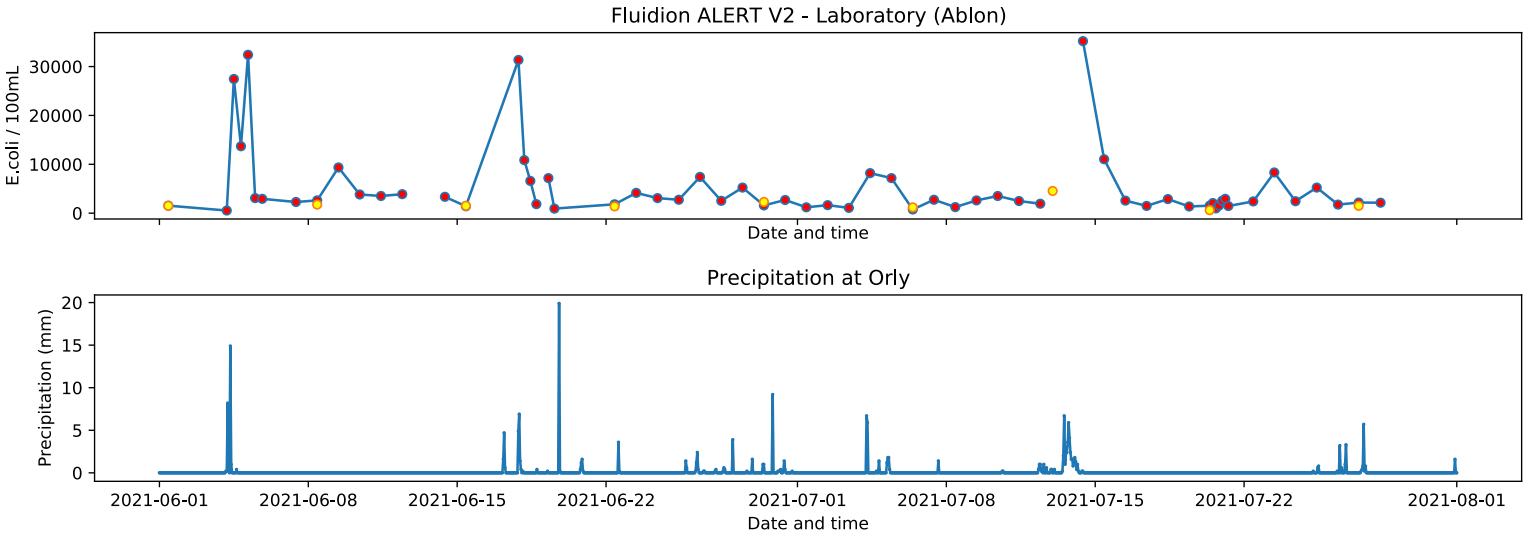


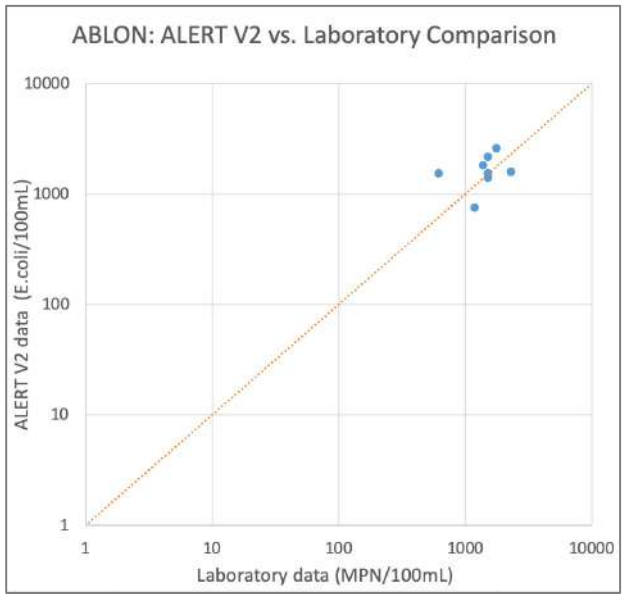
Fluidion ALERT V2 technology

- Accurate **E.coli** measurements, **in-situ**
- Fully autonomous, provides automated alerts
- Battery operation and worldwide wireless communication
- Powerful data repository and analytics platform
- Can combine with other external senso

  - Conductivity
  - Turbidity
  - pH
  - Dissolved Oxygen
  - fDOM
  - Chlorophyll
  - Phycocyanin
  - Nitrate
  - Total Ammonia

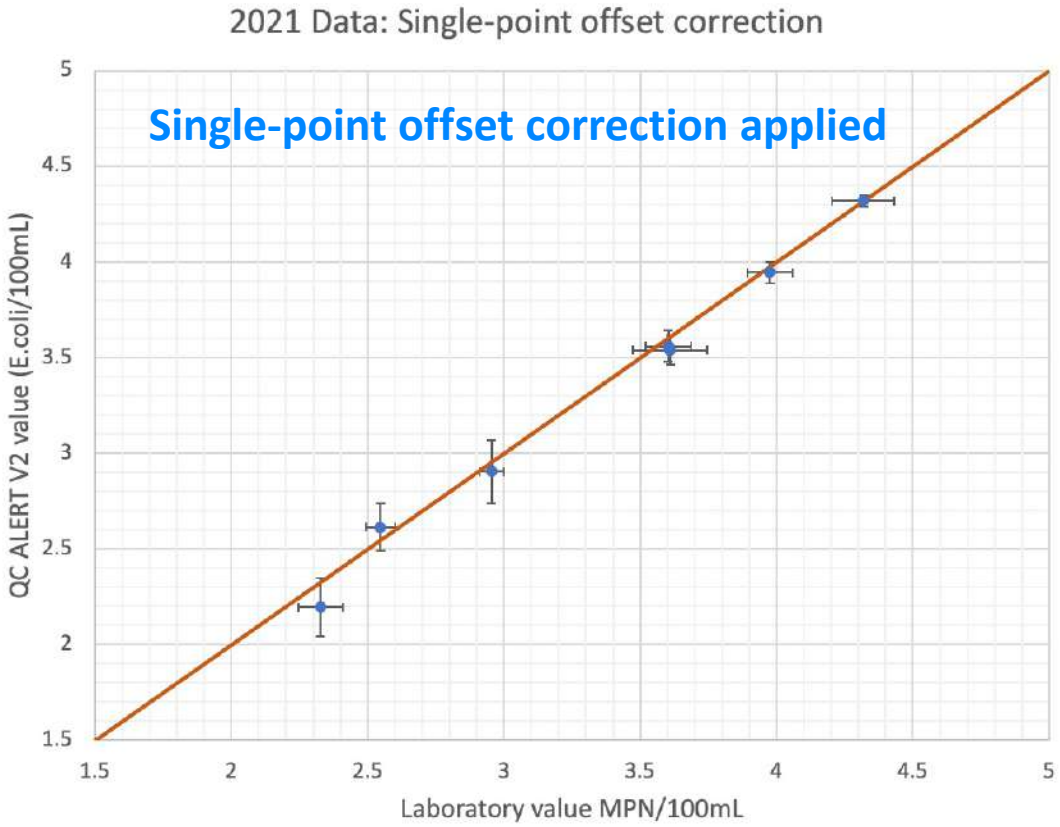
ALERT V2 - Paris operational installation



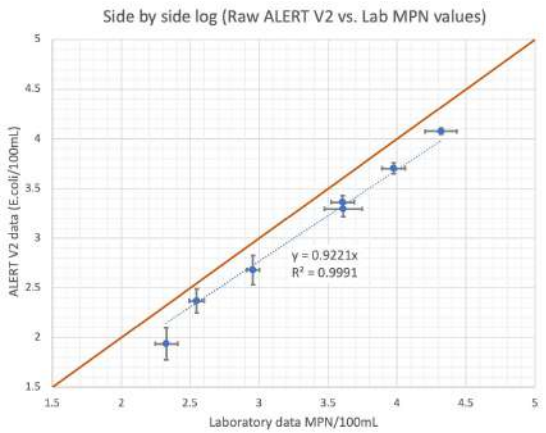


- ✓ Side-by-side analysis
- ✓ Observe wet and dry weather pollution
- ✓ High-frequency in-situ data
- ✓ Monitor CSO pollution
- ✓ Measure clean-up times

ALERT V2 – Berlin repeatability study



Alert V2 (2021 Berlin study)

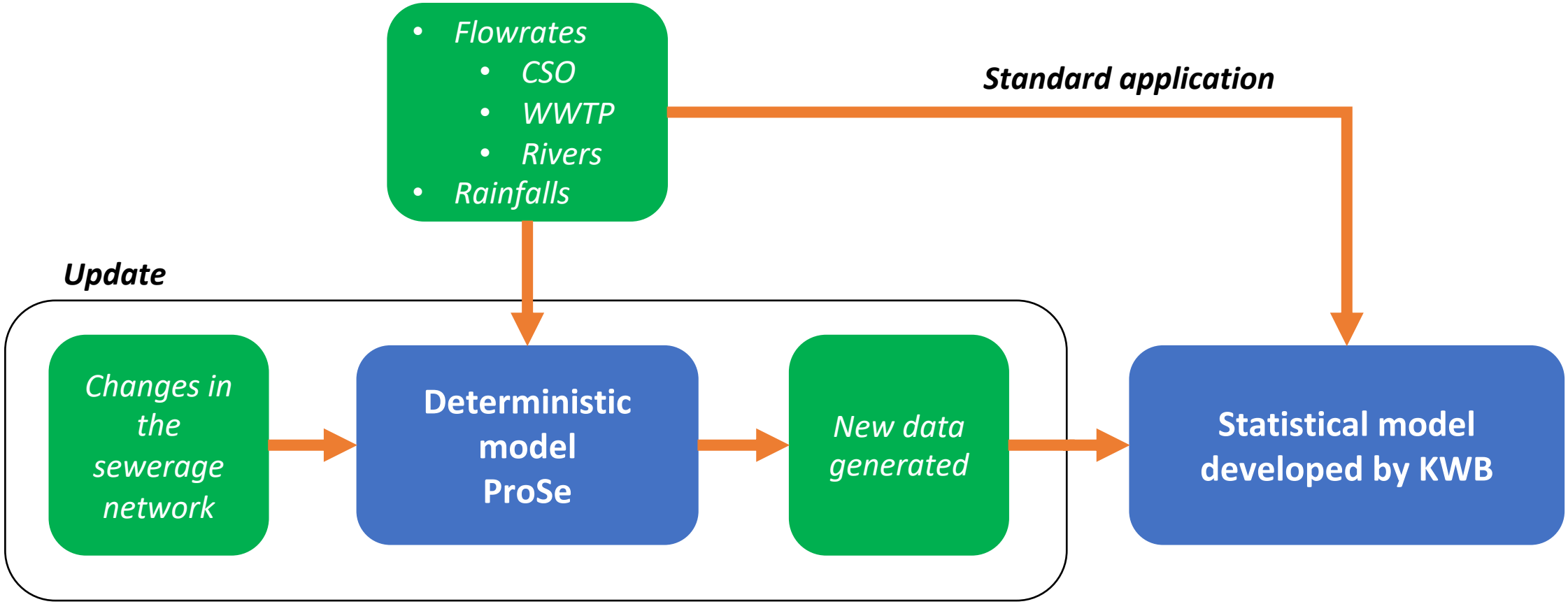


Achievements:

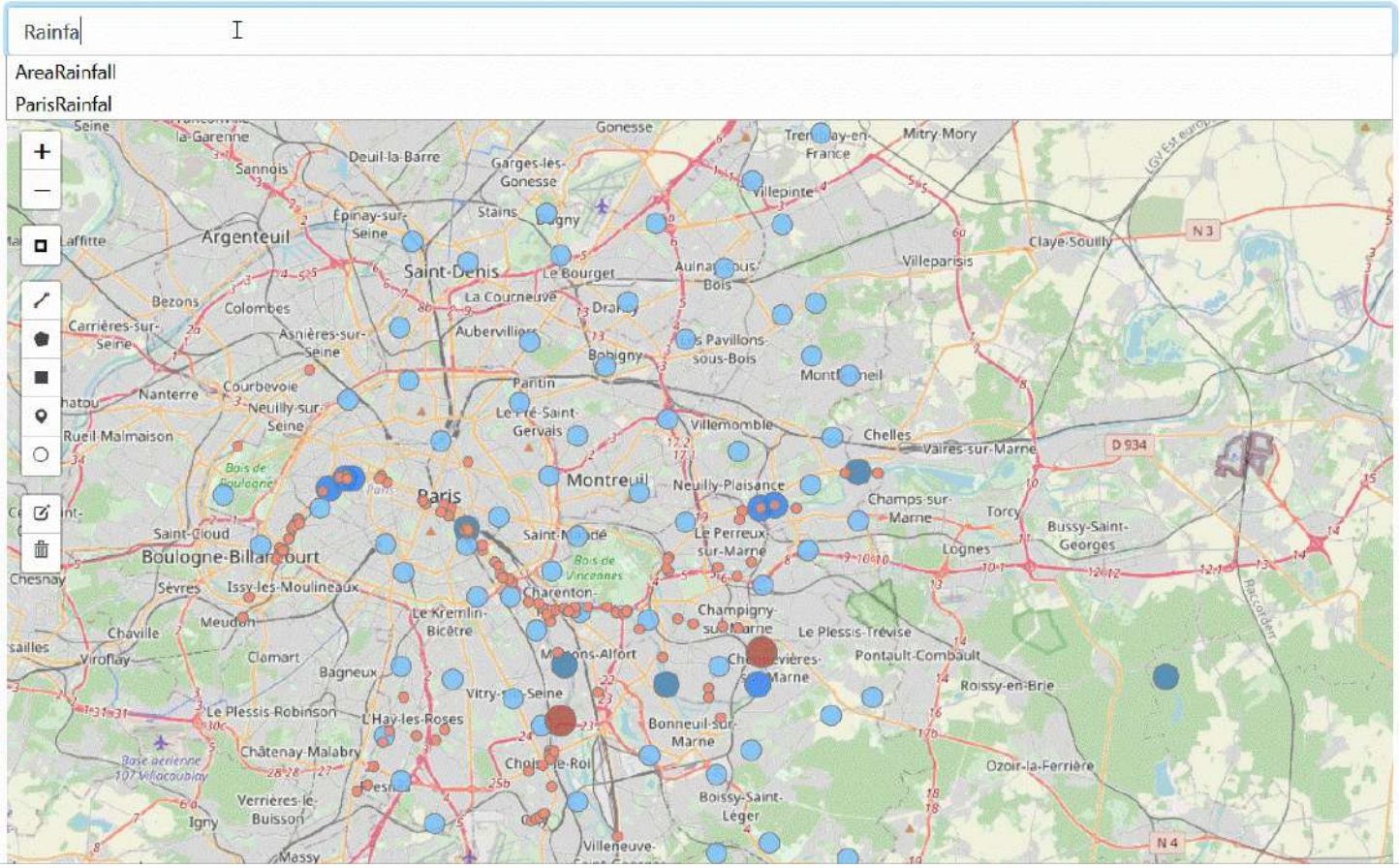
- ✓ 7 dilutions + blank
- ✓ 53 ALERT V2 measurements
- ✓ 56 side-by-side measurements
- ✓ No operational issues
- ✓ Excellent linearity, R^2=0.9991
- ✓ Excellent repeatability:

0.15 $\log_{10}$ (V2) vs 0.08 $\log_{10}$ (Lab) @ 200 MPN/100mL
0.08 $\log_{10}$ (V2) vs 0.13 $\log_{10}$ (Lab) @ 4000 MPN/100mL
0.03 $\log_{10}$ (V2) vs 0.11 $\log_{10}$ (Lab) @ 20000 MPN/100mL

Prediction tool

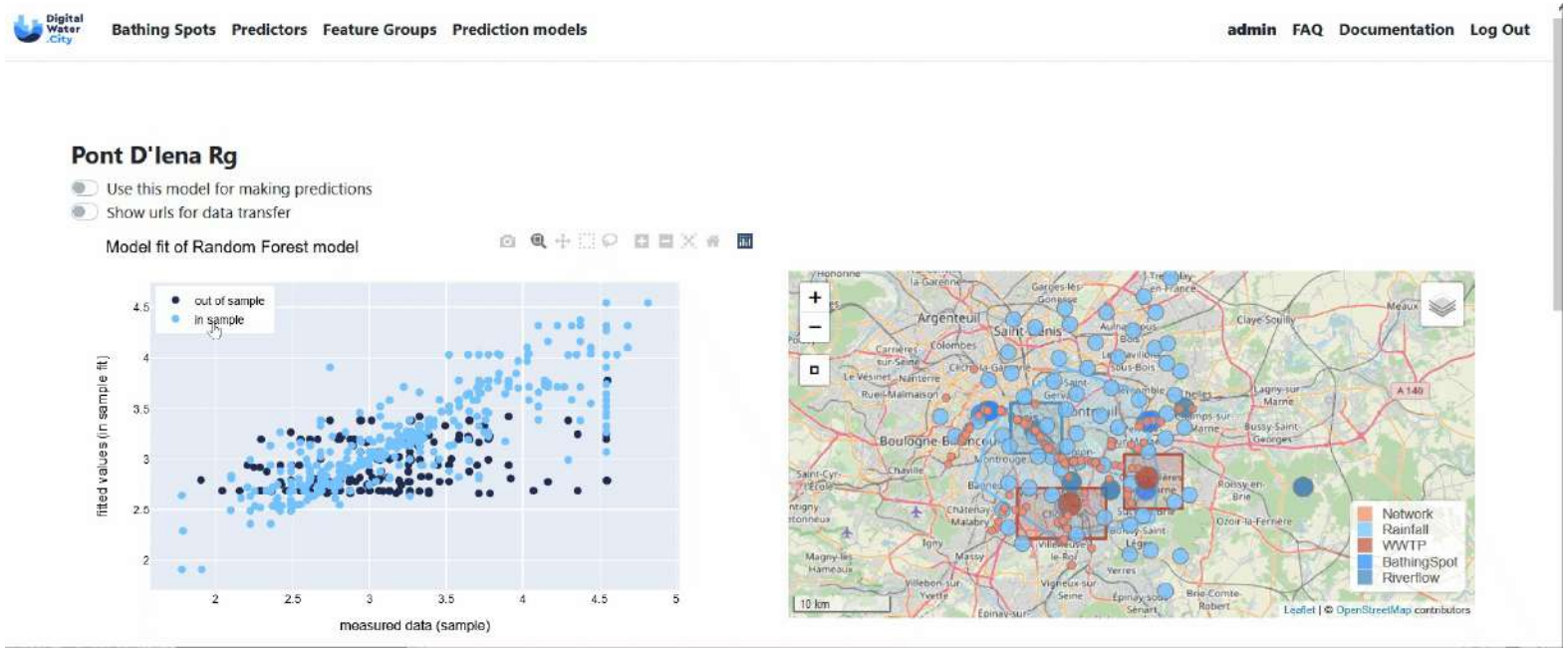


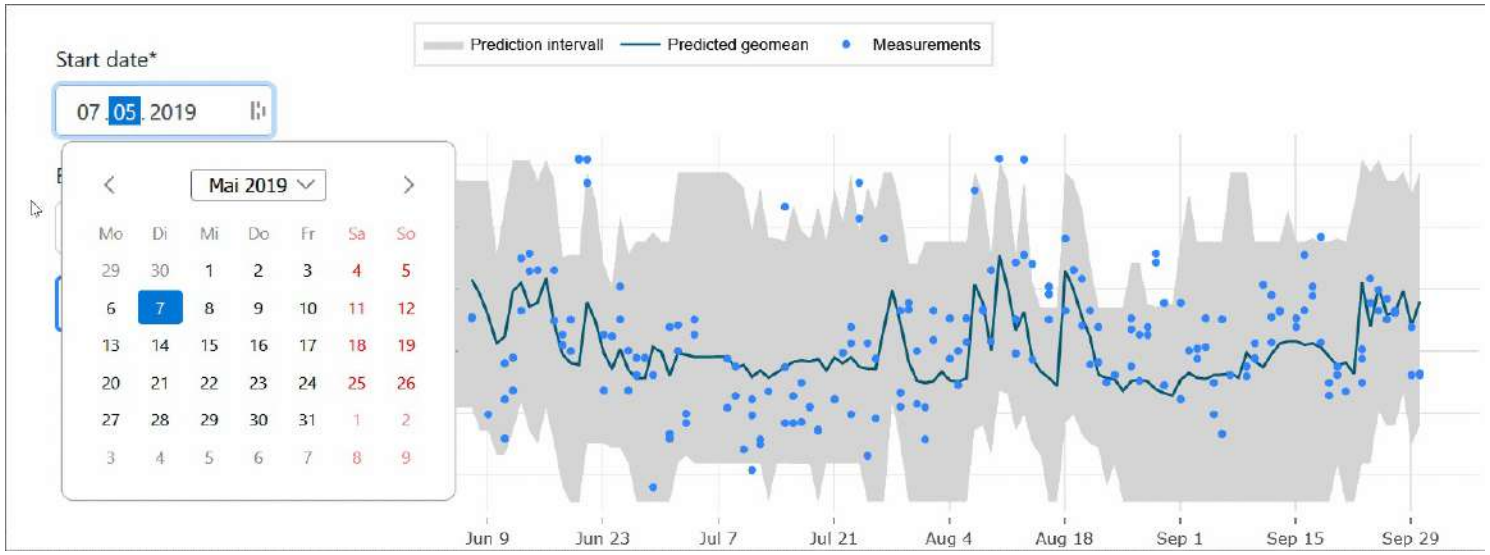
Prediction tool for ML-based EWS



- **Graphical User Interface (GUI)**
- **Content Management System (CMS)**
- Creation of **spatial variables** by an **interactive map**
- **Calibration** and **interactive analysis of state-of-the art ML** and **probabilistic forecasting models**
- **FIWARE Orion Context Broker**

