NAIADES

Webinar Series

SMART WATER MANAGEMENT IN CITIES

Jan 28, 2022
13-16.00 CET

ONLINE

Join Us!

NAIADES Pilots

VILLE DE CAROUGE

AGUAS DE ALICANTE

COMPANIA DE UTILITATI PUBLICE DUNAREA BRAILA

NAIADES Partners

CERTH CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

Jožef Stefan Institute

MANDAT INTERNATIONAL

UNESCO IHE DELFT

UDG Alliance

Some info

This session will be entirely recorded and published on the NAIADES channels.

Feel free to post your questions in the chat.

Please feel free to share your thoughts about the workshop on Twitter, via:

@naiadesproject, using #NAIADESwebinars

Moderation by:

NAIADES Webinar Series

Anna Brékine
Mandat International

Agenda

NAIADES Webinar Series

Feedback 1: General

Introduction 15'

- **NAIADES concept and innovation:** Elpiniki Papageorgiou, Athanasios Anagnostis, *CERTH*

SESSION 1 – Smart water management through smarter, interoperable data - The NAIADES pilot in Carouge 30'

- Maurizio Rossi, *City of Carouge*
- Eunah Kim, *UDG Alliance*

Feedback 2: Carouge pilot

SESSION 2 – NAIADES' smart solutions for the urban water cycle of Alicante 30'

- Ignacio Casals, *Aguas de Alicante (AMAEM)*
- Matej Posinković, *Jožef Stefan Institute (JSI)*
- Babis Magoutas, *Institute of Communication and Computer Systems (ICCS)*

Feedback 3: Alicante feedback

SESSION 3 – Brăila 30'

- Iulian Mocanu, *CUP Braila*
- Clara Maria Corzo, *IHE Delft*

Feedback 4: Braila feedback

Feedback 5: Wrap-up feedback (not for NAIADES partners!)

Conclusion

Feedback session

Webinar Series

https://ahaslides.com/SW2022

Statement from CERTH - Coordinator

NAIADES Webinar Series

Elpiniki Papageorgiou
CERTH

Athanasios Anagnostis
CERTH

NAIADES

Webinar Series

Introduction – NAIADES concept and innovation

Elpiniki Papageorgiou, Athanasios Anagnostis, CERTH

NAIADES

Webinar Series

- **A holistic water ecosystem for digitisation of urban water sector**
- **Coordinator: Centre for Research and Technology, Hellas**
- **Beneficiaries: 18,** (8 Research Institutes, 6 SMEs, 1 University, 1 Municipality (Ville Carouge) and 2 water utilities (AMAEM, CUP Braila)
- **EU contribution: € 4,999,980.13**
- **Duration: 06/2019-05/2022**

NAIADES concept

- Smart Water Management for Sustainable Development Goals
- https://naiades-project.eu/

NAIADES supports digitization of the water sector by providing a holistic solution for the control and management of water ecosystems and sustainable and eco-friendly water management

NAIADES Objectives 1/2

NAIADES Webinar Series

- To harmonise and integrate the different water EU vocabularies and data by designing and developing the NAIADES data-driven methodology and workflow process for rapid development and deployment translational data capture tools
  - NAIADES core architecture based on FIWARE and the Orion Context Broker
  - Creation of common data models aligned with NGSI-LD (ETSI)
  - Contribution to standards; ITU-T (Y.Sup63: Unlocking IoT with AI)
  - Open Water Standards Observatory
- To support connectivity, intelligence, actuation and control features trough innovative methods and technologies for data analytics, open APIs and interoperability
  - Adoption of FIWARE standards and data models
  - Universal set of standards for context data management
  - NGSI API protocol to share data between context broker and the other components

NAIADES Objectives 2/2

NAIADES Webinar Series

- ❑ To develop an AI-driven ICT framework, AI-based models and DSS for improved water management
  - ➢ AI-based services using state-of-the-art ML and Deep Learning (water-related anomaly detection/ prediction, weather prediction, water consumption prediction, and water quality detection/prediction)
  - ➢ AI-based water quality model is developed and integrated into NAIADES platform (Carouge)
  - ➢ HMI and AI-driven DSS with main functionalities
  - ➢ Open Water Standards Observatory
- ❑ To enhance end-users awareness on water consumption
  - ➢ Water consumption Awareness Apps and Dashboards for (i) Water Management Companies officials, (ii) Public Employees (iii) Water Consumers (i.e., young persons/schools)
- ❑ To realise a holistic security and privacy toolkit for smart water management
  - ➢ A security toolkit is being developed ensuring data integrity (blockchain technology)

Pilots and developed solutions

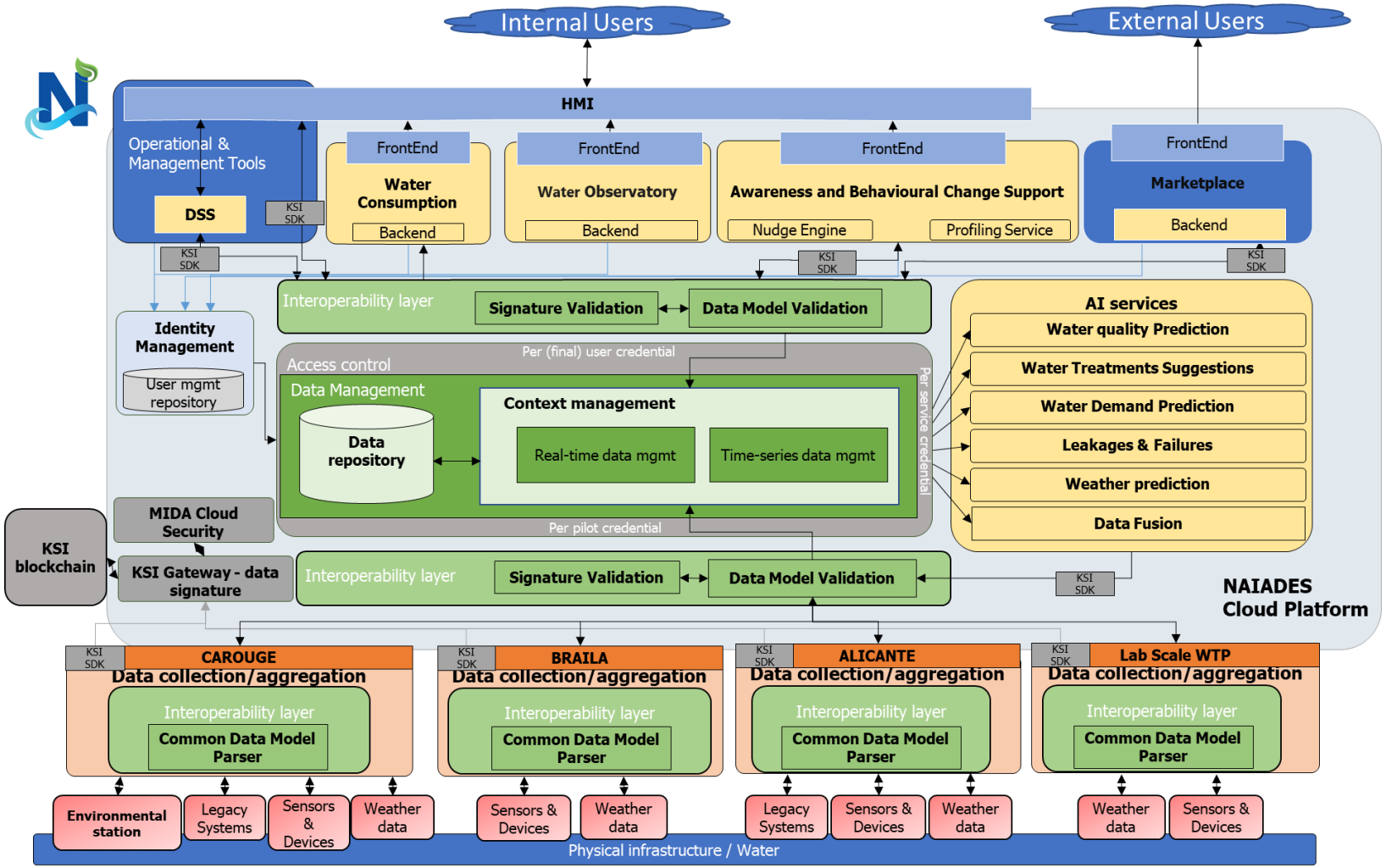
NAIADES Webinar Series

Pilots cases and solutions validation matrix

Pilot Area	Problems Addressed and NAIADES Services		
Water Utility managing the urban water cycle of Alicante and the surrounding municipalities AGUAS DE ALICANTE	- NAIADES DSS - AI consumption monitoring - Weather forecast - Water demand prediction - Data models, Open APIs and data infrastructure, Security framework **Water demand prediction**	- NAIADES DSS - Failure and leakage prediction - Weather forecast - Data models, Open APIs and data infrastructure, Security framework **Saline Intrusion Detection**	- Consumption Awareness Dashboard for Water Management Companies & Public officials - Water Consumers Awareness Dashboard - Data models, Open APIs and data infrastructure, Security framework **Water consumption awareness and Behavioural change support**
Public water company managing the water infrastructure and network in Braila and surrounding regions	- NAIADES DSS - Urban Water Models - AI consumption monitoring - Weather forecast - Water demand prediction - Data models, Open APIs and data infrastructure, Security framework **Water demand forecast**	- NAIADES DSS - Urban Water Models - Weather forecast - Failure and leakage prediction - Data models, Open APIs and data infrastructure, Security framework **Leakage reduction**	- NAIADES DSS - Water Treatment Models - Weather forecast - AI future water quality prediction - Data models, Open APIs and data infrastructure, Security framework **Treatments prediction**
City with a complete network and IT infrastructure for the Smart City that faces various water problems VILLE DE CAROUGE Le bon côté de la ville	- Consumption Awareness Dashboard for Public Employees - Weather forecast - AI consumption monitoring - Water demand prediction - Data models, Open APIs and data infrastructure, Security framework **Watering**	- NAIADES DSS - AI future water quality prediction - Weather forecast - Data models, Open APIs and data infrastructure, Security framework **Fountains**	

NAIADES Ecosystem Platform

NAIADES Webinar Series



Innovations

- ✓ Interoperable
- ✓ Modular & Scalable
- ✓ Secure

Innovation 1: Interoperable

NAIADES Webinar Series

- **Fosters communication between end-users, service providers and also other platforms in various sectors, such as Synchronicity (smart city platform), by following the standards of the water sector**

✓ Data Collectors and Aggregators (DCA) tool	→ Data ingestion of input data collected by heterogeneous sensors
✓ Common Data Models (CDM) tool	→ Integration of common water sector data into FIWARE systems and their compliance with the data model
✓ Data models Validation (DMV) tool	→ Analysis of all data pushed to the NAIADES data manager, forwarding or returning error messages depending on the correctness of their data models format

Innovation 2: Modular and scalable

NAIADES Webinar Series

- **Provides a set of state-of-the-art smart solutions with interoperability capabilities relevant to the NAIADES end-users(city managers and water utilities) for improved water management**

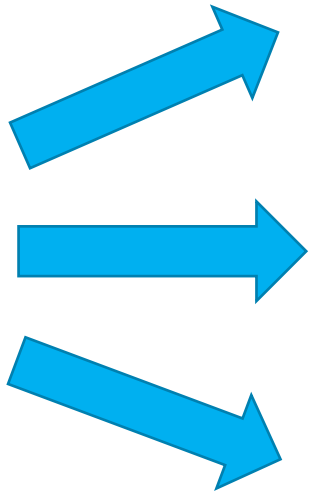
✓ Dynamical Treatments for drinking WTP	Estimates the optimal treatments for diverse quality inputs generated during extreme events
✓ Data Fusion Middleware (DFM)	Extends data pre-processing (analysing, cleansing and combining data) by filtering time-series, combining data and applying mathematical and logical operations to selected inputs
✓ Consumption Awareness Dashboard	Provides tools and mechanisms for related stakeholders to better understand available consumption data
✓ Water quality predictions for preventive measurements	Estimates the next days water quality values through data-driven water quality modelling, by taking into account weather conditions influence

Innovation 3: Secure

NAIADES Webinar Series

- Data consumers can independently validate the authenticity of the received data through the integration and deployment of privacy preserving blockchain technology into a complex water management ecosystem with different components and multiple partners

✓ KSI® blockchain technology



Provides early-warning protection for critical log and event feeds by creating an immutable audit trail which can be independently verified at any point in the future

Guarantees immutability by preserving the integrity of log events, which in turn enables detection of changes and promotes situational awareness through generated alerts

Enables EU based water utilities (10,000+) to connect with NAIADES platform and use it to compare and analyze its datasets, benefiting from technologies available to largest utilities today

NAIADES ecosystem main functionalities 1/2

NAIADES Webinar Series

1. NAIADES solutions tailored to end-users and stakeholders' requirements

- ❑ Solving current issues from three different end-users (water utilities and one city)

2. Data acquisition and management: NAIADES platform is designed to manage already anonymized data structured following NAIADES data models specifications

- ❑ Since NAIADES data models were designed based on FIWARE ones, the platform can be easily adapted to work with any FIWARE data model

3. Interoperability: NAIADES' solutions are based on a robust, secure, flexible, portable, replicable, scalable and interoperable platform

- ❑ Use of different technologies on data collection by providing data/semantic interoperability from the collected data to the final services

4. Plug-n-Play: NAIADES components are automatically informed about the installation of new devices (or the appearance of new data) associated to specific assets

- ❑ Enables components' plug-n-play functionality at platform level

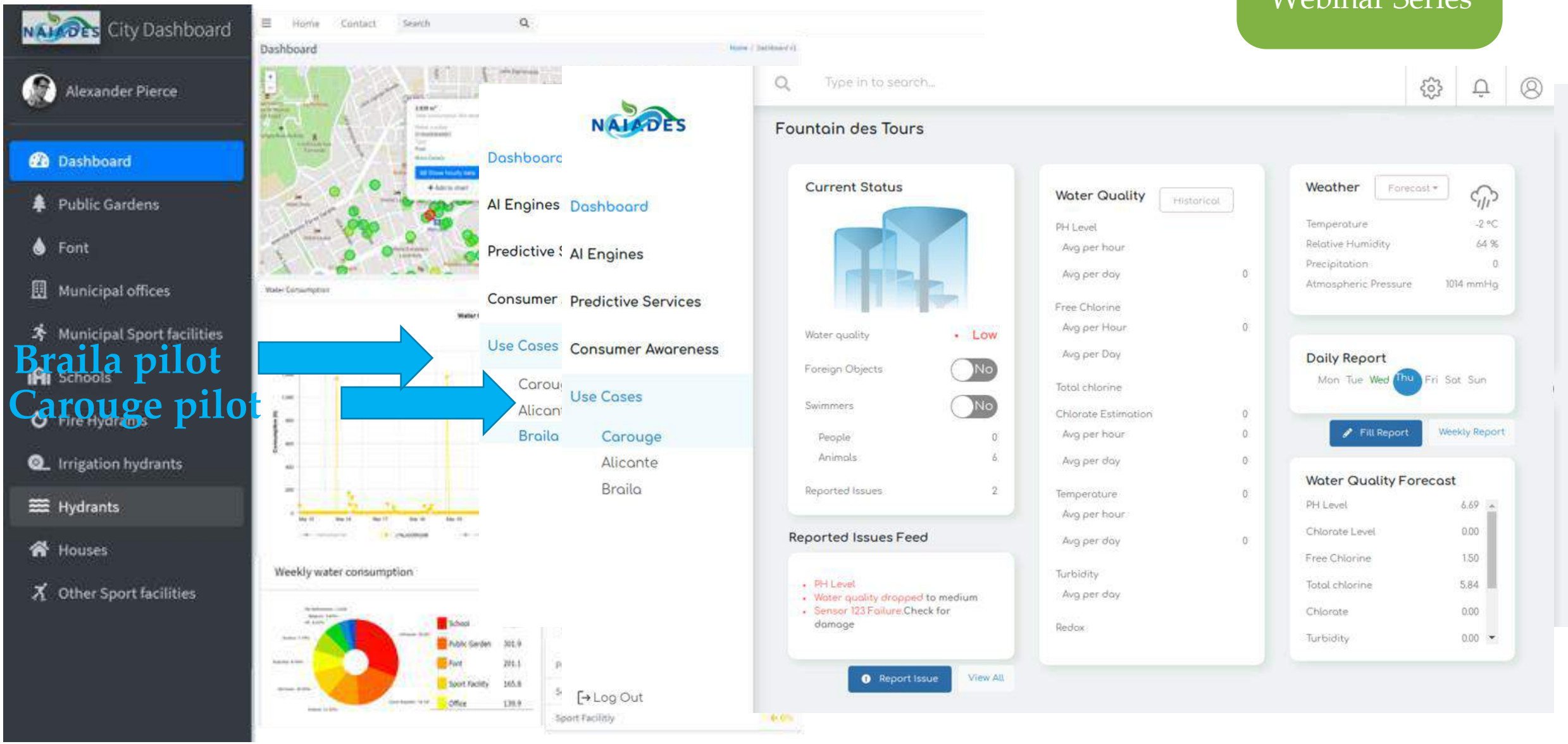
NAIADES ecosystem main functionalities 2/2

NAIADES Webinar Series

5. Effective monitoring for management of water infrastructure and staff
   - ❑ Monitoring of combined measurements from different sectors and critical water consumption
   - ❑ Supervision of water sector trends on each end-user's location
6. Data analysis/prediction of future measurements and events
   - ❑ Forecasting analysis for weather prediction, water demand & quality prediction
   - ❑ Failures and leakages
7. Decision Support System: NAIADES links each individual process and operation of the value chain
   - ❑ Process monitoring in water resources and early detection of daily details and flaws
   - ❑ Facilitation of communication between actors and stakeholders with different and roles and responsibilities
   - ❑ Maintenance procedures and requirements
8. User awareness and behavioural change support
   - ❑ Water consumption awareness for water management companies and public officials
   - ❑ Behavioural change support for inducing sustainable water use behaviours among water consumers

DSS – User Interfaces for each pilot

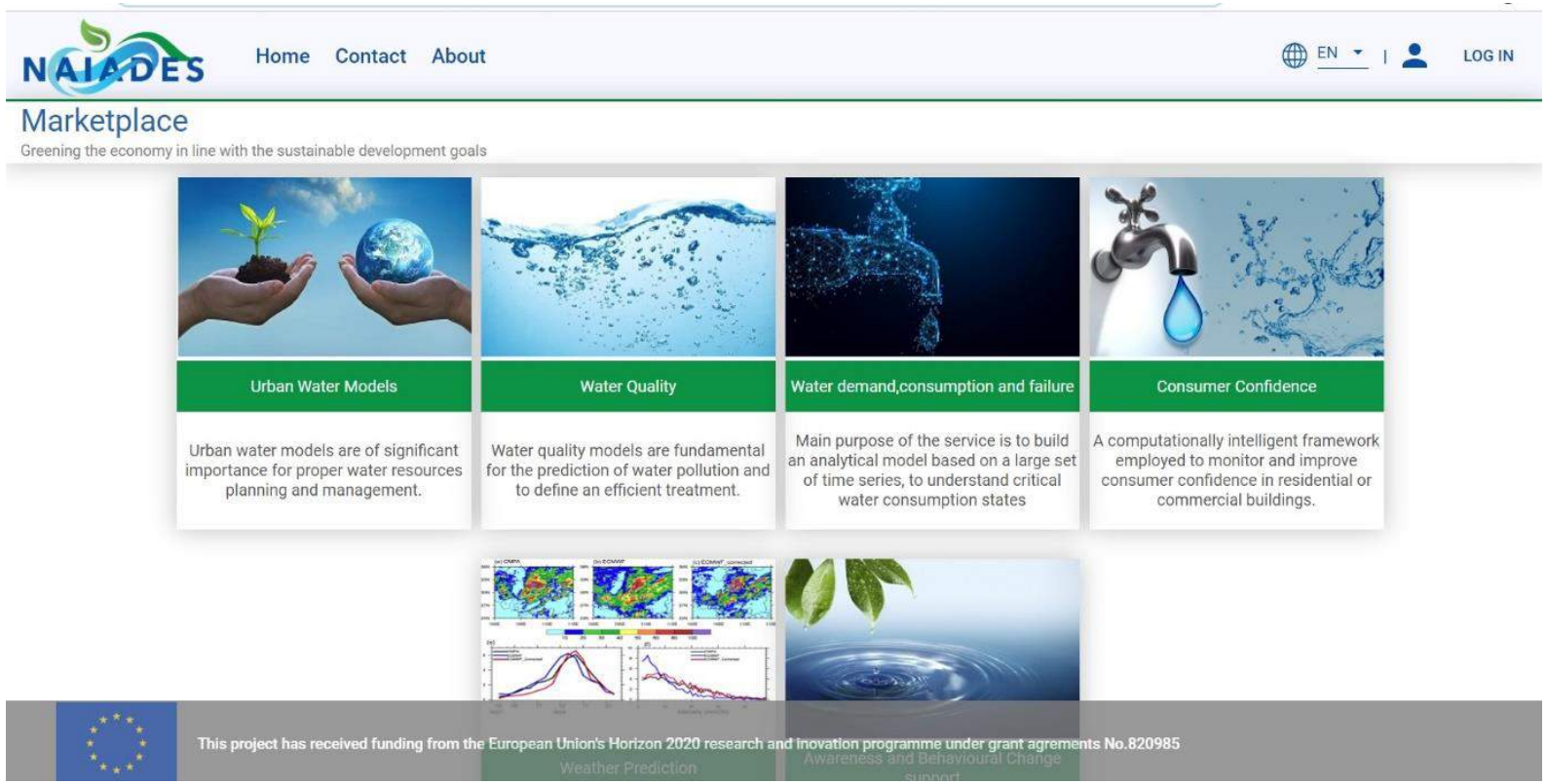
NAIADES Webinar Series



NAIADES Marketplace

Webinar Series

- **Web-based application that demonstrates existing services available at NAIADES to new end-users and service providers**



- ✓ **Available for both public and authenticated users**
- ✓ **Describes various services to external users (e.g., water processing, analysis and monitoring services)**
- ✓ **Enables integration of external applications with the presented services**

NAIADES

Webinar Series

Thank you for your attention.

NAIADES

Webinar Series

Session 1: Smart water management through smarter, interoperable data - The NAIADES pilot in Carouge

Speakers (Carouge pilot)

NAIADES Webinar Series

Maurizio Rossi
City of Carouge

Eunah Kim
UDG Alliance

NAIADES

Webinar Series

NAIADES Use cases in Carouge

Maurizio Rossi, City of Carouge

Carouge: key facts

NAIADES Webinar Series

- Located in the Geneva Canton:
  - a global financial center
  - international organizations headquarters (UNO, WHO, ITU, WMO, ILO, CICR…)
- Industries, services and about 20’000 jobs
- Fast-growing population (23’000)
- Not-as-fast-growing budget

Geographical situation

Sustainable development

NAIADES Webinar Series

- City of Carouge: efforts to wisely use natural resources and undertake sustainable actions for the environment
- Engagements and Awards: Cité de l'énergie, first Zero waste city in Switzerland
- Strong will by City Council to improve its own water usage and promote responsible water consumption
- Participation to NAIADES as one of the pilot cities is consistent with this effort
- Need for technological solutions that can help to achieve this goal
- Existing smart city infrastructure (LoRaWAN by SIG)
- Smart city pioneer, several research projects

Carouge european energy award

Cité de l'énergie

CAROUGE ZÉRO DÉCHET

FAIR TRADE TOWN CAROUGE

Water resources

NAIADES Webinar Series

- Water provided by public utility SIG
- Mostly from the lake (90%)
- 10% from deep wells.
- Water scarcity: increasingly a threat due to climate change
  - Increased episodes of draughts in the region
  - Schrinking glaciers a real issue in the mid-term
- Affected by contamination (underground water from 20% down to 10% due to perchlorates pollution)

NAIADES @Carouge

NAIADES Webinar Series

- 2 Use Cases
- Carefully identified by the city's relevant departement (SVEM)
  - Watering of flowerbeds
  - Water management in public fountains
- General Goals:
  - Decrease water usage by further optimizing it
  - Reduce the workload by improving its efficiency

Watering Use Case

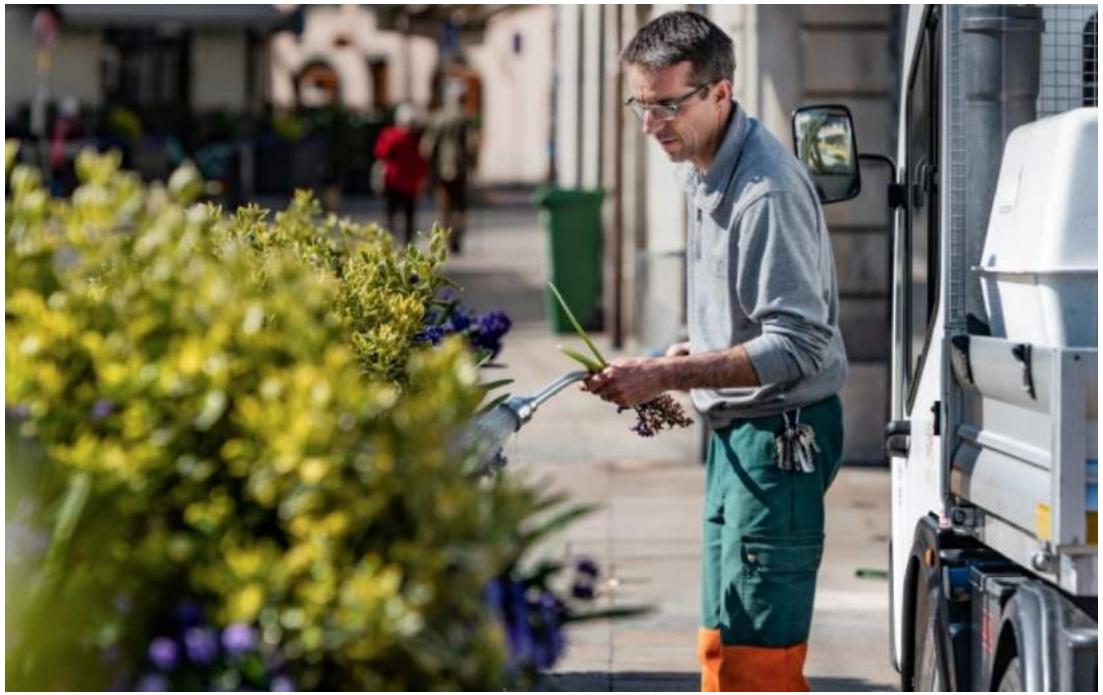
NAIADES Webinar Series

- Carouge: a blooming city
- Regularly awarded for its flowers
- 180 flowerbeds, green areas
- Focus on local species
- pesticide-free ecological urban gardening
- watering performed with electric trucks.

