Université de Lille

POLYTECH LILLE

Laboratoire Génie Civil et géoEnvironnement Lille Nord de France

SUNRISE SMART CITY

Master Urban Engineering and Habitat

(2022 – 2023)

Course Smart City

Ch3: Smart water supply

Professor Isam SHAHROUR

Outline

- Water key figures
- Water supply system (how does the system work ?)
- Smart water system ?
- Smart water pilot (SunRise) ?

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Public water data (France)

En bref

- 626 jeux de données
- 63 contributeurs
- dernière mise à jour : 21/10/2021

http://www.data.eaufrance.fr

L'eau et les milieux aquatiques en quelques chiffres

Water withdrawn (2017):

32 Billions m^3 (23 days of rainfall)

500 m^3/ inhabitant/year

- 50% for nuclear plants cooling
- 17% for potable water
- 9% for the agriculture
- 8 % for the industry

France

Drinking Water network

- 906 000 km (value: ~ 80 billion €)
- Annual investment = 1.5 billion €

Sewage network :

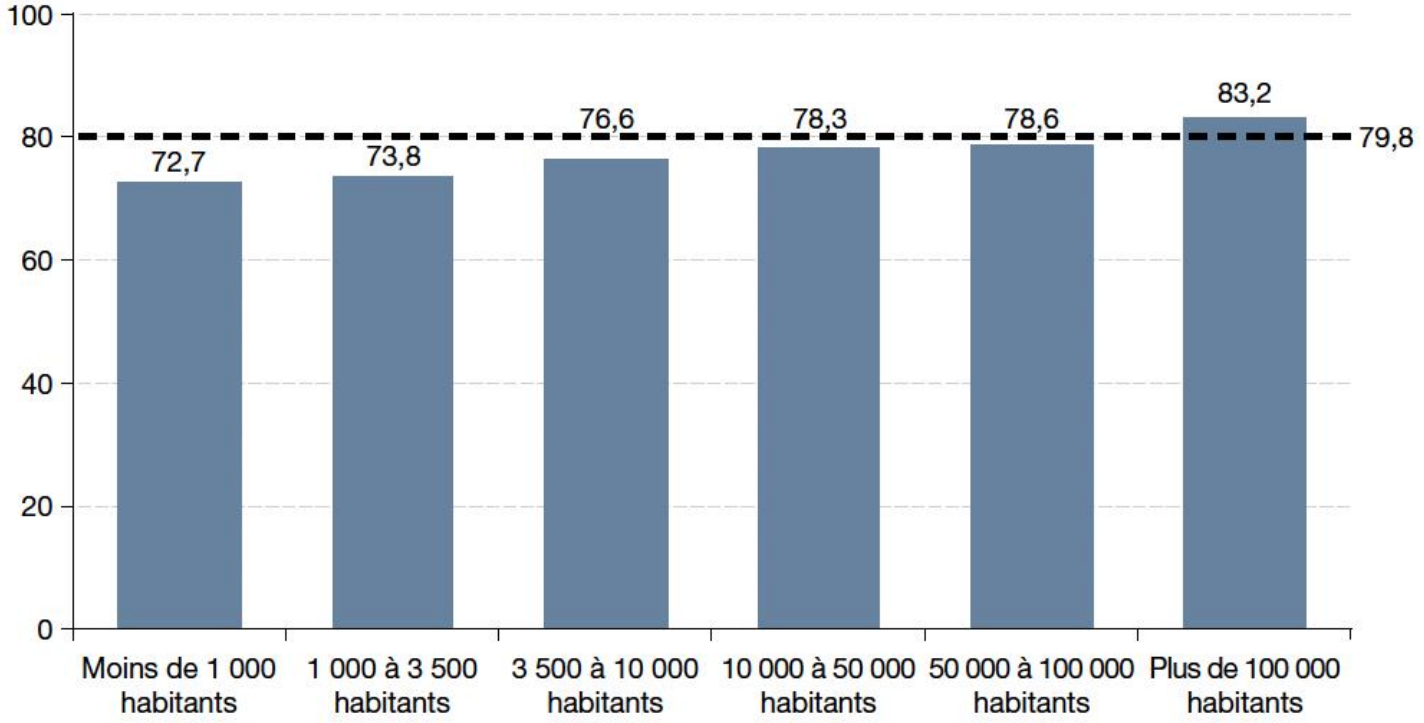
- 394 000 km (~ 70 billion €)
- Annual investment =: 0.8 to 1.3 billion €

France

- Average life span of the pipelines: ~ 70 years
- Average age of pipes: ~ 40 years (more than 100 years for some pipes)
- Average renewal rate = 0.6%

Performance of drinking water supply system

Efficiency factor (%)