Interactive model analysis





<u>Predictions models constructed for Pont d'Iéna</u>

- **Quantile Random Forest models**
  - Rainfall
  - WWTP
  - Riverflow
- Further **reduction of time-step → improvment of predictions**
- For now, no « sufficiently good water quality » predictions
  - WWTP discharges
  - Wrong connections
  - …
- **Combination with ProSe**
- **Scheduling functionality**

The applications

Expert App **Public App**

Sociological studies

- Interviews
- Focus Groups
  - Diversifies groups
  - Content of public app
- Community of Practice
  - Members
    - Bathing site manager
    - French partners
  - Role
    - Content of the apps
    - Data needed

Apps development

Provider enrolled by SIAAP

Participation to COP and Focus Groups

Specifications

- Content
- Design
- Technical specificities

Development

- Mock-up
- Prototypes

Acknowledgement

digital-water.city is a research project supported by the European Commission under the Horizon 2020 Framework Programme

Grant Agreement No 820954

Duration: 01/06/19 - 30/11/22

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The use of satellite data for oil spill detection in inland waters

Dr. Ioannis Lioumbas
Katerina Christodoulou

EYAΘ Quality in life! THESSALONIKI WATER SUPPLY & SEWERAGE Co S.A.

aqua3S

Division of Strategic Planning,
Hydraulic works & Development
Department of Research and Development

aqua3S

aqua3S

Exposure of citizens to potential disasters has led to vulnerable societies that require risk reduction measures. Drinking water is one of the main risk sources when its safety and security are not ensured.
aqua3S project steps in to combine novel technologies in water safety and security, aiming to standardize existing sensor technologies complemented by state-of-the-art detection mechanisms.

Area of Interest

Polyphytos Artificial lake

This reservoir is the artificial lake of Polyphytos which is the main source of drinking water for Thessaloniki and provides drinking water for +1M citizens

- Has an area greater that 70km^2
- Is related with a significant variety of anthropogenic actions
- Is located at a distance more than 120km from Thessaloniki Water Treatment Plant

Polyphytos Artificial lake ~70km^2

Description of the situation

Periodical presence of hydrocarbons in the inflow of Thessaloniki Water Treatment Plant

Difficulty to locate the exact source of pollution

Preliminary exploration of the Copernicus products

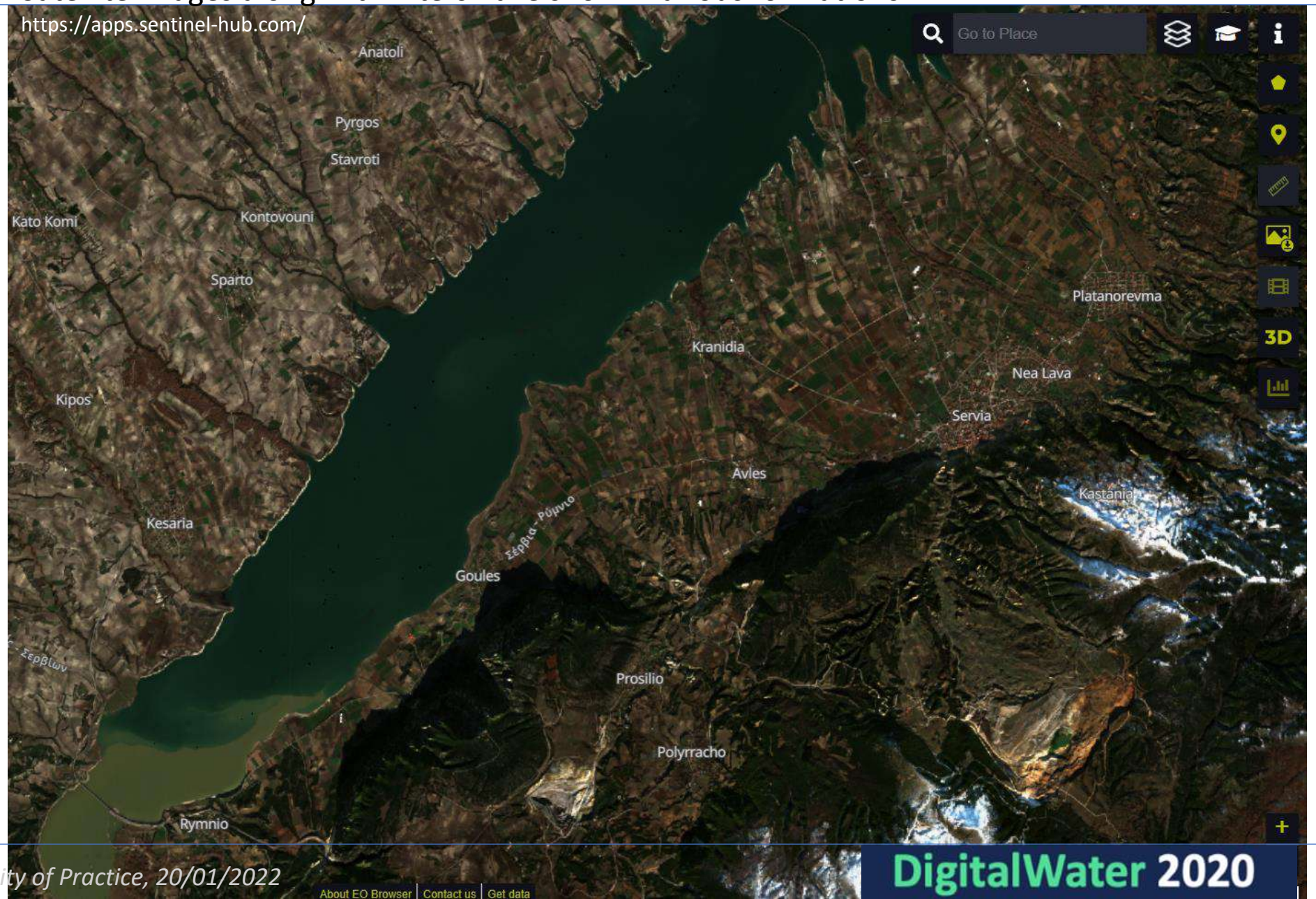
Satellite tools

Satellite images along with filters have shown various formations

Typical case:
2021-12-24

Image analysis:

<u>True color,</u>
Based on bands 4, 3, 2



Sentinel 2 bands

Band	Central wavelength (nm)	Bandwidth (nm)	Spatial resolution (m)
1	443	20	60
2	490	65	10
3	560	35	10
4	665	30	10
5	705	15	20
6	740	15	20
7	783	20	20
8	842	115	10
8a	865	20	20
9	945	20	60
10	1375	30	60
11	1610	90	20
12	2190	180	20

https://platform.pulchra-schools.eu/wp-content/uploads/2021/02/User-guide-for-the-Remote-Sensing-Tool.pdf

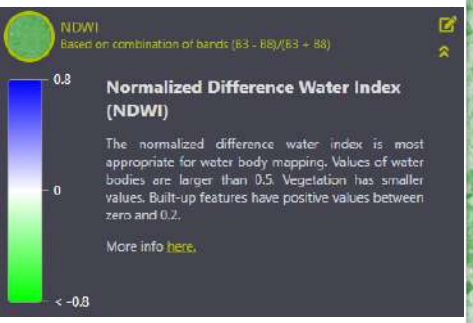
Satellite tools

Satellite images along with filters have shown various formations

Typical case:
2021-12-24

Image analysis:

NDWI



Satellite tools

Satellite images along with filters have shown various formations

Typical case:
2021-12-24

Image analysis:

B04/B08

Sentinel 2 bands

Band	Central wavelength (nm)	Bandwidth (nm)	Spatial resolution (m)
1	443	20	60
2	490	65	10
3	560	35	10
4	665	30	10
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Satellite tools

Satellite images along with filters have shown various formations

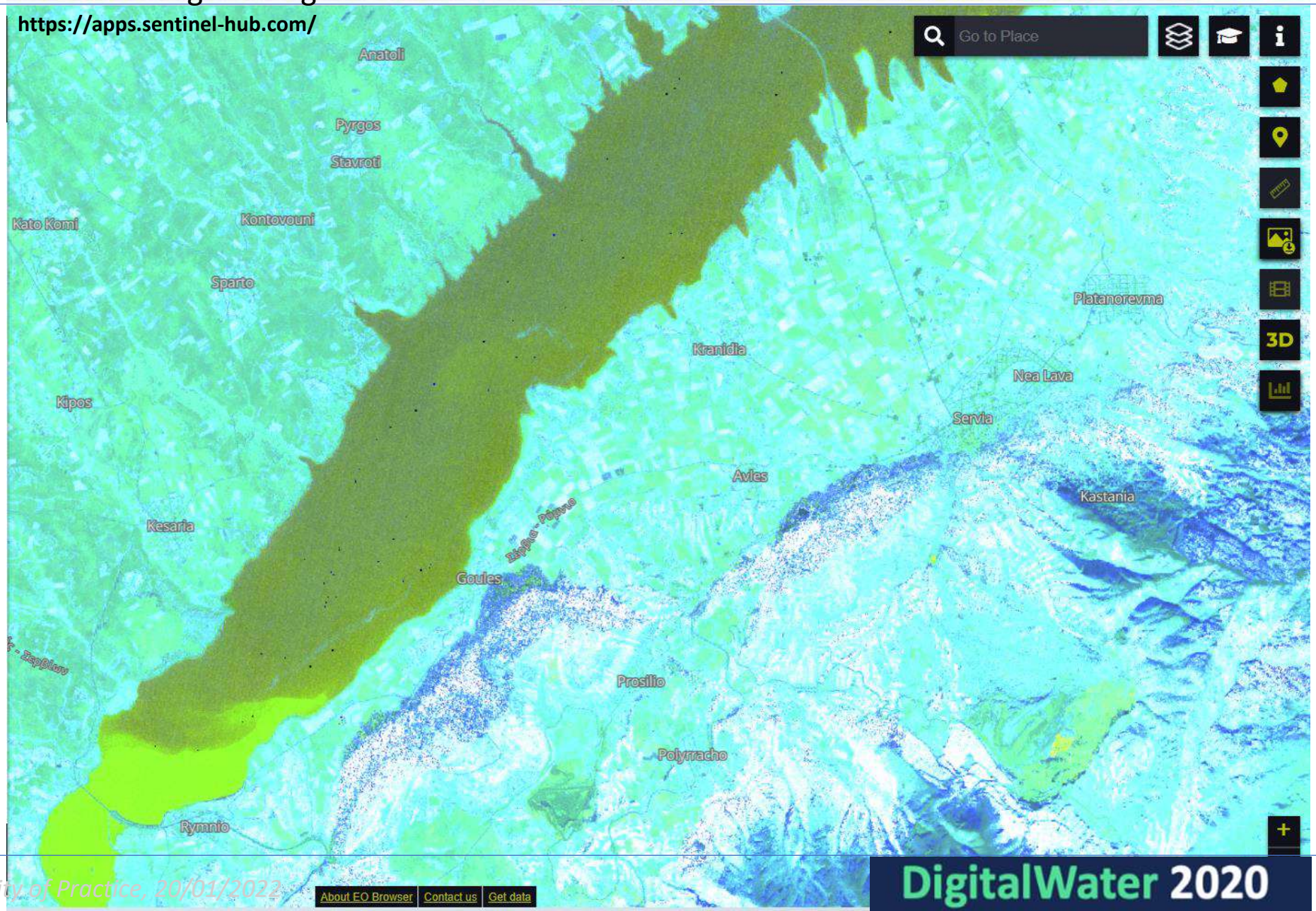
Typical case:
2021-12-24

Custom script:

<u>Oil Spill detection</u>

```
let R = (B03/B02)
let G = (B03+B04)/B02
let B = (B06+B07)/B05
return [R/3, G/3, B/3]
```

The OSI (Oil Spill Index) uses visible Sentinel-2 bands to display oil spills over water in the **<u>costal/marine</u>** environment.



Satellite tools

Satellite images along with filters have shown various formations

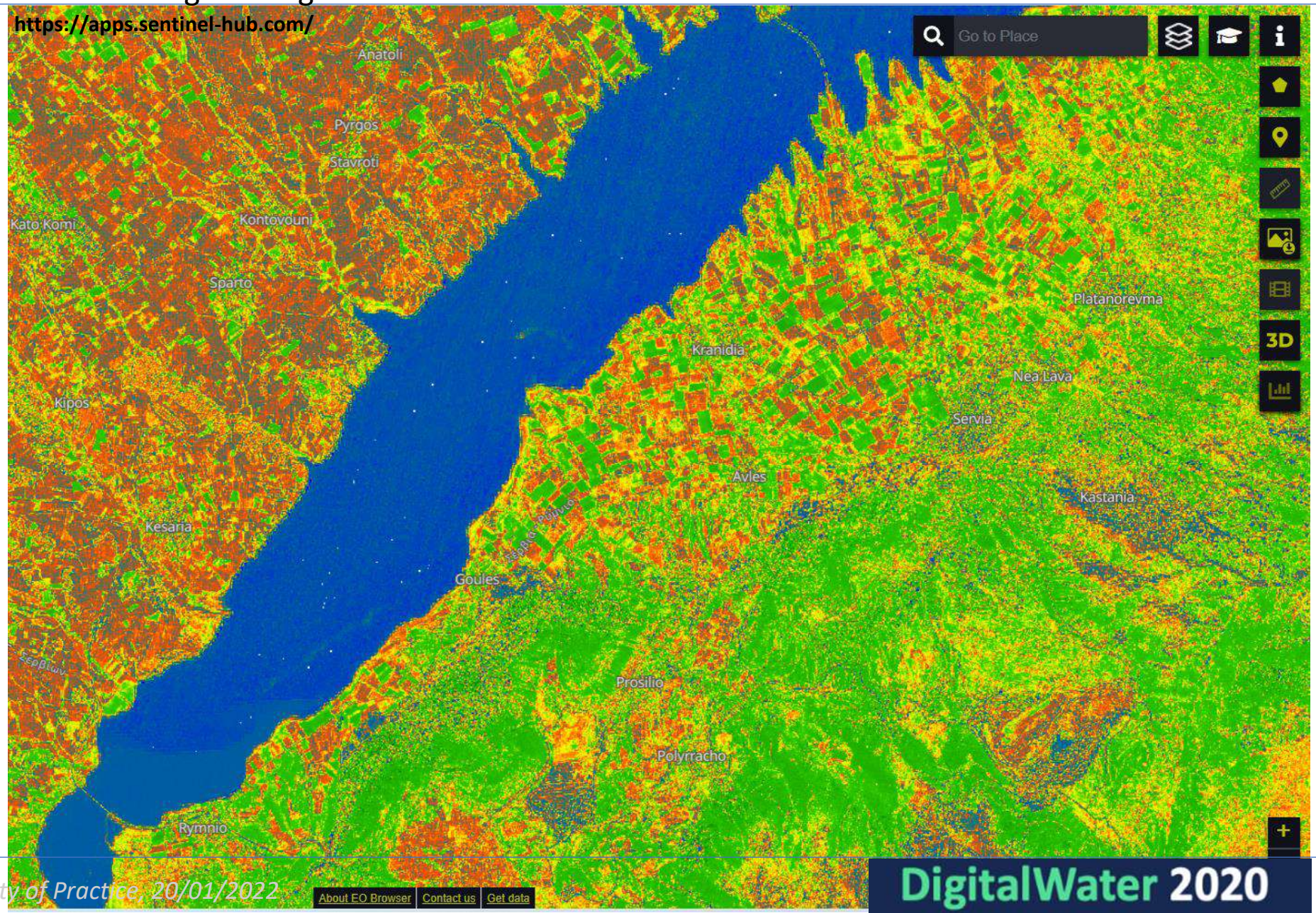
Typical case:
2021-12-24

Image analysis:

<u>Chlorophyl</u>

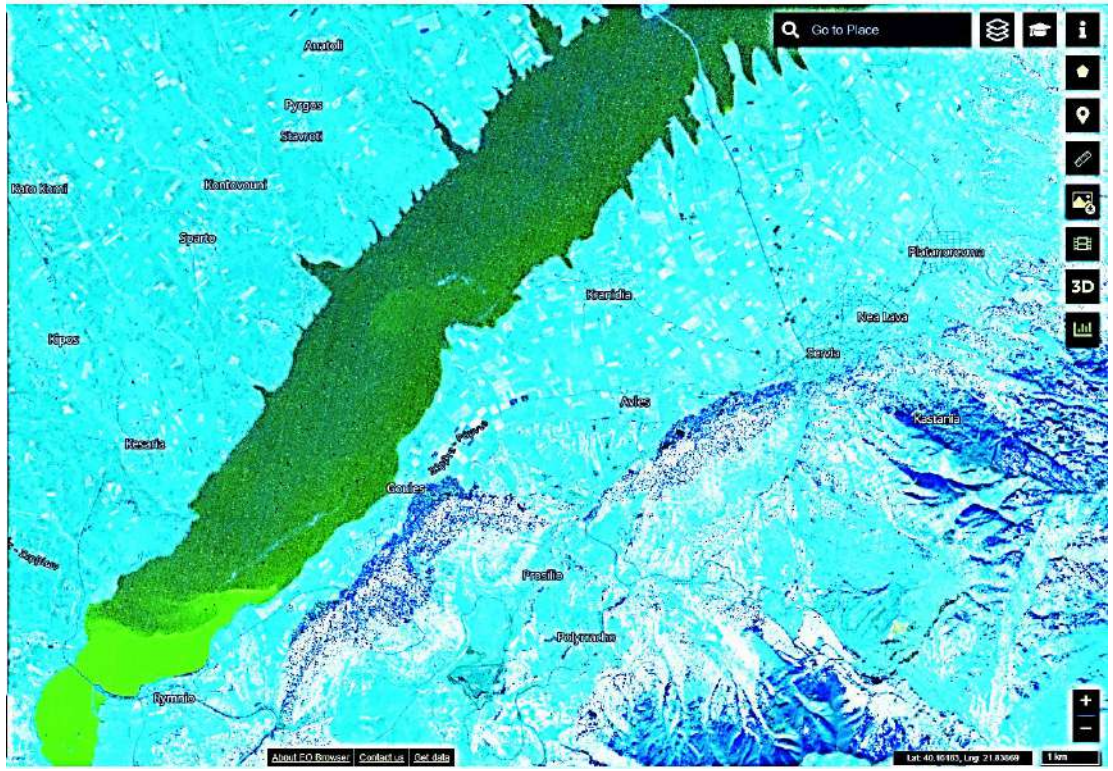
```
if ((B05+B04)==0){
  return [1,1,1]
};
var val = (B05-B04)/(B05+B04);

return colorBlend
(
  val,
  [-0.5,0,0.1,0.2,0.3,1],
  [
    [0,0,1],
    [0,0.5,0.5],
    [1,0.3,0],
    [1,1,0],
    [0.2,0.8,0],
    [0,0.5,0]
  ]
);
```