The problem(s)

NAIADES Webinar Series

- Manual watering of all 180 flowerbeds twice per week by staff, even more during heatwaves
- Conditions vary (type of plant and soil, location)
- Risk to use more water than actually needed, “to be on the safe side”
- Tests with commercial solutions, not fully satisfatory:
  - Lock-in solutions
  - Lack of added-value in terms of knowledge: systems tend to work like a black box; teams only get instructed what to do, and the system ignores the existing and vast know-how of the professional gardeners involved
  - Lack of data interoperability, issues with data accessibility and ownership

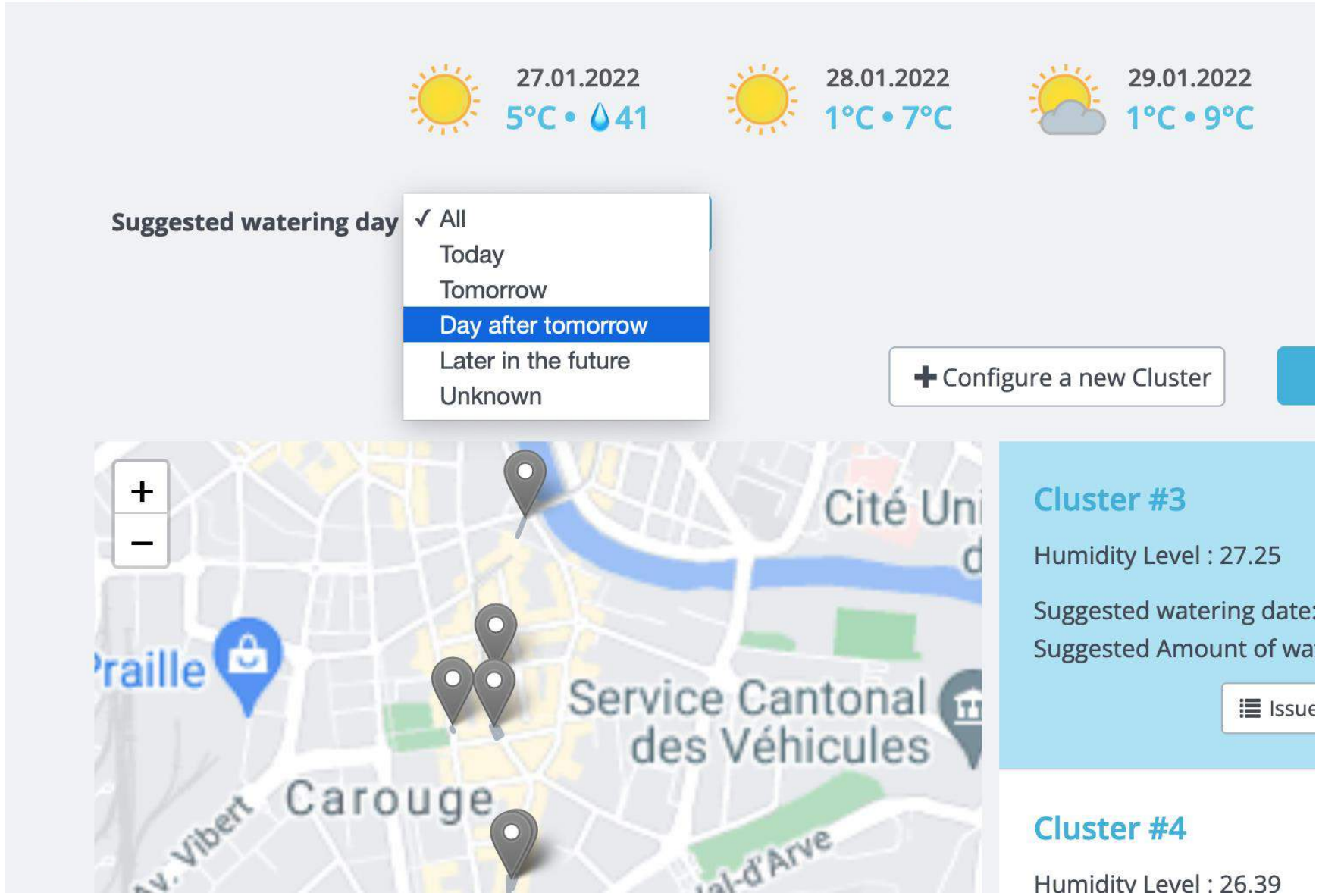


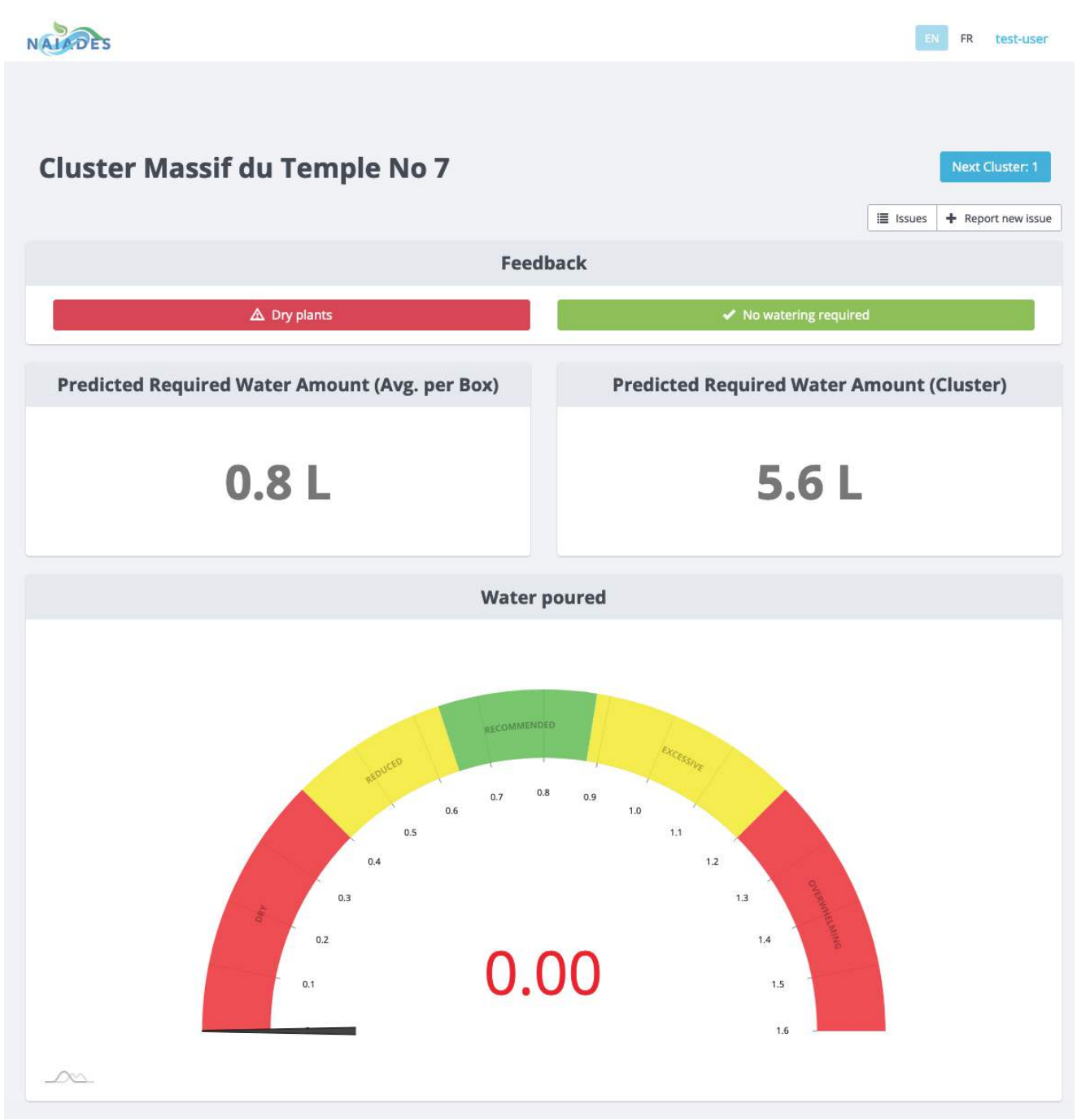
NAIADES solution for watering

NAIADES Webinar Series

In a nutshell:

- Soil sensors (clustering to avoid having too much sensors), LoRa
- Waterflow sensor on the watering truck
- AI-based predictions of required watering amounts
  - Using data from additional sources: local environmental station (several local parameters including evapotranspiration), public weather services
- Human – Machine Interface (HMI)
  - Task-oriented: assistance for watering, on the truck, via tablet
  - Administrative tasks, statistics and planning on desktop
  - Log of flowerbeds to keep track of issues
  - Suggests the optimal route based on the cluster that require watering
  - Developed with user awareness in mind
- Integration of the gardeners' feedback – leveraging the existing know-how, not trying to replace it.


27.01.2022
5°C • 41
28.01.2022
1°C • 7°C
29.01.2022
1°C • 9°C
Suggested watering day
✓ All
Today
Tomorrow
Day after tomorrow
Later in the future
Unknown
Configure a new Cluster
Cité Uni
Service Cantonal des Véhicules
Carouge
Cluster #3
Humidity Level : 27.25
Suggested watering date:
Suggested Amount of wa
Issue
Cluster #4
Humidity Level : 26.39

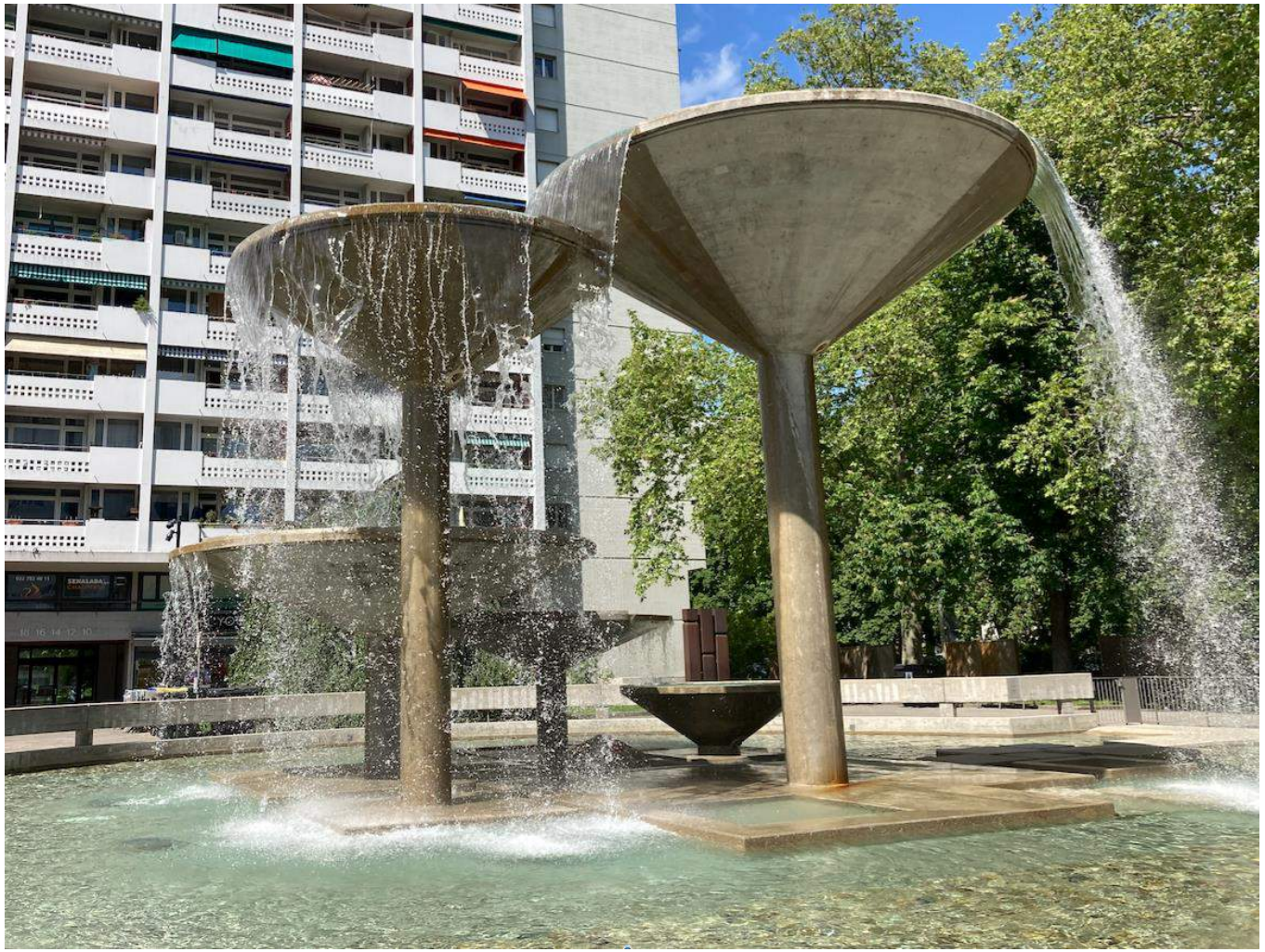


NAIADES Webinar Series

Fountain Use Case

NAIADES Webinar Series

- Iconic fountain located in the very centre of the City
- Beloved from inhabitants, especially families
- A source of refreshment during the hot summer days



Fontaine des Tours: key facts

NAIADES Webinar Series

- Using potable water from public network
- Water treated like in a swimming pool
- Additional, specific challenges
- City is responsible for the water quality
- Contamination can be an hazard for users
- When contamination is excessive, fresh water is added.
- In extreme cases, the fountain has to be closed and fully drained

The problem(s)

NAIADES Webinar Series

- Lack of continous measurements
- Limited set of parameters measured
- No sensors exist for some key parameters such as chlorates or bacteria

- High fluctuation of the measured parameters
- Situation can escalate quickly
- Early detection of issues is key

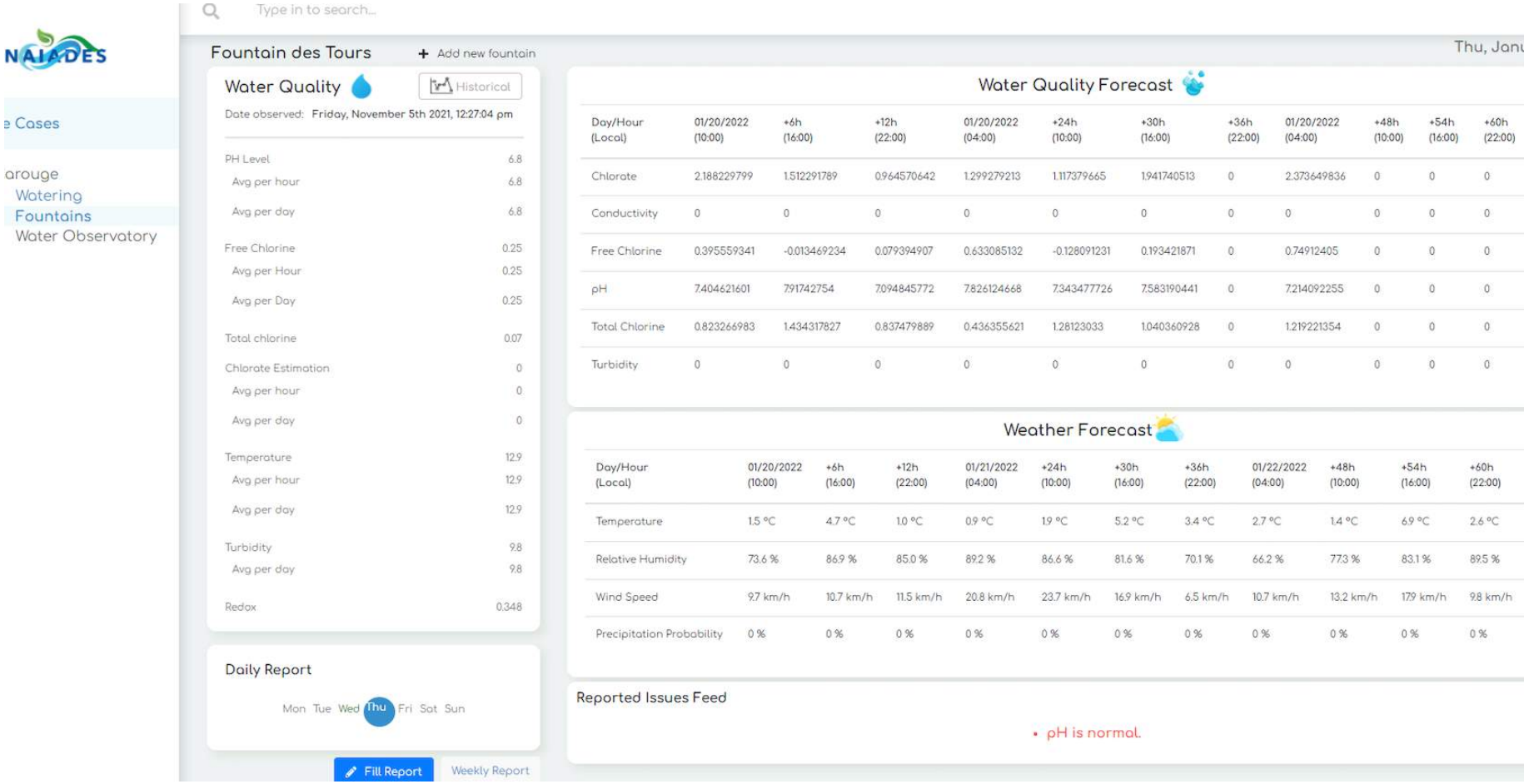
NAIADES solution for the fountains

NAIADES Webinar Series

- Integrated sensor platform with wider range of sensors, LoRa
- Novel approach to determine presence of chlorates
- AI-based water quality forecast based on measurements history
- Decision support system (DSS) based on multidimensional criteria
- HMI application for city staff and management

Goals:

- Improve awareness of water quality
- Improve sustainability by reducing the usage of freshwater and chemicals
- AI and advanced DSS to overcome the problem of the fluctuation the measured data,
- Reduce the required workload


Type in to search...
Cases
arouge
Watering
Fountains
Water Observatory
Fountain des Tours
+ Add new fountain
Thu, Jan
Water Quality
Historical
Date observed: Friday, November 5th 2021, 12:27:04 pm
PH Level 6.8
Avg per hour 6.8
Avg per day 6.8
Free Chlorine 0.25
Avg per Hour 0.25
Avg per Day 0.25
Total chlorine 0.07
Chlorate Estimation 0
Avg per hour 0
Avg per day 0
Temperature 12.9
Avg per hour 12.9
Avg per day 12.9
Turbidity 9.8
Avg per day 9.8
Redox 0.348
Daily Report
Mon Tue Wed Thu Fri Sat Sun
Fill Report
Weekly Report
Water Quality Forecast
Day/Hour (Local) | 01/20/2022 (10:00) | +6h (16:00) | +12h (22:00) | 01/20/2022 (04:00) | +24h (10:00) | +30h (16:00) | +36h (22:00) | 01/20/2022 (04:00) | +48h (10:00) | +54h (16:00) | +60h (22:00)
Chlorate | 2.188229799 | 1.512291789 | 0.964570642 | 1.299279213 | 1.117379665 | 1.941740513 | 0 | 2.373649836 | 0 | 0 | 0
Conductivity | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0
Free Chlorine | 0.395559341 | -0.013469234 | 0.079394907 | 0.633085132 | -0.128091231 | 0.193421871 | 0 | 0.74912405 | 0 | 0 | 0
pH | 7.404621601 | 7.91742754 | 7.094845772 | 7.826124668 | 7.343477726 | 7.583190441 | 0 | 7.214092255 | 0 | 0 | 0
Total Chlorine | 0.823266983 | 1.434317827 | 0.837479889 | 0.436355621 | 1.28123033 | 1.040360928 | 0 | 1.219221354 | 0 | 0 | 0
Turbidity | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0
Weather Forecast
Day/Hour (Local) | 01/20/2022 (10:00) | +6h (16:00) | +12h (22:00) | 01/21/2022 (04:00) | +24h (10:00) | +30h (16:00) | +36h (22:00) | 01/22/2022 (04:00) | +48h (10:00) | +54h (16:00) | +60h (22:00)
Temperature | 1.5 °C | 4.7 °C | 1.0 °C | 0.9 °C | 1.9 °C | 5.2 °C | 3.4 °C | 2.7 °C | 1.4 °C | 6.9 °C | 2.6 °C
Relative Humidity | 73.6 % | 86.9 % | 85.0 % | 89.2 % | 86.6 % | 81.6 % | 70.1 % | 66.2 % | 77.3 % | 83.1 % | 89.5 %
Wind Speed | 9.7 km/h | 10.7 km/h | 11.5 km/h | 20.8 km/h | 23.7 km/h | 16.9 km/h | 6.5 km/h | 10.7 km/h | 13.2 km/h | 17.9 km/h | 9.8 km/h
Precipitation Probability | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 % | 0 %
Reported Issues Feed
• pH is normal.


Historical Data
pH
8
6
4
2
0
5.11 02:46 5.11 03:14 5.11 03:36 5.11 04:04 5.11 04:26 5.11 04:54 5.11 05:16 5.11 05:44 5.11 06:06 5.11 06:34 5.11 06:56 5.11 07:24 5.11 07:46 5.11 08:14 5.11 08:36 5.11 09:04 5.11 09:27 5.11 09:54 5.11 10:17 19.1 14:34
Temperature
16
8
4
0
5.11 02:46 5.11 03:14 5.11 03:36 5.11 04:04 5.11 04:26 5.11 04:54 5.11 05:16 5.11 05:44 5.11 06:06 5.11 06:34 5.11 06:56 5.11 07:24 5.11 07:46 5.11 08:14 5.11 08:36 5.11 09:04 5.11 09:27 5.11 09:54 5.11 10:17 19.1 14:34
Turbidity
12
6
3
0
5.11 02:46 5.11 03:14 5.11 03:36 5.11 04:04 5.11 04:26 5.11 04:54 5.11 05:16 5.11 05:44 5.11 06:06 5.11 06:34 5.11 06:56 5.11 07:24 5.11 07:46 5.11 08:14 5.11 08:36 5.11 09:04 5.11 09:27 5.11 09:54 5.11 10:17 19.1 14:34
Chlorine

Smart data, smarter water management

NAIADES Webinar Series

- Smart cities increasingly ubiquitous
- Data, including from smart cities, more and more important
- Many existing solutions are limited in scope, tend to store data in silos
- Validity of the holistic approach, how to scale it up?
- Interoperability

NAIADES

Webinar Series

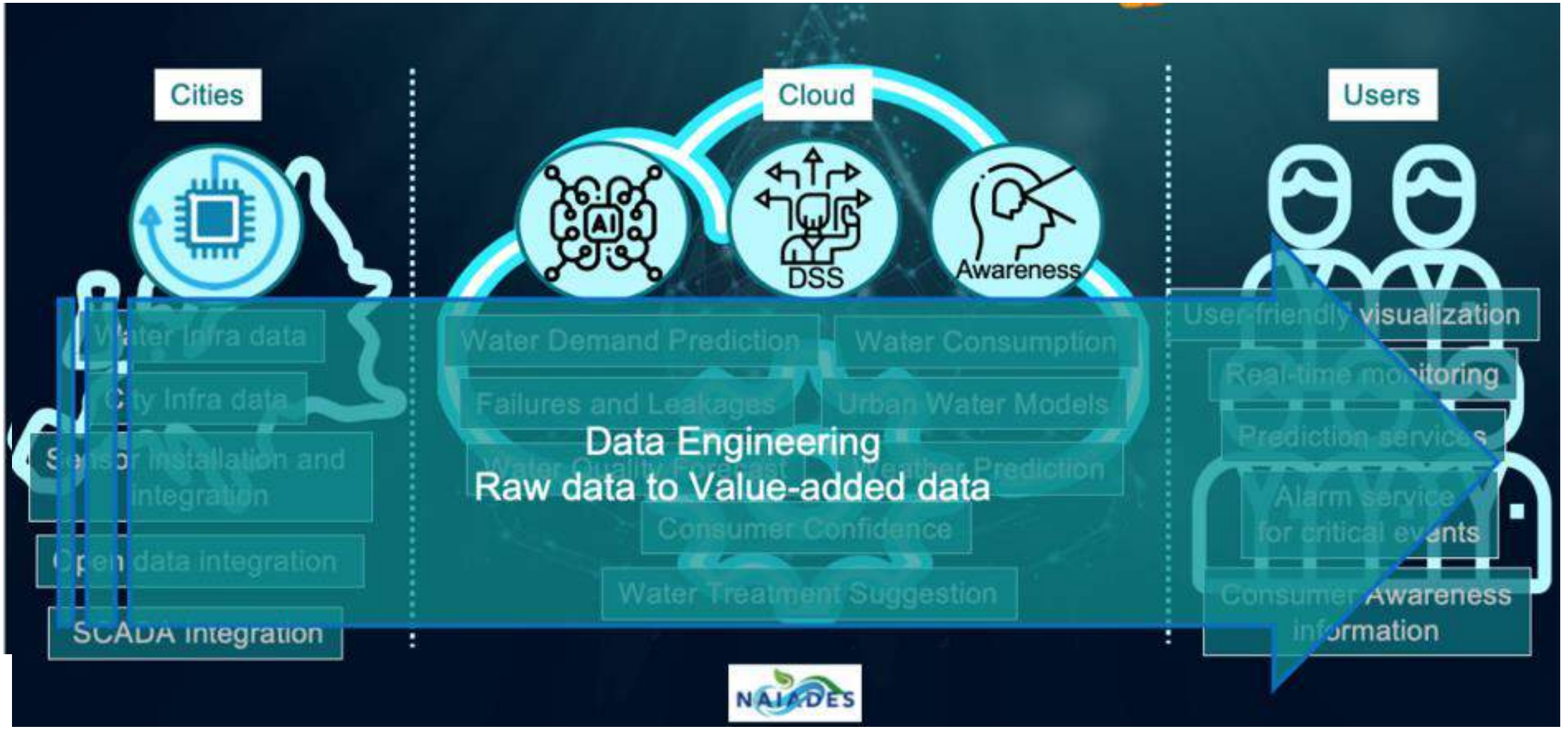
NAIADES IoT Platform:

Data interoperability is the key

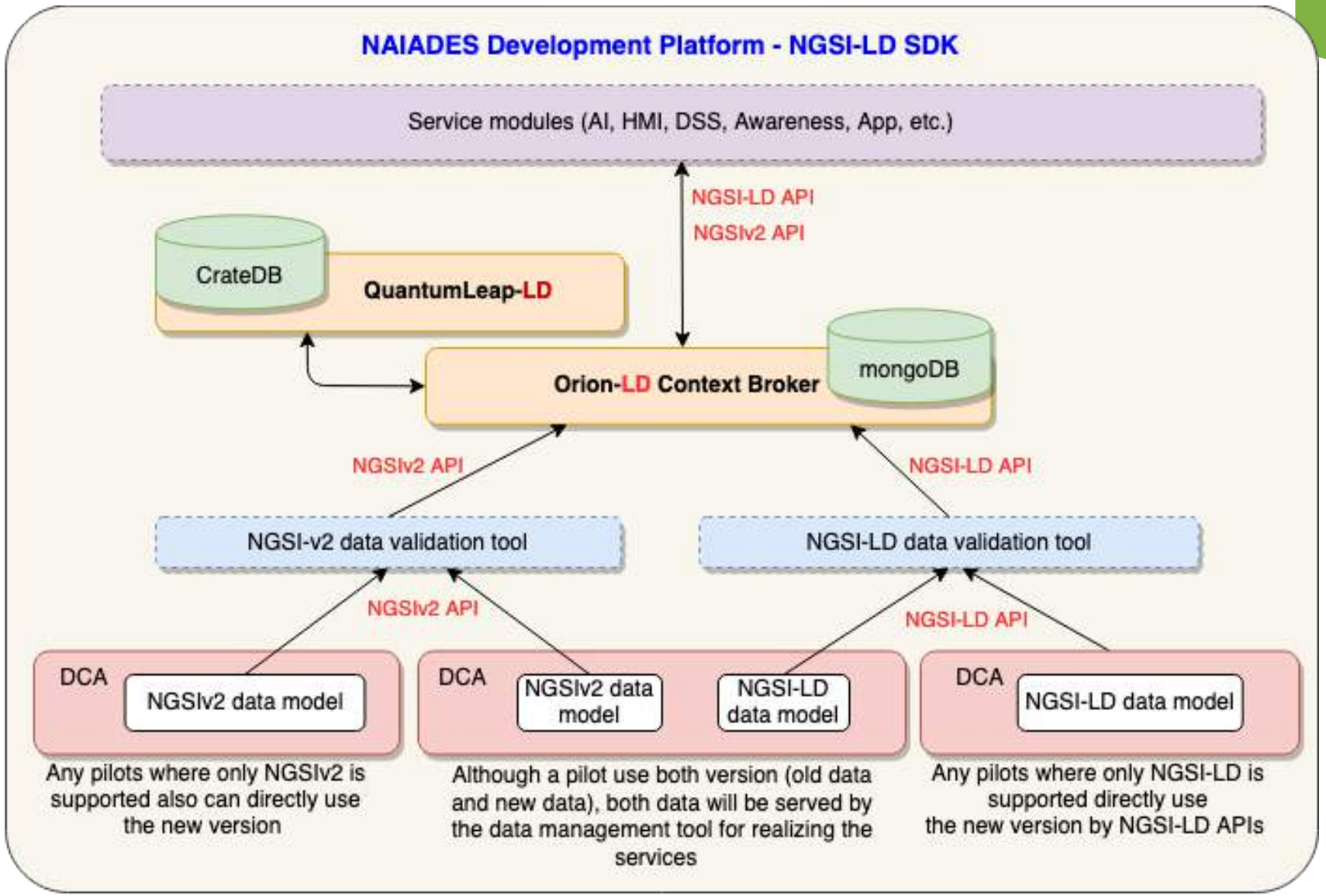
Eunah Kim, UDGA Alliance

Objective of NAIADES Data Management

NAIADES Webinar Series



NGSI-LD


NAIADES Development Platform - NGSI-LD SDK
Service modules (AI, HMI, DSS, Awareness, App, etc.)
NGSI-LD API
NGSIv2 API
CrateDB
QuantumLeap-LD
Orion-LD Context Broker
mongoDB
NGSIv2 API
NGSI-LD API
NGSI-v2 data validation tool
NGSI-LD data validation tool
NGSIv2 API
NGSI-LD API
DCA
NGSIv2 data model
DCA
NGSIv2 data model
NGSI-LD data model
DCA
NGSI-LD data model
Any pilots where only NGSIv2 is supported also can directly use the new version
Although a pilot use both version (old data and new data), both data will be served by the data management tool for realizing the services
Any pilots where only NGSI-LD is supported directly use the new version by NGSI-LD APIs

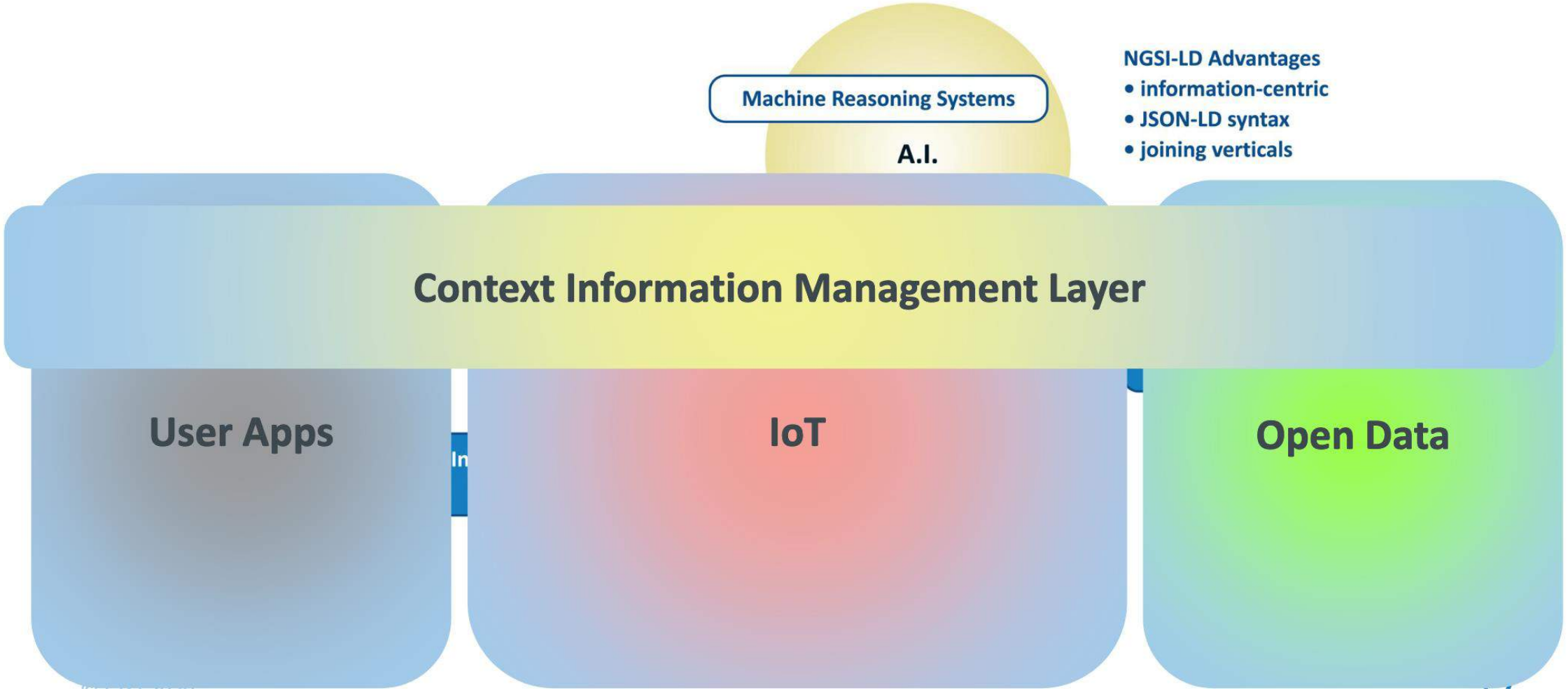
Standard data models

NAIADES Webinar Series

Use case	Data type	Data source	Type of Data Model	NAIADES extension
Watering of urban garden	Soil Moisture	Sensors (field)	Device (NGSI-LD and NGSIv2) FlowerBed (NGSI-LD and NGSIv2)	No Yes
	Water Flow	Sensor (field)	Device	No
	Weather data	Open data (DCA) Prediction (AI)	WeatherObserved (NGSI-LD and NGSIv2) WeatherForecast (NGSI-LD and NGSIv2)	No
		Environmental Station (field)	WeatherObserved (NGSI-LD and NGSIv2)	No
Water quality management of the fountains	Water quality	Sensors (field)	WaterQualityObserved (NGSI-LD and NGSIv2)	Yes
		Predictions (AI)	WaterQualityForecast (NGSI-LD and NGSIv2)	Yes

Why NGSI-LD?

Information-centric with developer-friendly NGSI-LD



Context Broker

What is the Context Broker

Enable Organizations – from public administration to business - to collect, manage and share context information

A system able to inform in right time what is currently happening

Context information support the adoption of smart decision

Objective 1

Managing Real time Data gathered from the different vertical systems within an organization generating a holistic view on what is currently going on within the organization.

Objective 2

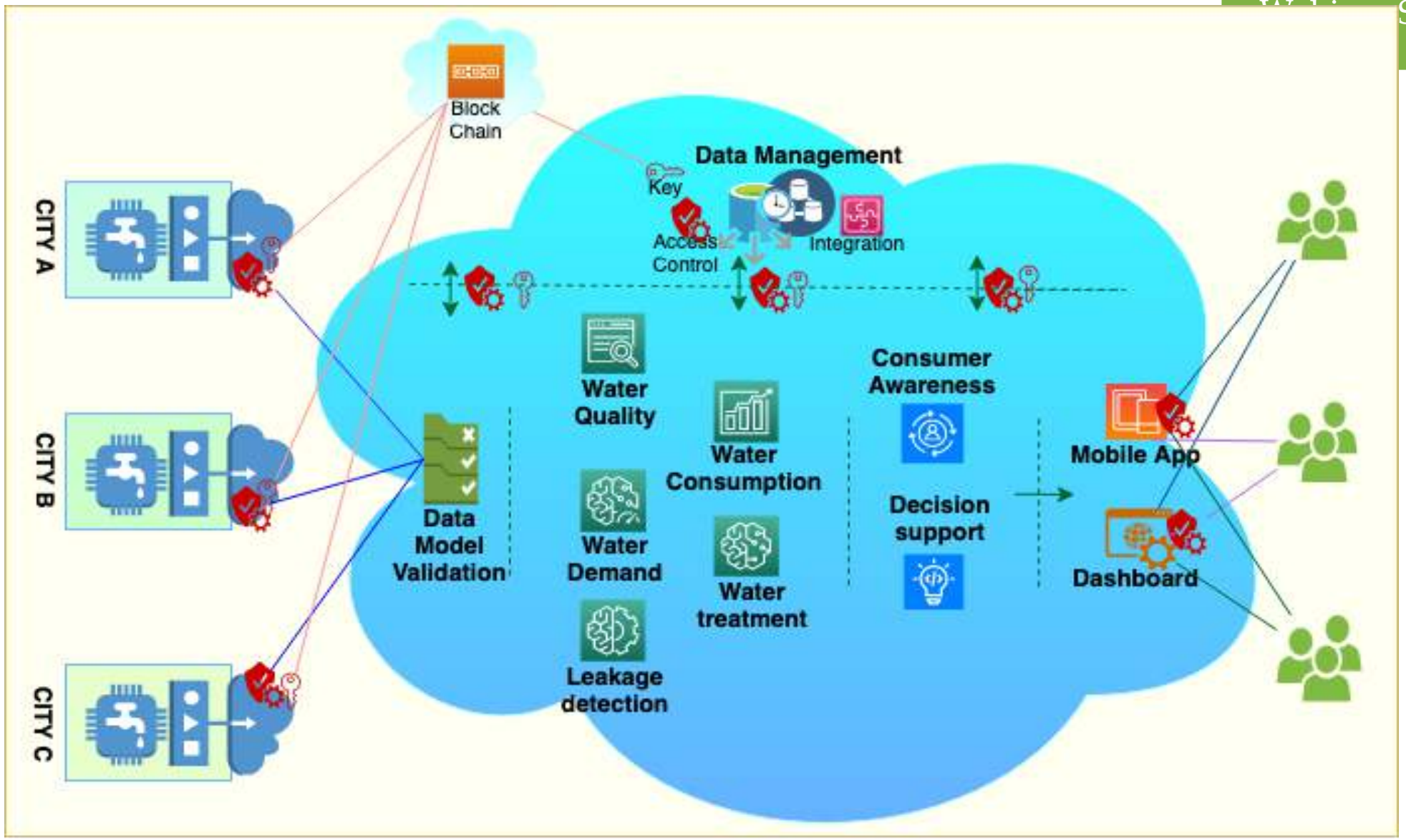
Processing and analysis of data, referred as context information bringing support to take smart decisions or make smart automation of certain processes.

Objective 3

Core component for Open platform standards easing the development of smart solutions for collecting, managing and sharing context information.

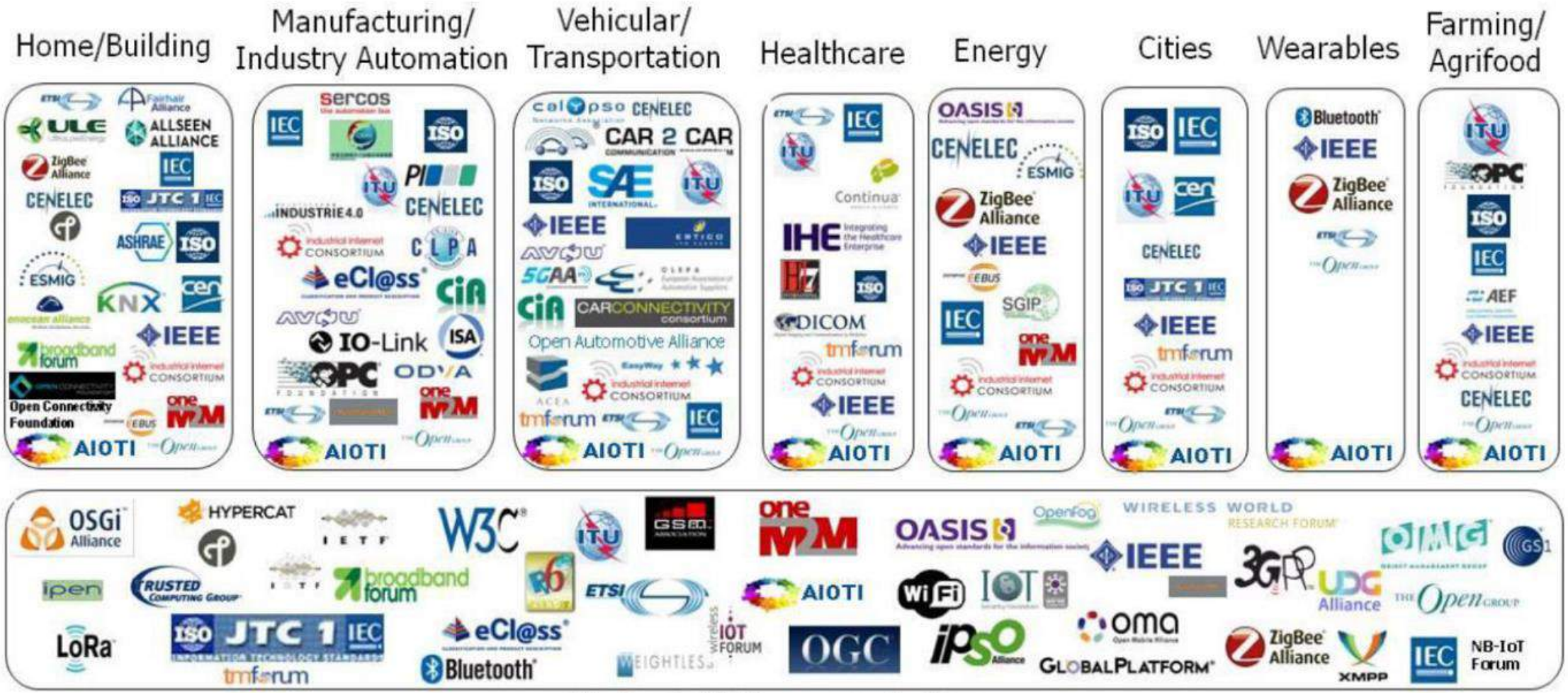
12

NAIADES IoT Cloud Platform



Why Interoperability?

NAIADES Webinar Series



Source: AIOTI WG3 (IoT Standardisation) – Release 2.7

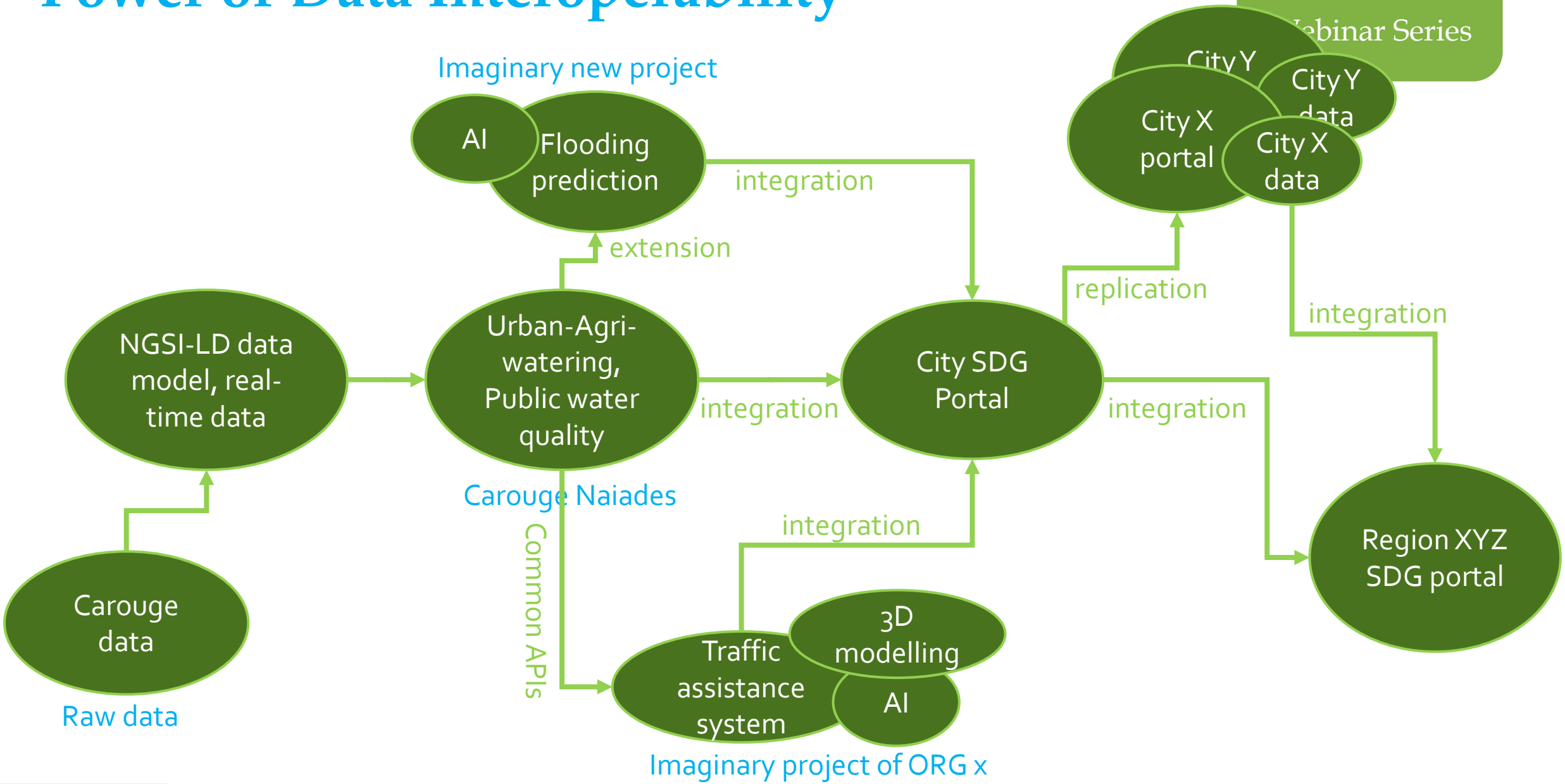
ICT4Water roadmap

References

- INTEROPERABILITY & STANDARIZATION **(I&S)**
- DATA SHARING **(DS)**
- SMART WATER **(SW)**
- CYBER-SECURITY **(CS)**
- ACTORS AWARNESS - WATER & DIGITAL **(AW)**
- POLICY **(POL)**
- BUSINESS MODELS **(BM)**

Source:ict4water

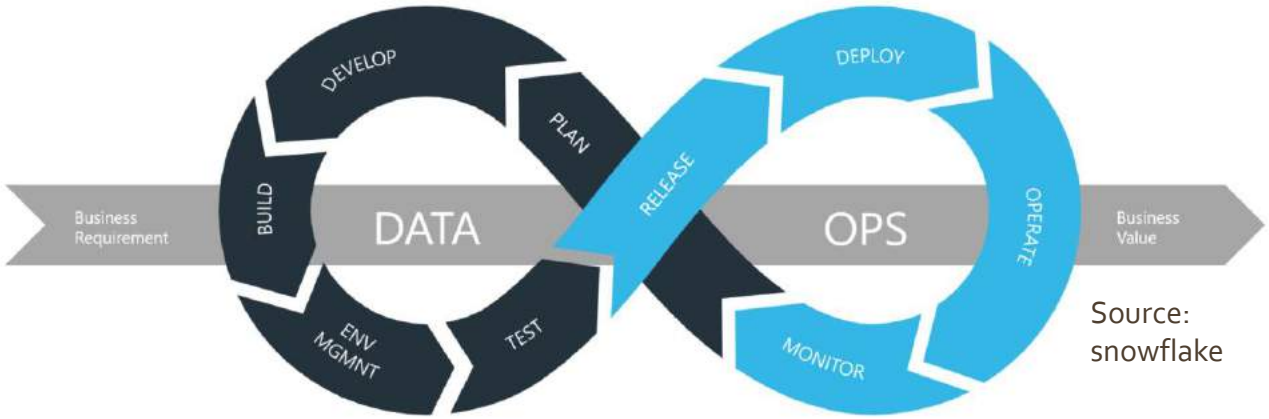
Power of Data Interoperability



Advantages

NAIADES Webinar Series

- Open Standard APIs
- Common Data models with large EU communities
- Semantic interoperability
- Data distribution (cloud – edge)
- Trust
- Customer-oriented solution
- Easy to extend and replicate
- Fit to the EU Data policy



Source: snowflake

Feedback session

NAIADES Webinar Series

https://ahaslides.com/SW2022

NAIADES

Webinar Series

Session 2: NAIADES' smart solutions for the urban water cycle of Alicante

Speakers (Alicante pilot)

NAIADES Webinar Series

Ignacio Casals
Aguas de Alicante (AMAEM)

Matej Posinković
Jožef Stefan Institute (JSI)

Babis Magoutas
Institute of Communication and Computer Systems (ICCS)

NAIADES

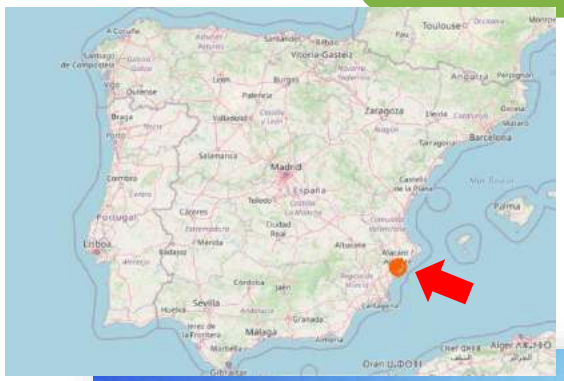
Webinar Series

NAIADES' Use Cases in Alicante: Context and Objectives

Ignacio Casals, Aguas de Alicante (AMAEM)

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
- No local water resources → Relevance of **Water Reuse** for the sustainability of water resources
- Sensitive coastal waters



Use Case 1: Water Demand Forecast

NAIADES Webinar Series

Rationale of the Use Case

- **Short term** (1-7 days) water demand forecast is needed for operational purposes
  - Water production (→ energy consumption optimization)
  - Water volume to be stored in tanks
  - Anomaly (Leak) detection
- **Long term** (>1 month)
  - Operational planning (e.g. raw water purchase, production)
  - Financial planning