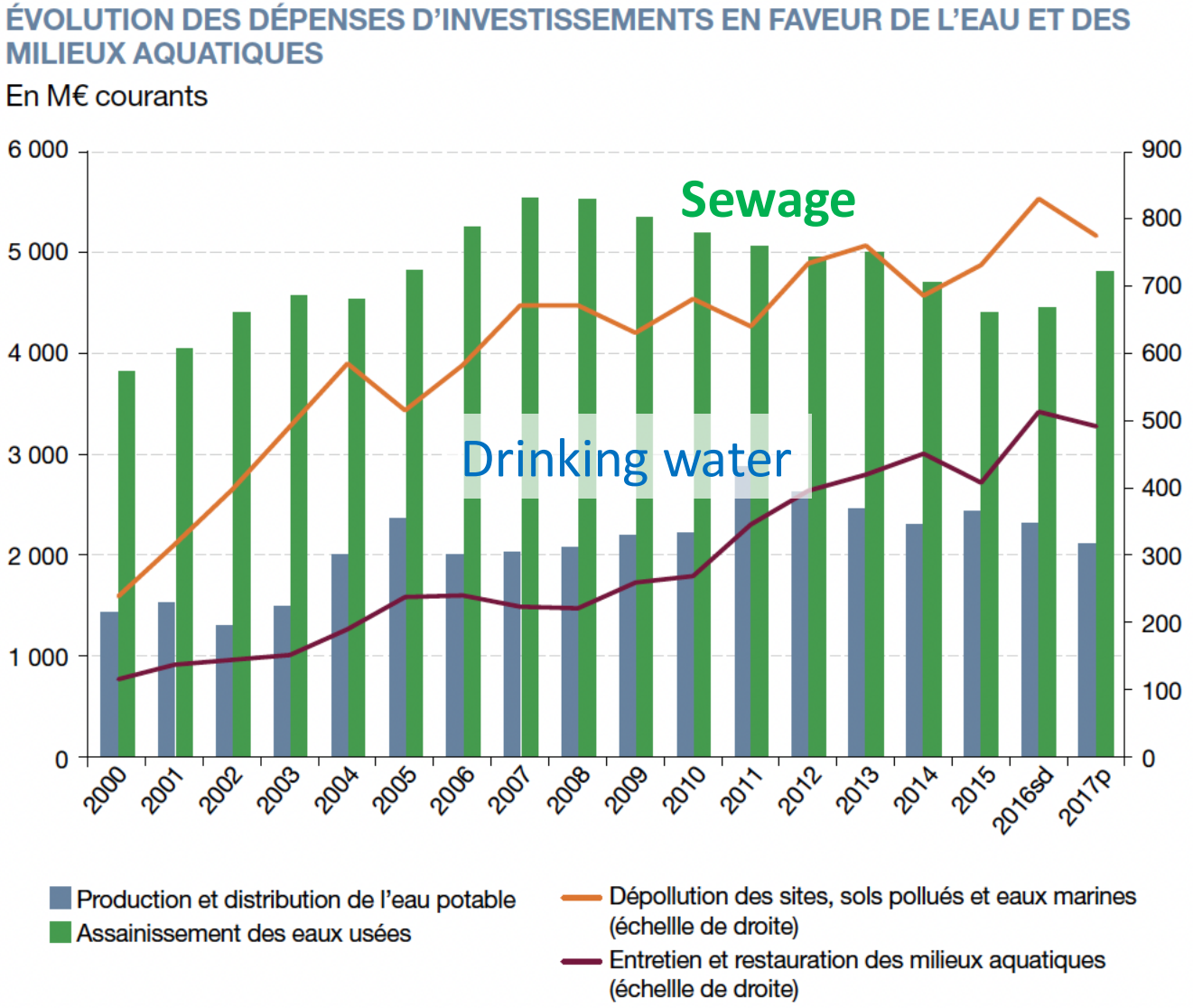


Size of the city

Dépenses d'investissements en faveur de l'eau et des milieux aquatiques

En 2017, les dépenses d'investissements en faveur de l'eau et des milieux aquatiques atteignent 8,2 milliards d'euros.

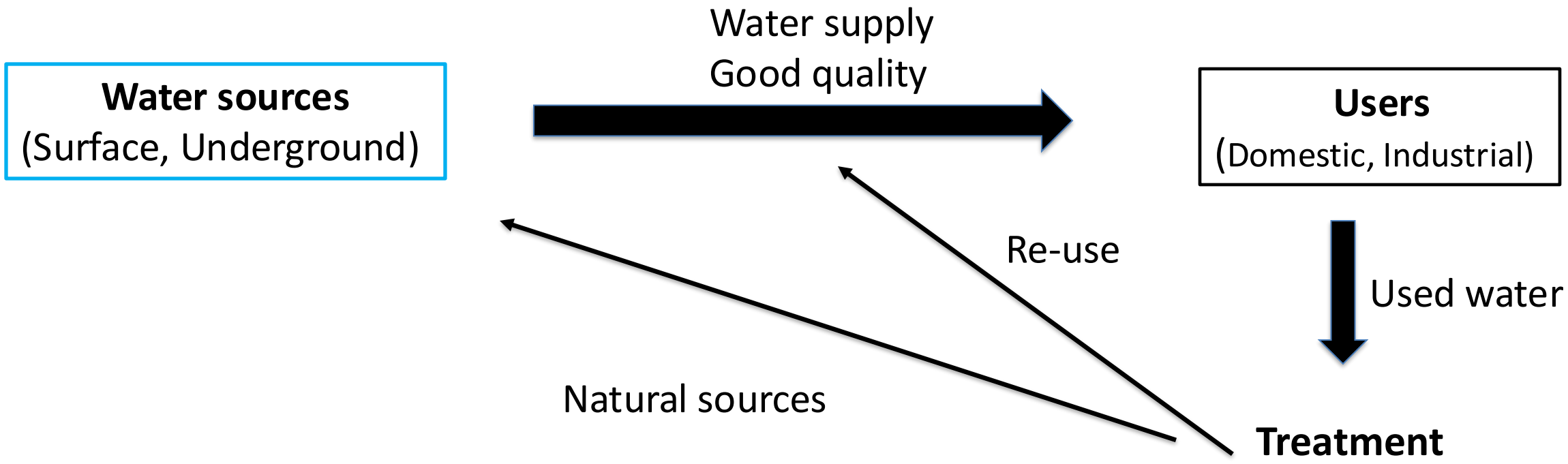
Investment in the water sector
(M€ /year)