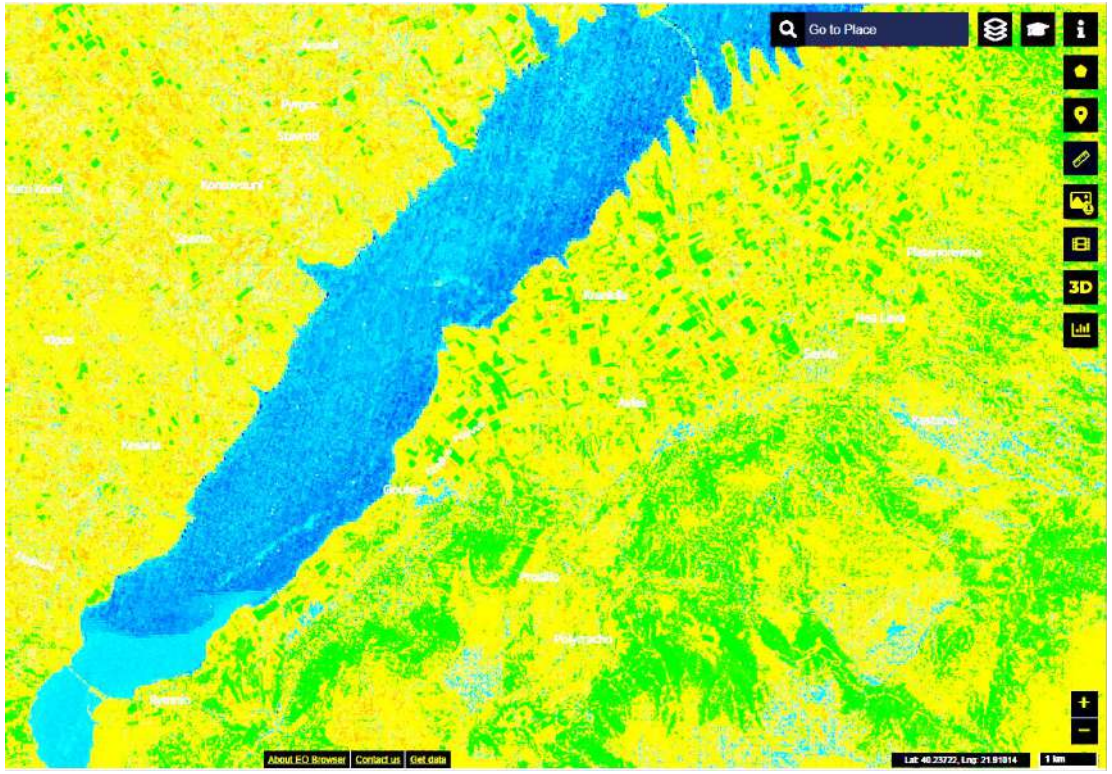


Operational application

Oil Spill detection



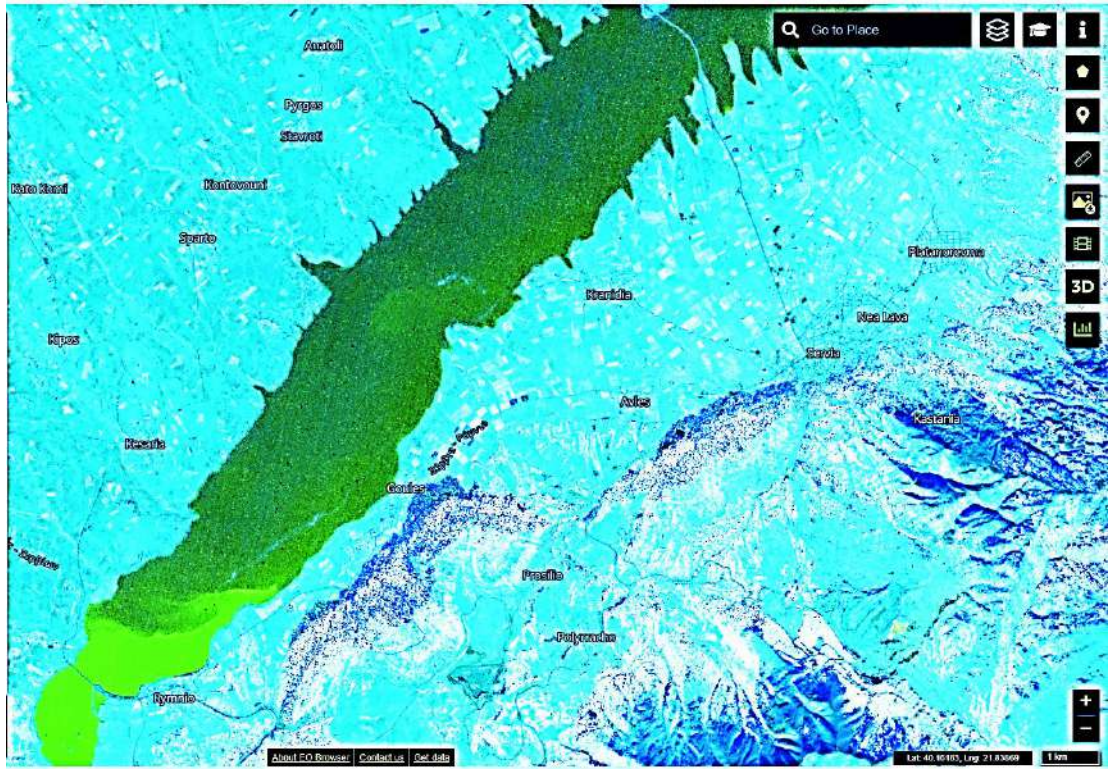
Chlorophyl



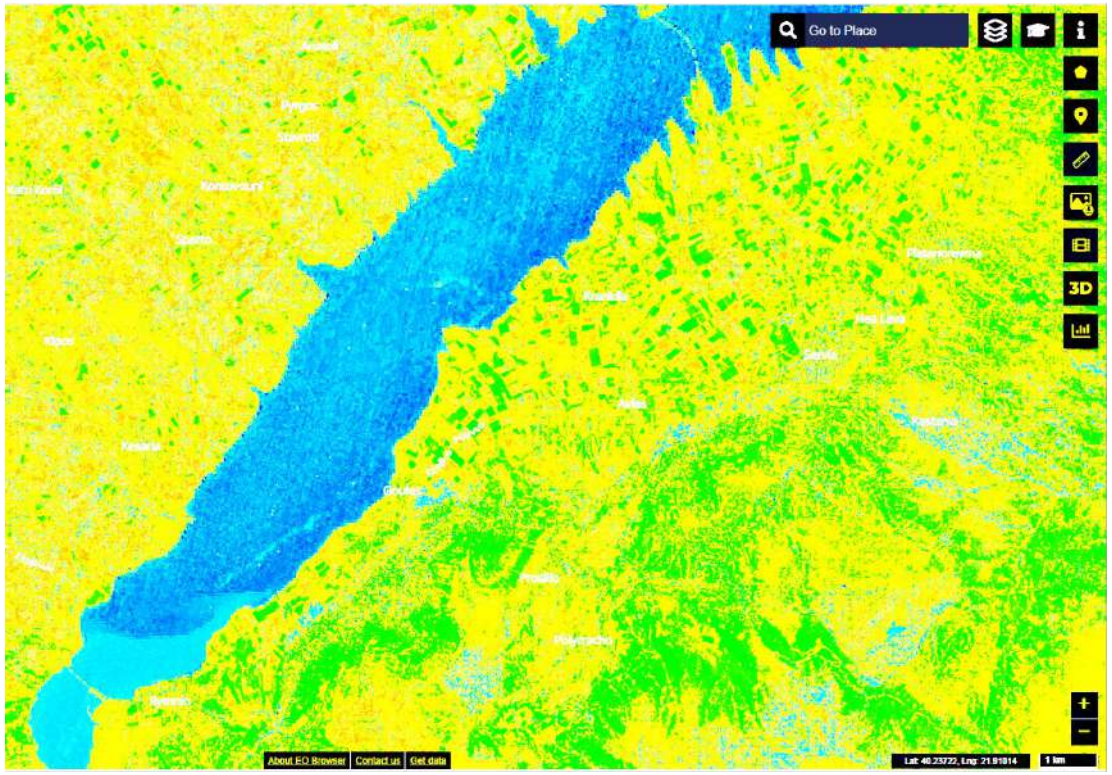
No clear answer on the type of the formations-spills

Operational application

Oil Spill detection



Chlorophyl



BUT

Good identification of the spill-formation spatial distribution

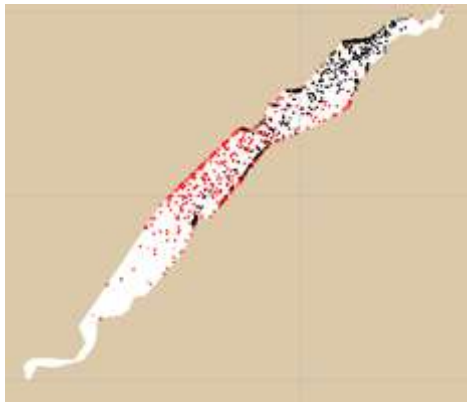
Relatively frequent new images (one image per five days)

Operational application

3. Efficient vigilance for our company mitigation actions

2. Optimize the sampling procedures

1. Oil spill diffusion model to locate possible sources' position and forecast the spill route in the lake



https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/response-tools/gnome-suite-oil-spill-modeling.html

Raw data for

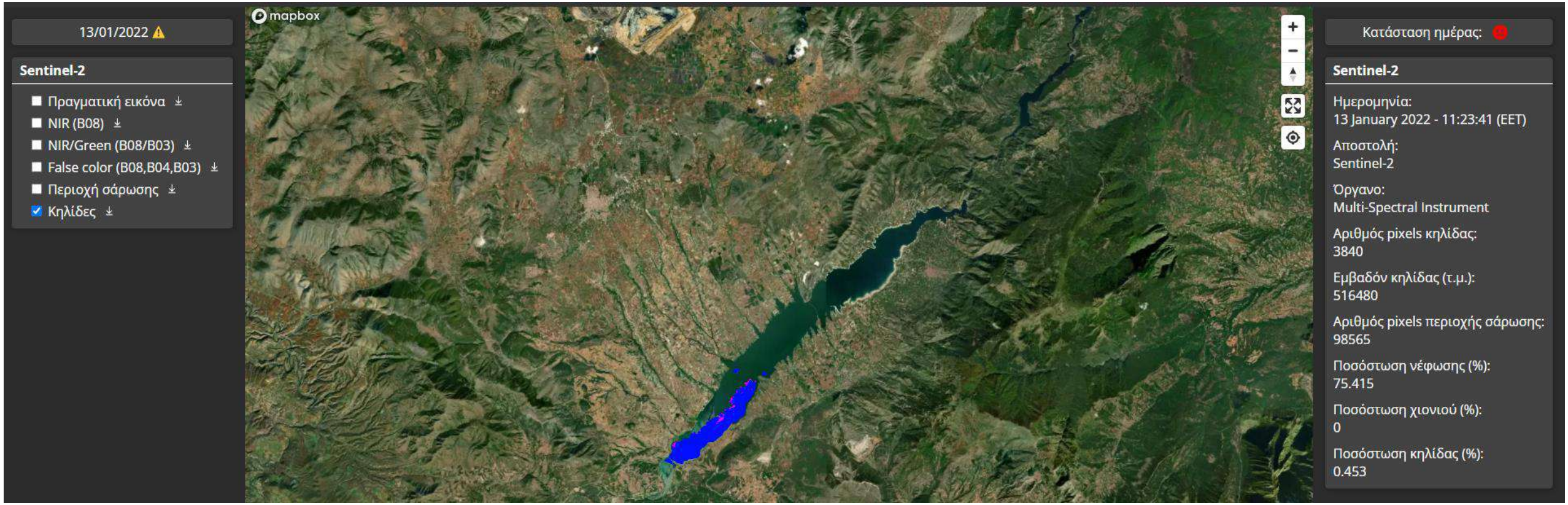
BUT

Good identification of the spill spatial distribution

Relatively frequent new images (one image per five days)

Operational application

3. Efficient vigilance for our company mitigation actions



Early warning system incorporated into our company procedures

Overall benefits

→**Scientific**:

→ Novel methodology developed to detect irregular formations in inland waters

→ Research initiated to offer methods to discriminate the type of formations observed on water surface

→**Economic impact:**

→ Optimize the sources related to sampling procedures

→ Avoid additional sources that are necessary for treating contaminated water in TWTP

→**Societal impact:**

→ Further enhance the water safety procedures related to drinking water supply to +1M citizens

Desired future satellite-based features

1. More frequent satellite images
2. Better image analysis
3. SAR based tools in better analysis
4. Advances in qualitative discrimination

Thank you for your attention

Machine Learning inflow forecast for real- time control of WWTP (Copenhagen)

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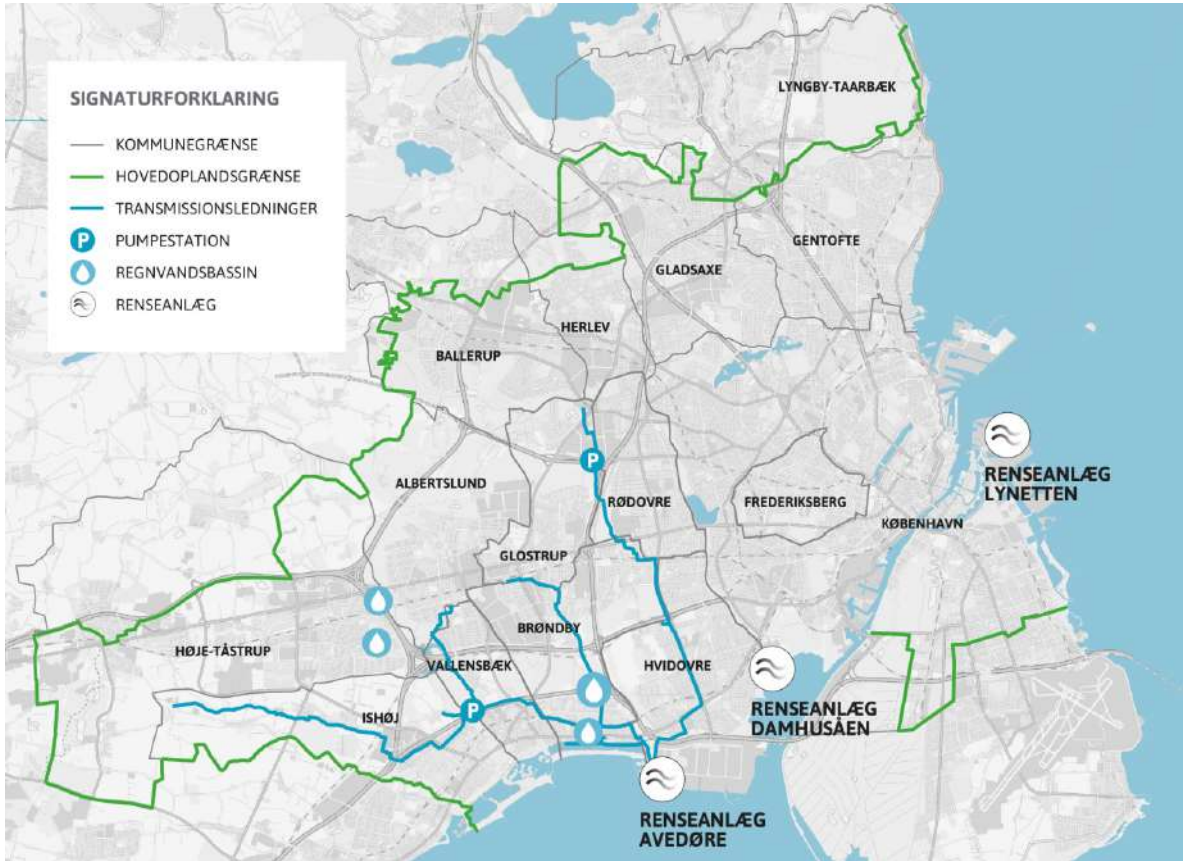
digital-water.city has received funding from the European Union's H2020 Research and Innovation Programme under Grant Agreement No. 820954.

Setting the scene



Background:

- → BIOFOS operates three WWTP, servicing 15 municipalities and 1,2 mio. people.
- → Two of the three catchments have mainly a combined sewer system, generating considerable rain runoff and inflow to the WWTP.
- → BIOFOS operates only the WWTP in these two catchments and does not control pumps or retention bassins.
- → BIOFOS WWTP operate in two modes: dry whether mode and a wet weather mode of operation, depending on the size of inflow to the plants.

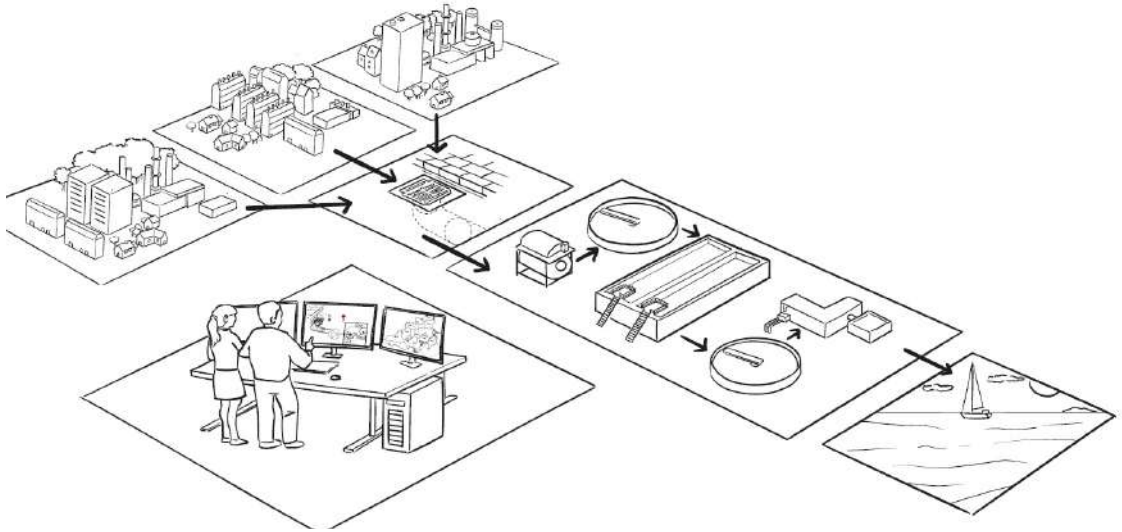
Problem:

- → With more rain events, it is crucial to ensure that capacity available in urban drainage systems is leveraged optimally.
- → BIOFOS currently uses a simple forecast model and control points in the catchment to change from dry to wet weather operation. –> we observe wrong starts.

Why machine learning for real- time control of WWTP?