Use Case 1: Water Demand Forecast

NAIADES Webinar Series

Water consumption

- Data from district meters
- Historic (6 years) and present hourly records

Inputs

Weather data

Forecast

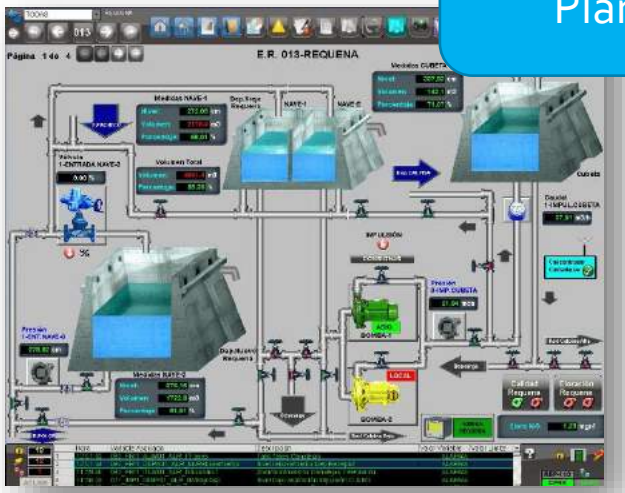
Long Term Planning

Short Term Planning

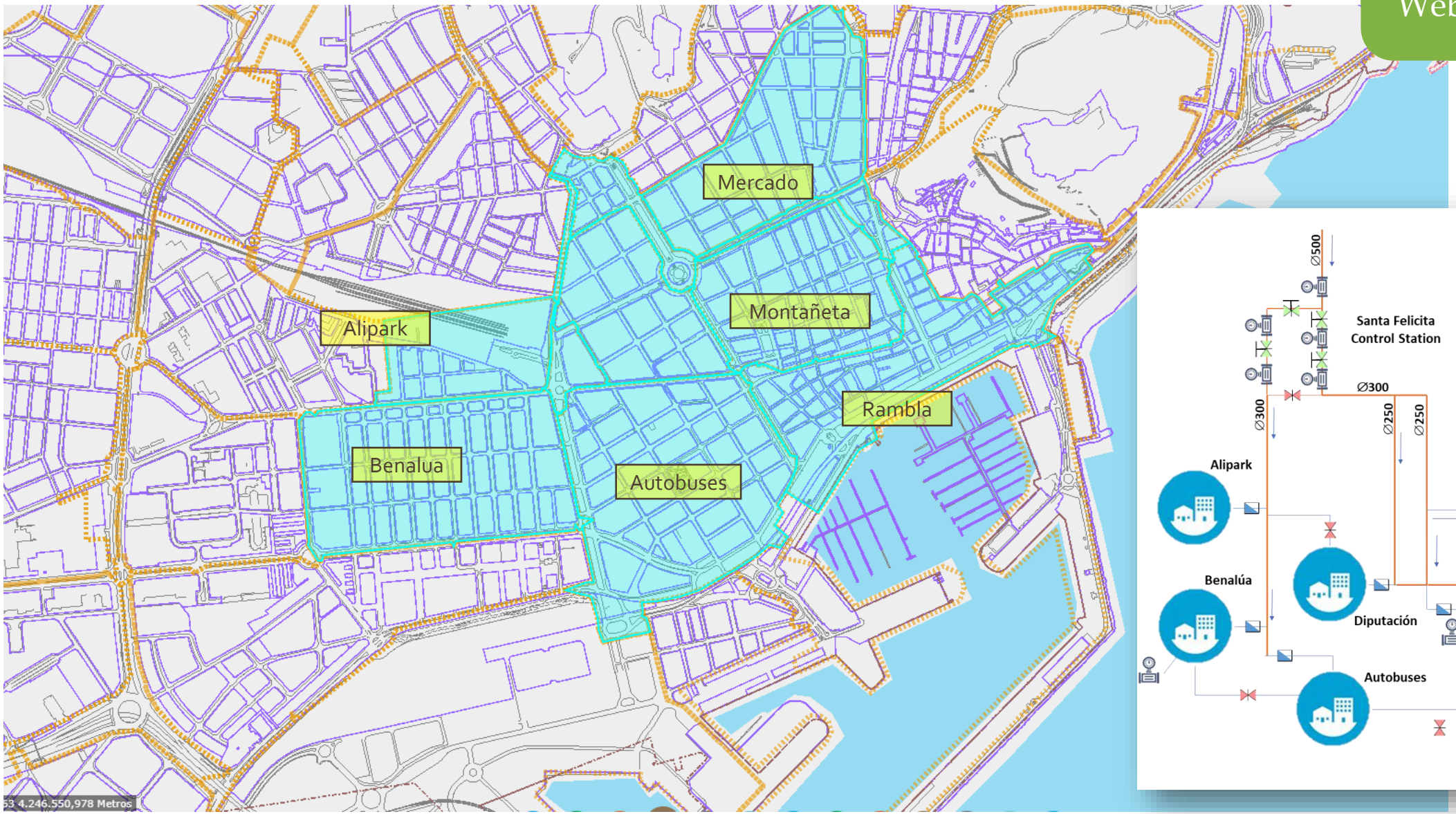
Forecast vs Real Demand

Anomaly Detection

Pilot in 7 District Metered Areas



Use Case 1: Water Demand Forecast



Use Case 2: Detection of saline intrusion

NAIADES Webinar Series

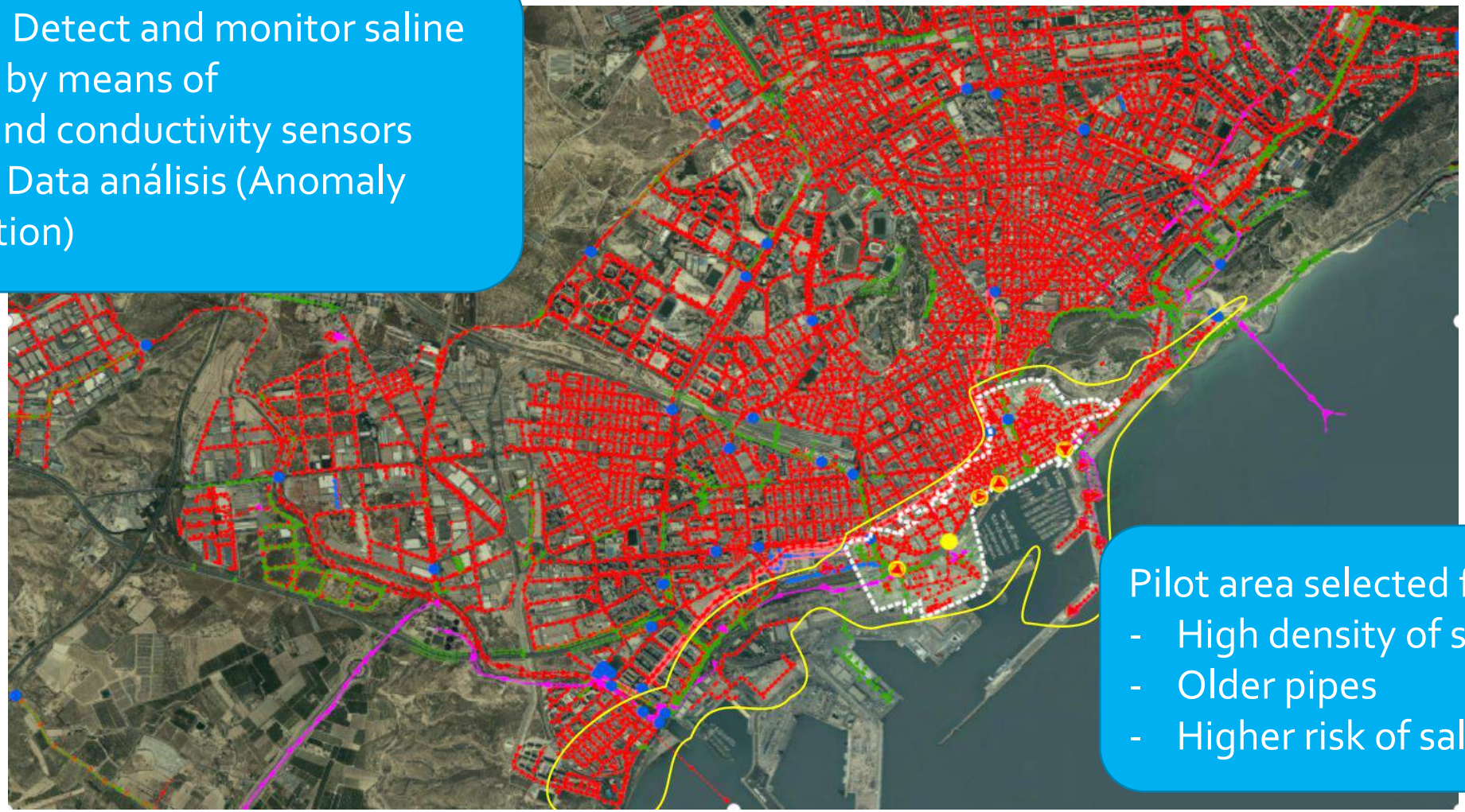
Rationale of the Use Case

- Saline intrusión to the sewarage amounts to **12%** of the water that gets to the Waste Water Treatment Plant
- Energy costs of Waste water treatment: 0,5 kWh/m3
- Energy costs of Water Recycling: 0,9-1,25 kWh/m3
- The estimated total economic cost of saline intrusion in Alicante's sewarage amounts to **1M€/year**
- Furthemore, salinity limits the **quantity and quality** of recycled water
- This problem is shared by most coastal cities in Europe

Use Case 2: Detection of saline intrusion

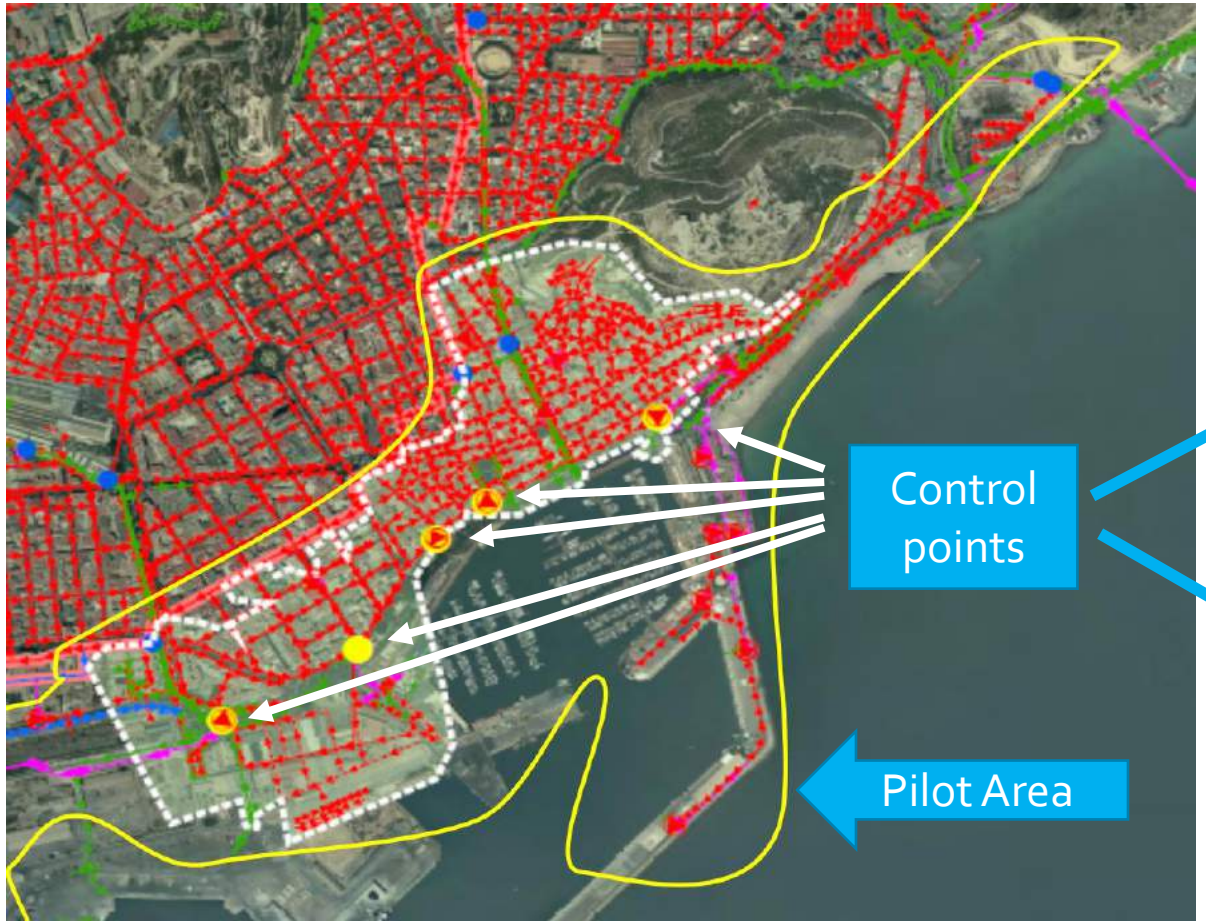
NAIADES Webinar Series

Objetive: Detect and monitor saline intrusión by means of
- Flow and conductivity sensors
- Smart Data análisis (Anomaly Detection)



Pilot area selected for
- High density of sewer mains
- Older pipes
- Higher risk of saline intrusion

Use Case 2: Detection of saline intrusion



Water level

Inlet Conductivity

Anomaly detection

Spatial analysis

Infiltration Location

Use Case 2: Municipal Consumption

NAIADES Webinar Series

Rationale of the Use Case

- Municipal (public) consumption accounts for 10% of urban consumption in Spain
- Large potential for consumption reduction
- Most consumption points equipped with **Smart Water Meters** for remote reading

- **BUT** the high number of consumption points (>500 in Alicante) hinders their effective control
- Many factors involved in the interpretation of data (type, size, users…)
- Need for awareness campaigns based on real data

Use Case 2: Municipal Consumption

NAIADES Webinar Series

Hourly metered consumption per point
- Present (last days)
- Historic record

Context Information
- Type (garden, school…)
- Normalization
  - Number of users
  - Size (gardens)

Municipal Water Consumption Dashboard
- Consumption evolution
- **Normalized** consumption ranking (per type)
- Map view
- Comprehensive insight & **understanding** of the consumption

School Awareness Dashboard
- Tool to boost the students' awareness on their water consumption **through real data**
- Tested on a Water Efficient Consumption Contest for Schools ("The Water Watchers")

NAIADES

Webinar Series

Alicante use case

Matej Posinković, Jožef Stefan Institute (JSI)

Intro

Webinar Series

Presenting two use cases:

- UCA1: Water consumption prediction
- UCA2: Anomaly detection

UCA1: Why?

- Water abstraction far from Alicante:

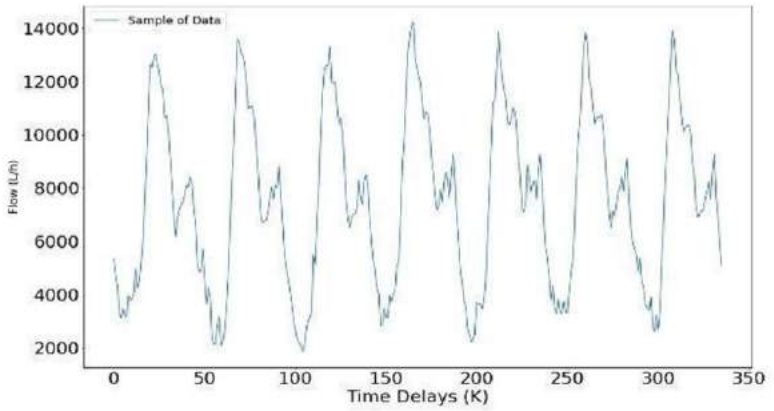
- Current predictions done in Excel:

- Water losses == Energy losses == Financial losses

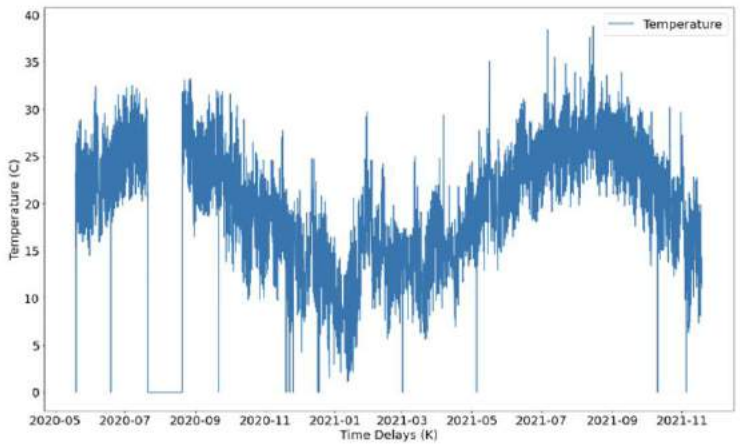
UCA1: How?

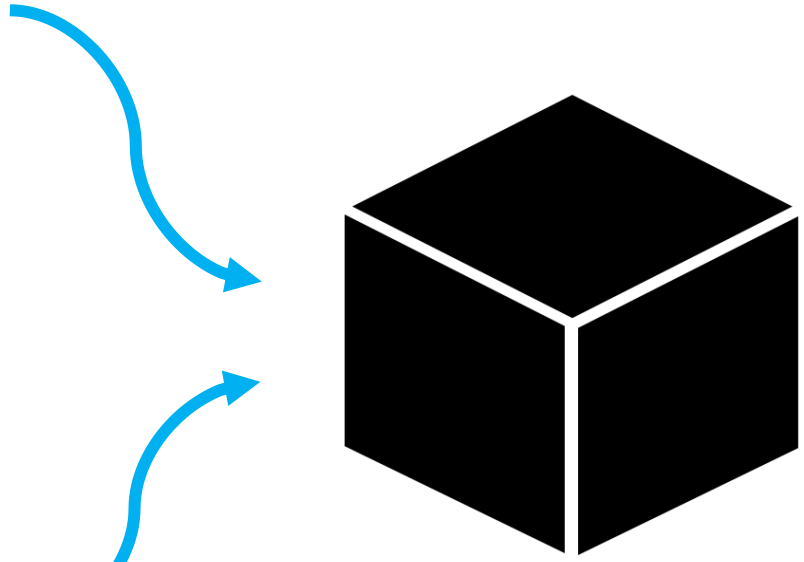
NAIADES Webinar Series

Time series



Weather data

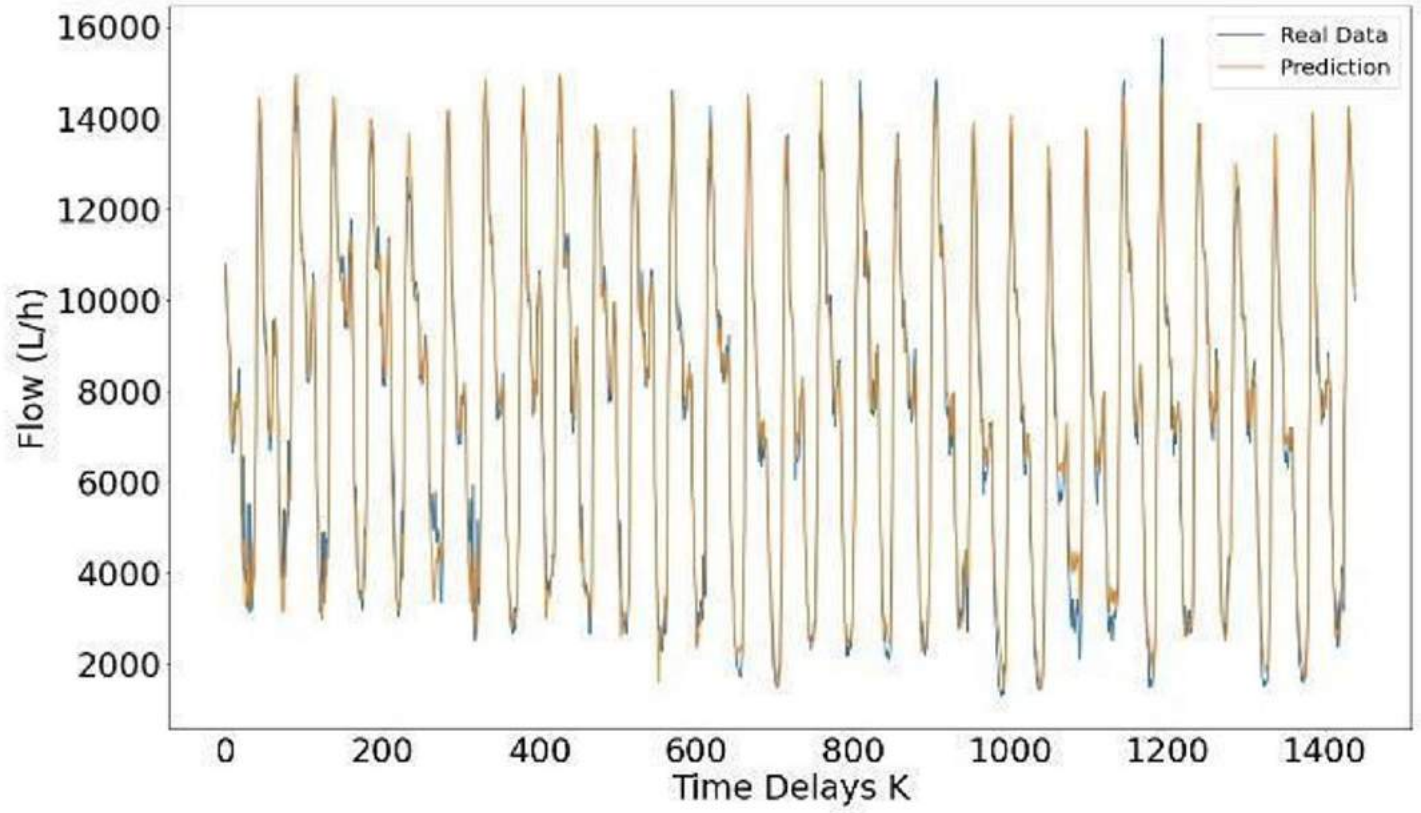




UCA1: Result

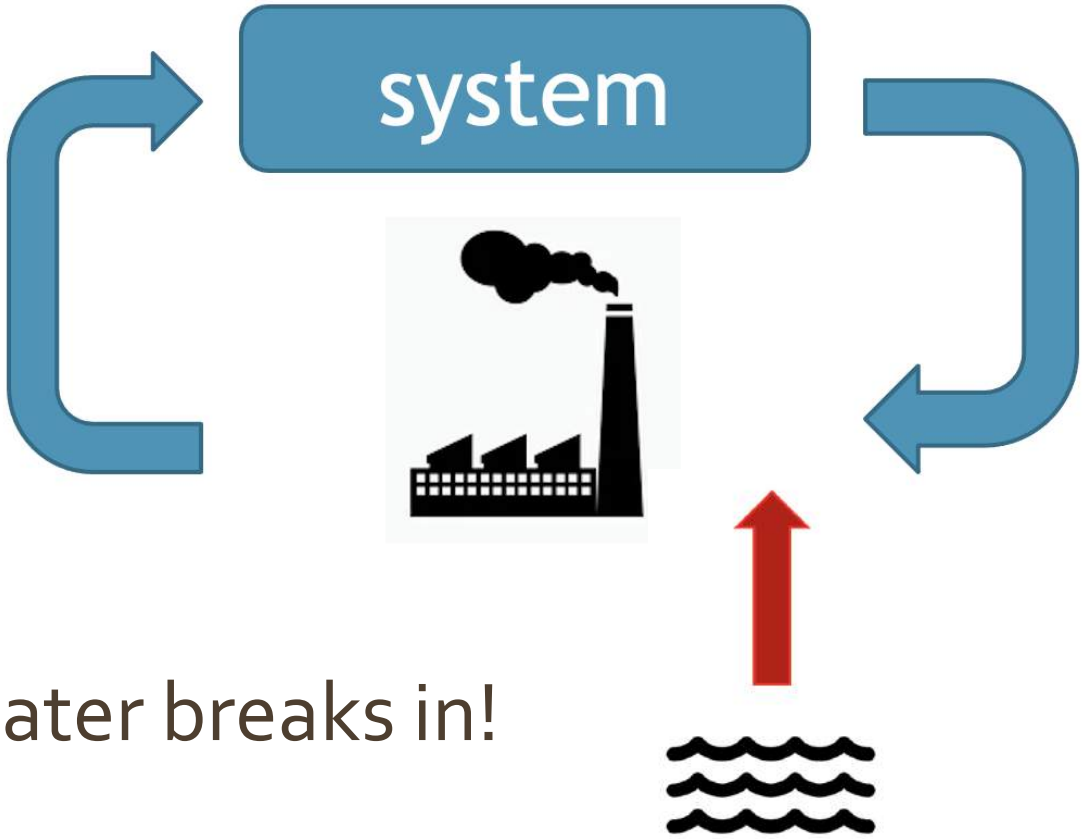
NAIADES Webinar Series

Real data vs predictions:



UCA2: Why?

Waste water can be preprocessed and returned to the system:



Unless salty water breaks in!

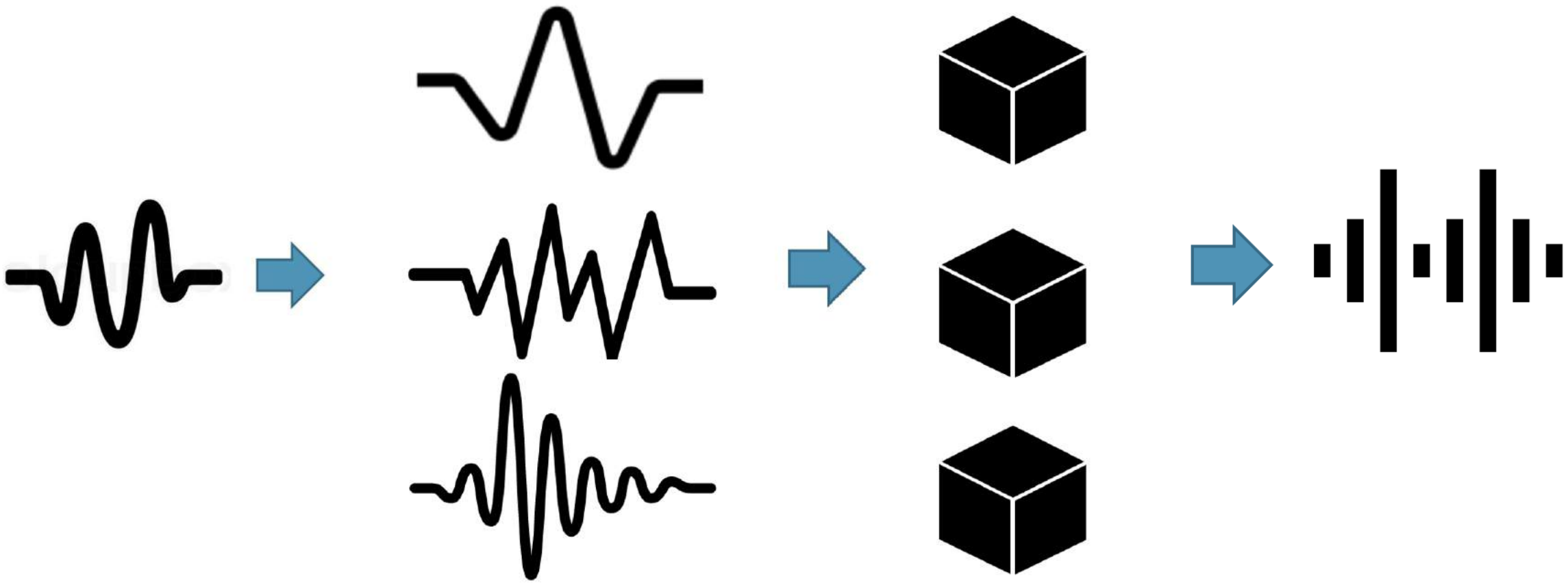
UCA2: How?