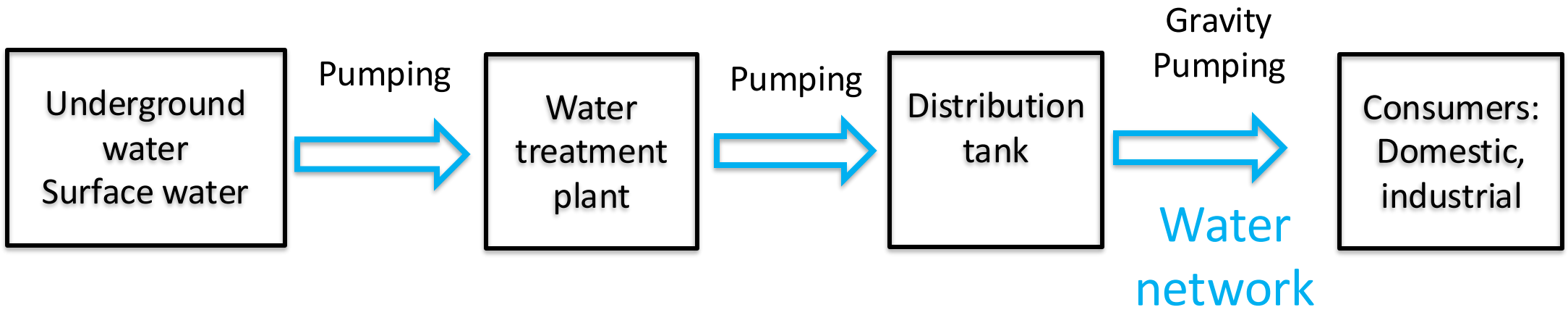


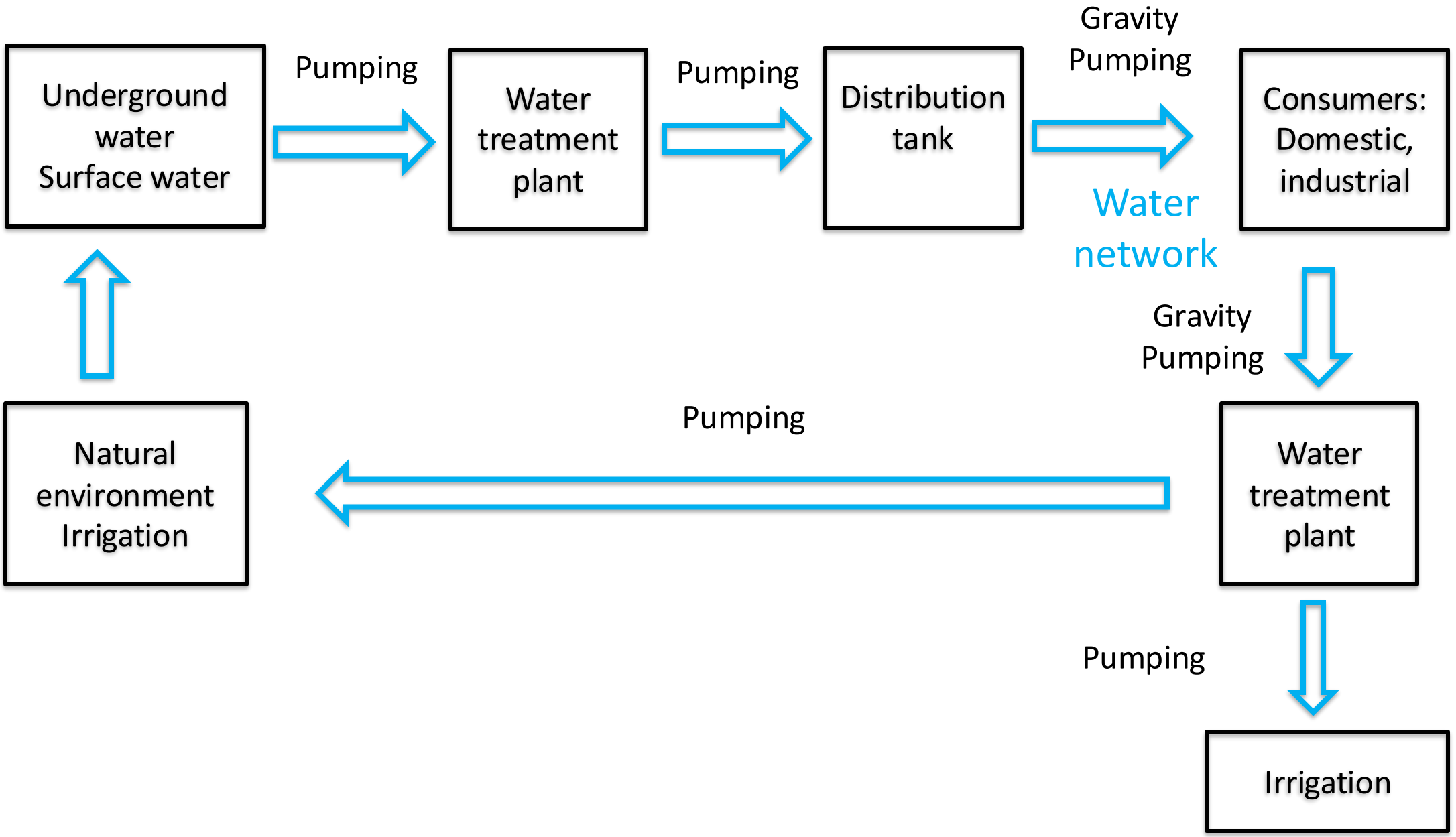
Outline

- Water key figures
- Water supply system (how does the system work ?)
- Smart water system ?
- Smart water pilot (SunRise) ?