Motivation and expected benefits:

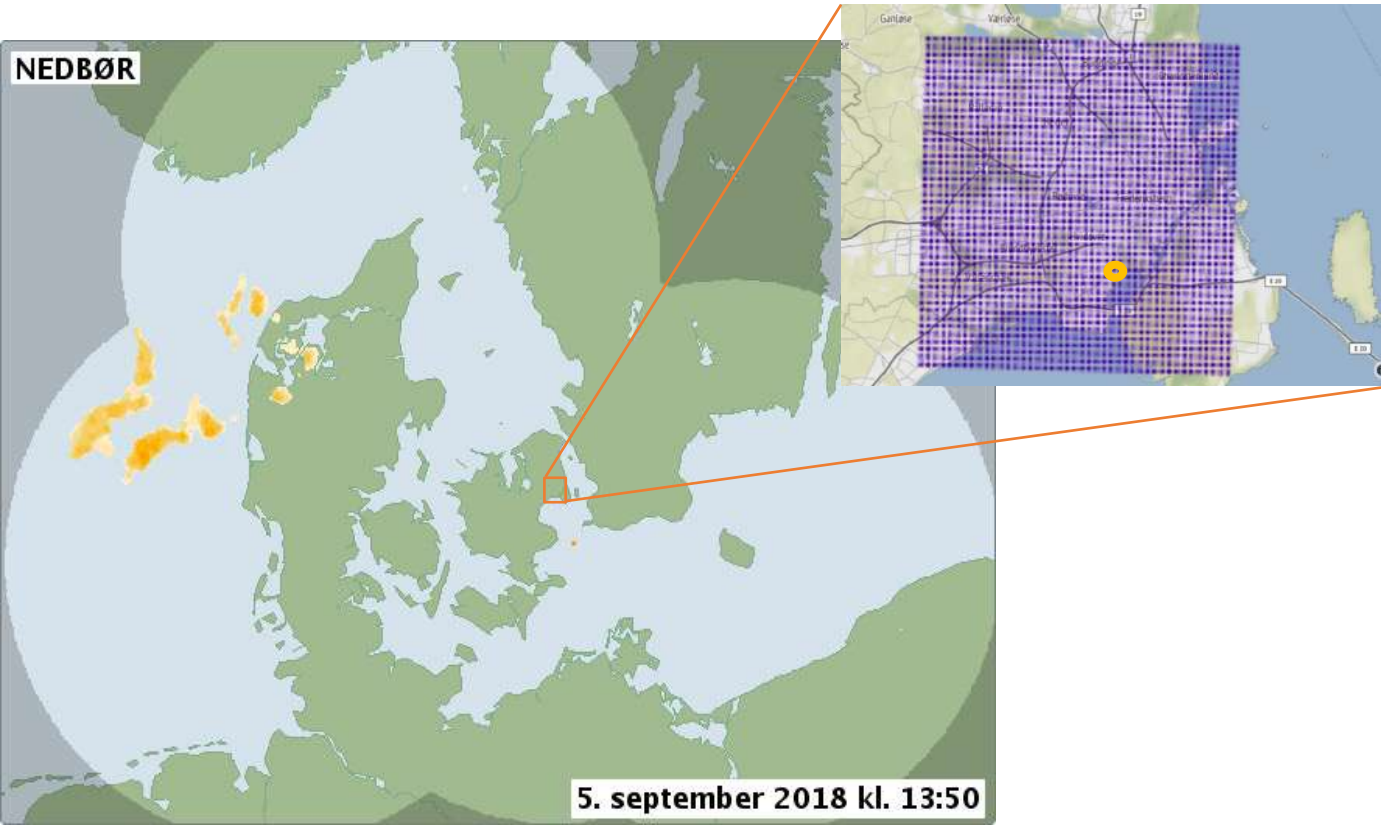
- We expect ML to be a valuable tool to generate fast and reliable forecast, facilitating optimal operation of wastewater treatment plants (WWTPs) and better utilization of detention basin storage during rain events.
- Improve decision making at the plant regarding dry or wet weather operation.
- Increase flexibility in operations, both at the WWTP and the catchment.
- Minimize bypass (only mechanically cleaned water) at the WWTP.
- Investment in new infrastructure can be reduced, saving environmental and monetary costs.
- Leverage on the existing online- data.

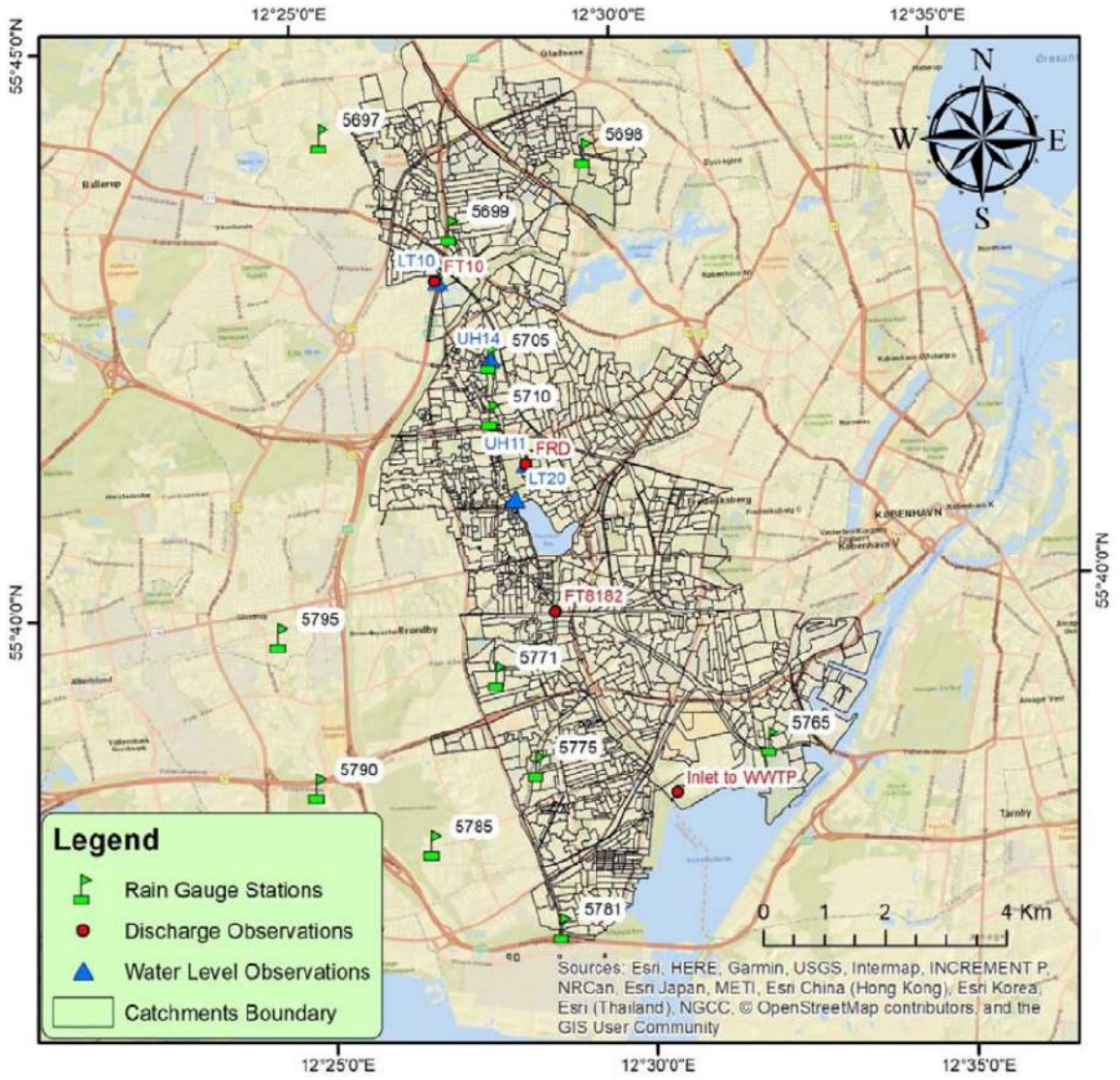


Case study

Time series data from rain gauges, level, flow, and volume sensors

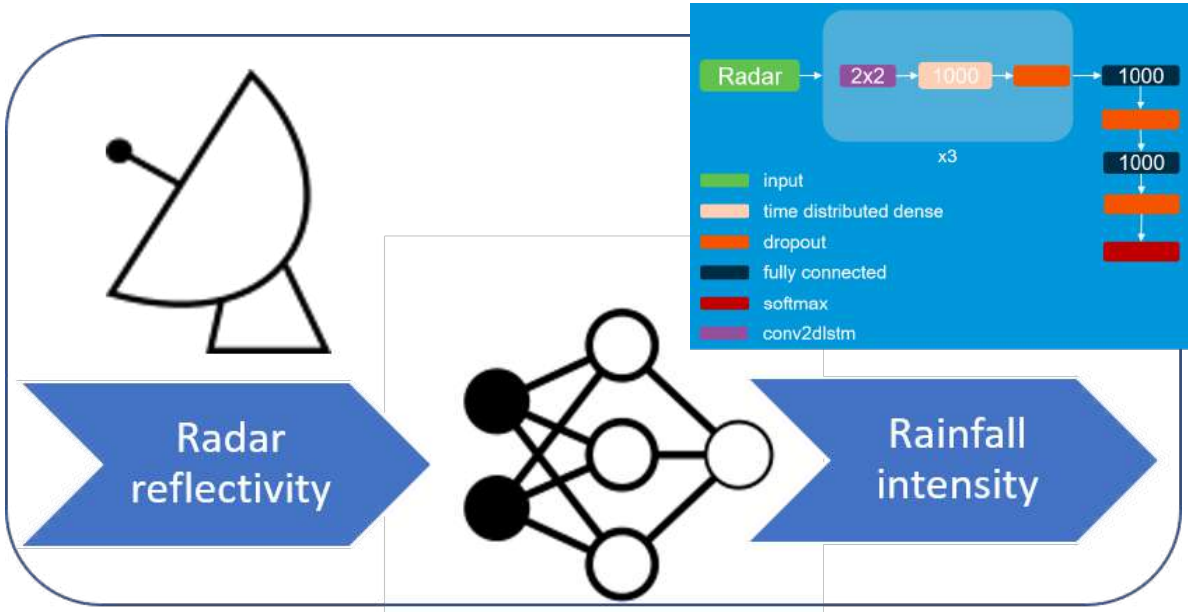
Weather radar data



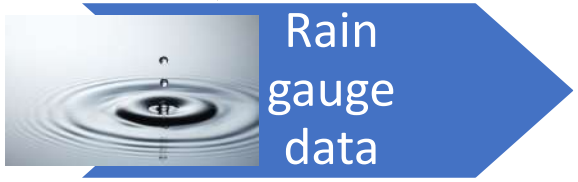


Methods

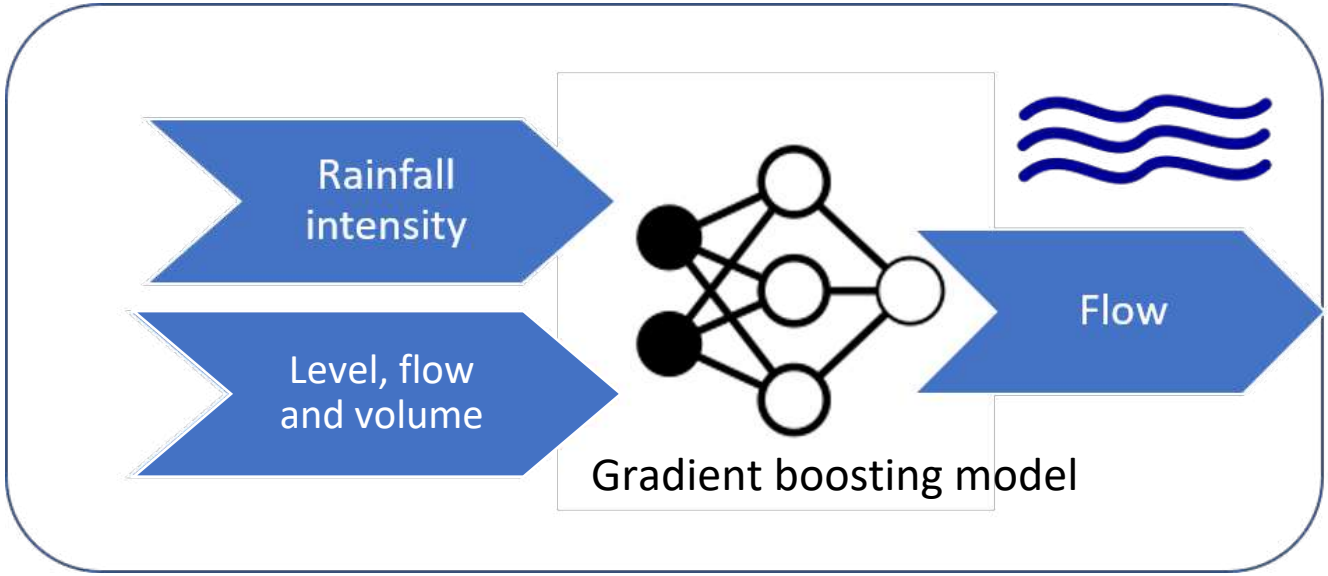
Radar to rain model



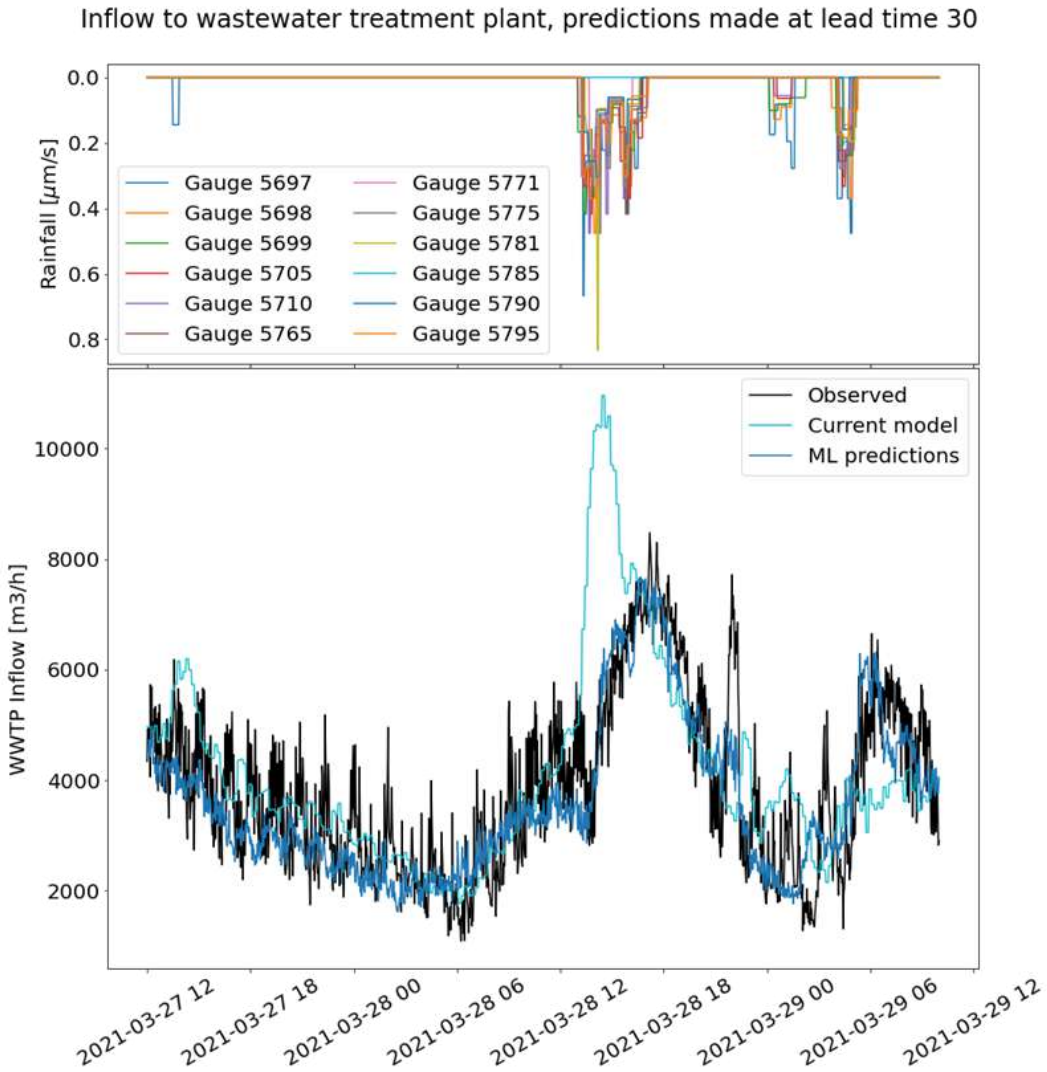
or

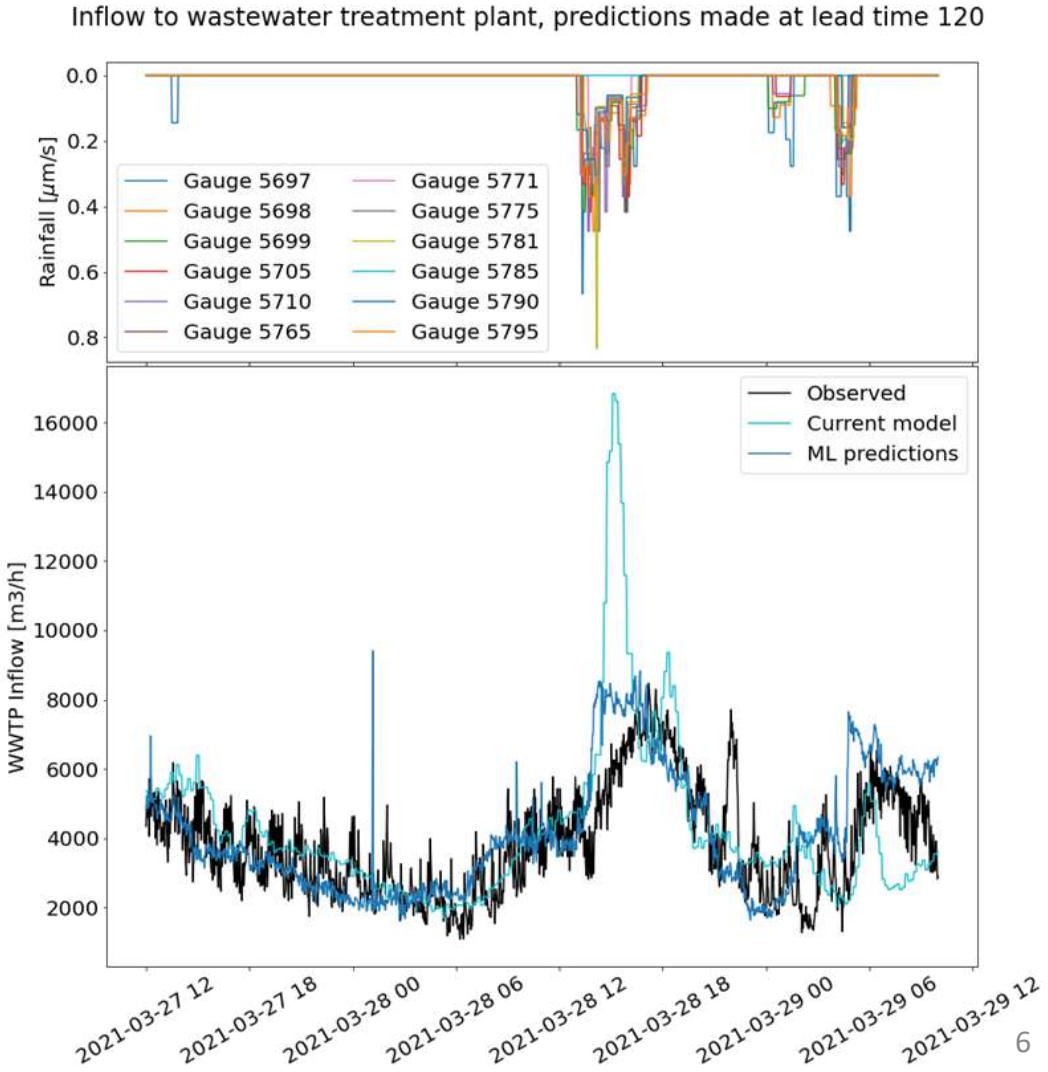


Rain to flow prediction



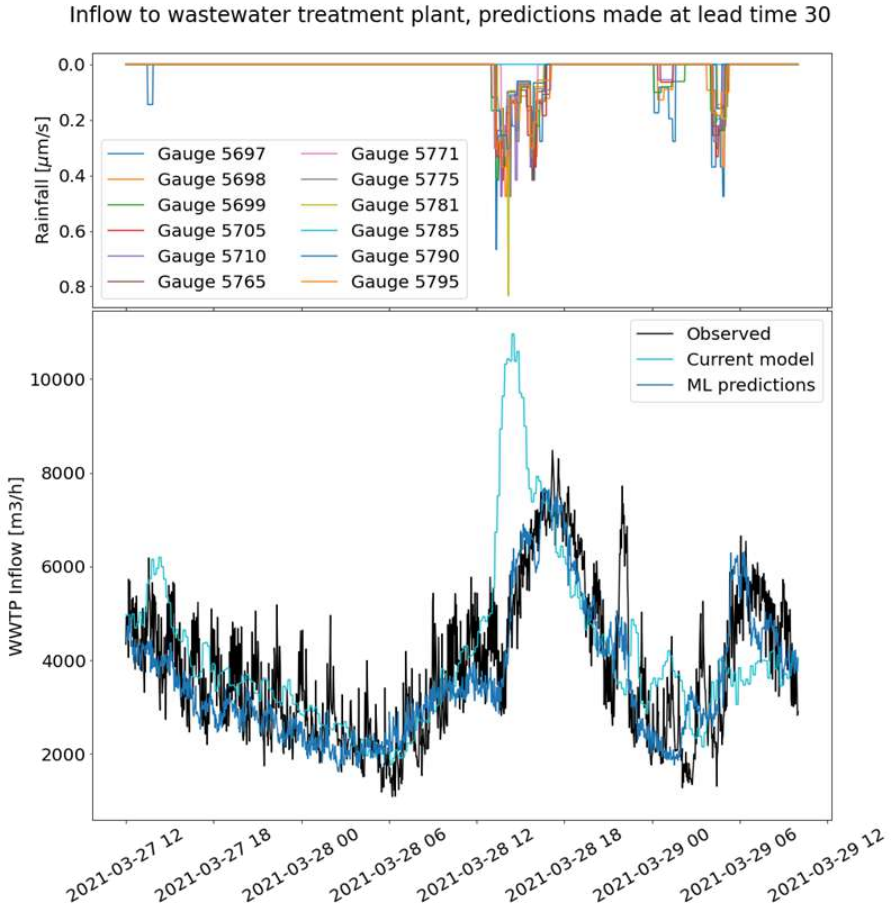
Flow predictions from rain gauge-based model





Value creation for BIOFOS

- Proof of concept- is ML a reliable tool for real- time control?
- If it is- integrate the ML tools as a decision support system within BIOFOS' control system.
- Leveraging on existing data.
- Improve integrated control between the WWTP and the catchment, achieving better operation and environmental benefits.