Original signal

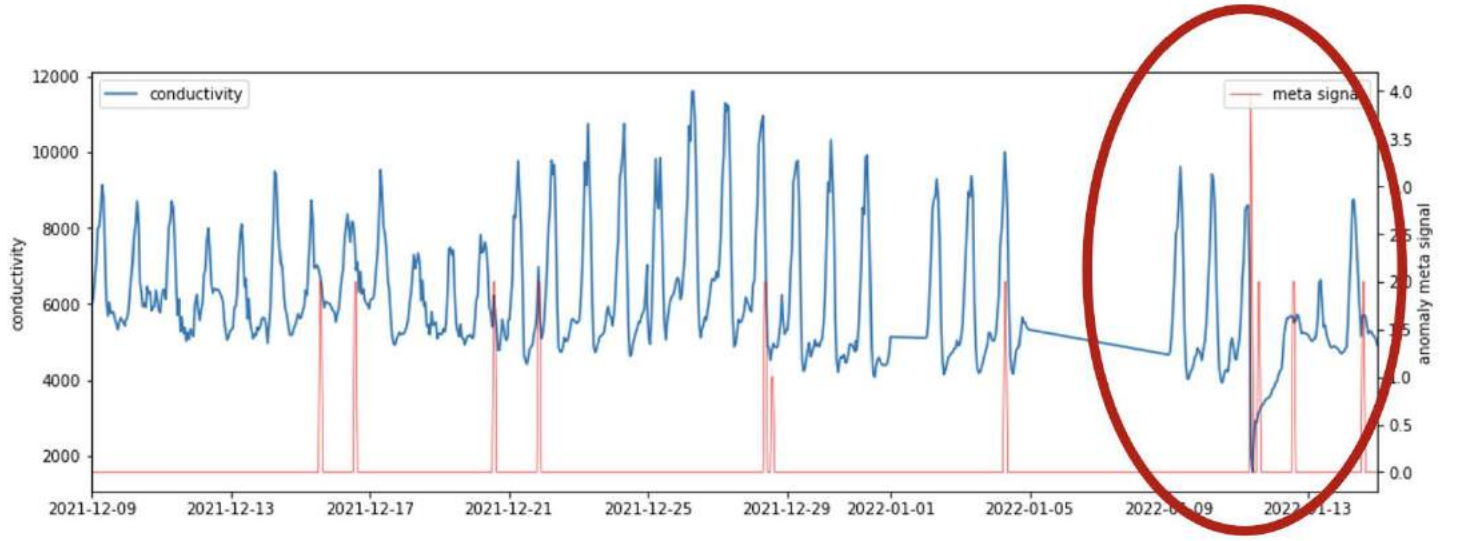
Processed signals

Anomaly detection

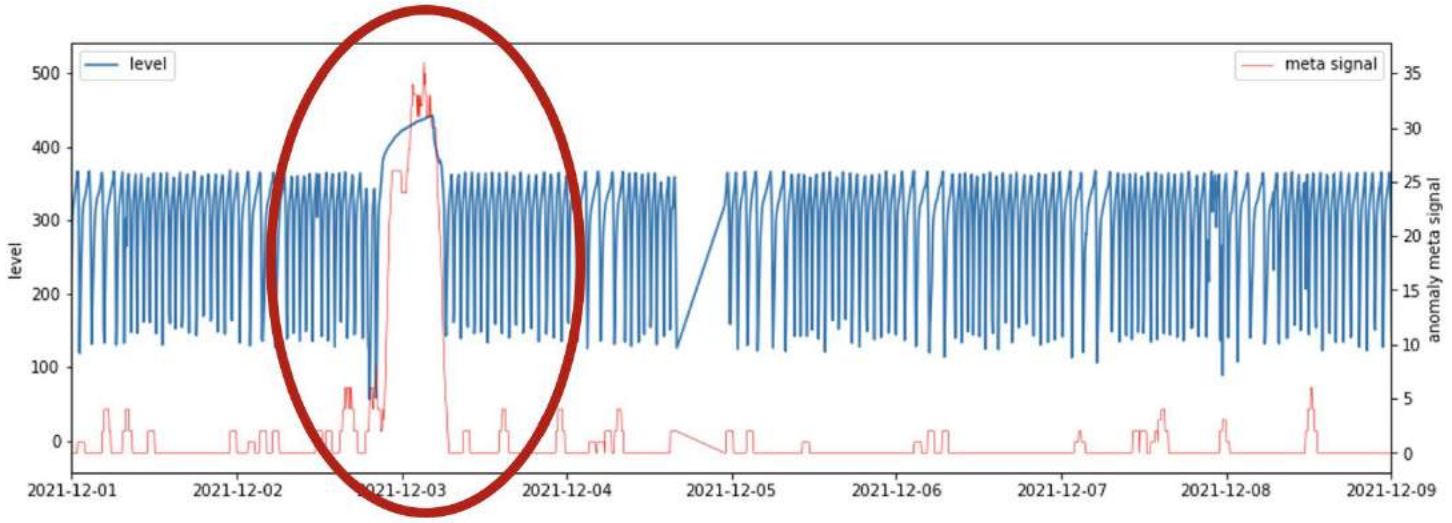
Anomaly signal



UCA2: Result



Conductivity signal



Water Level signal

NAIADES

Webinar Series

Water Consumption Awareness in Alicante

Babis Magoutas, ICCS

Consumer Awareness and Behavioural Change Support Framework

NAIADES Webinar Series

- NAIADES framework for water consumption awareness and behavioural change support
- Leverages the data and AI services residing in the NAIADES intelligence framework
- Includes apps assisting different types of users towards achieving awareness and behavioural change for efficient water usage
  - For cities: stakeholders who want to make sense of water consumption data, e.g. Alicante
  - For water consumers, e.g. students in schools
  - For city workers responsible for irrigation of public spaces, such as the Carouge employees

Water consumption awareness for cities

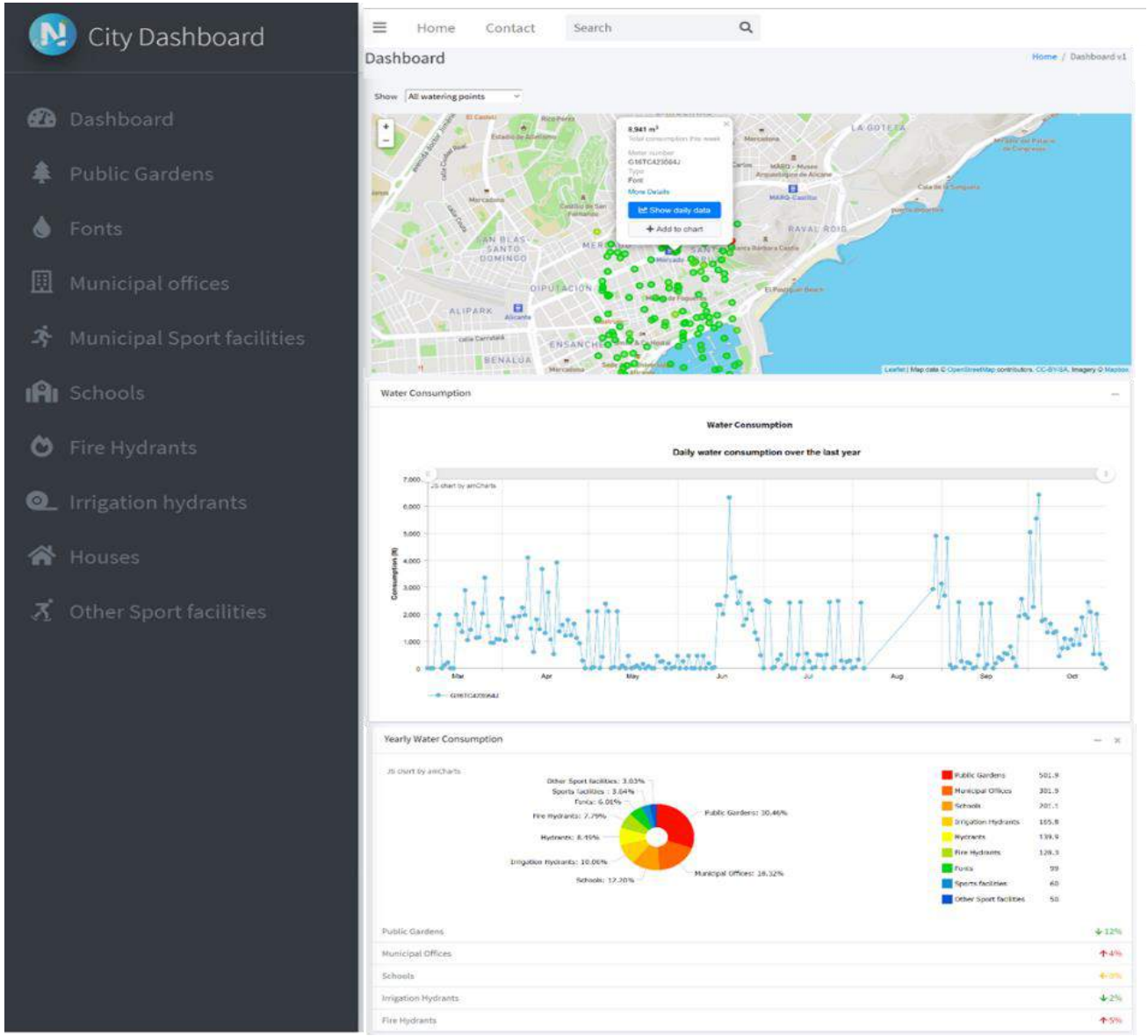
NAIADES Webinar Series

- Motivation / Problem: Emergence of public-private partnership (PPP) projects where water utilities collaborate with cities to provide "smart city platforms" exposing water consumption data for raising awareness

- Approach: Provision of water consumption awareness tools and mechanisms to better understand available consumption data

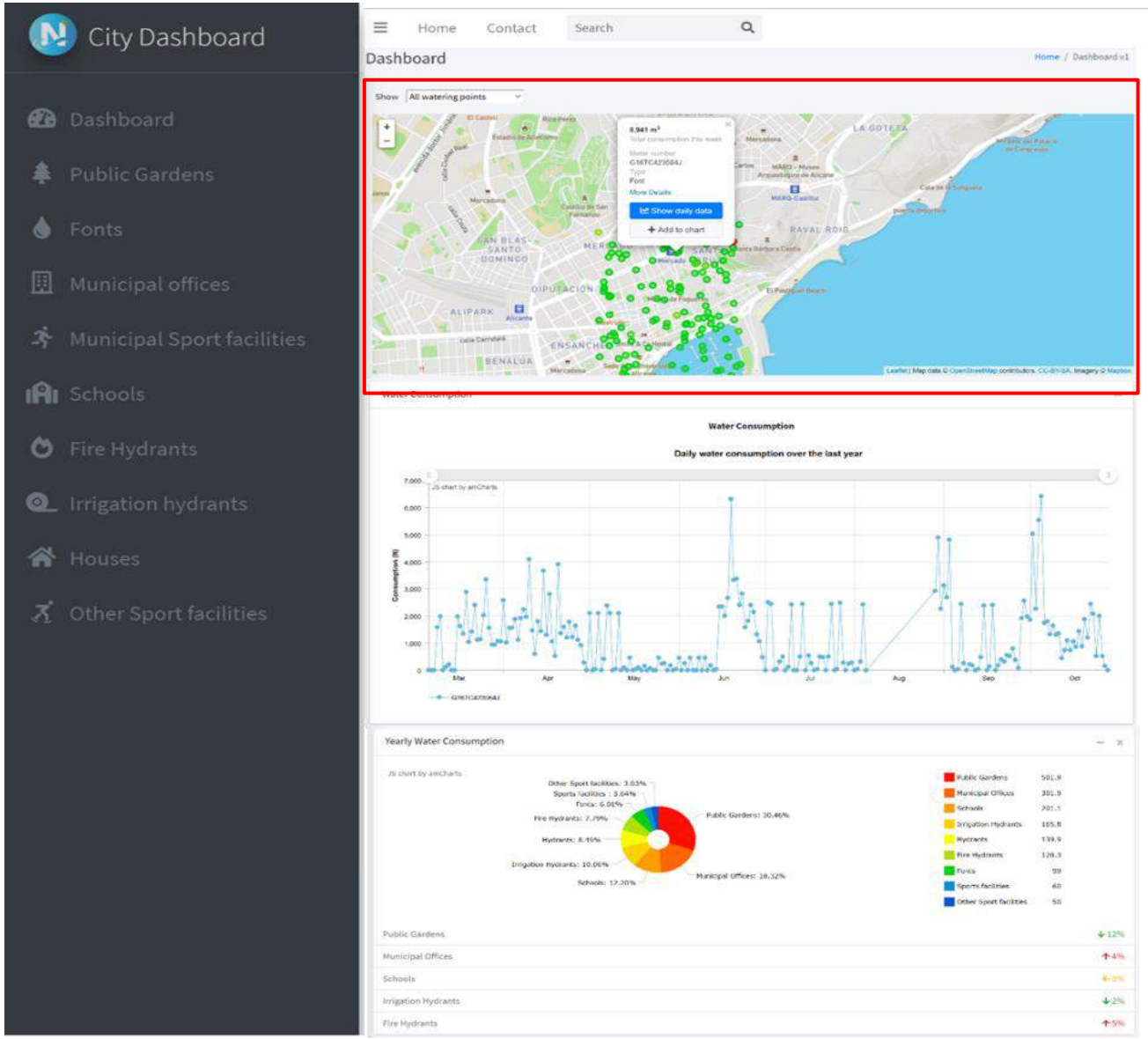
- We have developed a holistic water consumption awareness dashboard that supports public officials to:
  - monitor and understand how water is consumed in a specific area or consumption point (schools, sport facilities, gardens, other buildings) in the course of time
  - compare consumption across various dimensions, including per groups of consumers, areas, types of consumption points and time periods.
  - take decisions regarding water consumption mitigation measures based on such information
  - monitor the impact of consumption mitigation measures after their implementation

Water consumption awareness for cities – Dashboard Overview



- Main page of the dashboard

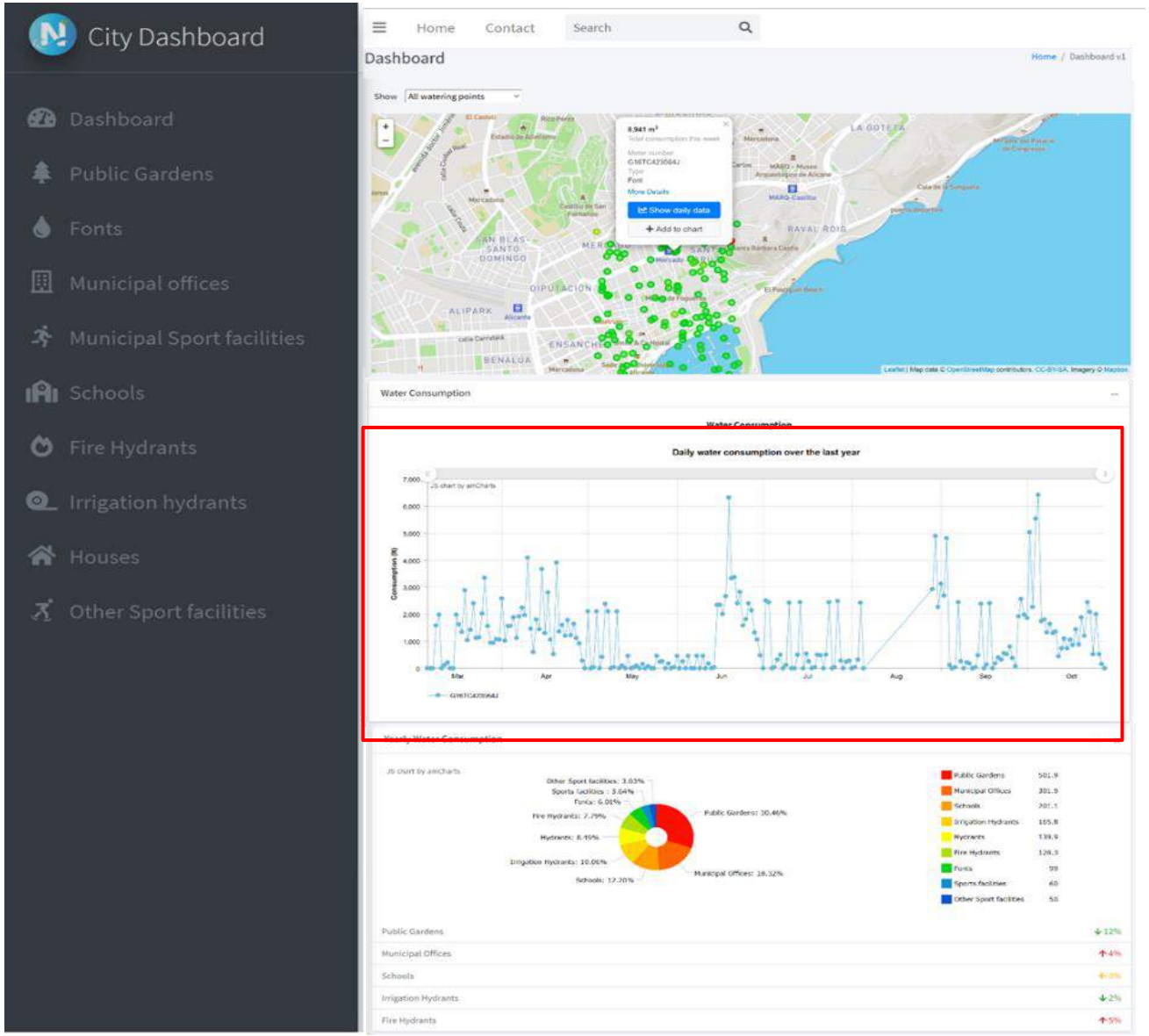
Water consumption awareness for cities – Dashboard Overview



- Main page of the dashboard
  - Public officials can see all the watering consumption points in a map
  - Consumption points are presented with different colours ranging from green to light green, yellow, orange and red, based on the level of their water consumption over the last week
  - Admin users can add new consumption points and edit the existing

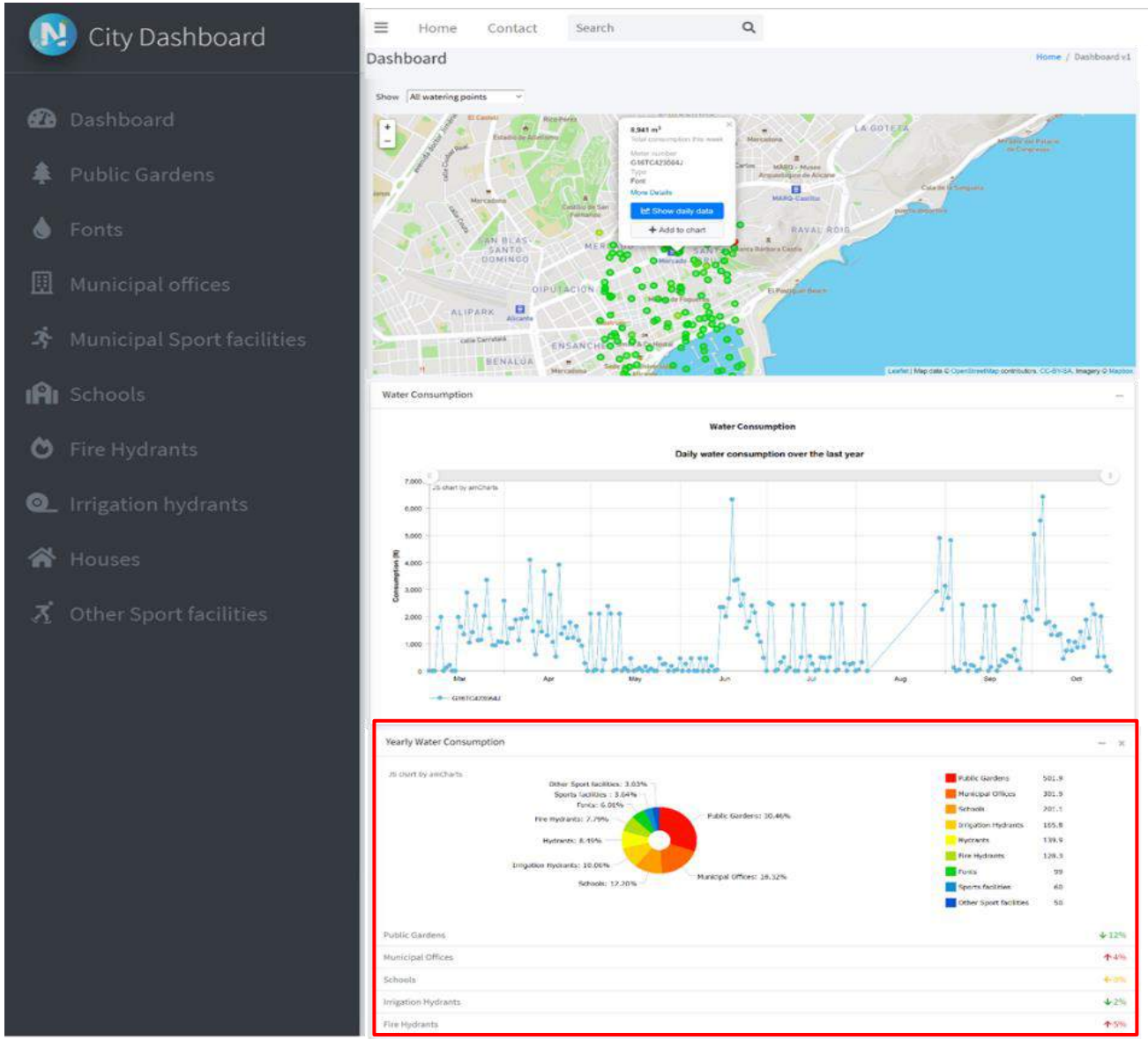
$$\frac{consumption - min}{max - min} \in [0,1] \rightarrow [green, red]$$

Water consumption awareness for cities – Dashboard Overview



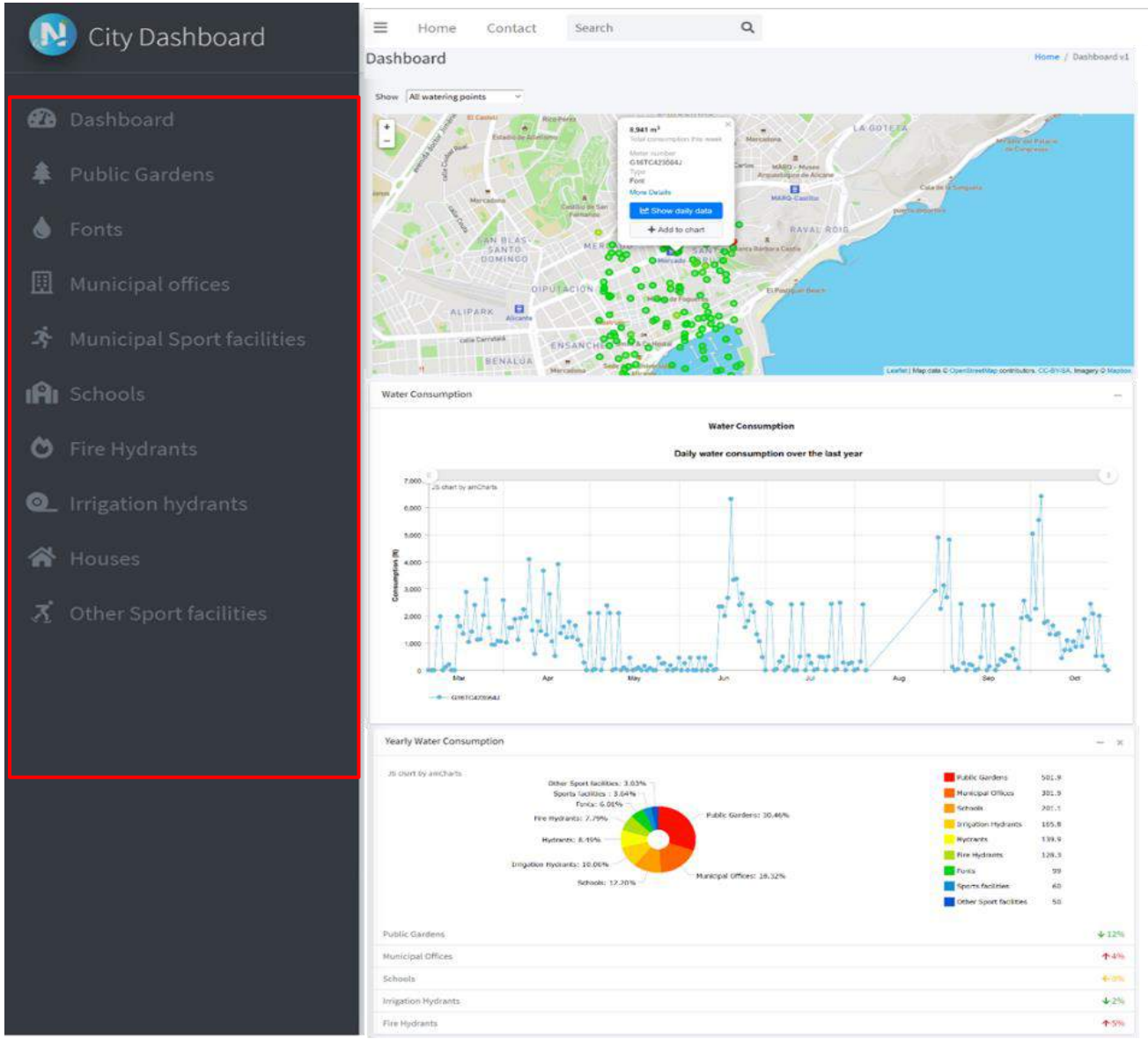
- Main page of the dashboard
  - Users can see the average daily water consumption for all consumption points on a graph view

Water consumption awareness for cities – Dashboard Overview



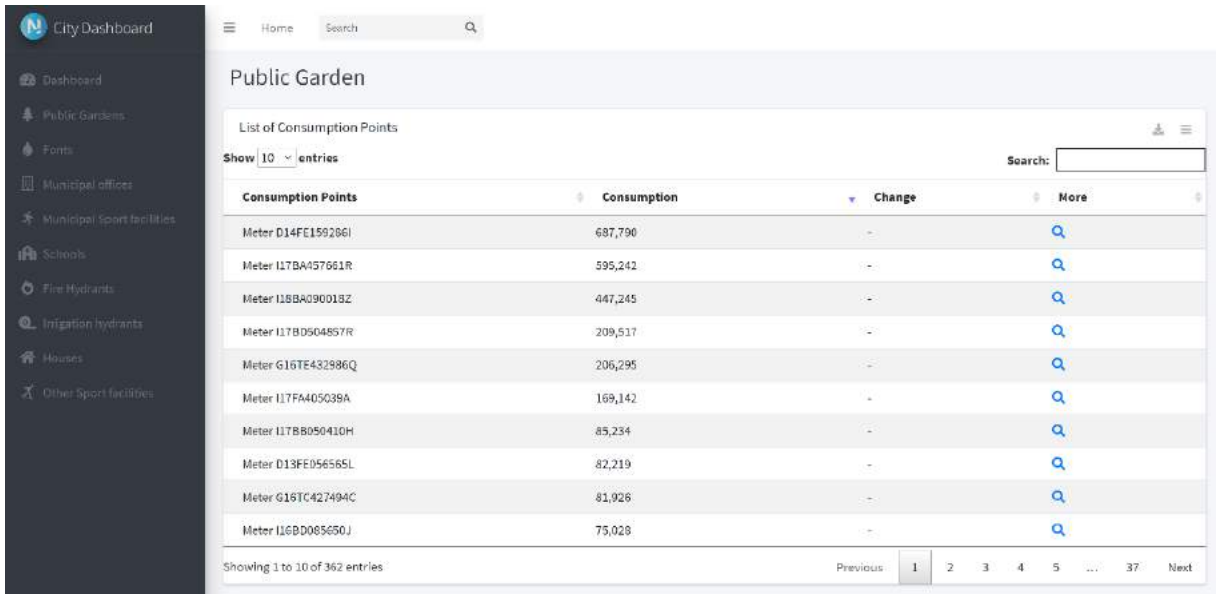
- Main page of the dashboard
  - The dashboard presents the yearly water consumption in cubic meters per different use (schools, public gardens, municipal offices etc.) along with the respective percentages, as well as the water consumption change per consumption type over the last year

Water consumption awareness for cities – Dashboard Overview



- Users can filter the depicted consumption points on the map based on their type
- The consumption points types have been defined after analysing those available at the city of Alicante and include:
  - public gardens, fonts, municipal offices, municipal sport facilities, schools, fire hydrants, irrigation hydrants, houses and other sport facilities

Water consumption awareness for cities – Dashboard Overview



- List view of all consumption points of the specific type (public gardens in the example).
- Users can search a consumption point by its name or meter ID, and see more details about each consumption point by clicking the search icon in the “More” column, which redirects to the corresponding consumption point details page
- The details page shows
  - The water consumption during the last week compared to the previous week.
  - The monthly water consumption during this year compared to the previous year.
  - In addition, it presents the daily, weekly, monthly and yearly water consumption change
  - Users can download a pdf report dedicated to the consumption points of a specific type

NAIADES city dashboard in Alicante

NAIADES Webinar Series

- A TRL-9 version of the NAIADES city dashboard, has been included as one of the main actions of the Alicante's Smart City Plan which has been recently published.
- The realization of the plan is supported by a public-private partnership (PPP) project where Aguas de Alicante collaborate with the Alicante City Council to enable the development of the Alicante's smart city platform.