Objective of the water supply system




Underground water
Surface water
Pumping
Water treatment plant
Pumping
Distribution tank
Gravity Pumping
Consumers: Domestic, industrial
Water network


Underground water Surface water
Pumping
Water treatment plant
Pumping
Distribution tank
Gravity Pumping
Consumers: Domestic, industrial
Water network
Gravity Pumping
Water treatment plant
Pumping
Pumping
Natural environment Irrigation
Pumping
Irrigation

Water Distribution system

Water pipes

- Ductile iron
- Plastic (HDPE/PVC)
- Concrete
- Steel

Valves

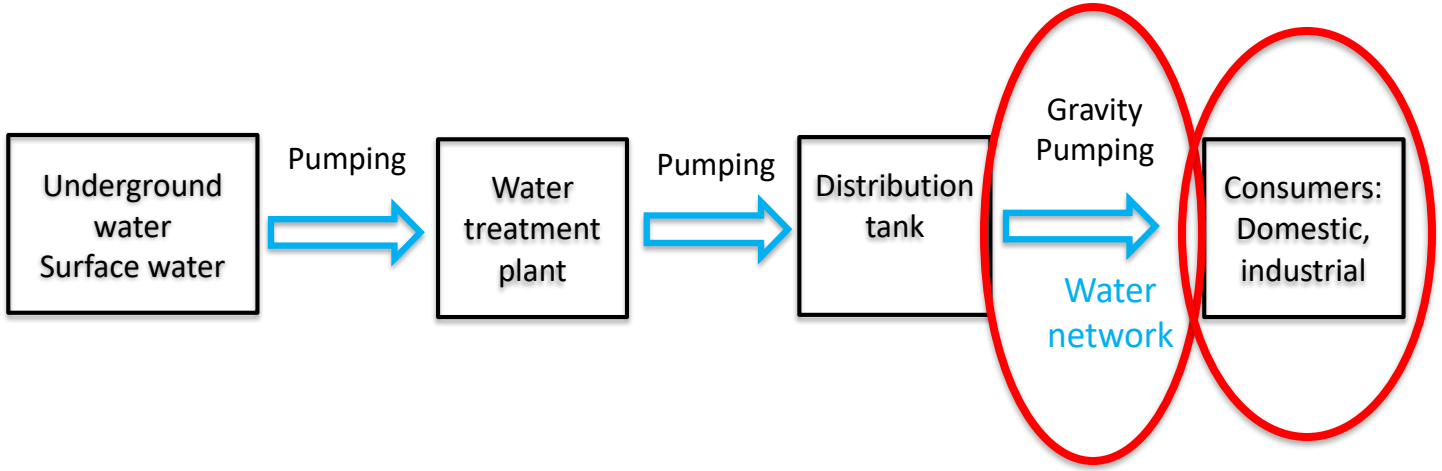
water counter

Challenges :

1) Water quality :

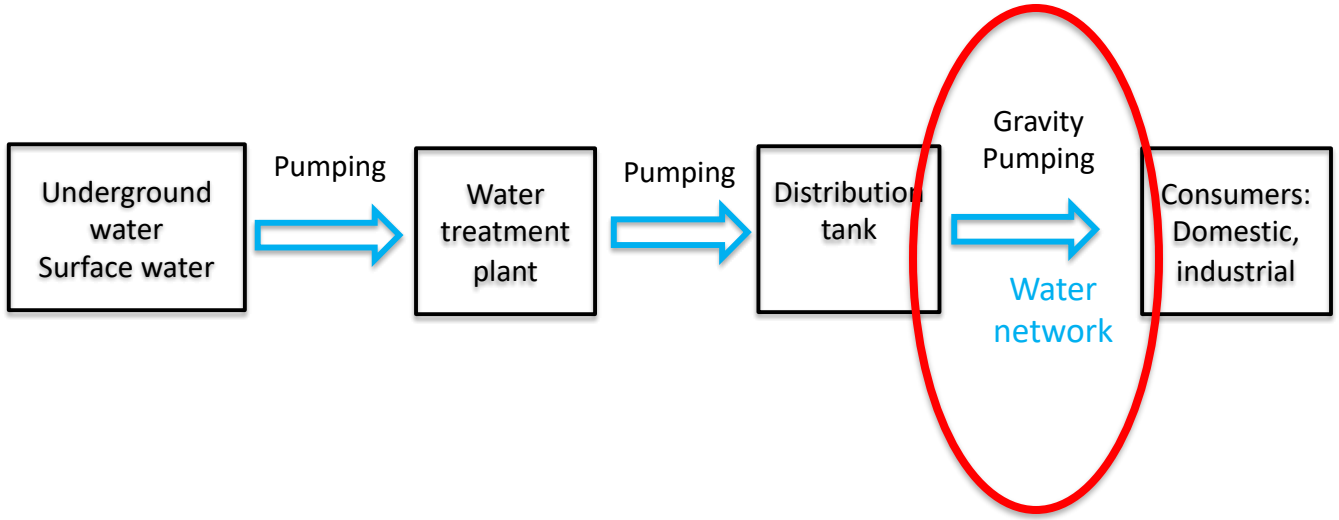
Contamination could occur at :

- The water source **(strict control)**
- Transportation from the treatment station to the tank **(strict control)**
- Transportation from the tank to consumers
- At home …