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Acknowledgement

digital-water.city is a research project supported by the European Commission under the Horizon 2020 Framework Programme

Grant Agreement No 820954

Duration: 01/06/19 - 30/11/22

Intelligent Control for Wastewater Treatment

Fiware4Water
Demo case Amsterdam

Dr. Alex van der Helm
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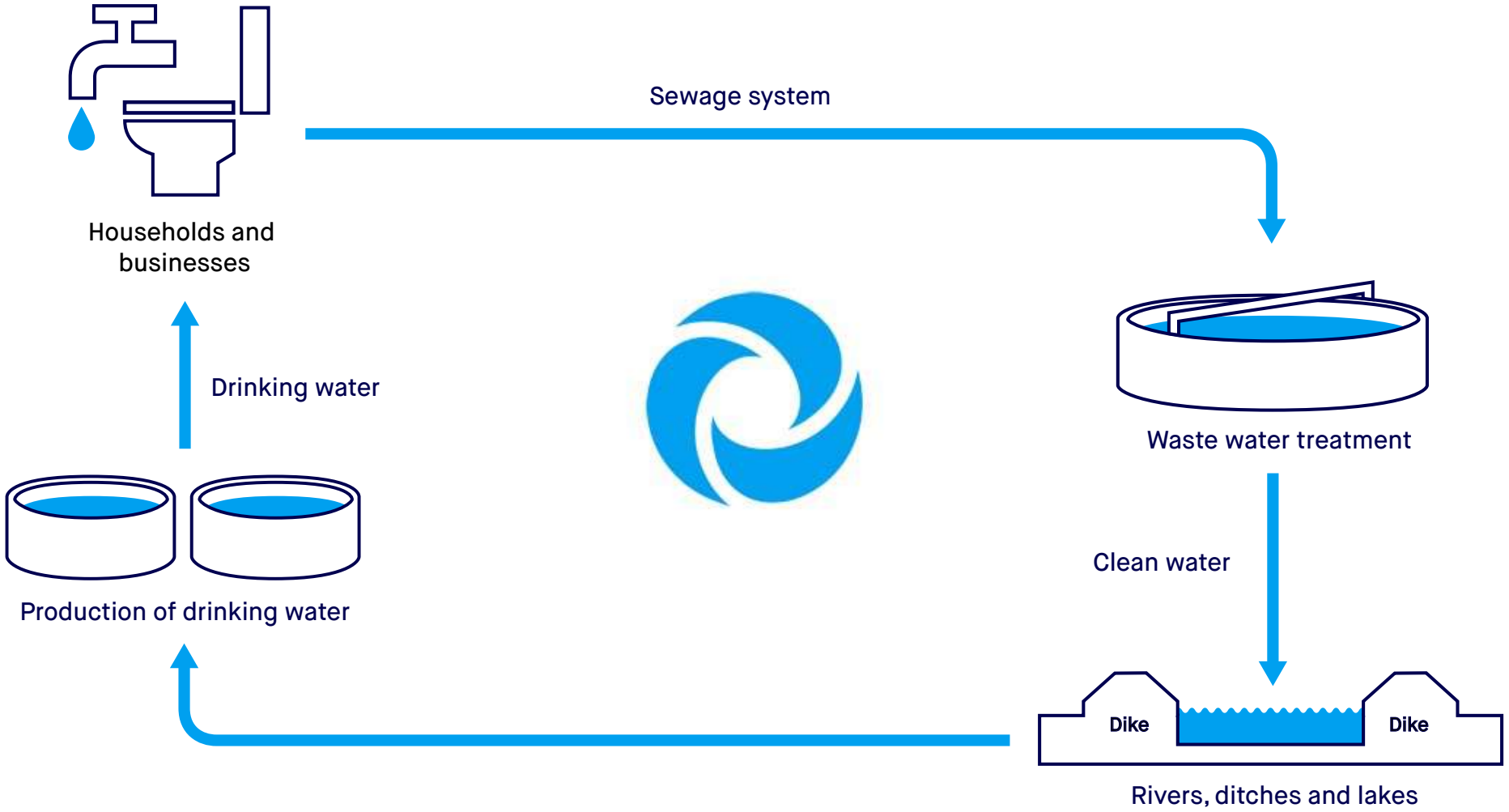
COP Digital Water, January 20th 2022

waternet
waterschap amstel gooi en vecht
gemeente amsterdam

Waternet water cycle utility Amsterdam



waternet
regional public water authority
amstel gooi en vecht
city of amsterdam

Our service area

- 18 municpalities
- Ca 1,3 million inhabitants
- In Amsterdam all water tasks

waternet
regional public water authority
amstel gooi en vecht
city of amsterdam

FIWARE 4 WATER

Demo Case #1 • Greece

Athens • Water Supply System
real time operational managment

Demo Case #2 • France

Cannes • Improving the Water
Supply System

Demo Case #3 • Netherlands

Amsterdam • Intelligent control
for wastewater treatment

Demo Case #4 • United Kingdom

Great Torrington • Smart Meters
and Customers

www.fiware4water.eu

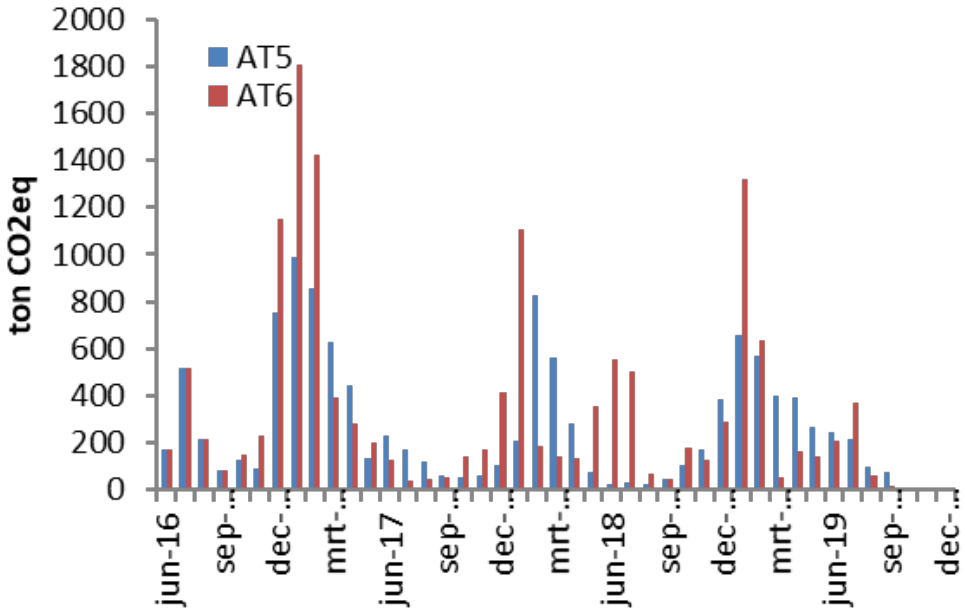
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 821036.

Wastewater treatment plant Amsterdam West

Nitrous oxide (N_2O) gas emissions

Real-time measurement in off-gas aeration tanks (ATs) of WWTP Amsterdam West starting 2016:

15 – 28 kton/year CO2-eq



Full-scale research lane

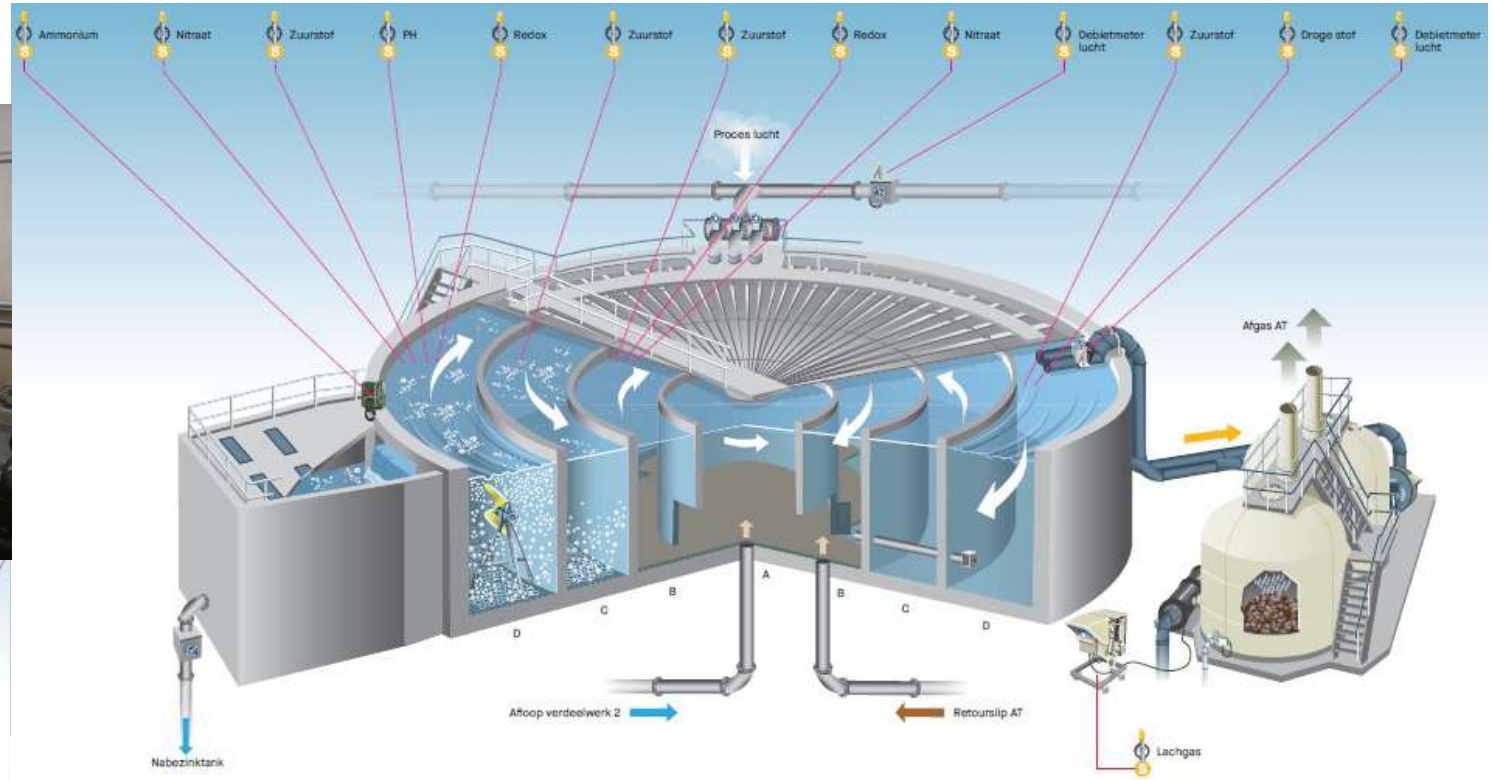
Objective: Reduction of nitrous oxide emission and electricity use aeration

Installing additional sensors

Treatment optimisation with Artificial Intelligence

Additional on-line sensors

Research facility

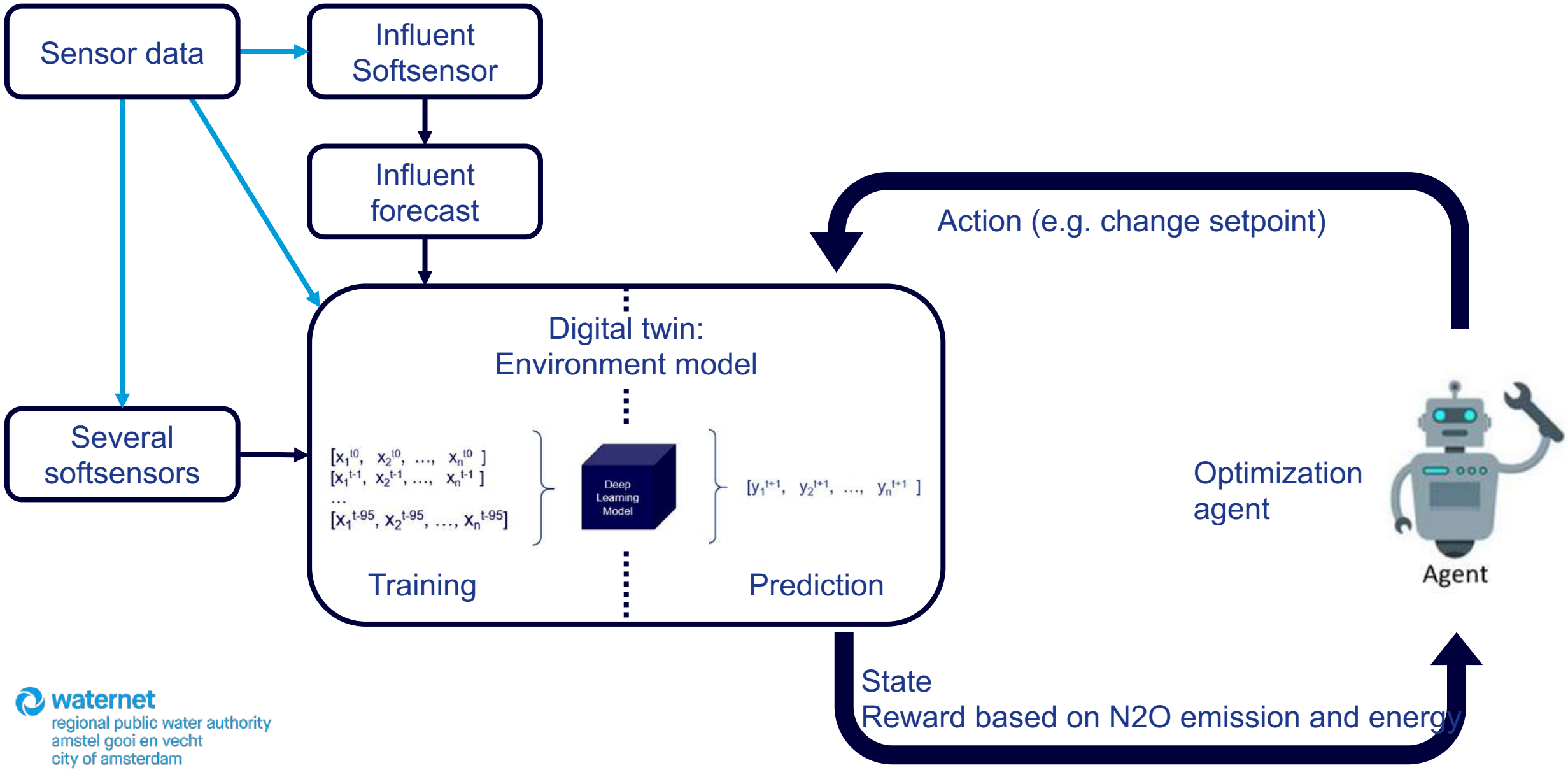


Aeration tank

Off-gas

waternet
regional public water authority
amstel gooi en vecht
city of amsterdam

WWTP Amsterdam West AI setup



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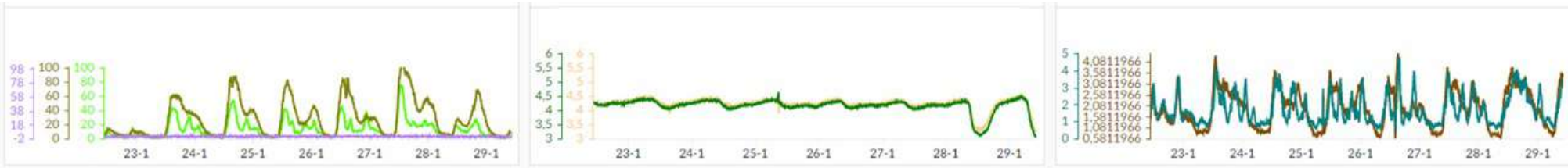
regional public water authority
amstel gooi en vecht
city of amsterdam

Data used in digital twin

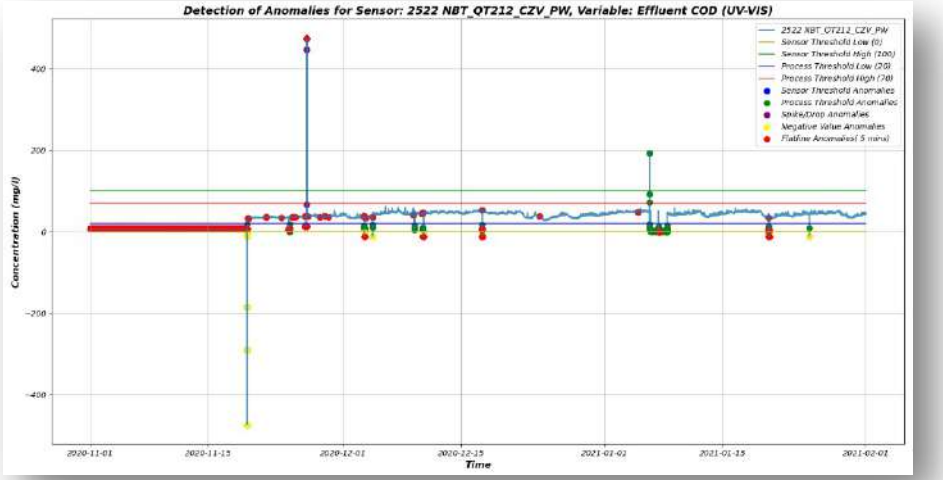
- Setpoints e.g. oxygen setpoint in aeration tank
- Water flows e.g. influent, internal recirculation flows
- Water quality parameters e.g. oxygen, ammonia, nitrate, dry solids
- Air flows, incoming process air and off-gas flows
- Off-gas quality parameters e.g. N_2O
- Blower data e.g. energy use
- Air valves settings of the different compartments in the aeration tank