❑ The PPP project includes a number of specific actions with an investment of 25M euros for the period 2021-2027, including the development of a TRL-9 version of the Consumption Awareness Dashboard

  ❑ allowing NAIADES to become a core element of the future development of the city

  ❑ ensuring the continuity of NAIADES innovations

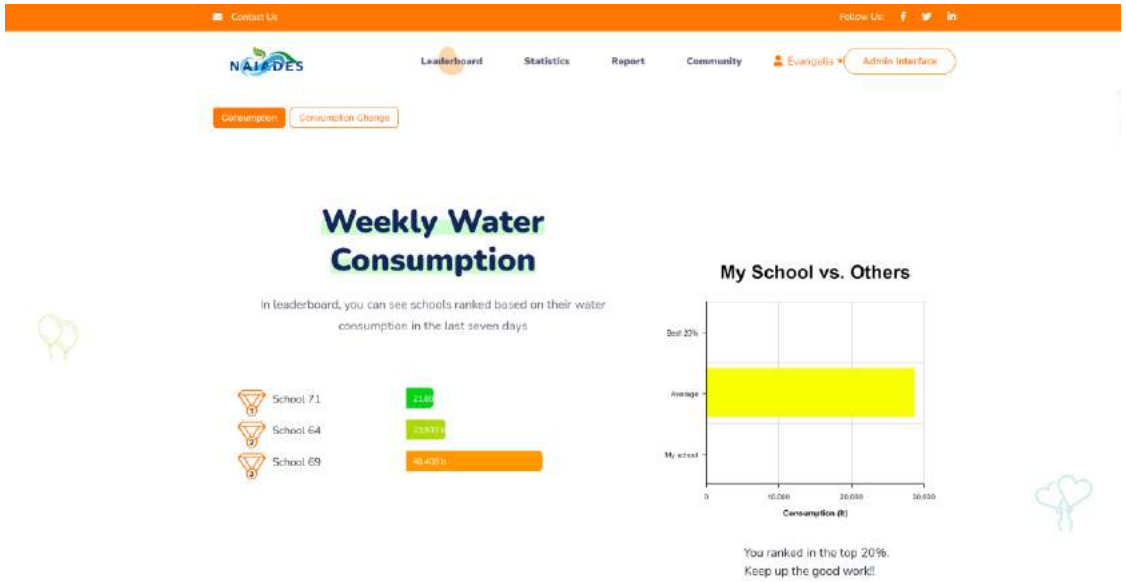
Water Consumers Awareness Dashboard

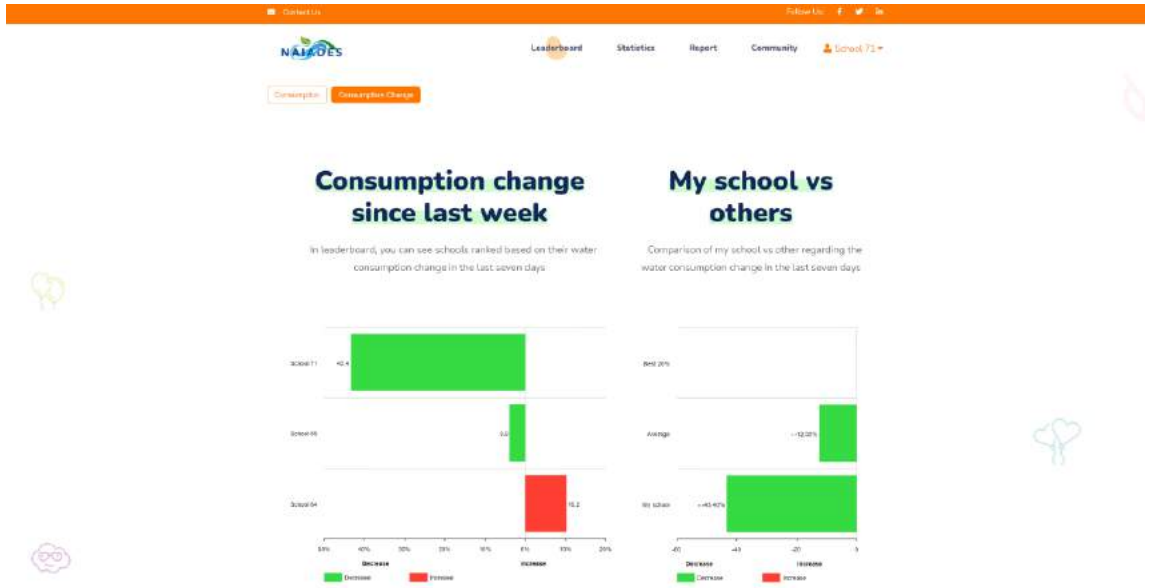
- Motivation: Water utilities need to to be able to deploy ICT-supported water consumption awareness programs and engage water consumers in water conservation activities
- Approach: We have developed a web-based behavioural change support application tailored for interventions at public schools engaging young users with the support of their teachers

- The application:
  - allows to run behavioural change support campaigns at schools, monitor them and assess their impact
  - supports different persuasive strategies including self-monitoring and feedback, social comparisons and rewards, suggestions and social norm based messages

Water Consumers Awareness Dashboard - Overview

Webinar Series

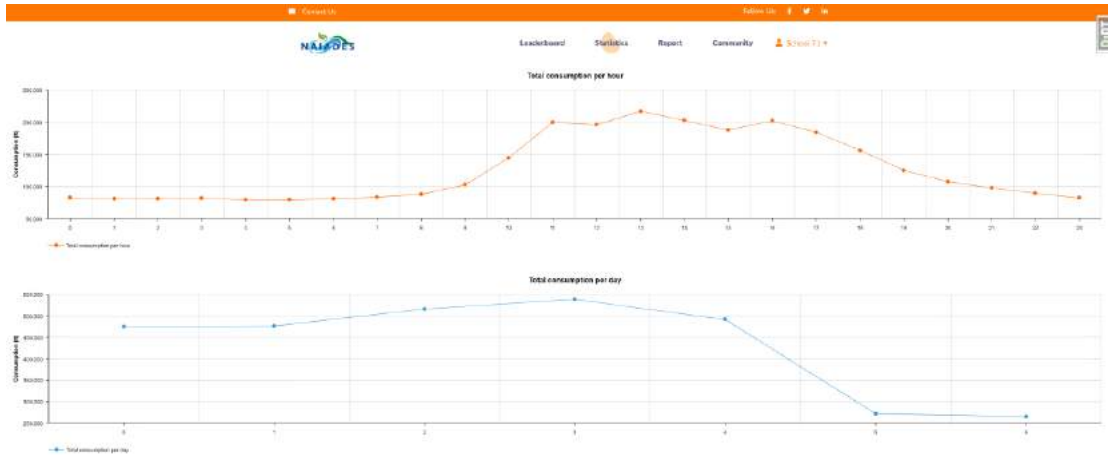




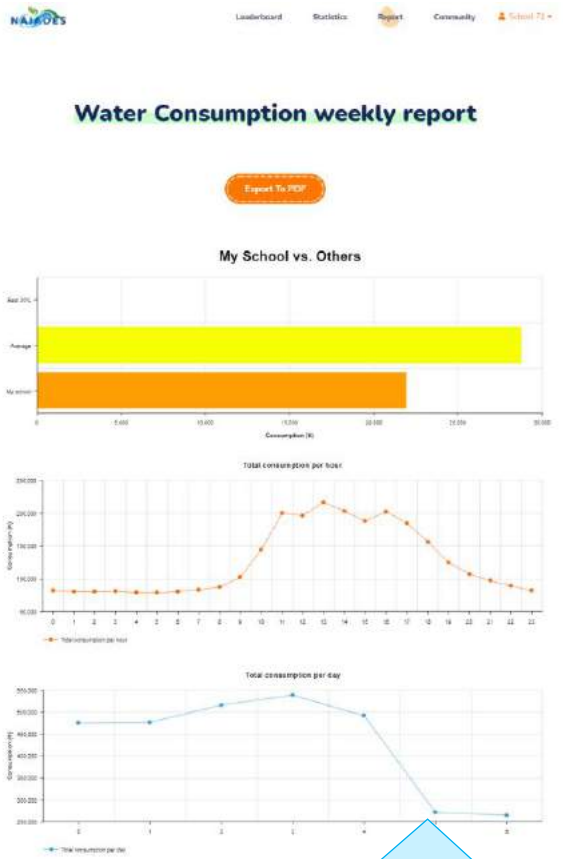
Leaderboard that shows the schools ranked based on their water consumption in the last week

Leaderboard that shows the schools ranked based on their water consumption change since last week

Water Consumers Awareness Dashboard - Overview



Total water consumption per hour and total water consumption per day of each school is presented in the "Statistics" page



Teachers can export and download consumption reports

Water Consumers Awareness Dashboard - Overview

NAIADES Webinar Series

The Water Consumers Awareness Dashboard also provides a forum where users can share their posts with other users either from the same school or from other schools

Posts are moderated by the teachers who are responsible to posting in the application

Water Consumers Awareness Dashboard in Alicante Schools

NAIADES Webinar Series

- Aguas de Alicante collaborate with local schools' authorities to apply the NAIADES approach in this academic year to primary and secondary schools
  - aiming at increasing student awareness on water consumption of their schools and engage them in water conservation activities.

- Students are a group of consumers that can provide a channel for generating great impact as
  - i) they will evolve to the responsible citizens of tomorrow and
  - ii) they can transfer the knowledge, attitudes and behaviours they shape to their families, leading to a cascading effect of the NAIADES impact.

Feedback session

NAIADES Webinar Series

https://ahaslides.com/SW2022

NAIADES

Webinar Series

Session 3: Smart Water Management in Brăila

Speakers (Brăila pilot)

Iulian Mocanu
CUP Dunărea Brăila

Clara Maria Corzo
IHE Delft

NAIADES

Webinar Series

Water Management at CUP Dunărea Brăila

Iulian Mocanu, CUP Dunărea Brăila

Water Management at CUP Dunărea Brăila

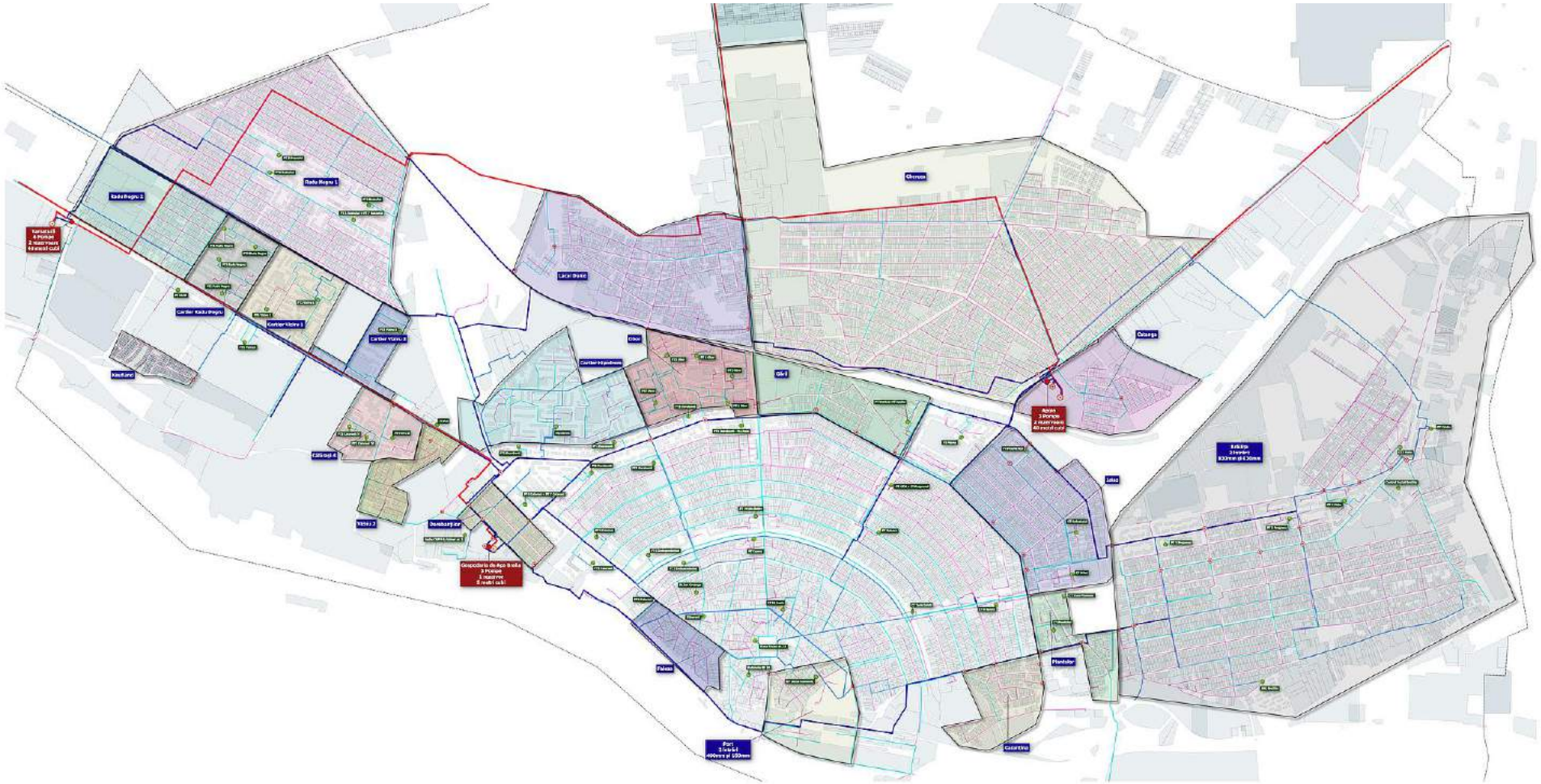
NAIADES Webinar Series

The City of Brăila

- Located in Eastern Romania
- On the left bank of the Danube
- Population: ~200.000
- ~78 square kilometers
- Was described by Herodotus as a swamp
- Over 600 years of recorded history under its current name
- Formerly one of the most important ports and commercial hubs in Eastern Europe
- Burned to the ground on the 27th of February 1470 by Stefan The Great

Water Management at CUP Dunărea Brăila

NAIADES Webinar Series



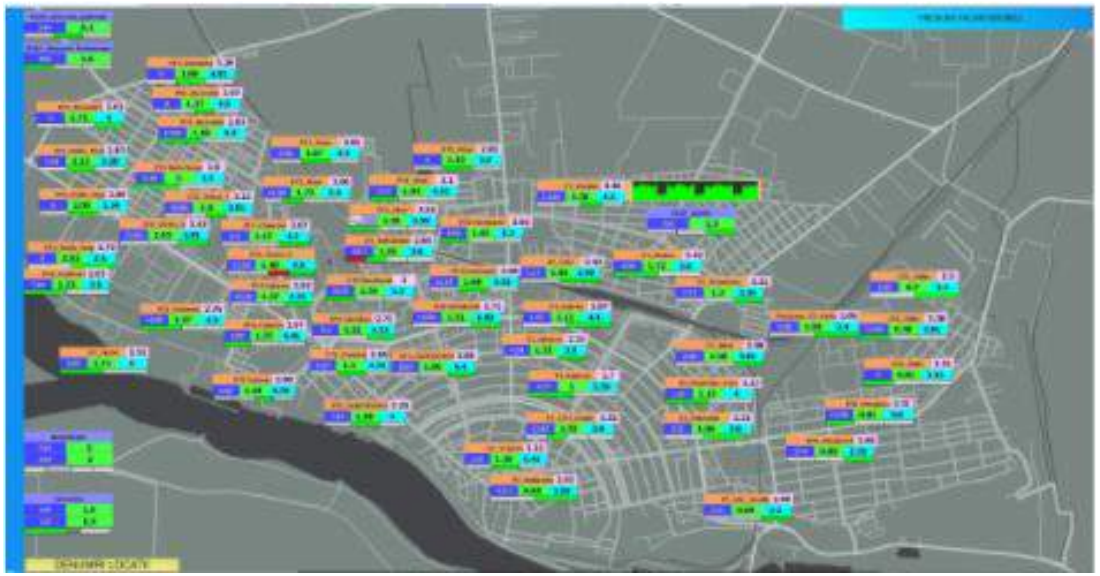
Currently established and monitored DMAs within the municipality of Brăila.

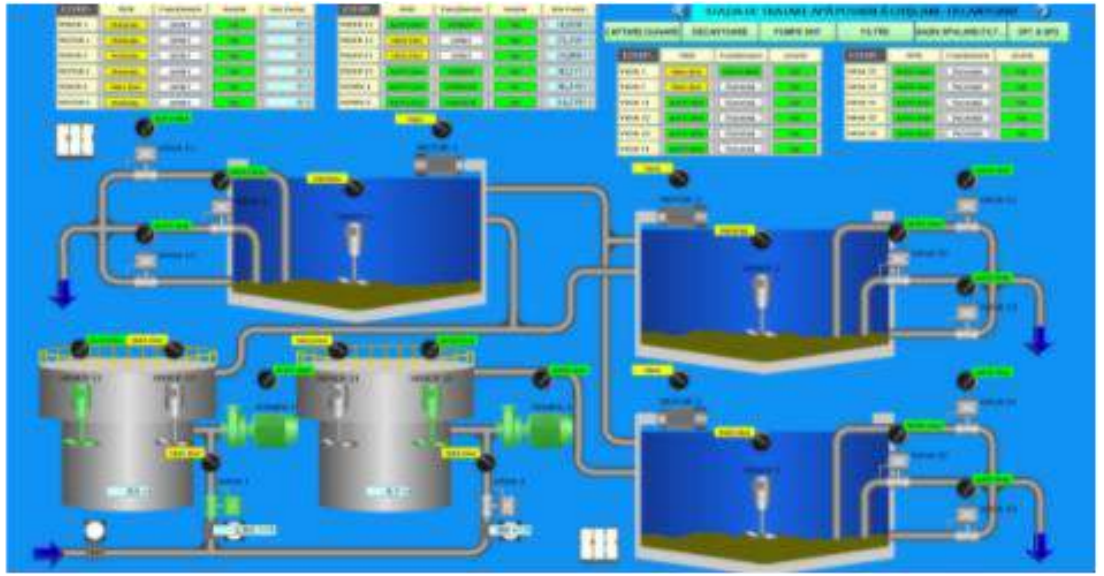
- Over 3000 pipes
- Over 350km total length
- Average pipe age of 40 years
- Oldest pipes still in use are over 130 years old
- Nearly 36.000 m^3/day
- Apparent loss of ~40%
- 13 DMAs established and monitored, more being established

Water Management at CUP Dunărea Brăila

NAIADES Webinar Series

The CUP Dunărea Brăila in-house built Regional SCADA System collects data from over 150 locations, monitoring over 25.000 parameters every 5 seconds.





Water Management at CUP Dunărea Brăila

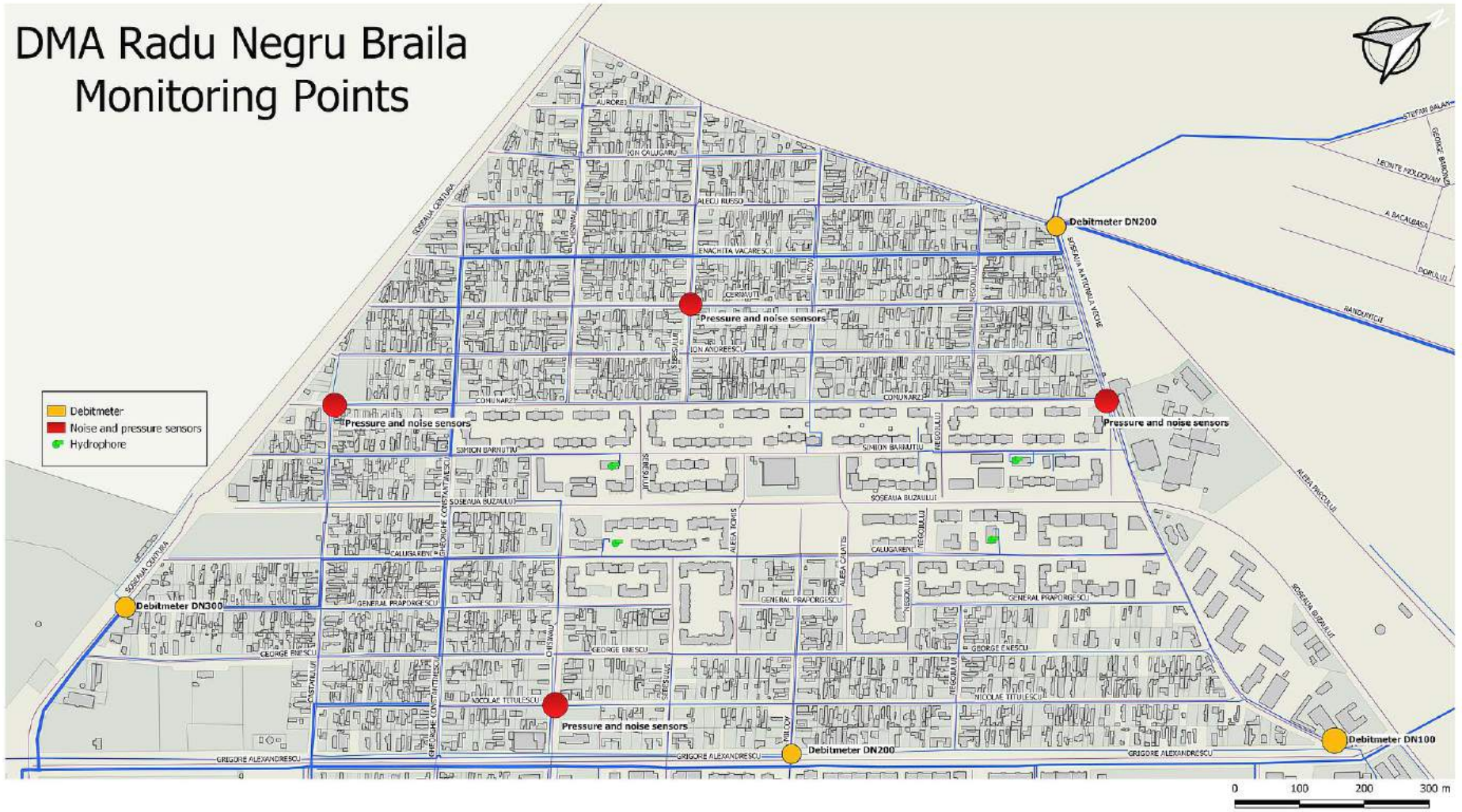
NAIADES Webinar Series

The Radu Negru Neighborhood

- Formally a rural village at the edge of Brăila
- Incorporated into the city early 1900s
- Underwent an urbanization process in the 1980s
- Is still expanding
- Targeted for modernization within the next decade

Water Management at CUP Dunărea Brăila

NAIADES Webinar Series



The Radu Negru DMA

- Established in 2020 for the NAIADES Project
- Over 190 pipes
- Over 27 km total length
- Around 40 years average pipe age
- Oldest pipes in use are around 60 years old
- 3000+ m^3/day flow
- 145 m^3/h minimum flow before new water management measures were taken

Water Management at CUP Dunărea Brăila

Radu Negru DMA SCADA telemetry interface

Water Management at CUP Dunărea Brăila

Siemens MAG8000 Flow Meter

Flow Meter housing

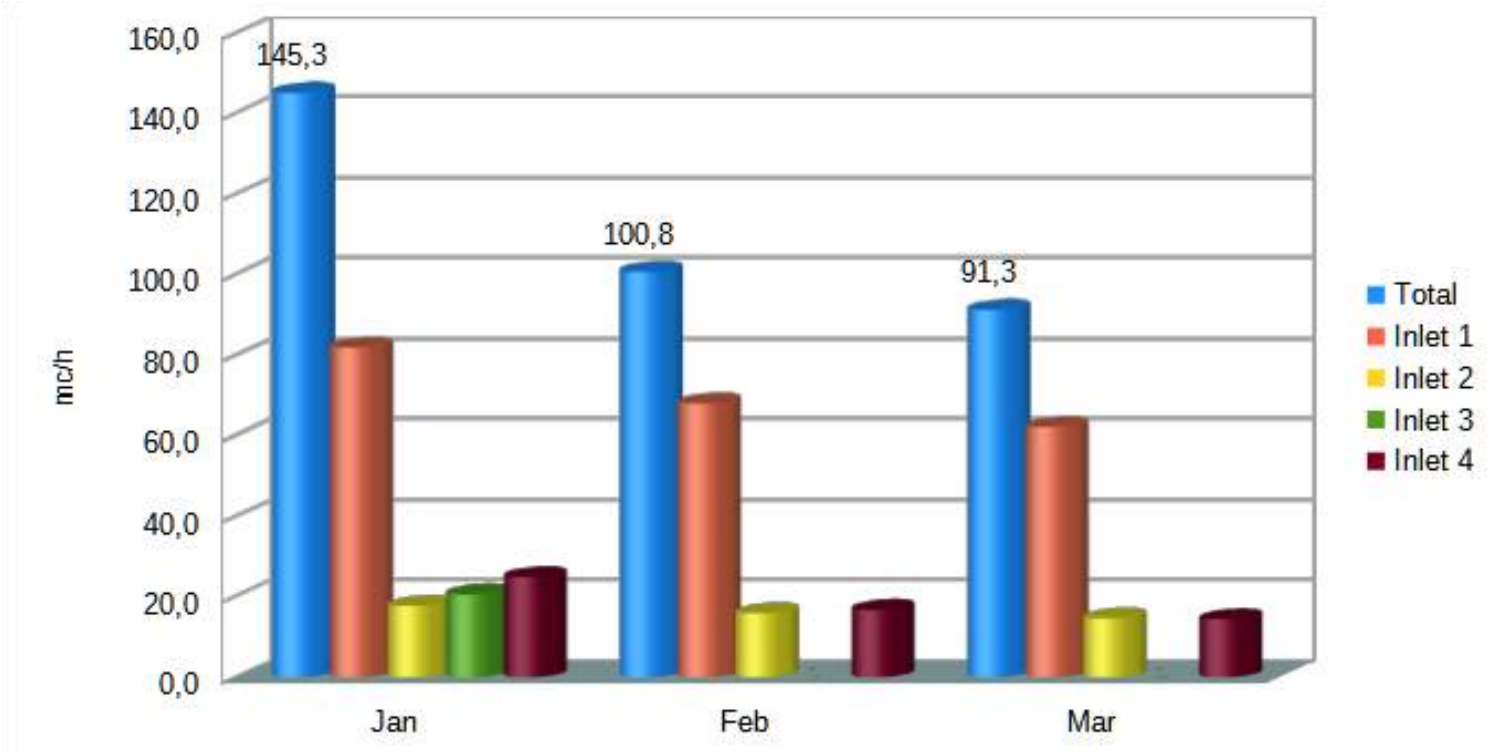
Flooded Flow Meter housing

Water Management at CUP Dunărea Brăila

HWM MultiLog Pressure Sensors and PermaNET Noise Sensors

Noise and Pressure Sensor Housing

Water Management at CUP Dunărea Brăila

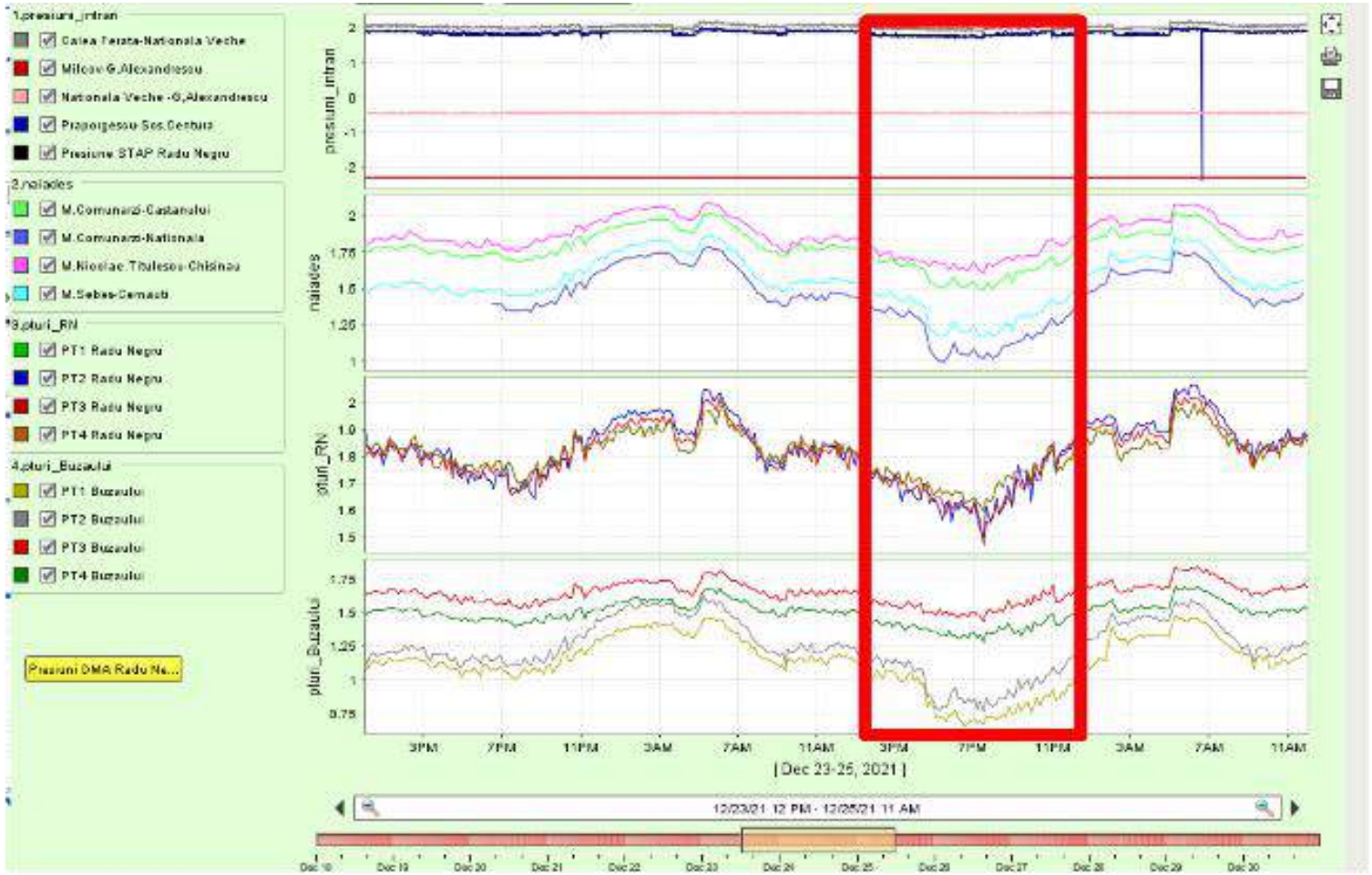


First stage of loss reduction in the DMA:

- comparing in-flow to billed water consumption
- comparing night flow to estimates
- visual inspection of sewer line for ruptures

Water Management at CUP Dunărea Brăila

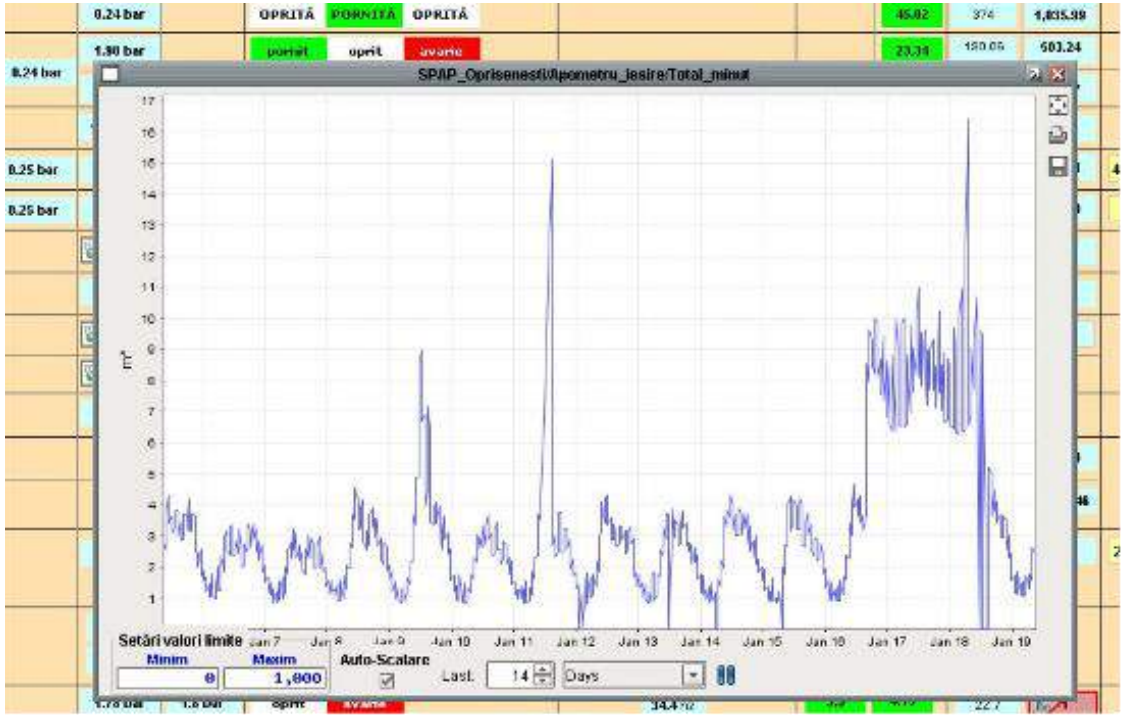
NAIADES Webinar Series



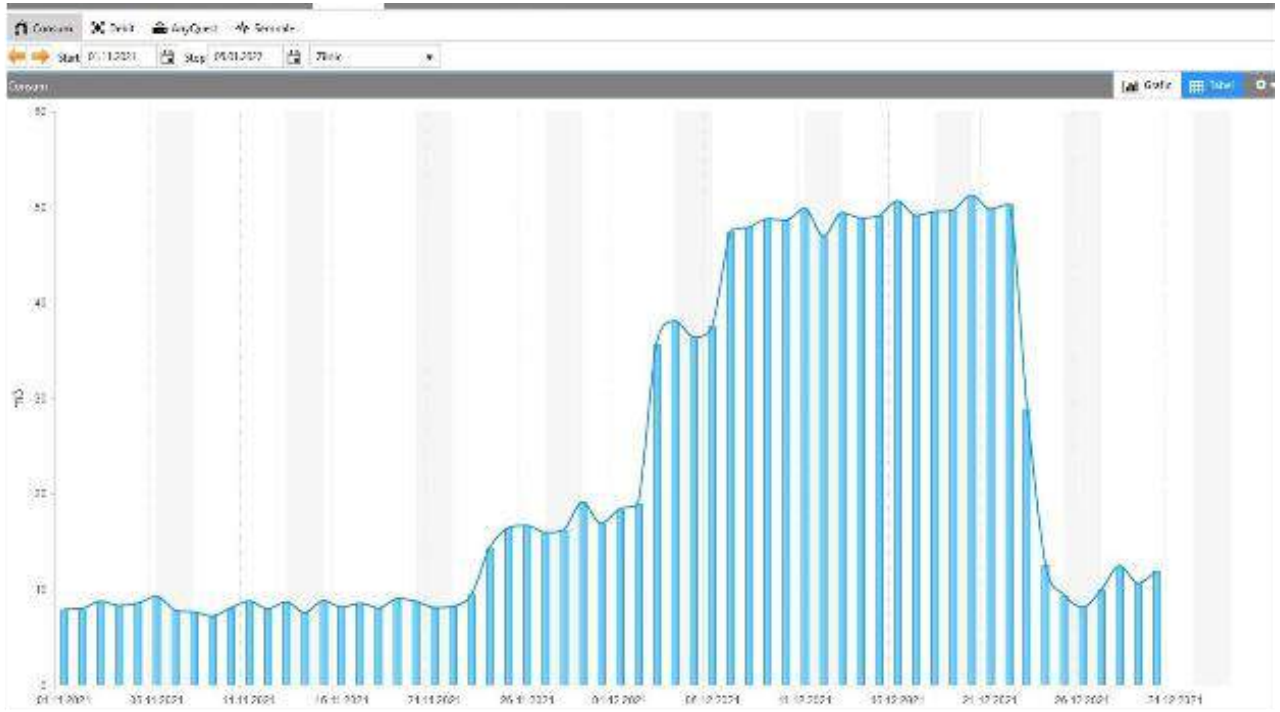
DMA wide pressure anomaly detected as a result of a burst pipe (encircled in red) downstream of a local pumping station.

Water Management at CUP Dunărea Brăila

NAIADES Webinar Series



Large increase in flow registered at a pumping station as a result of a leak down the line.



Large increase in flow at an end-user meter after a pipe burst in a high-rise building

Water Management at CUP Dunărea Brăila

Phases of the NAIDES Noise AI Algorithm Calibration

Water Management at CUP Dunărea Brăila

NAIADES Webinar Series

Further development:

- Increase sensor coverage
- Develop new tools to better use sensor data
- Prevent new leaks from propagating through constant and automated monitoring
- Reduce and eventually eliminate pre-existing leaks
- Implement solutions in other DMAs
- Scale up to city-wide coverage

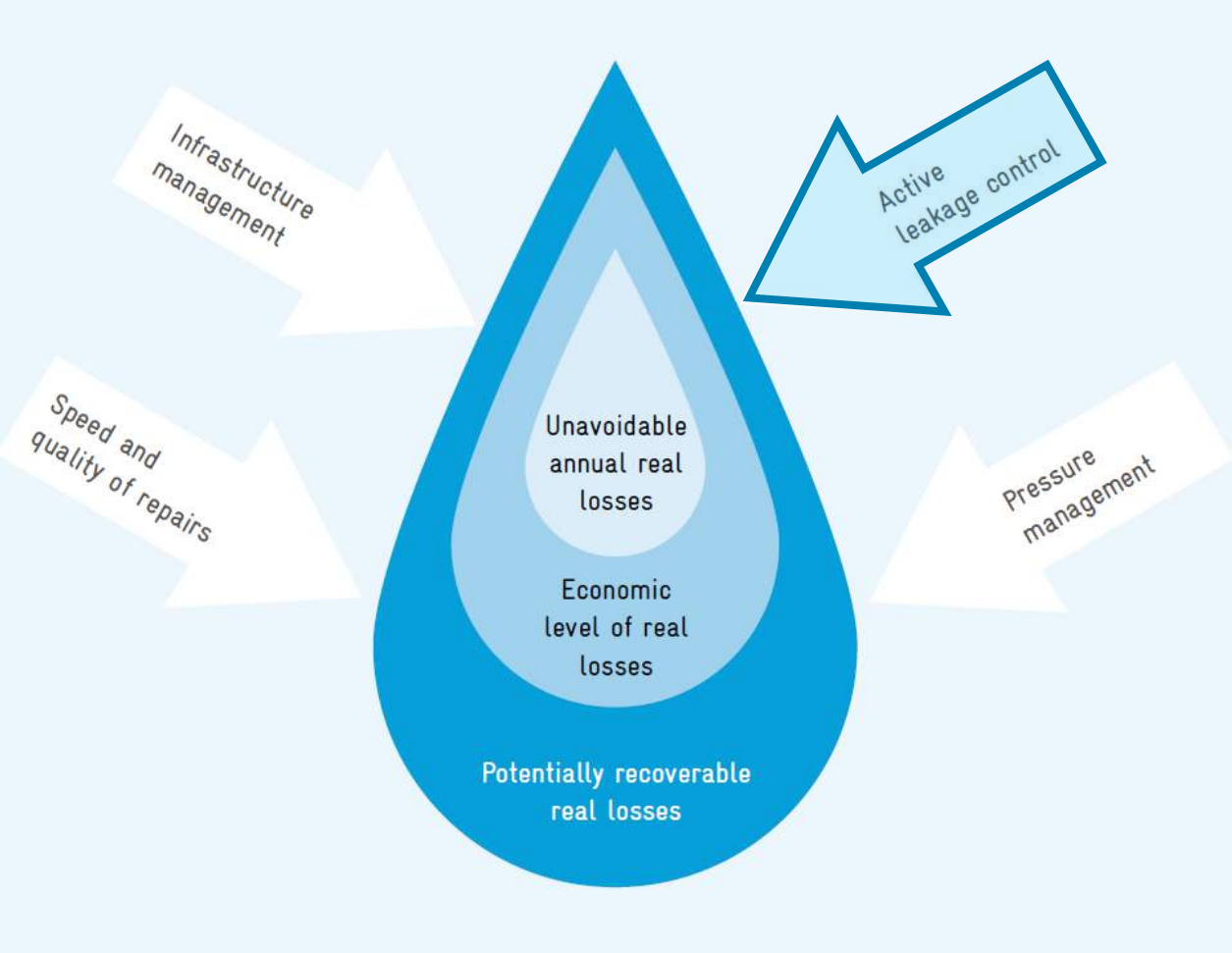
NAIADES

Webinar Series

Smart algorithms for Water Management - Case of Brăila

Clara Maria Corzo, Leonardo Alfonso. IHE Delft

Interventions for real loss reduction



(Baader et al., 2011. Guidelines for water loss reduction)

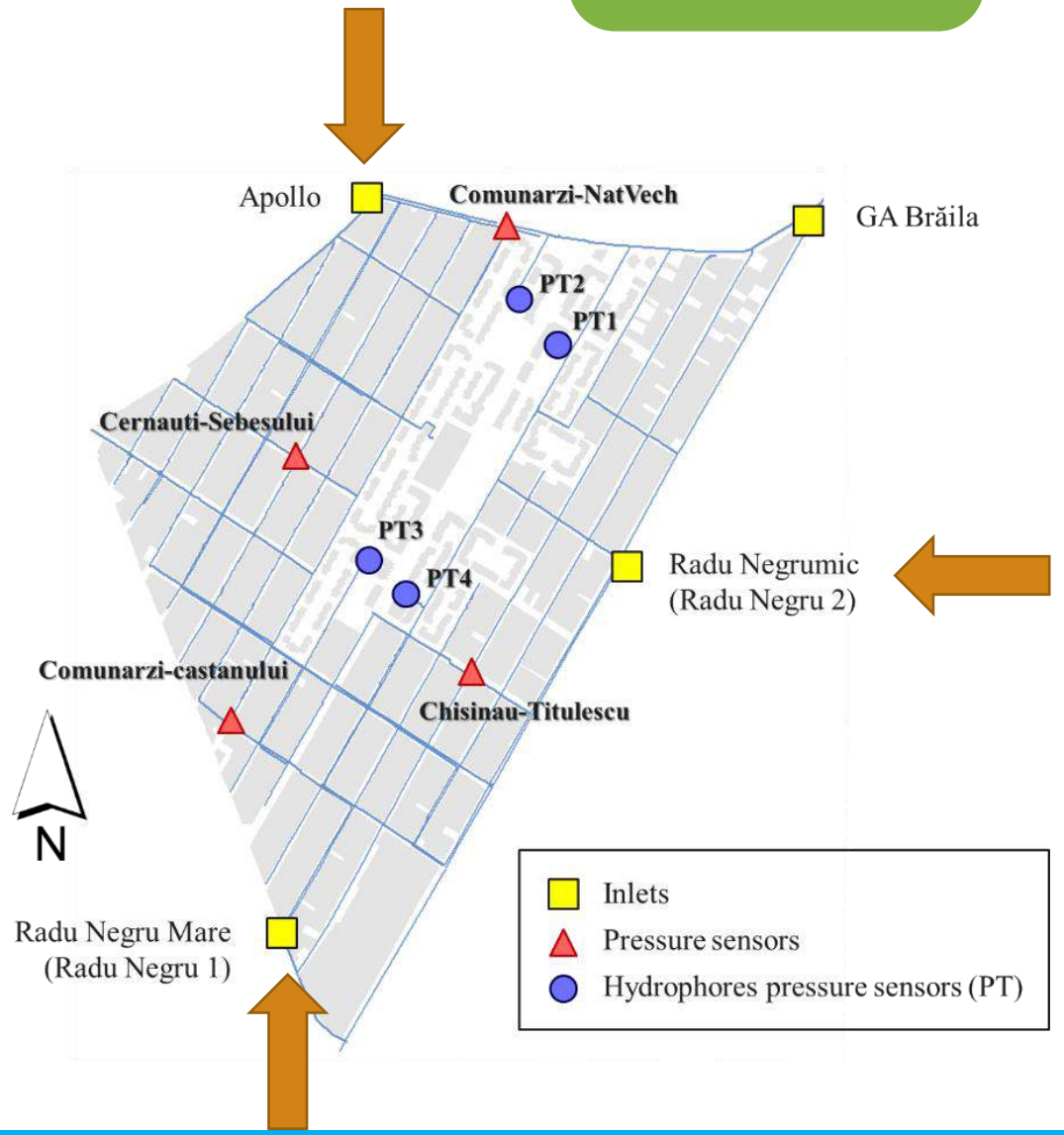
Active leakage control

- Effectively and efficiently detect and repair leaks that do not reach the surface.
- Reduce the runtime of hidden leaks.
- Reduce the awareness time for new leaks.
- Contains three steps:
  - Awareness
  - Detection (location)
  - Pinpointing

Case study

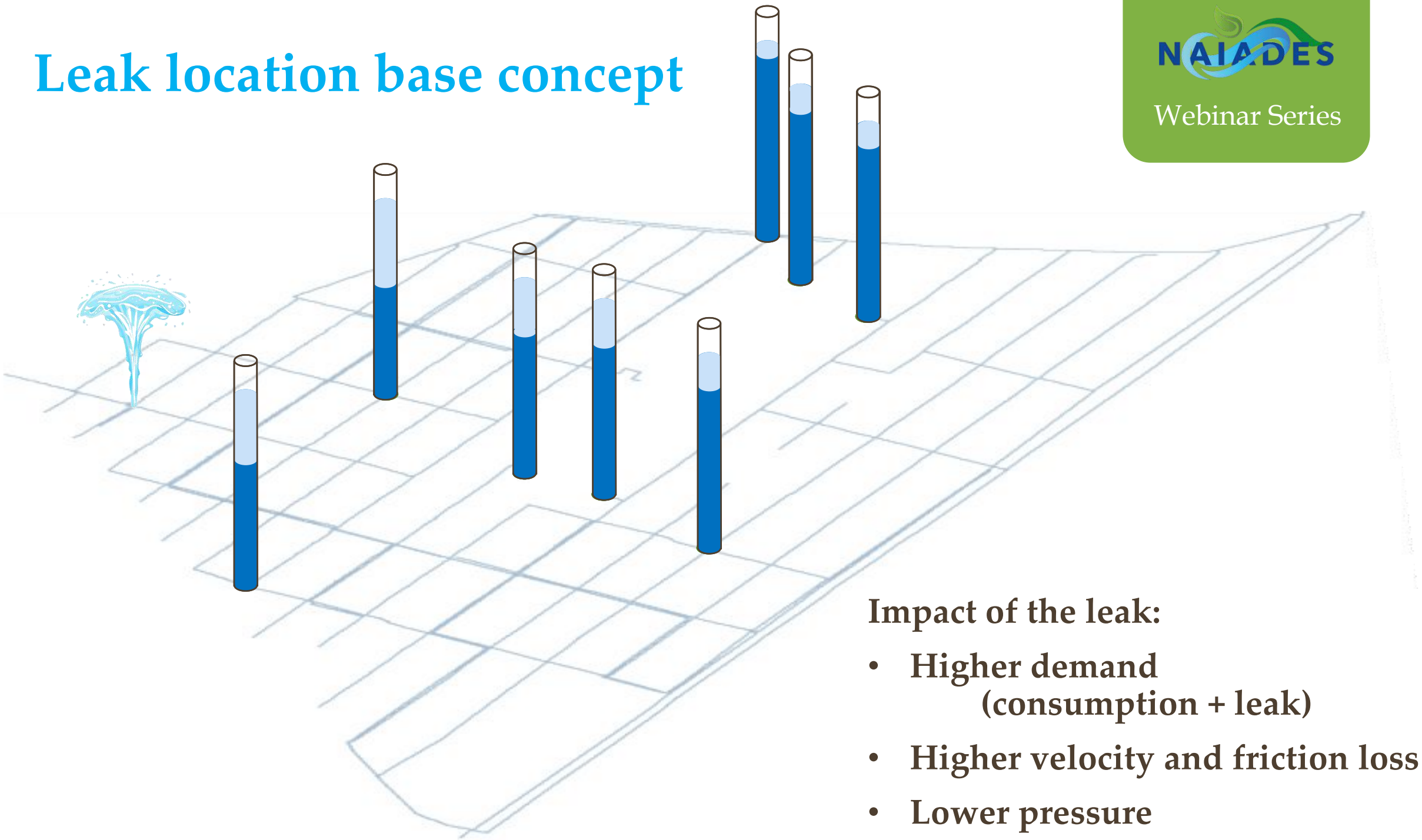
Radu Negro DMA

- High water losses (>40%)
- Multi-inlet DMA
- Water is directly pumped into the WDN (variable boundary conditions)



Leak location base concept

NAIADES
Webinar Series



Impact of the leak:

- **Higher demand (consumption + leak)**
- **Higher velocity and friction loss**
- **Lower pressure**

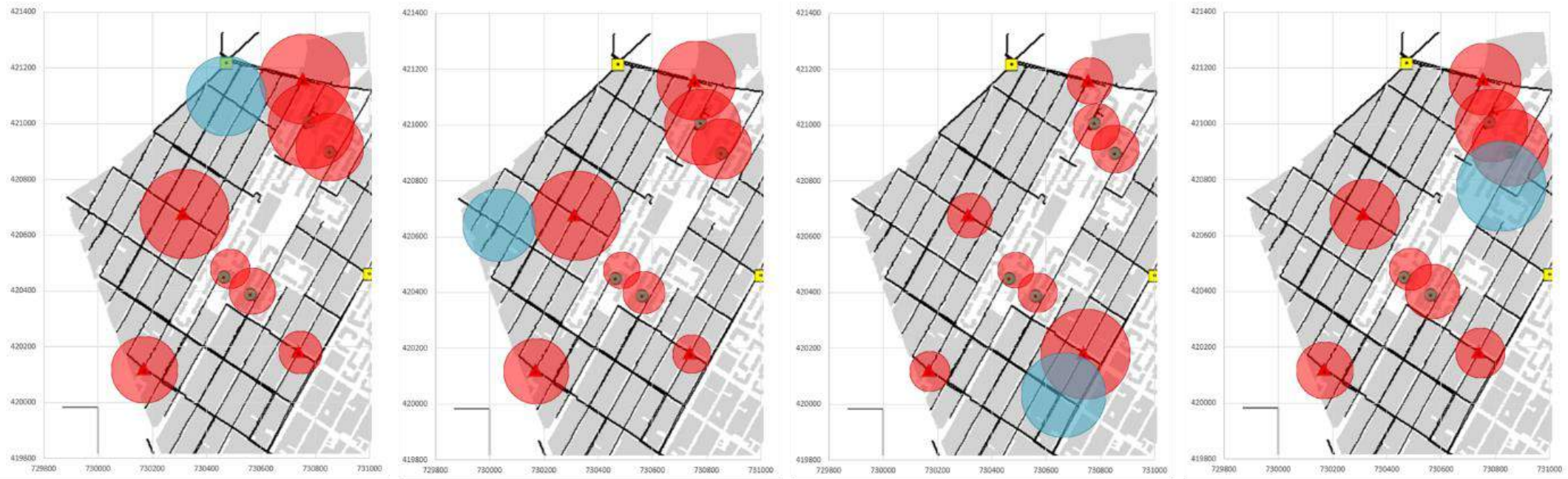
Leak location base concept

NAIADES Webinar Series

Each leak has an impact in the pressure sensors.

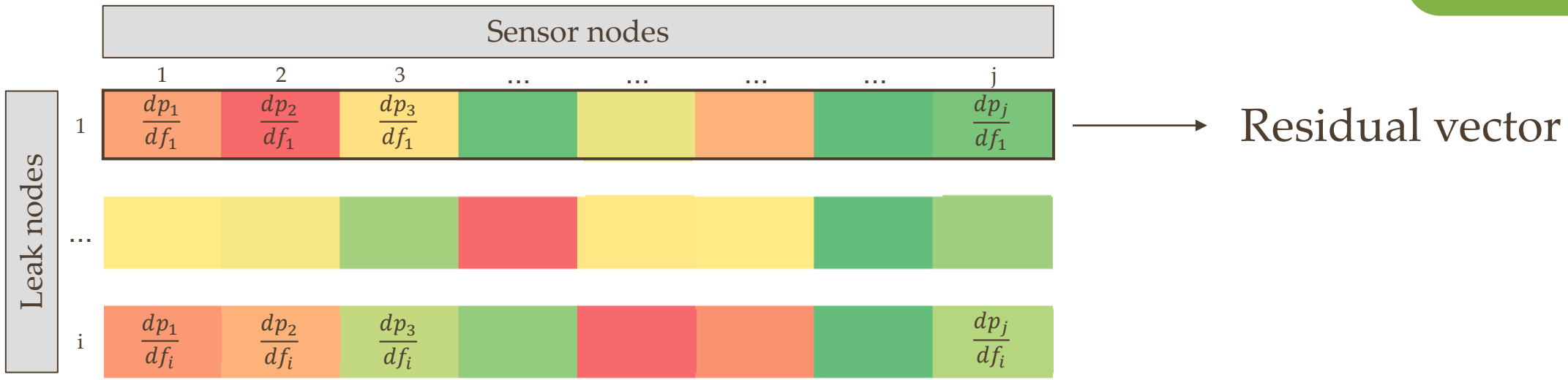
The pressure difference between network scenarios with and without leaks is called pressure residual.

The set of pressure residuals in all sensors for a given leak location and leak flowrate is called the residuals vector.