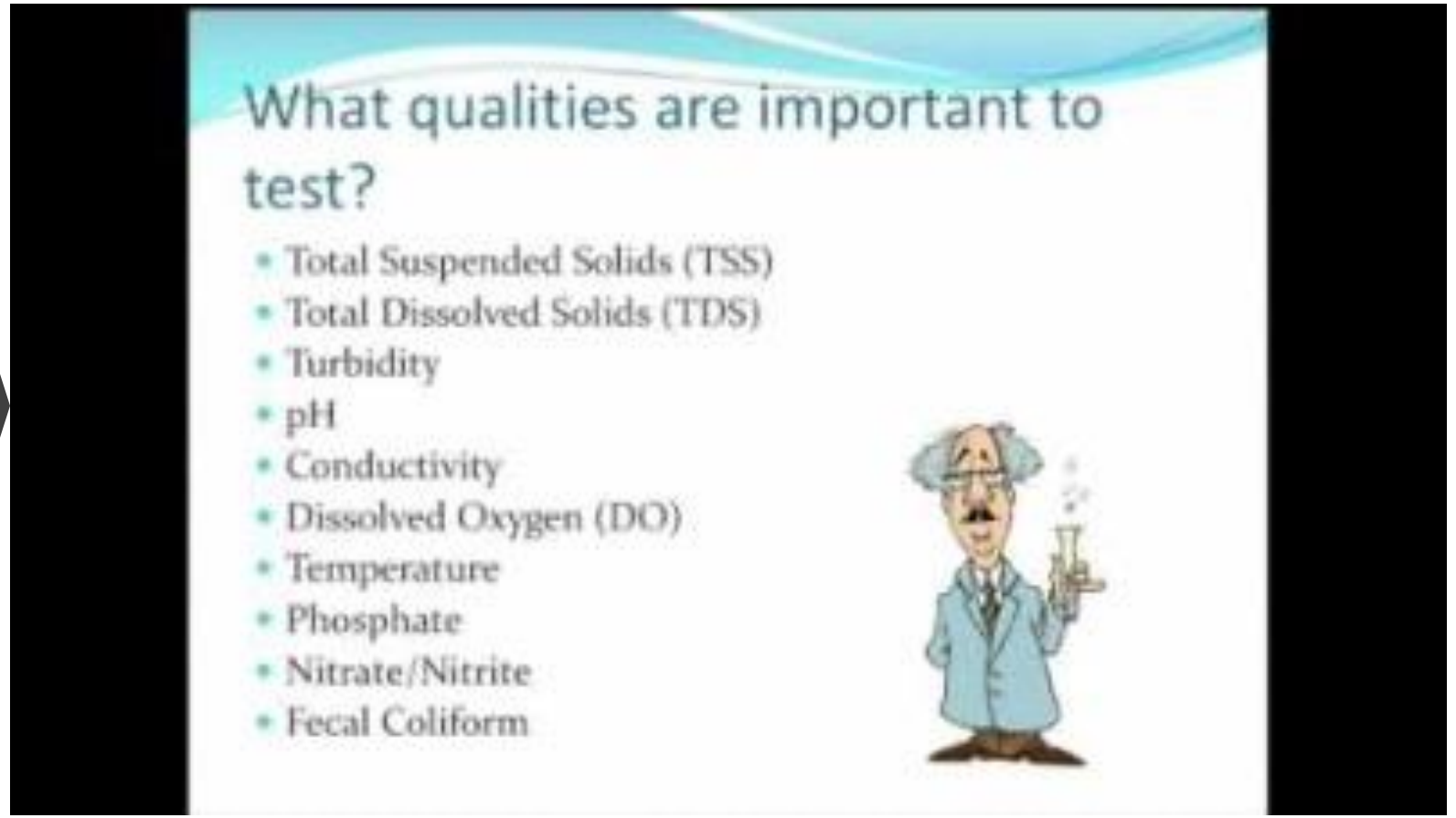
Challenges :

Water leak: in some cities up to 40% of the water sup



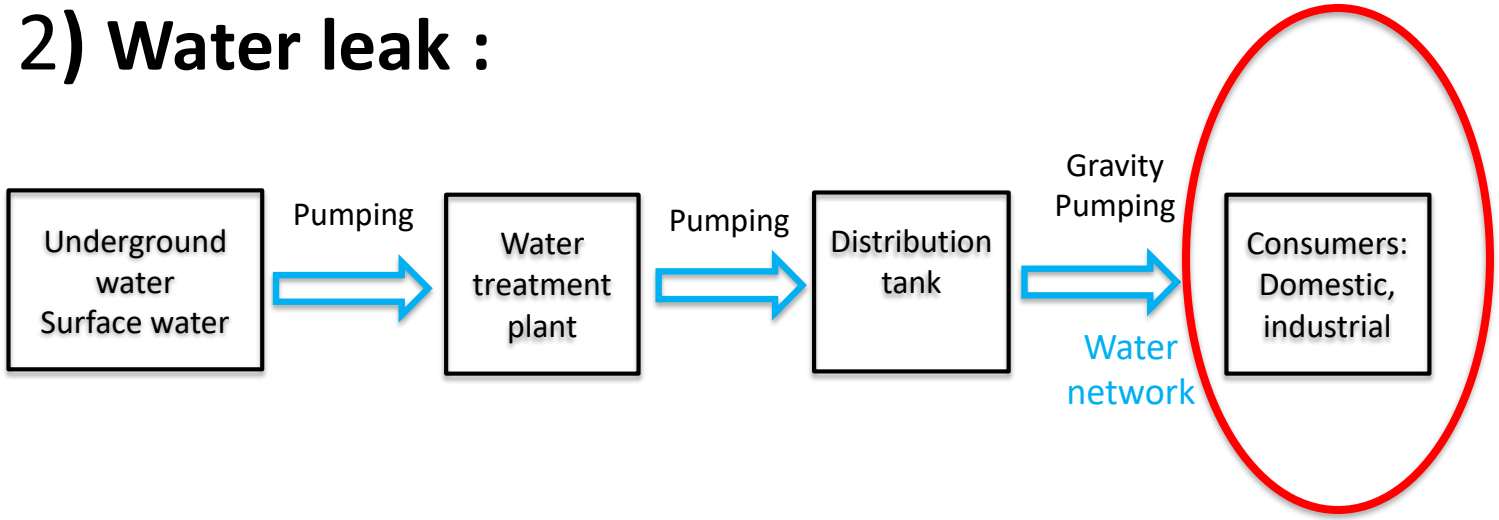
When is water safe to drink - Mia Nacamulli

Water Quality and Pollution - Am I Drinking Safe Water



Challenges :

2) Water leak :



Tap drip
44 m^3/year
175 € (France)

Toilet flush
220 m^3/year 880 € (France)

City's Faulty Water Meters Make Monthly Water Bills Skyrocket

Challenges:

3) Asset management:

- Network maintenance, rehabilitation, modernization and extension.
- Huge expanses

Challenges:

4) Quality of water service (customers satisfaction)

Interruption, pressure, water quality, price,….