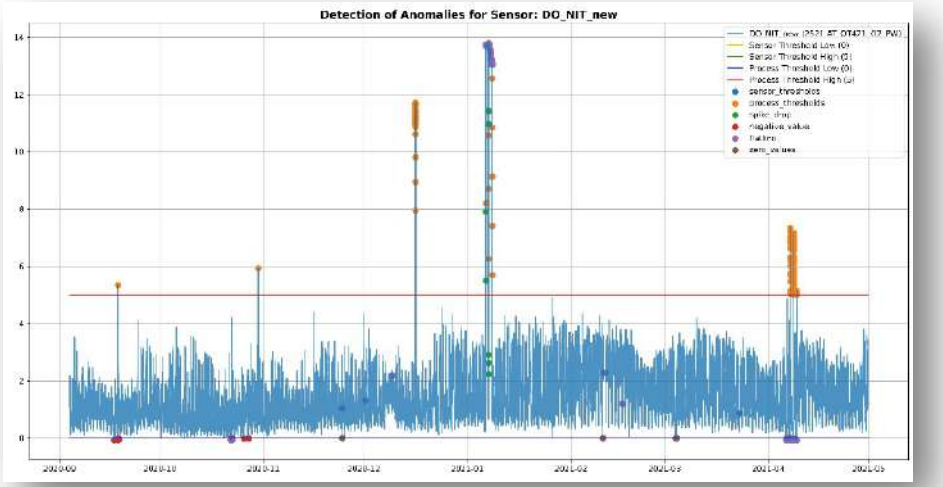


waternet
regional public water authority
amstel gooi en vecht
city of amsterdam

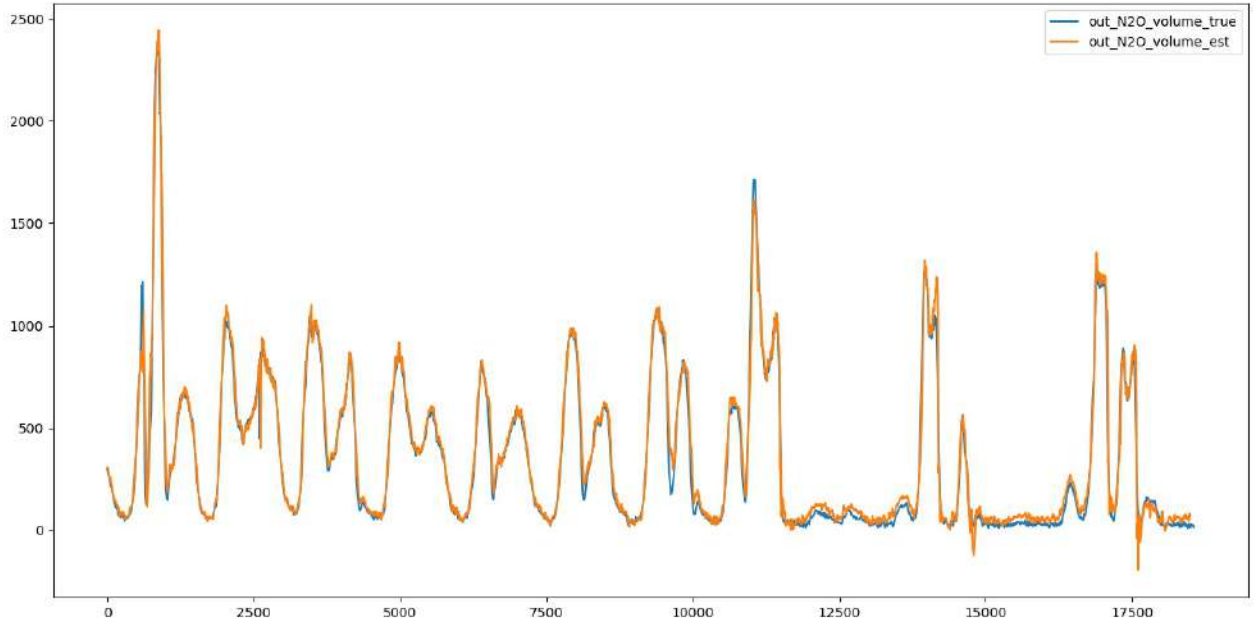
Automatic Data Validation and Data Quality Control

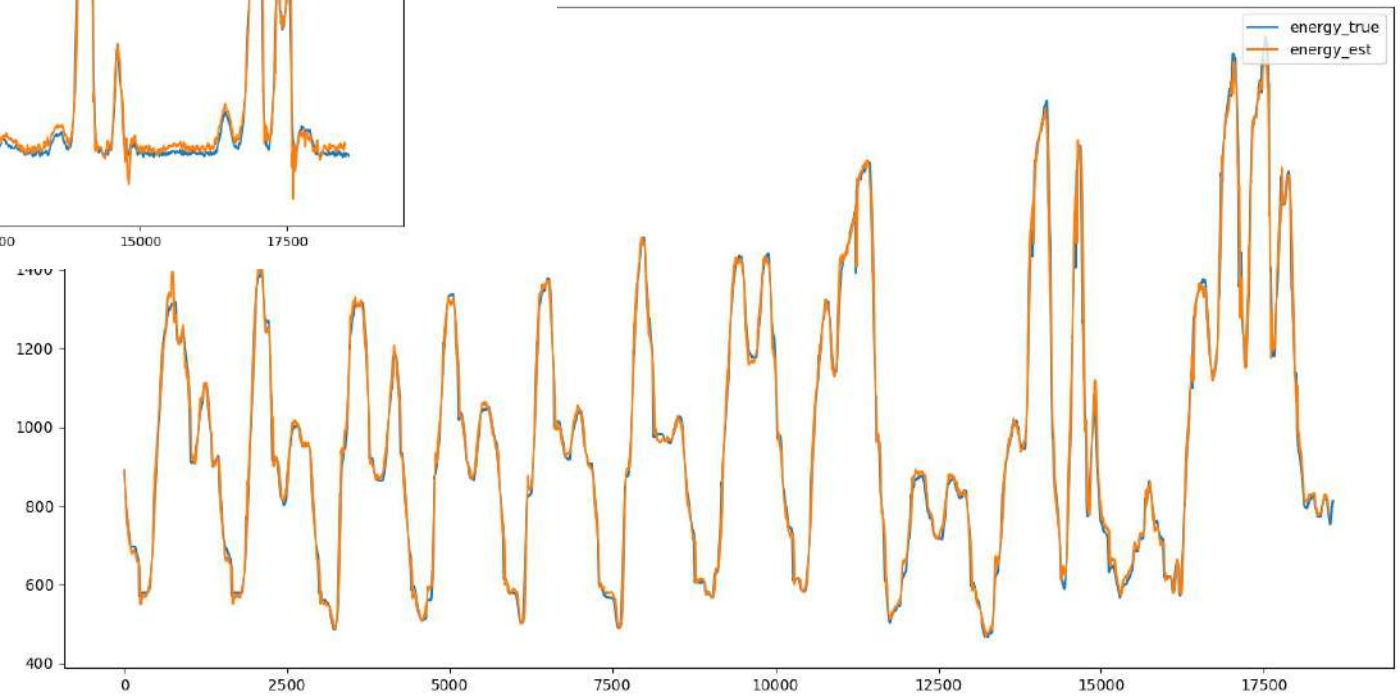
- Simple statistical methods to detect gross sensor anomalies due to sensor failures.
- Collection of crucial metadata on sensors and guidance from process technologists.
- Detection of contextual anomalies using model-based detection.
- Development of soft sensors for crucial parameters (such as NH4 in aerobic tank) for data reconciliation.
- Conduct a (near) real-time data validation process using Fiware.





Validation results for N_2O emissions and blower energy use





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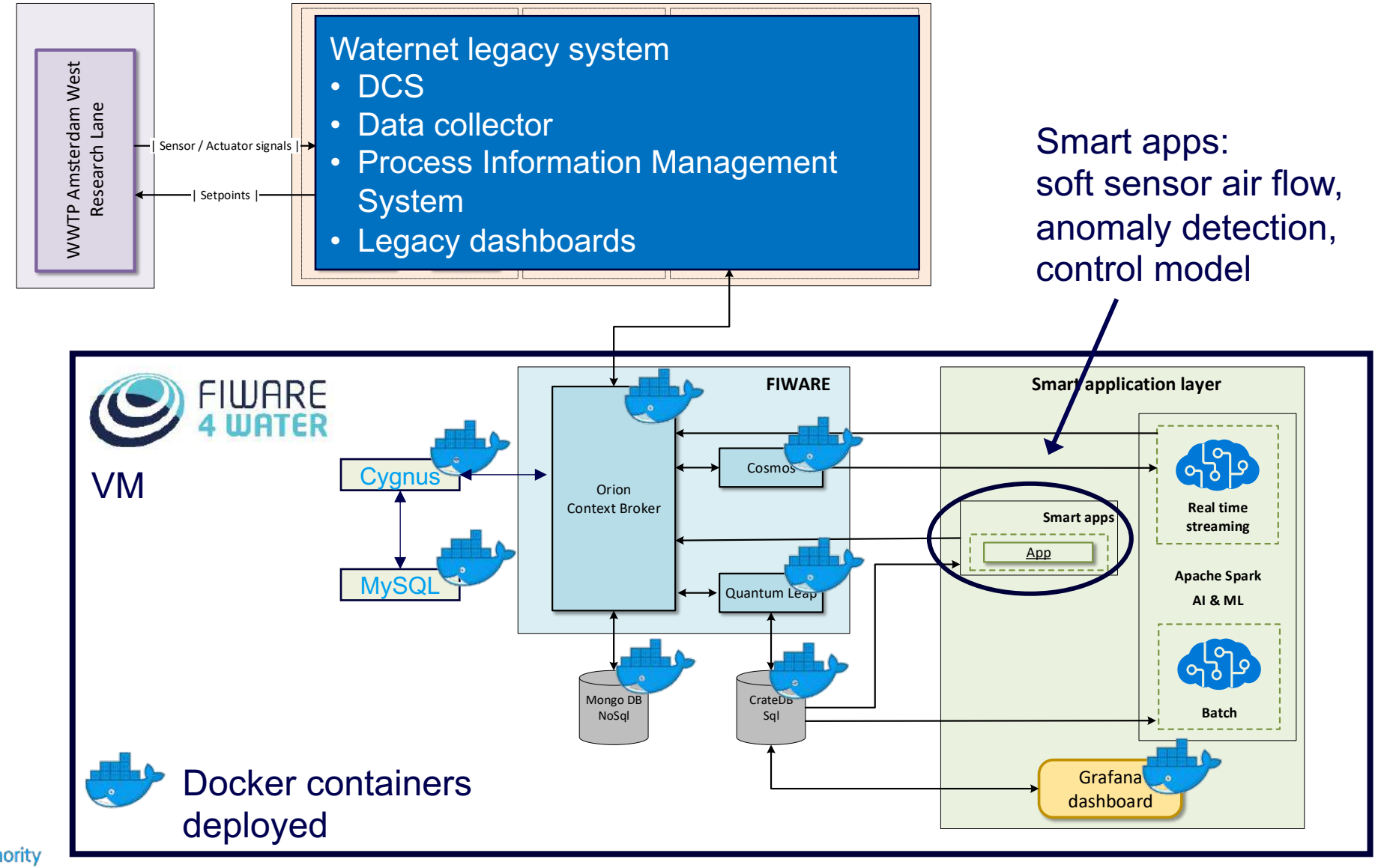
Integration of FIWARE to legacy system



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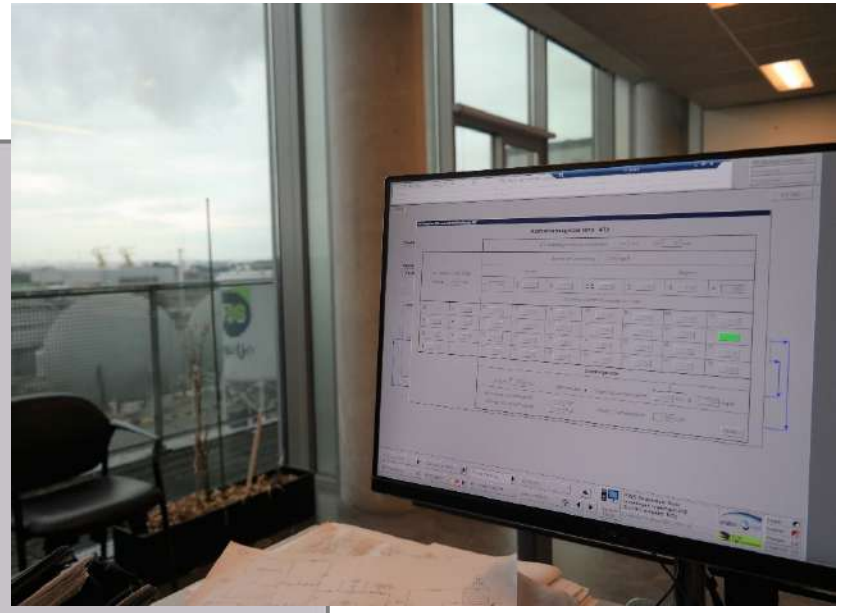
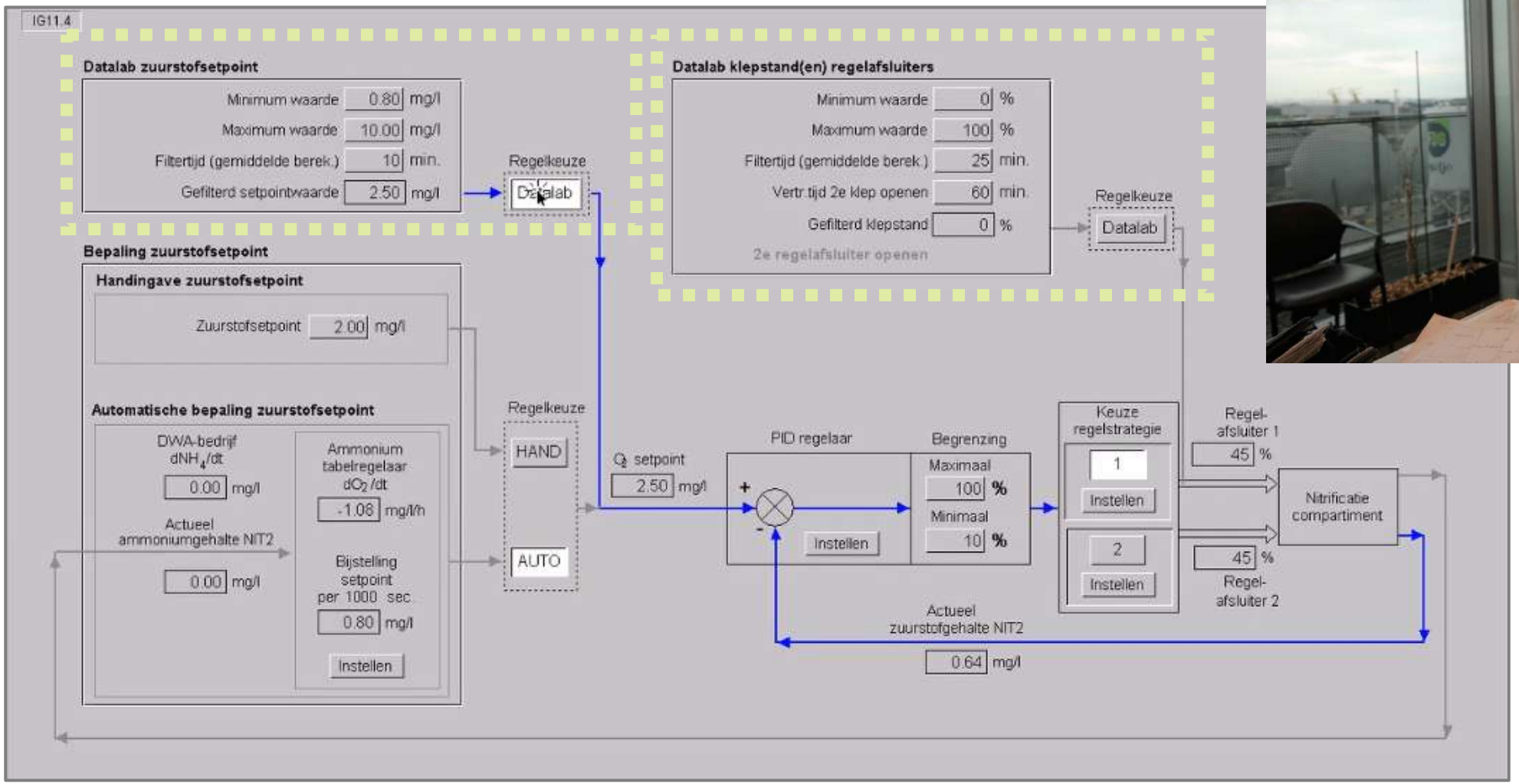
AI control implementation





Lessons learned

- Installing and maintenance of new sensors is time consuming
- Constantly checking data quality gives lots of new insight in the processes
- With fast agile implementation you learn quick and you fail quick
- Close interaction between data scientists and technologists is essential
- You need data scientists ánd machine learning engineers
- We just started to explore the power of implementing AI

New low cost sensors for CSO monitoring in sewer networks

Regina Gnirss Head of R&D, Berliner Wasserbetriebe
Michel Gunkel, Berliner Wasserbetriebe

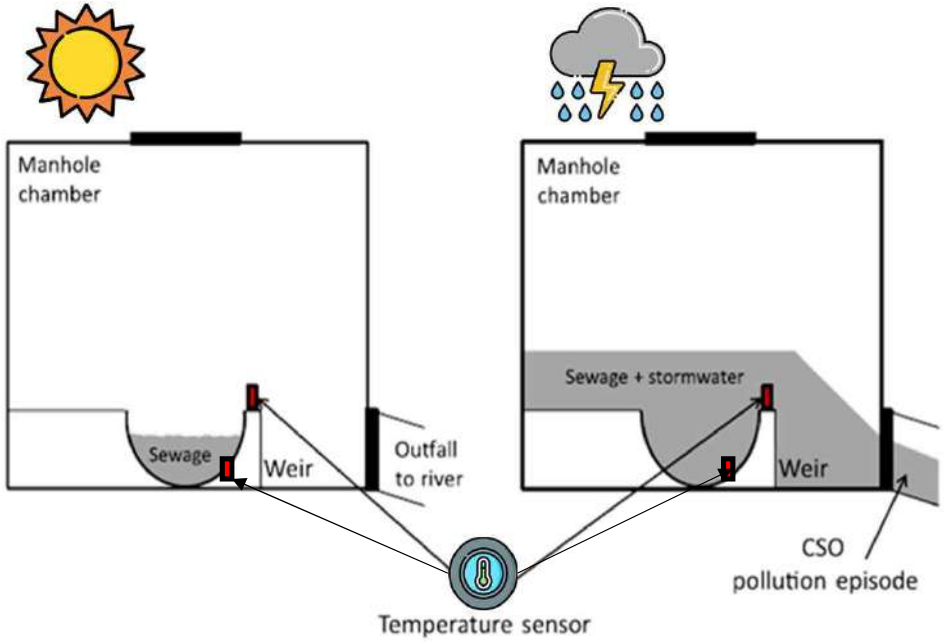
digital-water.city
digitalwater_eu

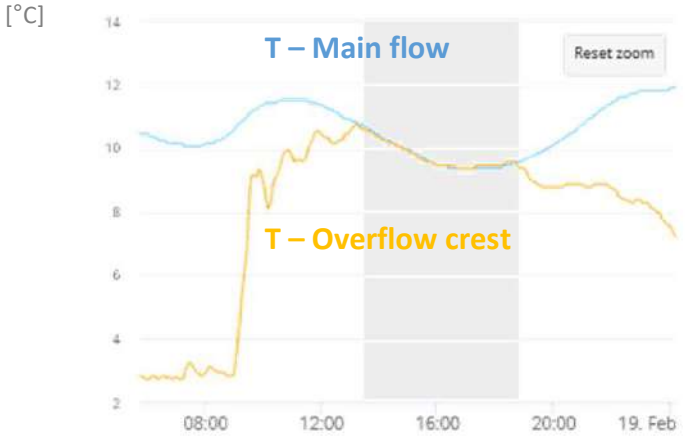
digital-water.city has received funding from the European Union's H2020 Research and Innovation Programme under Grant Agreement No. 820954.

COMBINED SEWER OVERFLOWS

- → 3 billion litres/year untreated wastewater.
- → 2.2% of total flow of WWTP.
- → From > 650,000 overflow structures.

CONCEPT OF TEMPERATURE SENSOR for CSO's





Where?

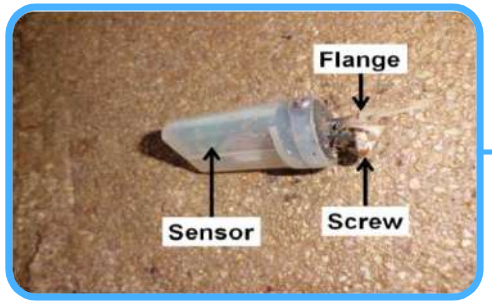
How often?

For how long?