Leak location Pressure residual in sensor nodes

Sensitivity matrix



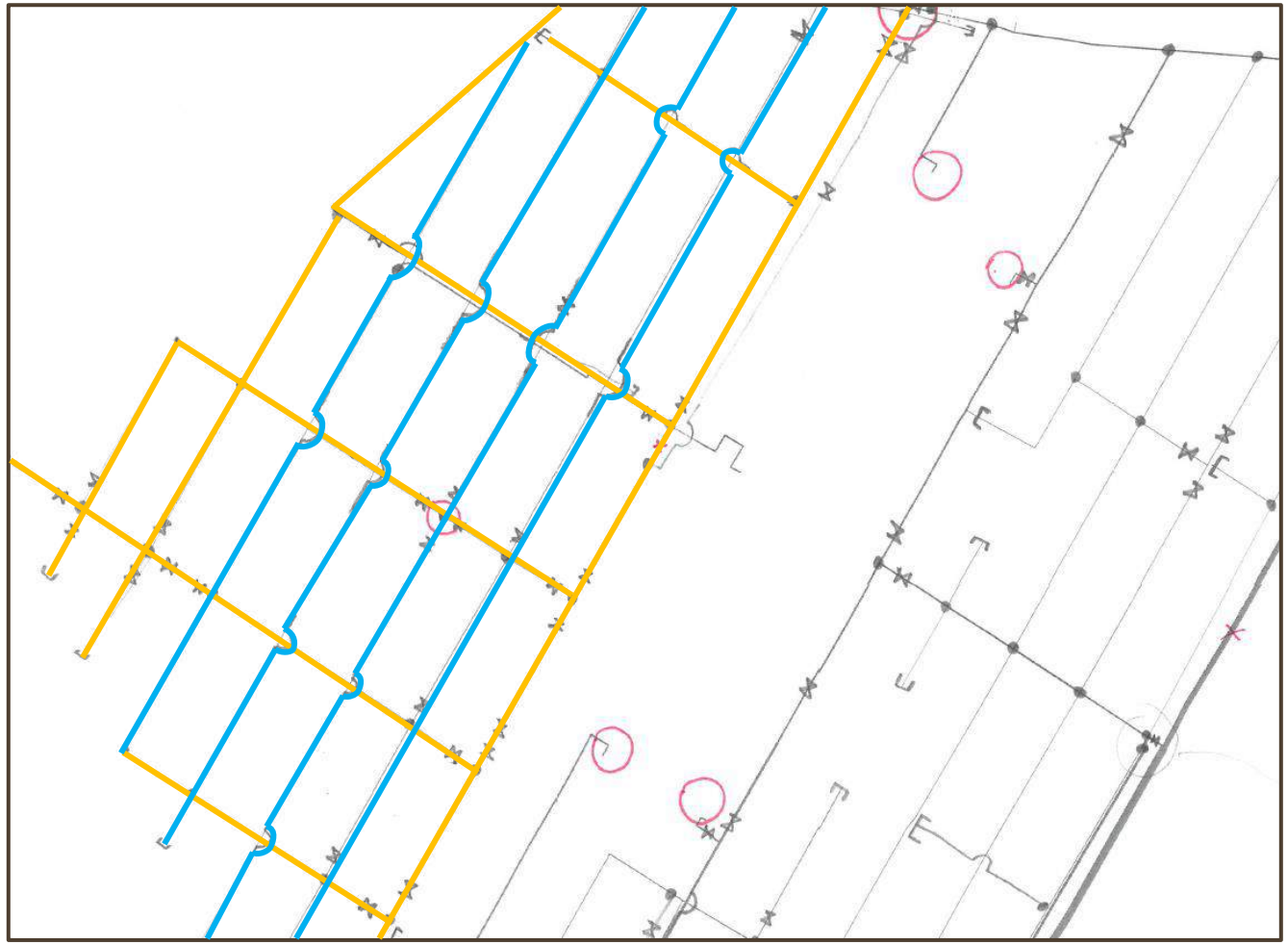
Training data:

- 41 leak flows were simulated with the hydraulic model for each leak node, starting on 0.5 L/s and varying 0.5 L/s.

Sensitivity matrix

NAIADES Webinar Series

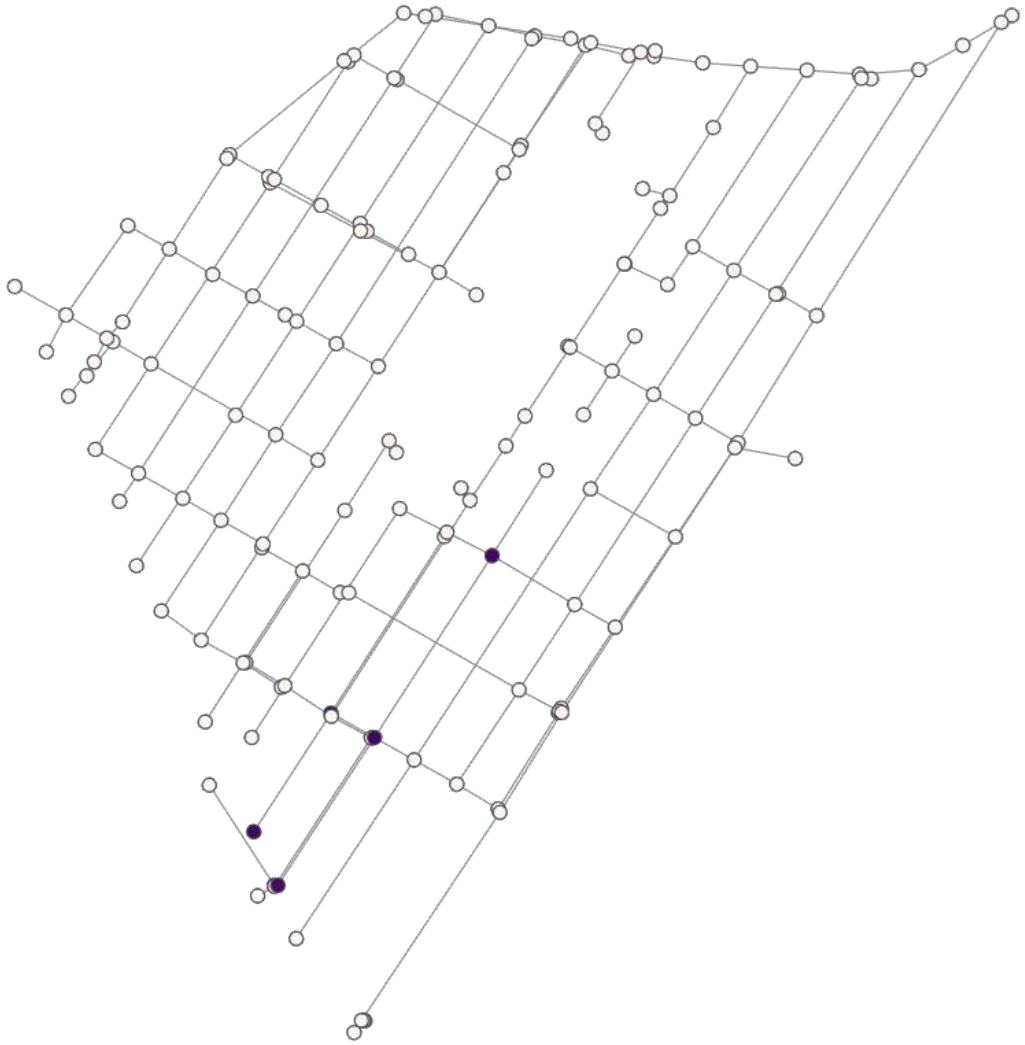
- Vector were compared by their similarity (machine learning and data analysis strategies).
- Two similar residual vectors for a given leak are expected to belong to hydraulically close-connected nodes, although not necessarily to spatially neighboring nodes.

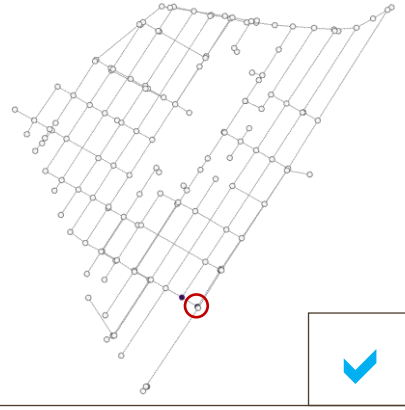
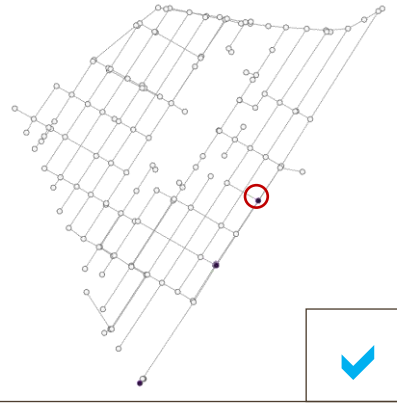
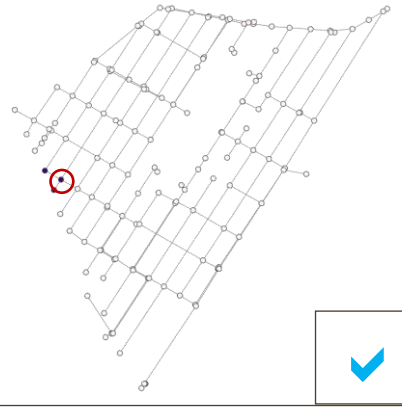
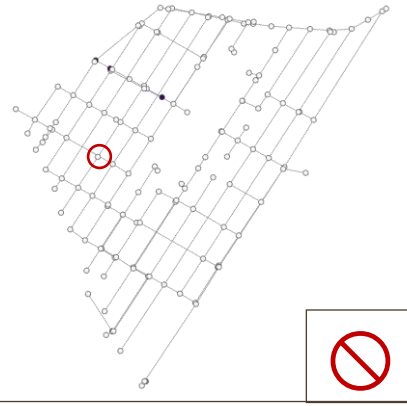
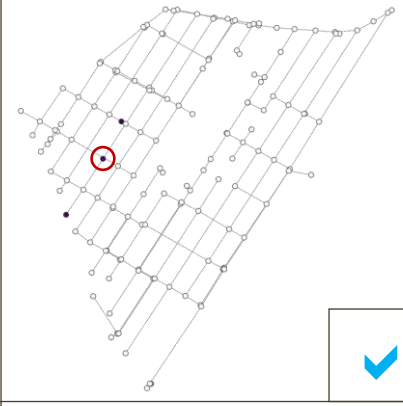
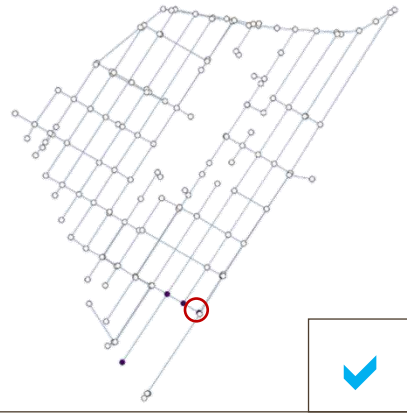
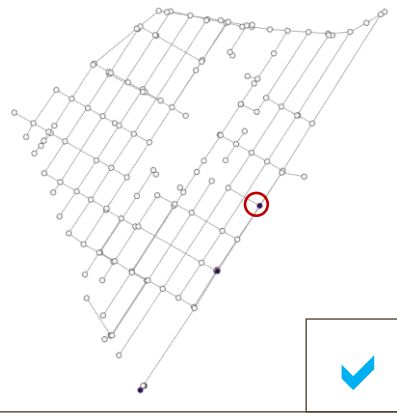
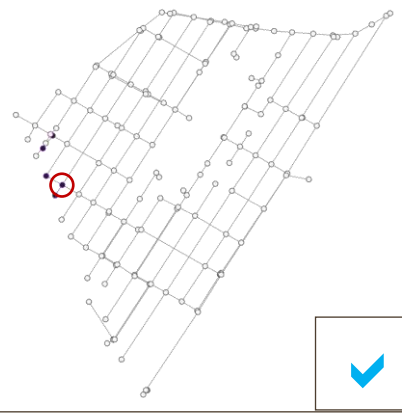
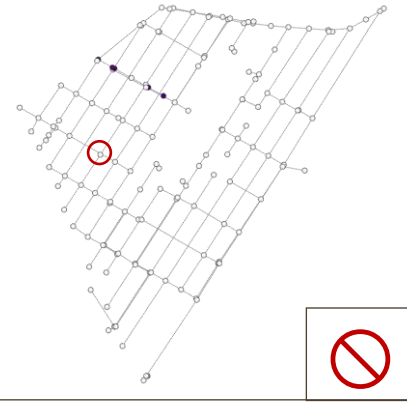
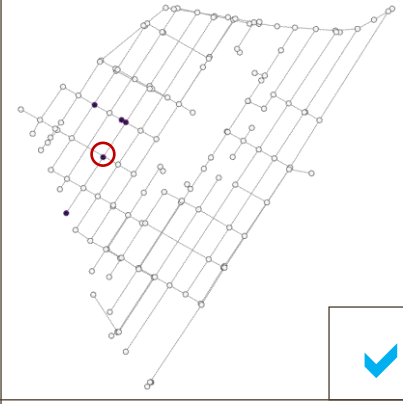
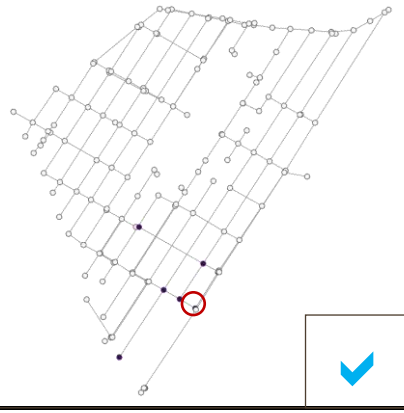
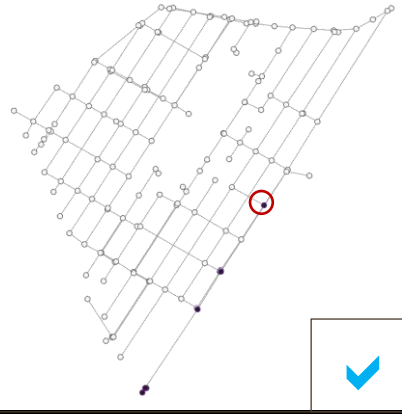
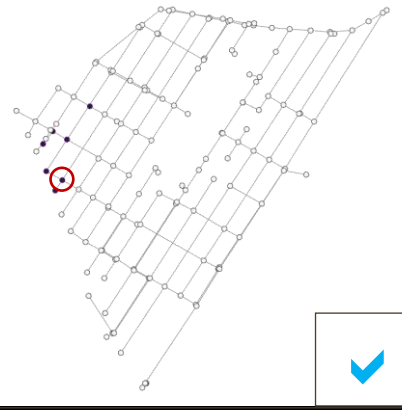
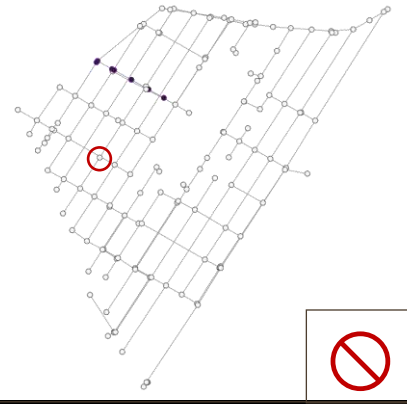
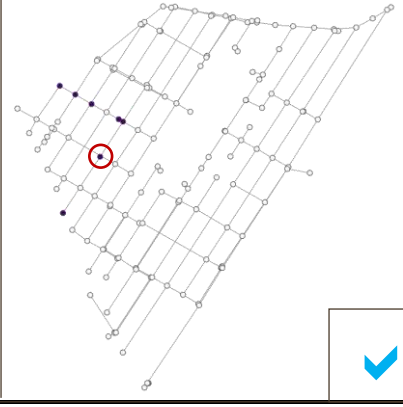


How does the leaking node prediction work?

NAIADES Webinar Series

- A set of pressure values is measured in the field at times t ($0 < t < 24$).
- Pressure residuals are estimated by comparing pressure values with and without leaks.
- The resulting residuals vector are compared to the training data. Similarity index is calculated for each pair of vectors.
- The nodes containing the most similar vectors are the most likely leaking nodes at time t.
- The procedure is repeated for all times t.
- The most likely leaking nodes are selected for all times t, establishing an area for pinpointing.

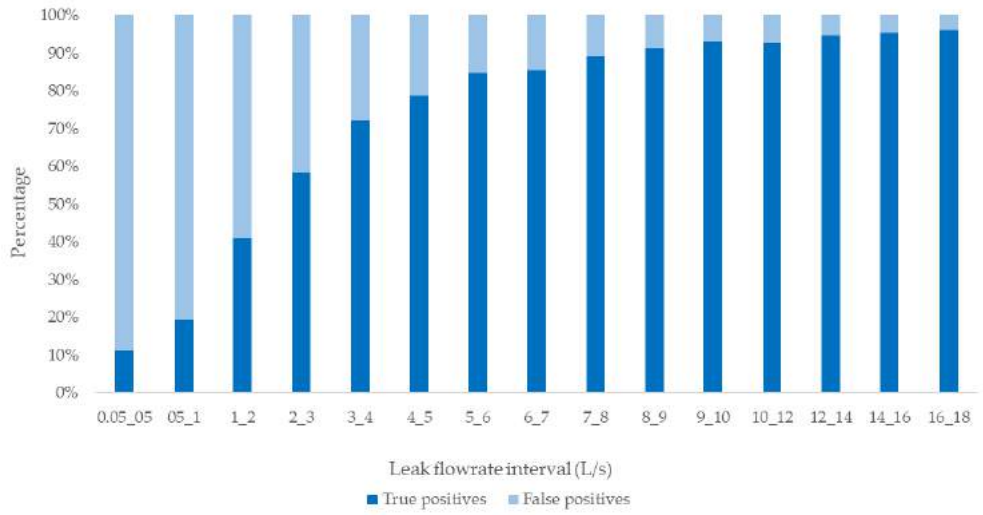


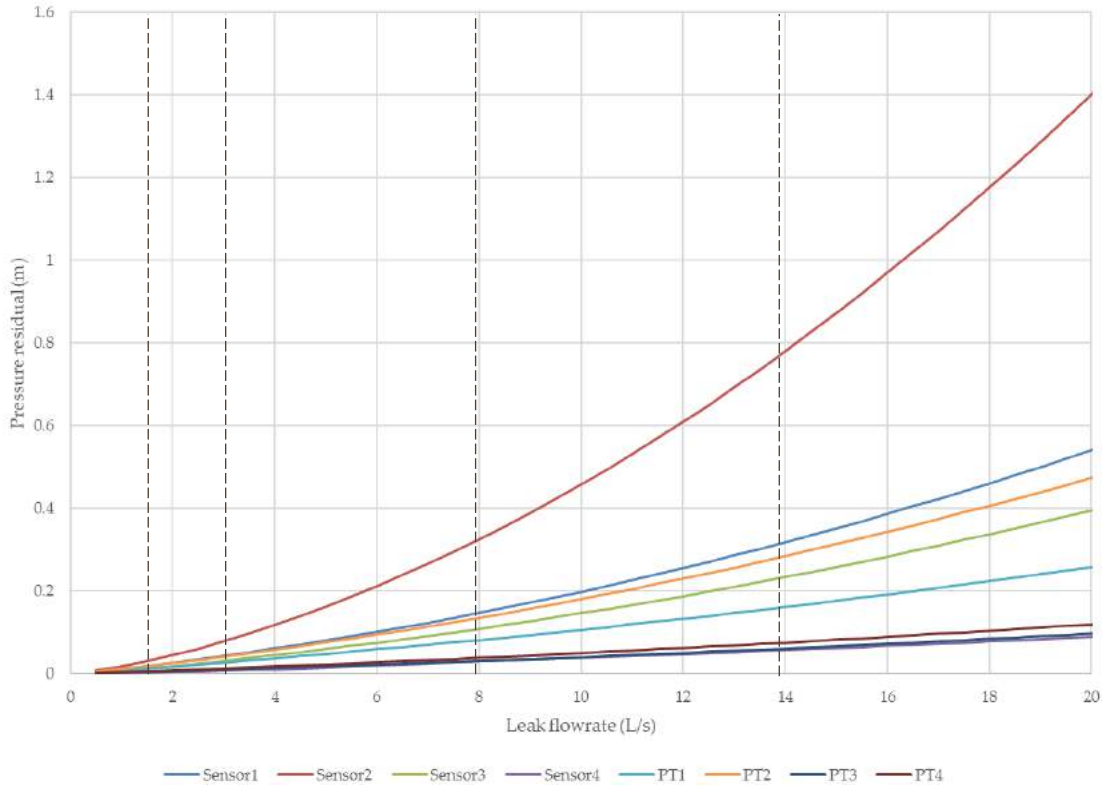
	Jonc-3446 (2.88 L/s)	Jonc-J-21 (4.48 L/s)	Jonc-12372 (7.63 L/s)	Jonc-2180 (1.2 L/s)	Jonc-2180 (2.36 L/s)
K = 3	 ✔	 ✔	 ✔	 ⊘	 ✔
K = 5	 ✔	 ✔	 ✔	 ⊘	 ✔
K = 7	 ✔	 ✔	 ✔	 ⊘	 ✔

Findings

- General accuracy was 83% for K=5

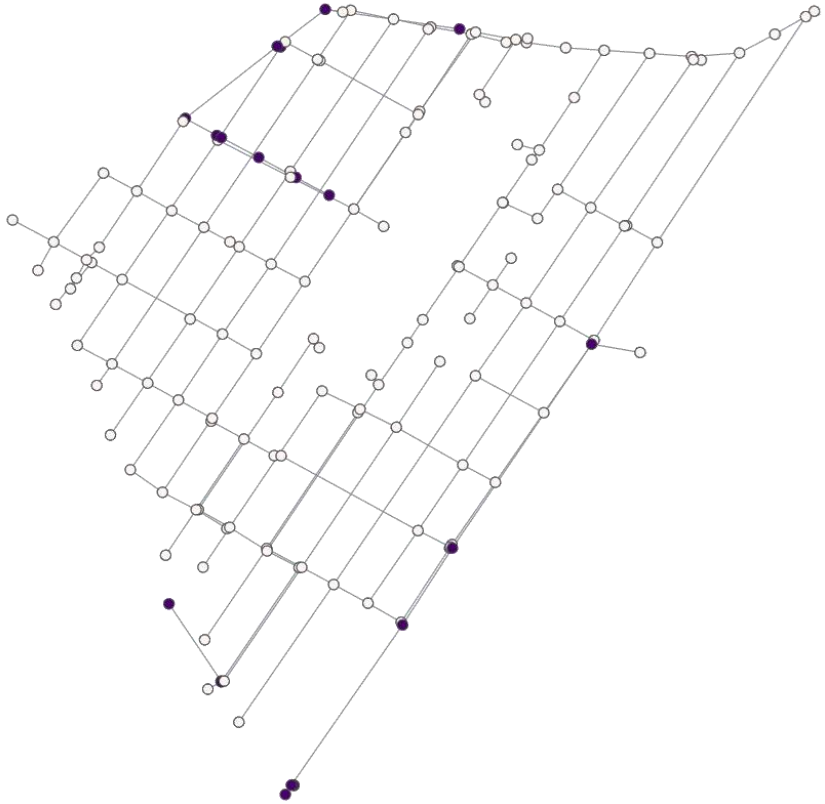
- Leak location accuracy decreases for low leak flows due to the similarity of the pressure residuals and the instrumentation precision.



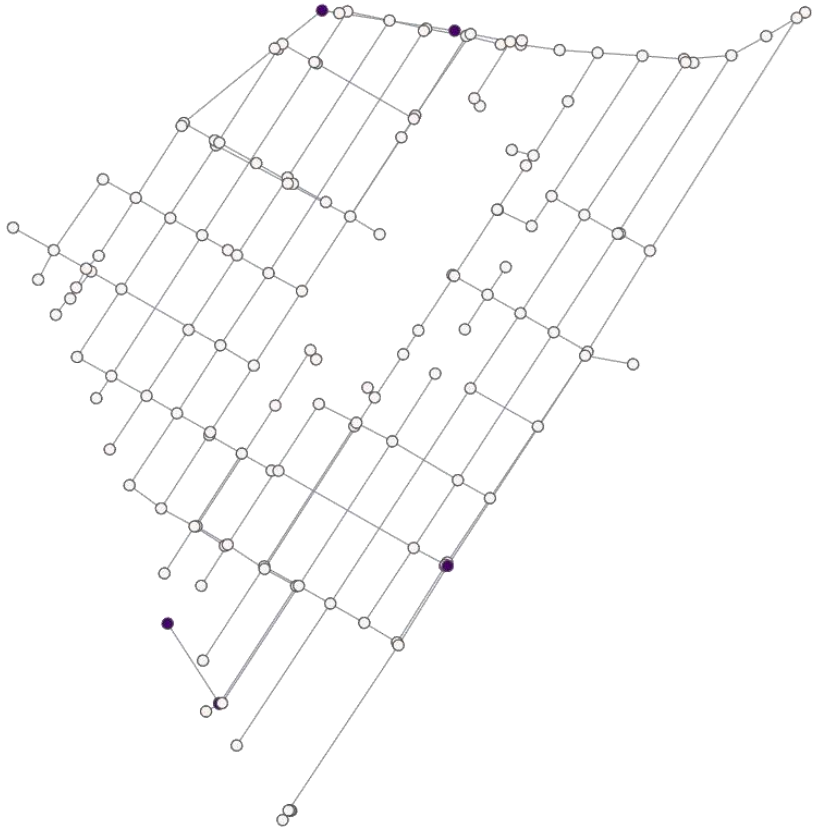


Findings

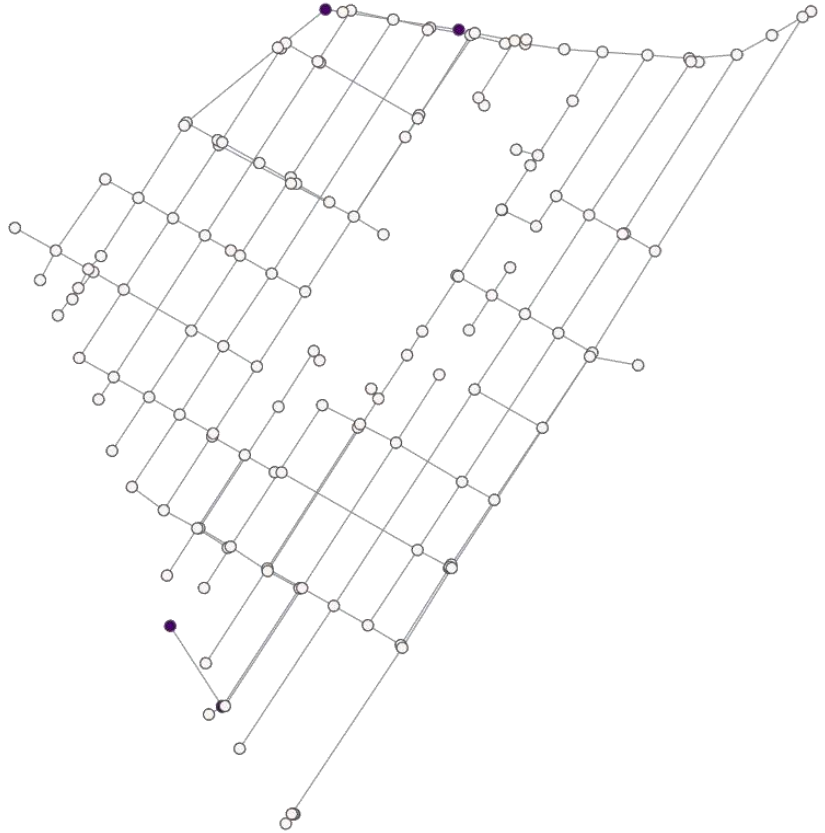
- Particular leak locations can be undetectable for different flow rates.
- No general flow threshold. It depends of the WDN characteristics.



0.05 - 0.5 L/s



0.5 – 1.0 L/s



> 1.0 L/s

Feedback session

NAIADES Webinar Series

https://ahaslides.com/SW2022

NAIADES

Webinar Series

wrap-up

NAIADES

Webinar Series

Follow us on social media

@naiadesproject

@naiadesproject

www.naiades-project.eu