Outline

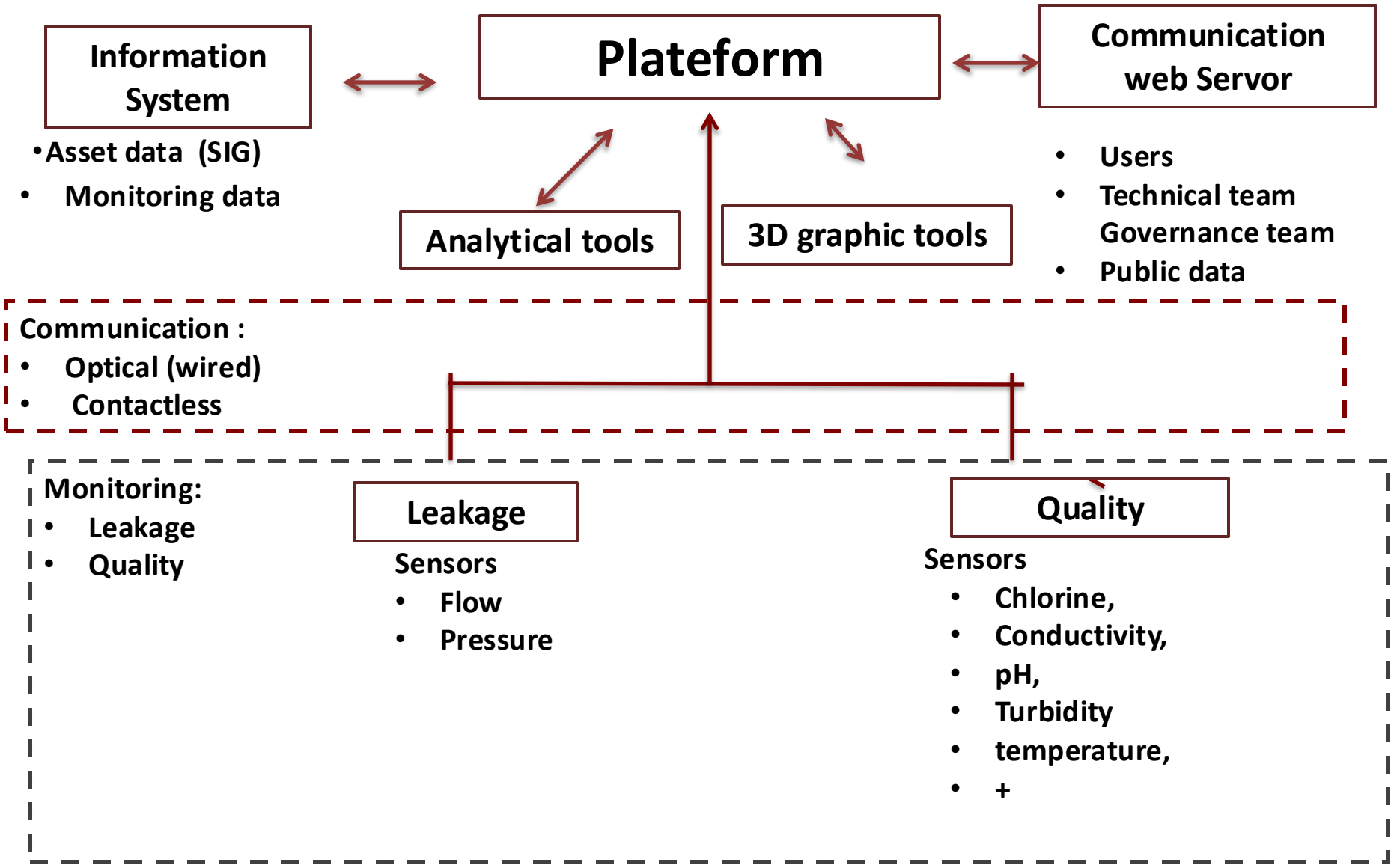
- Water key figures
- Drinking water system (how the system works ?)
- Smart water system
- Smart water pilot (SunRise)