Sensors + data transmission + web platform interface

Online

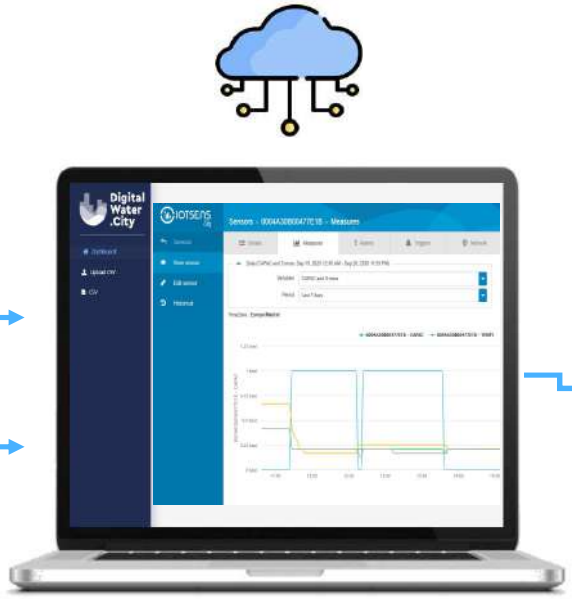
Offline



LoRa

upload

2 x 60-80 €



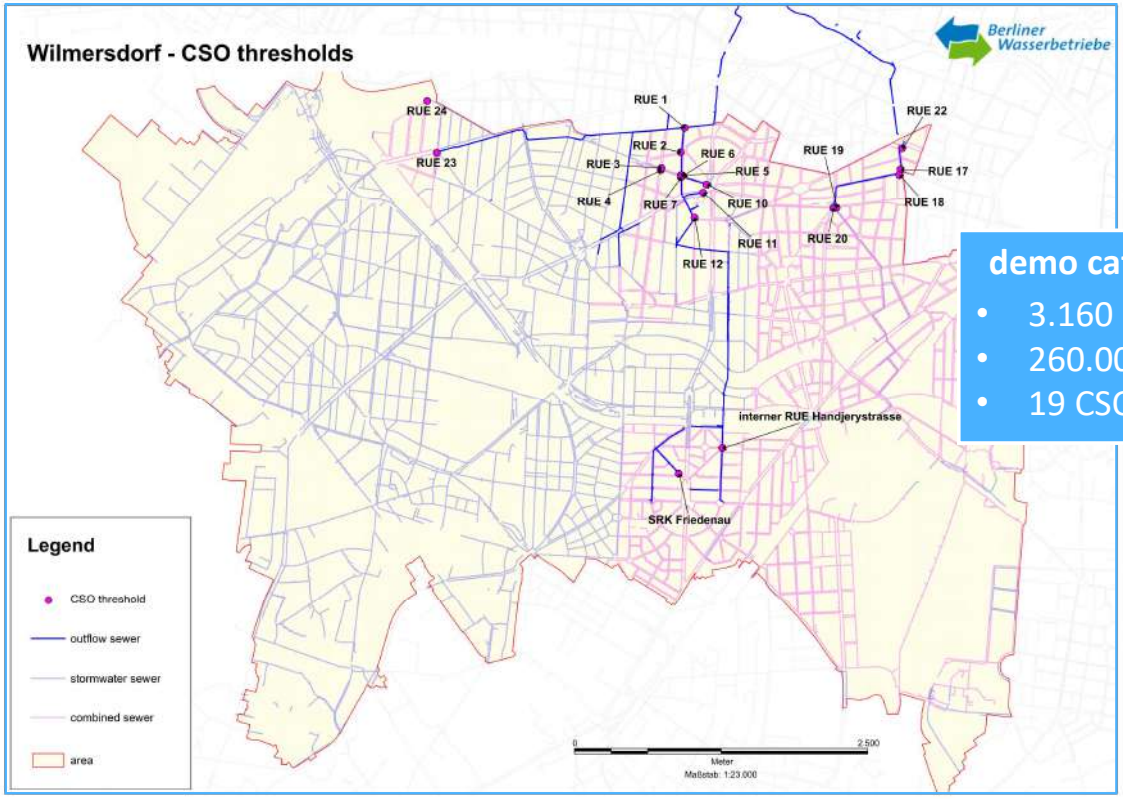
API

A network of low-cost temperature sensors for real-time monitoring of combined sewer overflows

Demo cities

Berliner Wasserbetriebe

Sofiyska Voda



demo catchment area

- 3.160 ha
- 260.000 inhabitants
- 19 CSO structures

Berlin: sensor network with 19 measuring sites (10 offline, 9 online)

Sensor installation for CSO monitoring: offline and online

Conclusion

Lessons learnt during the development and operation

UTILITES: BWB & SV

→ Feedback overall positive.

→ Easy installation, reliable; easy to change battery; easy to clean.

→ Online platform: easy to access, usability high.

DEVELOPERS: ICRA & IoTsens

→ Good-valid concept-approach, flexible and tailor-made to fit Utilities needs.

→ Improvement in its application (feedback. from utilities

→ Working on upgrades such as connections to rain data and flexibility in communication protocols…..

Results coming soon

→ Limited usage so far due to covid delays.

Acknowledgement

digital-water.city is a research project supported by the European Commission under the Horizon 2020 Framework Programme

Grant Agreement No 820954

Duration: 01/06/19 - 30/11/22

Thank you for your attention

Turbinator

A new turbidity and water level sensor

Helen Galfi

City of Gothenburg
Sustainable Waste and Water - Kretslopp och vatten
Sweden

Challenges

Needs

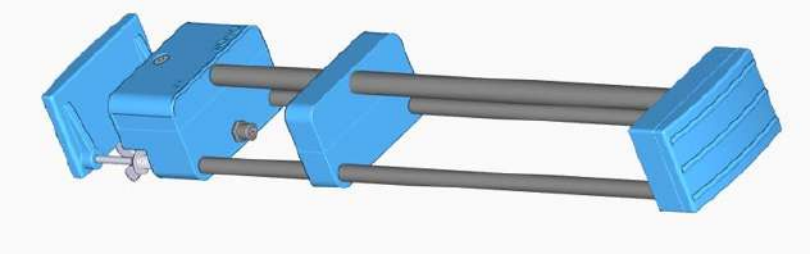

Wireless data transmission
Gateway
Manhole
Wireless module
Sewer water pipe
Water-level sensor
Wireless data transmission
Gateway
Manhole
Wireless module
Sewer water pipe
Water-level sensor

Digital solution

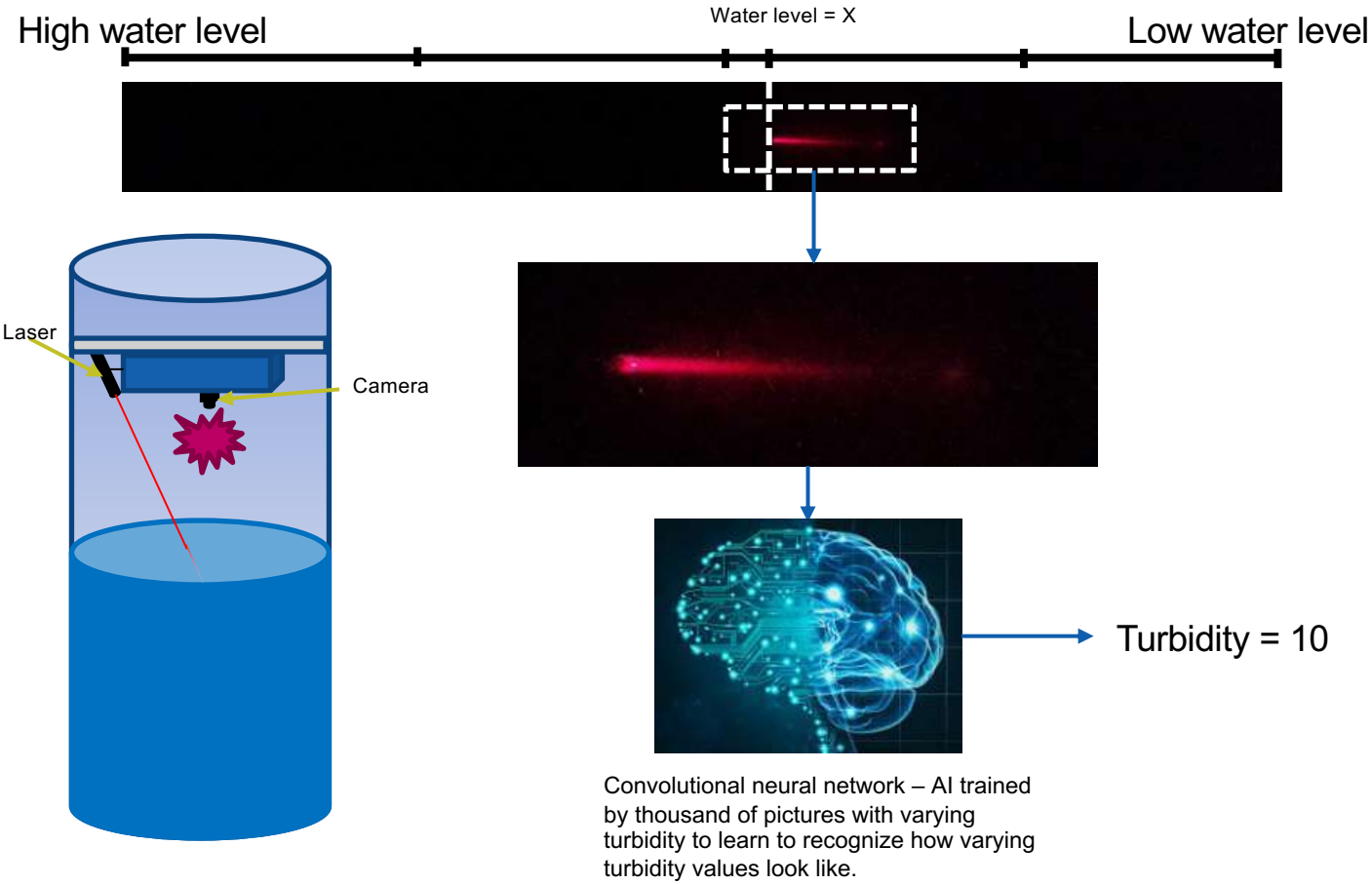
Göteborgs Stad

Turbinator – IVL development

- measuring turbidity and water level
- based on image processing and machine learning algorithms

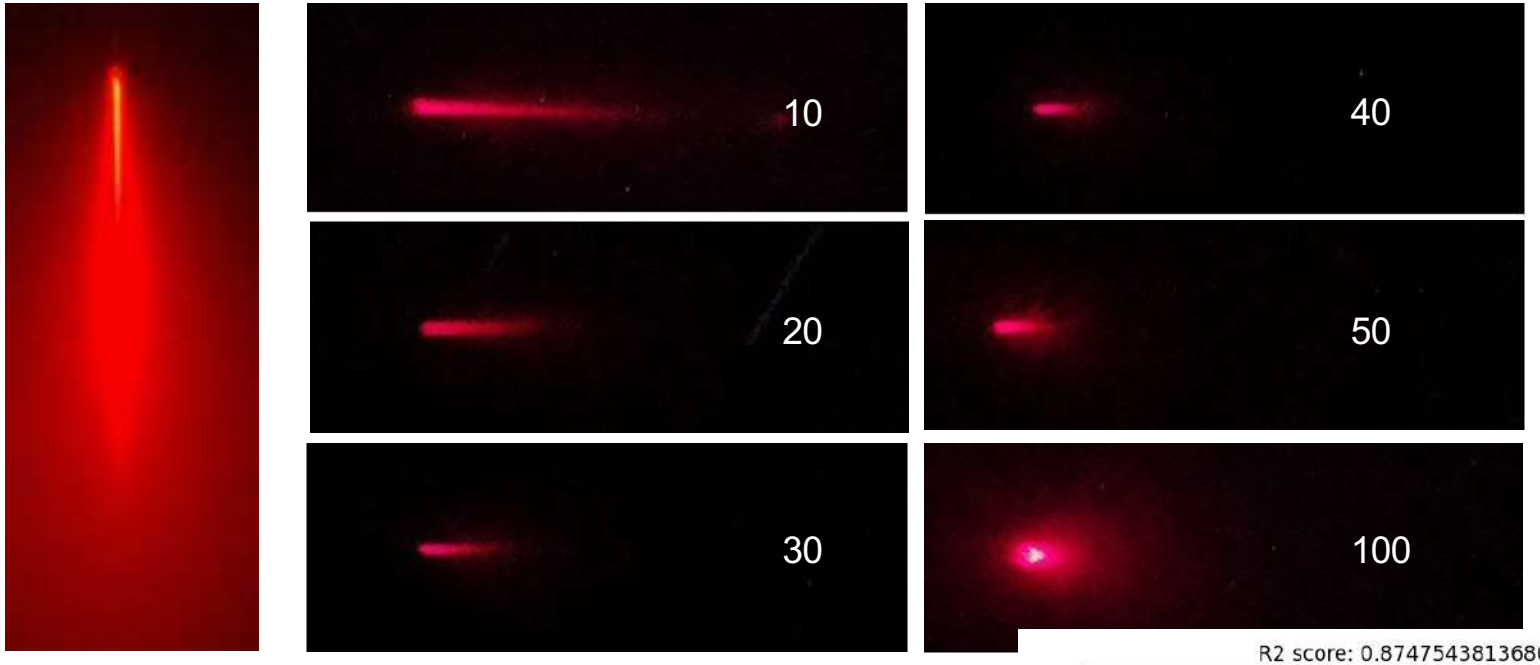


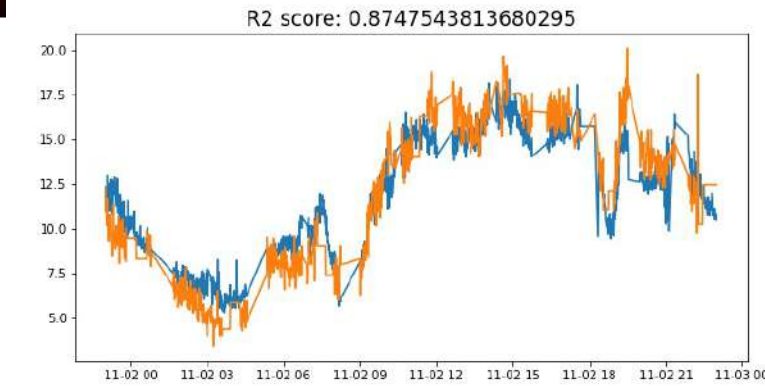
Digital solution – Turbinator step by step



Convolutional neural network – AI trained by thousand of pictures with varying turbidity to learn to recognize how varying turbidity values look like.

Digital solution – Turbidity measurements

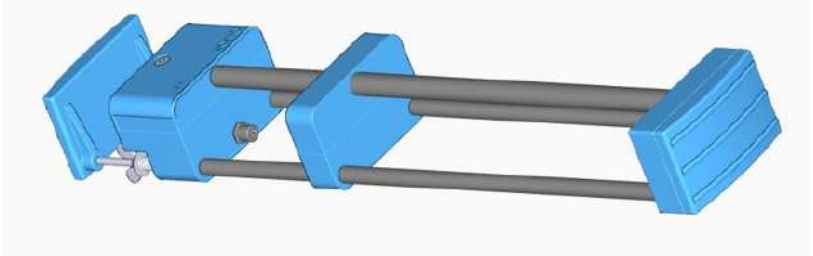


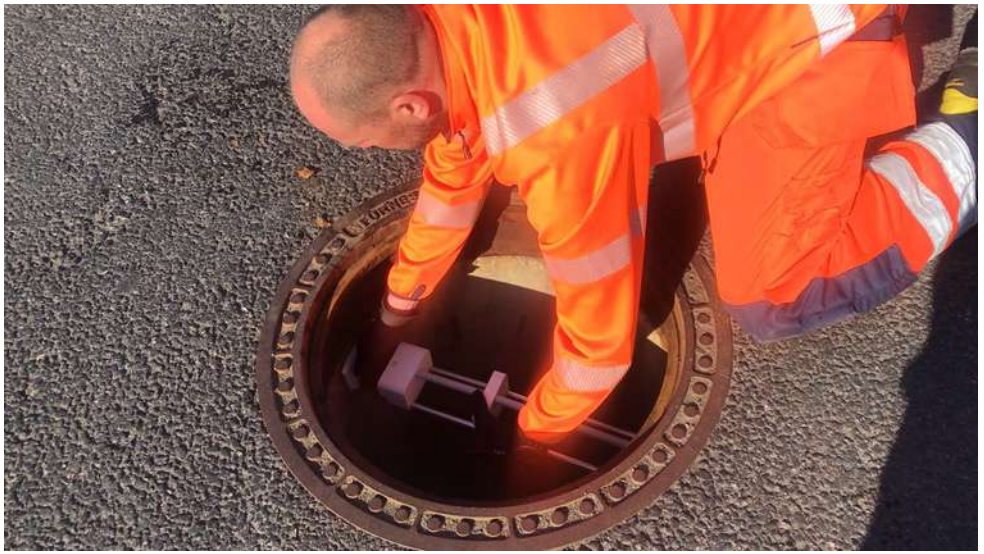


Benefits

Turbinator

- affordable components, can be installed in many wells
- contactless and battery driven (3y battery time) minimum maintenance
- easy to install



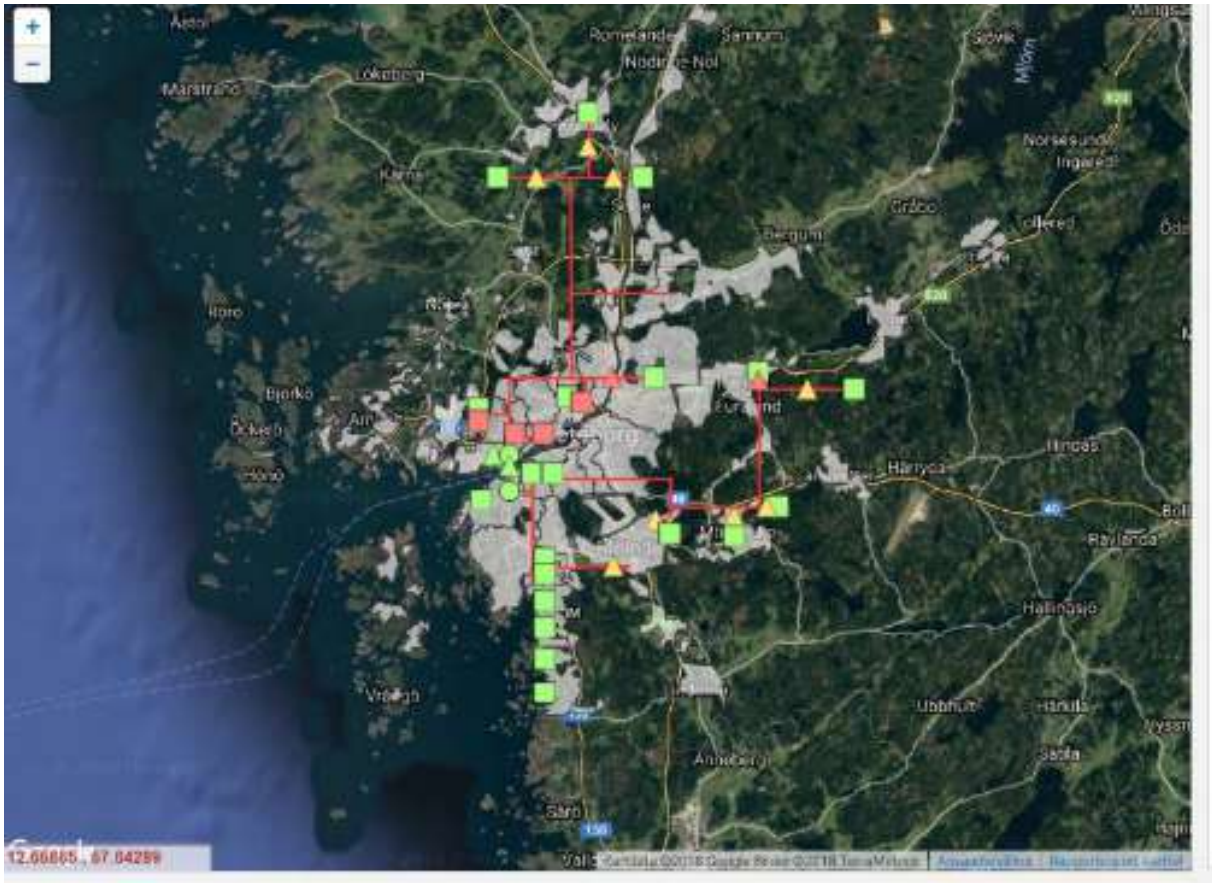


Challenges

- Turbinator seems to work on low turbidity ranges
- TSS vs turbidity – correlation analysis
- Turbinator in underground conditions vs surface conditions
- Validation and data in shared dataplattform

Vision

City of Gothenburg urban water map with real-time measurements at discharge points



Thank you!

Kontakt: Helen Galfi
helen.galfi@kretsloppochvatten.goteborg.se

NAIADES

Greening the economy in line with the sustainable development goals

Tools for wastewater management

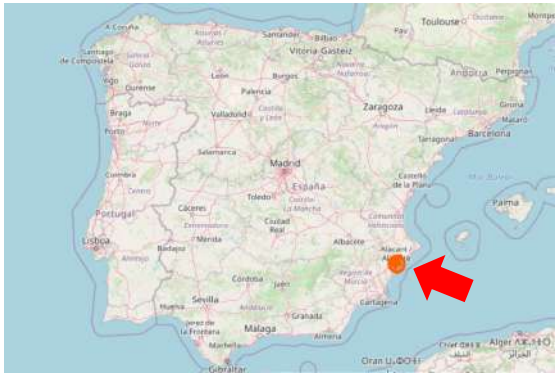
Presenters: Ignacio Casals (Aguas de Alicante) / Joao Pita Costa (IRCAI – UNESCO AI Research Institute & Jozef Stefan Institute)

DigitalWater 2020
Community of Practice

CONTENTS

- Background and motivation of the Pilot
- Use Cases for Waste Water Management
- NAIADES Water Observatory: Objectives
- Wastewater Through the Water Observatory
    - NWO Filtering News Feed
    - Exploring News & Twitter
    - Exploring Research
    - Local Statistics for Insight
- Challenges of implementation

Alicante: Background and motivation



- Alicante is a Mediterranean coastal City in the Southeast of Spain
- Pop. 335,000 inh. (> 500,000 in the summer)
- Aguas de Alicante manages all the urban water cycle:
  - Drinking water production and supply
  - Waste water collection and treatment
  - Recycled water treatment and supply
- Alicante is subject to **extreme weather events**:
  - Long drought periods
  - **Torrential rains** and **fast flood** episodes
- **Sensitive coastal waters**:
  - Economic relevance of beaches for tourism
  - Valuable sea and cost ecosystems

NAIADES: Use Cases for Waste Water Management

Sewerage Saline infiltration detection

- Detect, locate and monitor **saline infiltrations** of phreatic water into the sewer mains which cause:
  - Sewer deterioration
  - Increased waste water treatment costs
  - Barrier for waste water regeneration for reuse

NAIADES Water Observatory

- Extract **knowledge** from all available online sources
- **Real time and long term management** of the sewerage and drainage networks
- **Event** detection and analysis

NAIADES Water Observatory for Waste water: Objectives

Real Time & Short Term Operation

Nowcasting and forensic analysis of **events:**

- Large floods
- Sewer overflow and local flooding
- Waste water discharges to the sea
- Unpleasant odour episodes

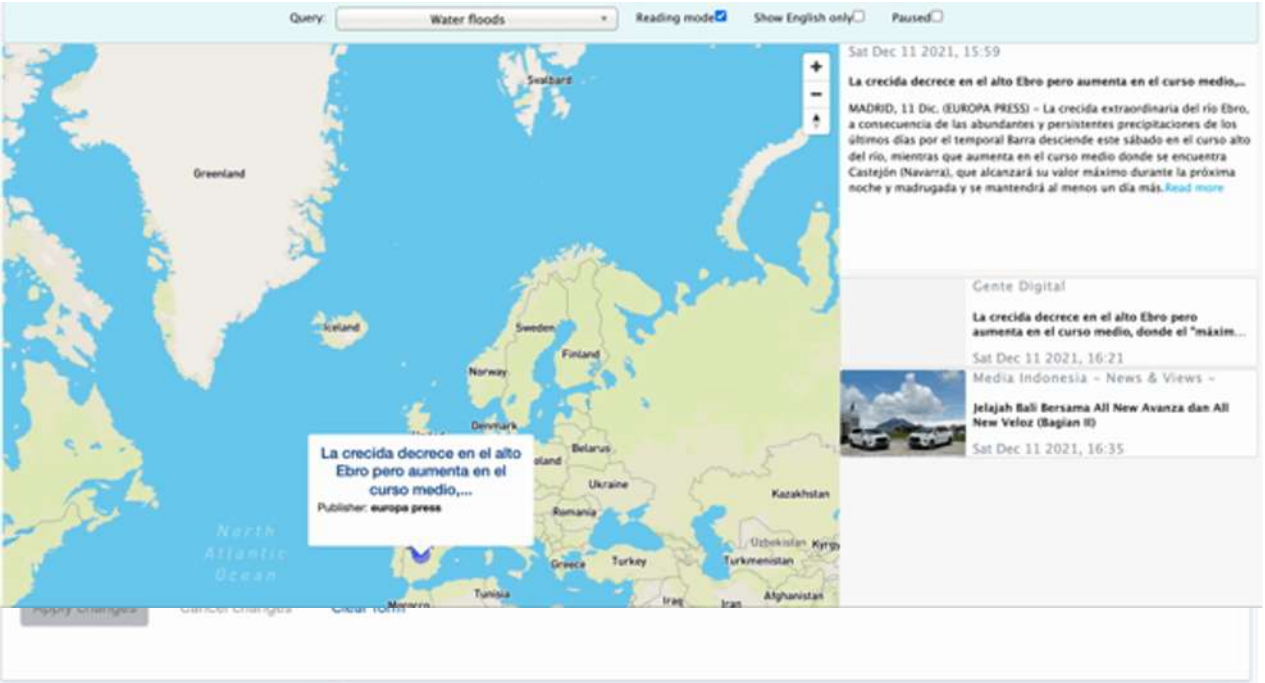
Long term & Strategic Planning

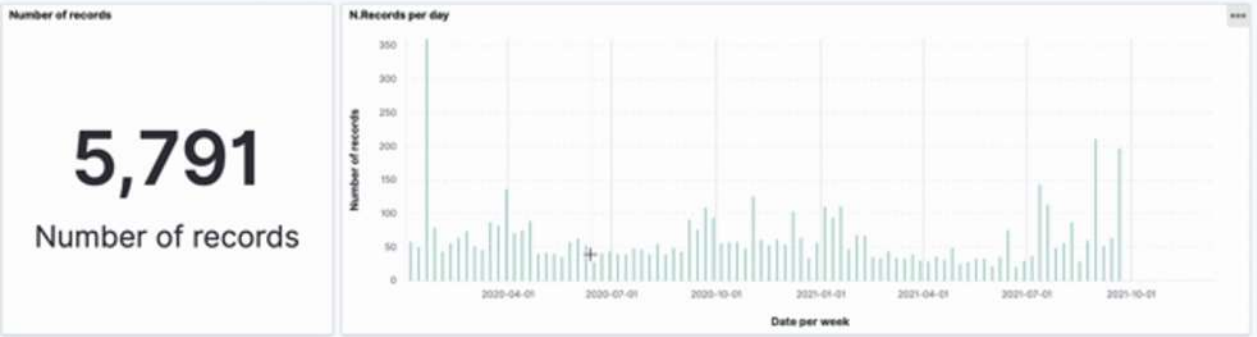
Access valuable insight on

- **Innovation** and technology trends
- Global tendencies in waste water management
- KPIs benchmarking and interrelations
- Topics of public interest

Citizen's feedback & appraisal of the water service

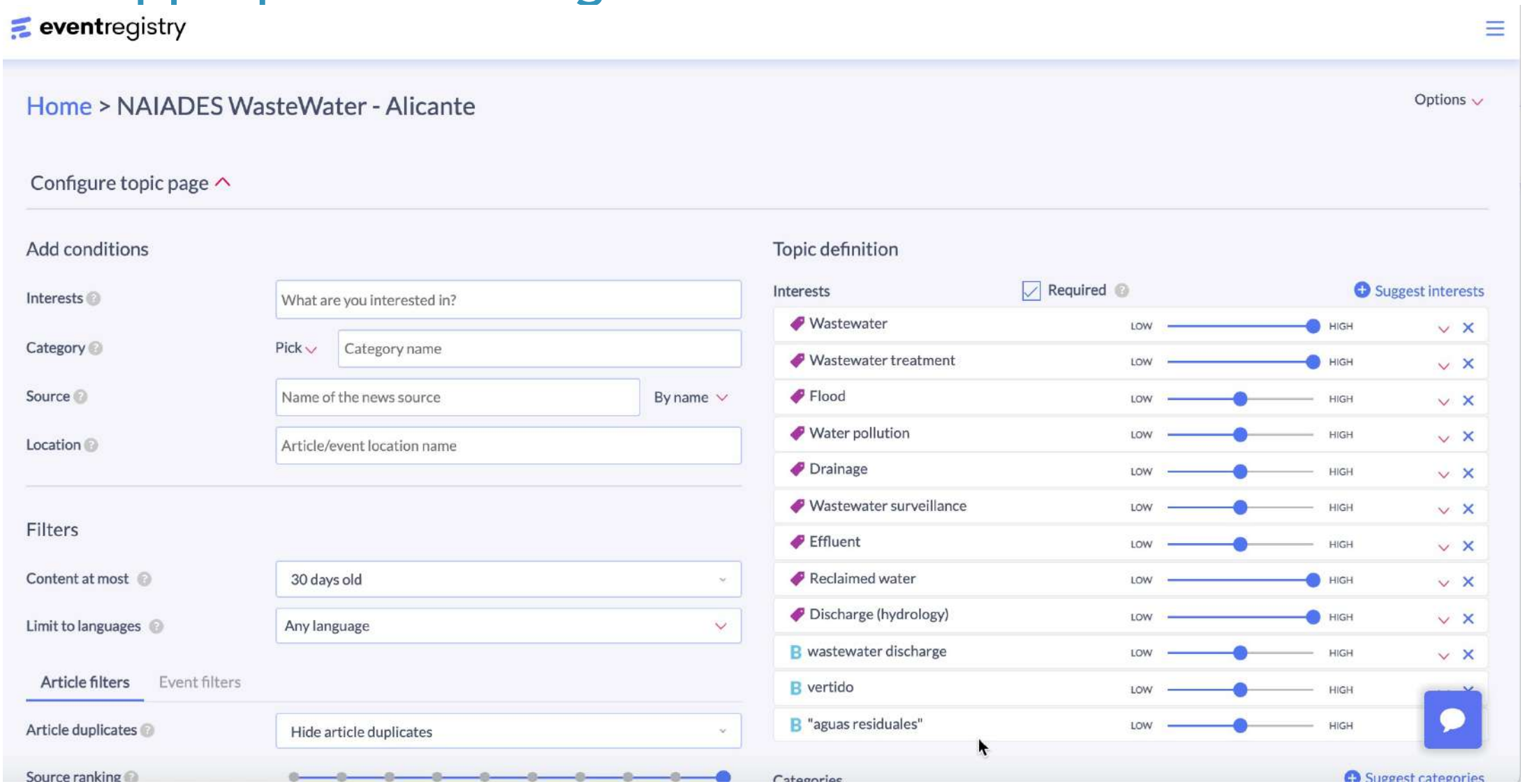
Real-time awareness of wastewater-related events





- A real-time stream of news on wastewater-related water events, e.g., floods can help us monitor specific topics
- Explore best practices from news and research worldwide using multilingual capabilities to learn from similar cases
- Twitter dashboard with data vizualisation modules for research (to explore what is useful to show)
- Nowcasting from Twitter triggered by weather can be used to define alerts based on thresholds
- We can learn relations between Twitter-News-weather to from historical events and investigate causality

An Appropriate Configuration of the News Feed



Further Exploring Wastewater News

aguas residuales OR Alcantarillado OR Inundación OR Drenaje AND alicante Provincia de Alicante, Spain

SEARCH

ARTICLES | EVENTS

Filters: Locations | Sources | Categories | From 2019-08-19 to 2019-08-31 | Any language | Misc.

List of articles (61,982 results found)

- List of Articles
- Top Concepts
- Languages
- Tag Cloud
- Timeline
- News Sources
- Article authors
- Sentiment
- Concept Graph

Note: Since the simple search mode was used, the results might mention just a subset of the entered keywords. To change the search mode, click the icon next to the Search button.

VIEW: List SORT BY: Relevance

El temporal deja un récord de lluvia en Alicante y los municipios trabajan para recuperar la normalidad

El temporal que afecta estos días a la Comunitat Valenciana ha dejado este miércoles registros históricos en la ciudad de Alicante, que ha vivido la jornada de verano más lluviosa en 160 años, ha provocado el desalojo de sus casas de seis personas en Els Poblets y El Verger y ha causado ...

20 MINUTOS
Wed, 21 Aug 2019, 19:34
Duplicate of this article

El temporal deja un récord de lluvia en Alicante y los municipios trabajan para recuperar la normalidad - Valencia Noticias

ALICANTE, El temporal que afecta estos días a la Comunitat Valenciana ha dejado este miércoles registros históricos en la ciudad de Alicante, que ha vivido la jornada de verano más lluviosa en 160 años, ha provocado el desalojo de sus casas de seis personas en Els Poblets y El Verger y ha

VALENCIA NOTICIAS
Thu, 22 Aug 2019, 09:23
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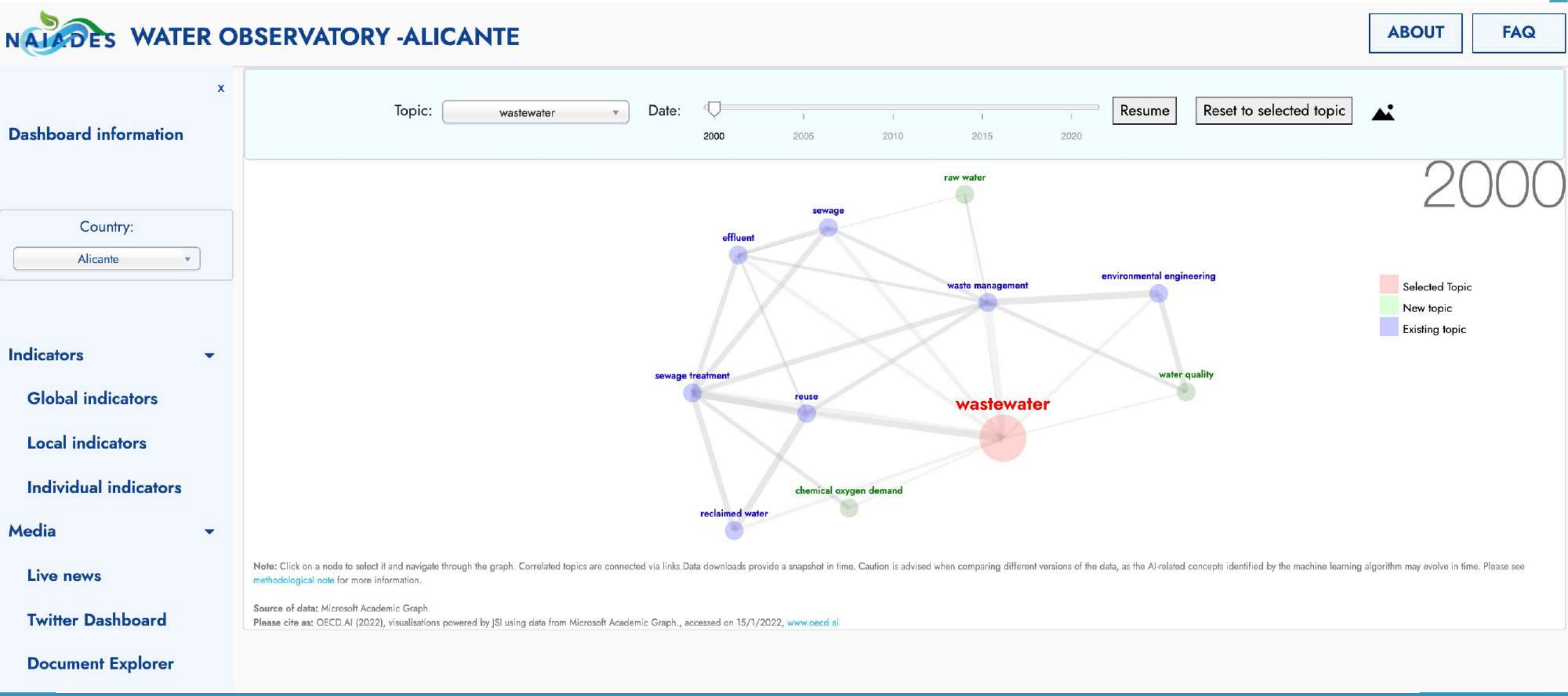
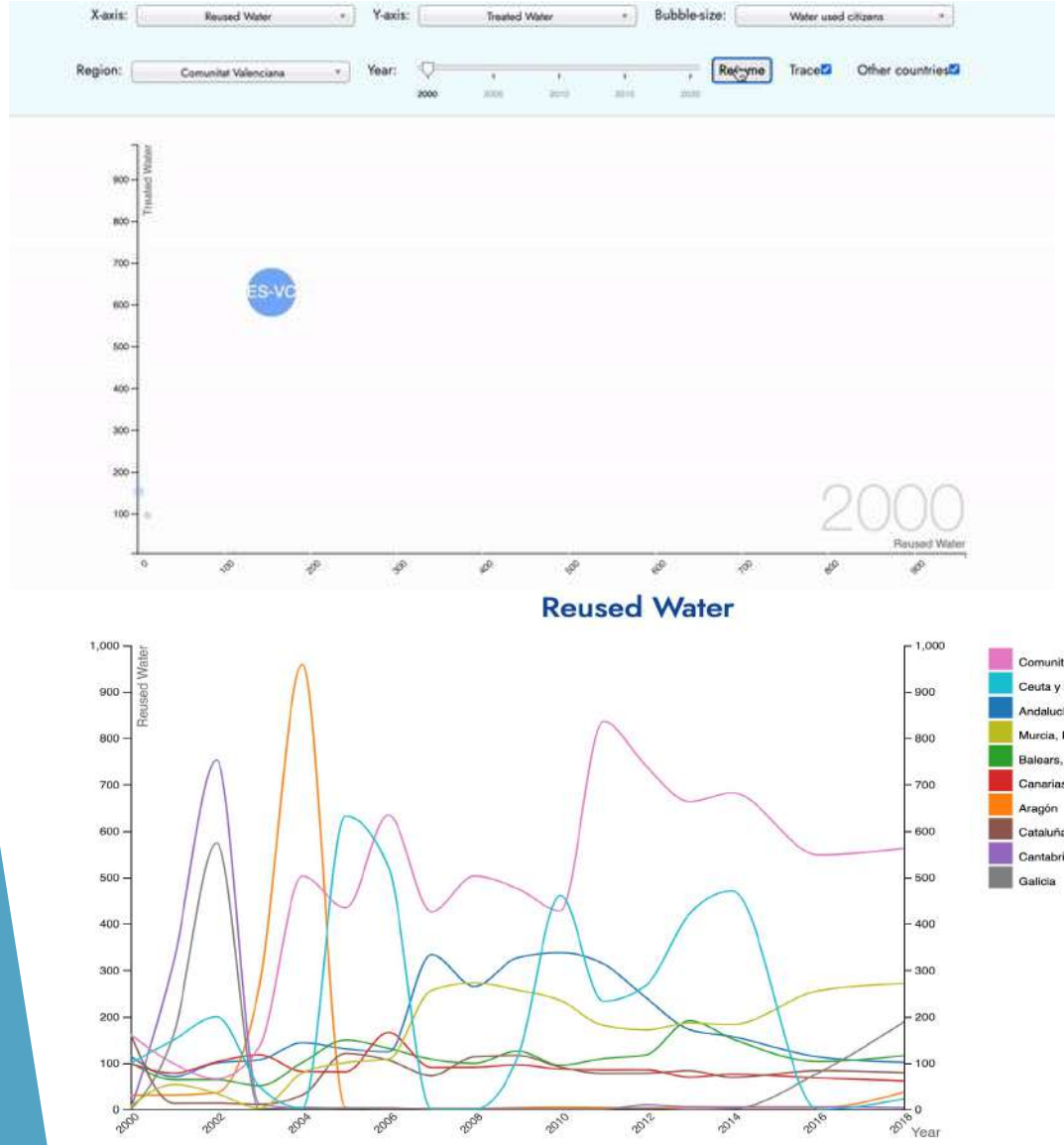
Exploring Best Practices & Innovation on Wastewater



Observing Progress Through Indicators



- Identifying relevant datasets to clean & ingest into the system allows us to understand the wastewater progress in local statistics and compare regions
- Understanding what indicators matter can be helped by the analysis of a single time series for one indicator
- We can use this data also to try and predict causality between indicators

Challenges of Implementation

- Difficulties to appropriately acquire the appropriate local statistical data to feed the Water Observatory
- Low adherence to the social media Twitter in Spain and consequent lack of data ingested
- Need to add additional local news sources that complement the information collected on water-related events
- Relevance of the configuration of the data ingested and the appropriate key phrases used to better capture the event and know what to monitor