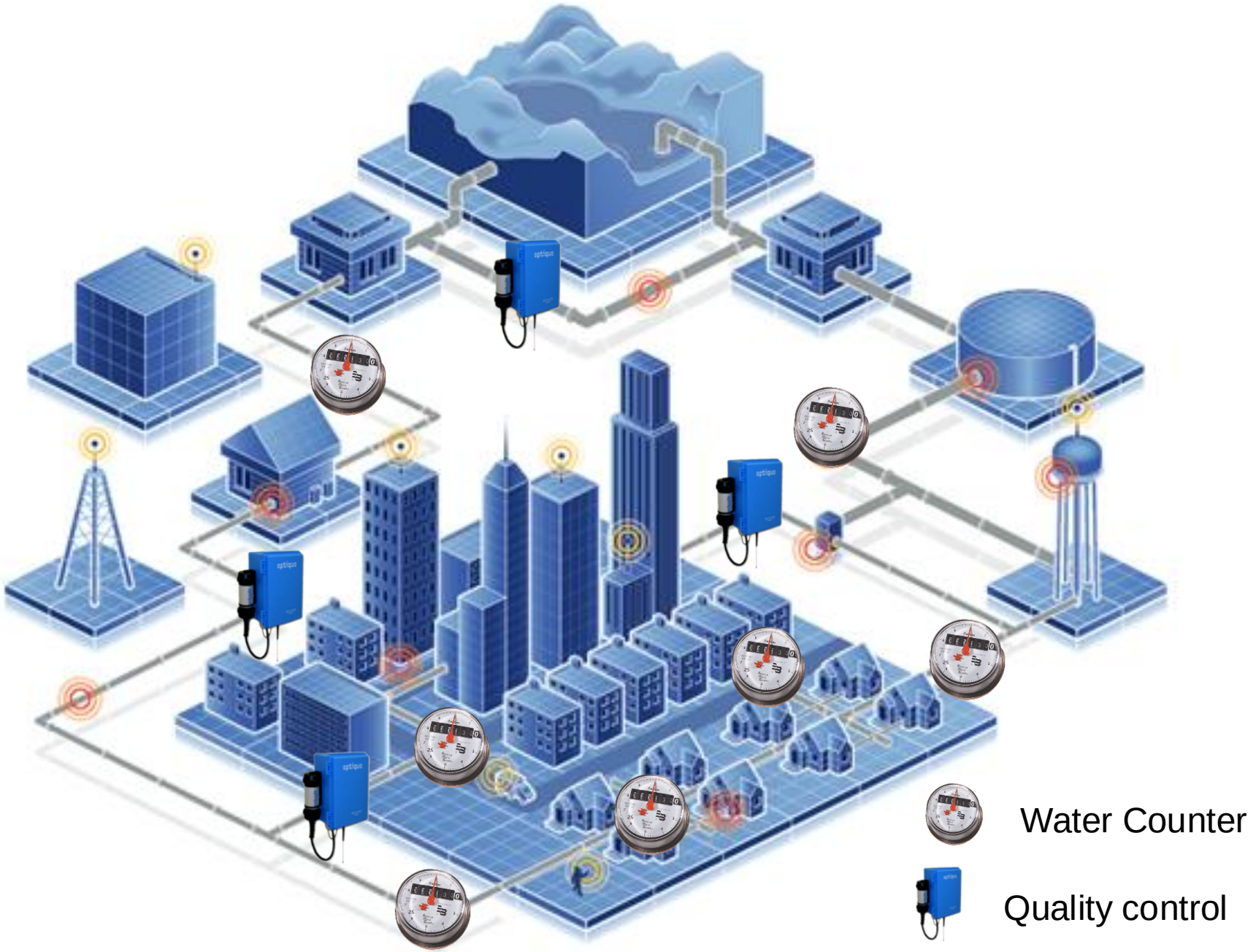
Objective of the smart water system

Improve the management of the water system

- Assets management
- Leakage detection
- Early contamination detection
- Users’ satisfaction

Smart Water System




Water Counter
Quality control

Information system

Geographic information system (GIS)

Assets information :

Pipes :

- geo-localization,
- diameter, material, roughness,
- surrounding soils,
- accident, maintenance,…

Information system

Geographic information system (GIS)

Asset information :

Valves : type, geo-localization, sate, accident, maintenance,…

Counters : type, geo-localization, accident, maintenance,…

Hydrants : type, geo-localization, maintenance,

Information system

Geographic information system (GIS)

Operating data :

Consumption : Water counter,

Velocity : water flow meter

Pressure :

Smart meters

[artists impression]

Smart Water Meter, What is it

Water quality parameters

Physical

- Temperature
- Flow
- Conductivity
- Pressure

Optical

- Turbidity
- Color

Chemical

- Free Chlorine
- Mono-chloramine
- Dissolved Oxygen
- pH
- ORP
- ISE (e.g. Ammonium, Fluoride, Nitrate)

Operating data :

Water quality devices

Chlorine analyzer

Operational data :

Water quality

Intellesonde

12 Parameters Monitored

Physical

- **Temperature**
- **Flow**
- **Pressure**

Optical

- **Turbidity**
- **Colour**

Chemical

- **Free Chlorine**
- **Mono-chloramine**
- **Dissolved Oxygen**
- **Conductivity**
- **pH**
- **ORP**
- **ISE (e.g. Ammonium, Fluoride, Nitrate)**

Quality instrumentation

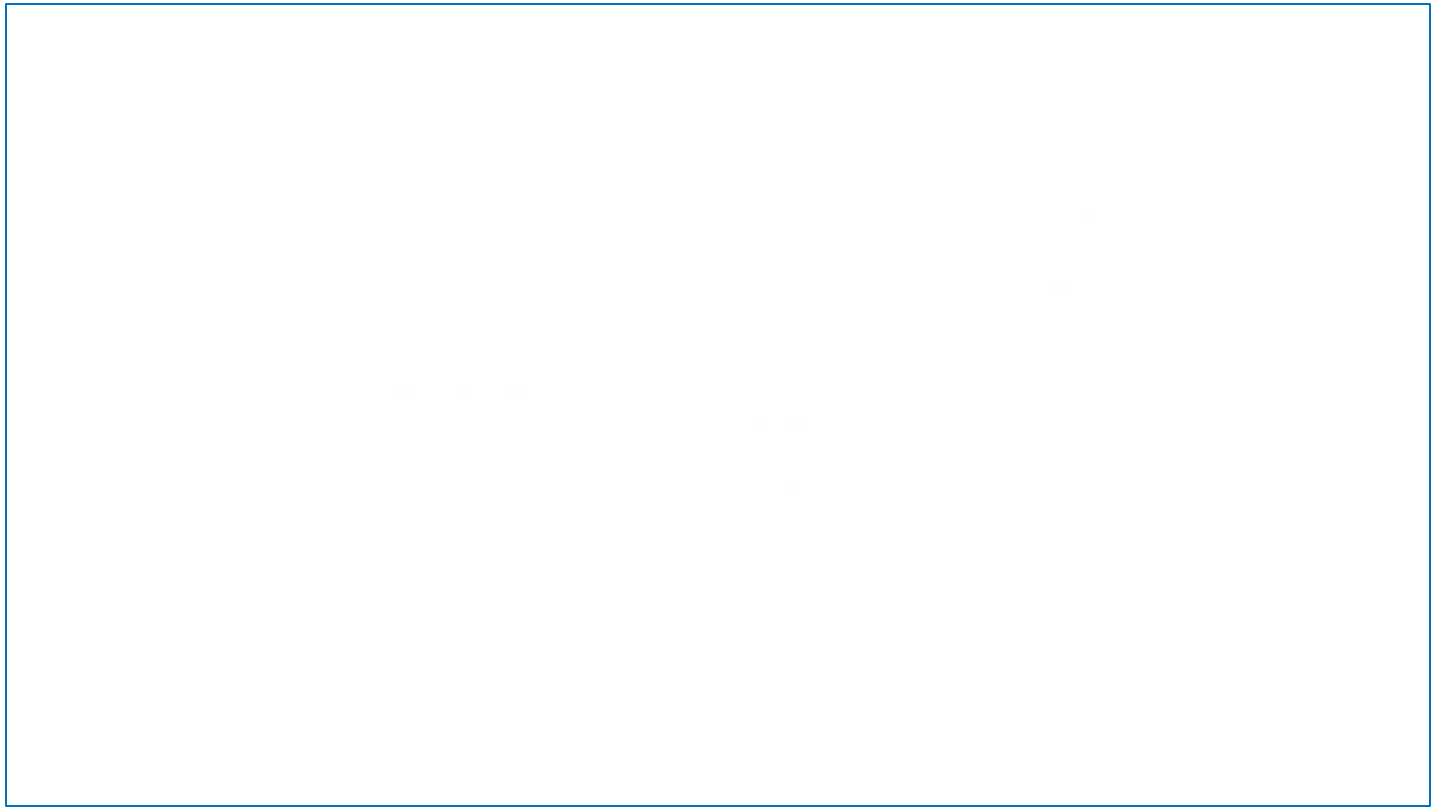
Optiqua EventLab:

measures refractive index changes in the water
It allows monitoring of the water quality for any change in (chemical)

S::Scan

AOC, BOD, BTX, COD, color, DOC, FTU/NTU, H2S, NO2-N, NO3-N, O3, TOC, TSS, UV254,

Smart Water Quality Monitoring Solution



Real Time Water Quality Monitoring Technology

Outline

- Water key figures
- Drinking water system (how the system works ?)
- Smart water system
- Smart water pilot (SunRise)

SunRise – Smart City

Large Scale Demonstrator of the Smart City

University campus: Smart City demonstrator

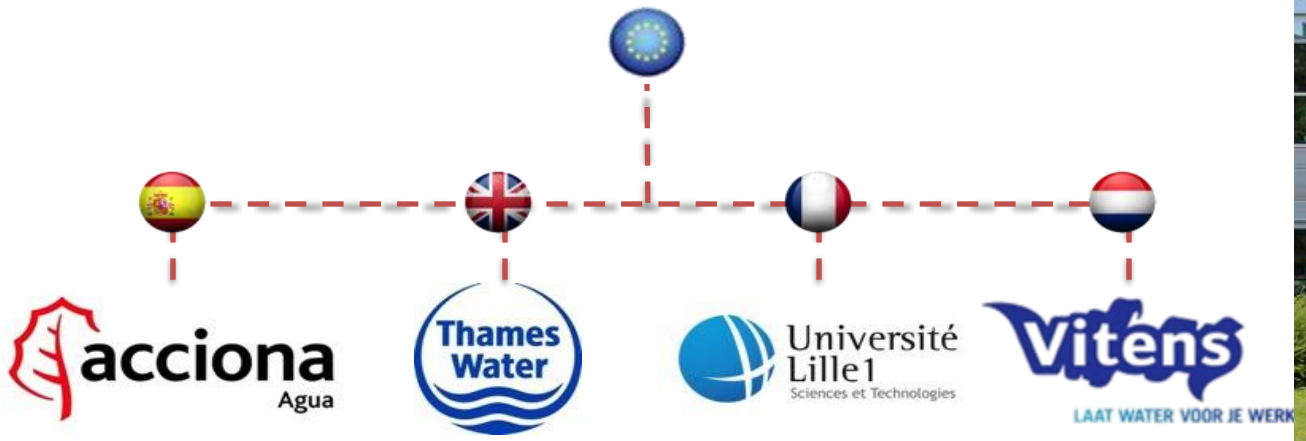
Small town

- 25 000 users
- 140 Buildings

100 km of urban networks

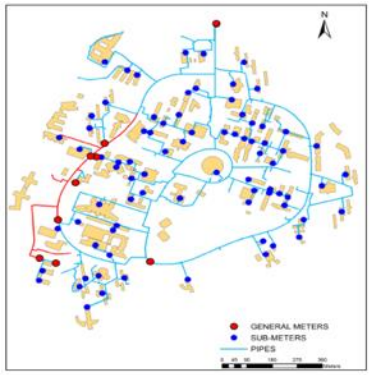
- **Drinking Water**
- **Sewage**
- **District Heating**
- **Gas**
- **Electrical (HV, LV)**
- **Public light**

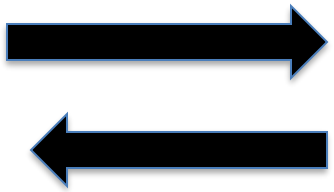
European Smart Water Demonstrator
SmartWater4Europe



Smart Water solution

Asset Digital model (GIS)





Data transmission

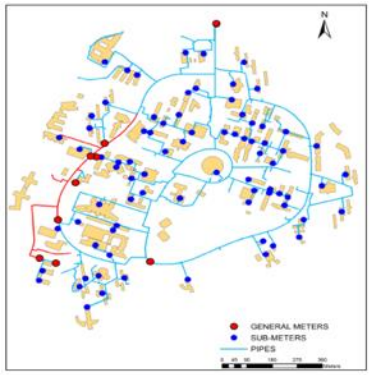
Data Storage Analysis

Monitoring

- Sensors
- Actuators

Smart Water solution

Asset Digital model



Data transmission

Data Storage Analysis

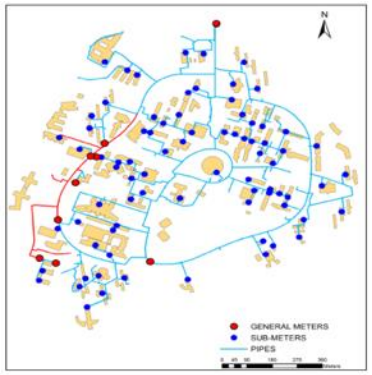
Monitoring

- Sensors
- Actuators

Users

Smart Water solution

Asset Digital model



Monitoring

- Sensors
- Actuators

Data transmission

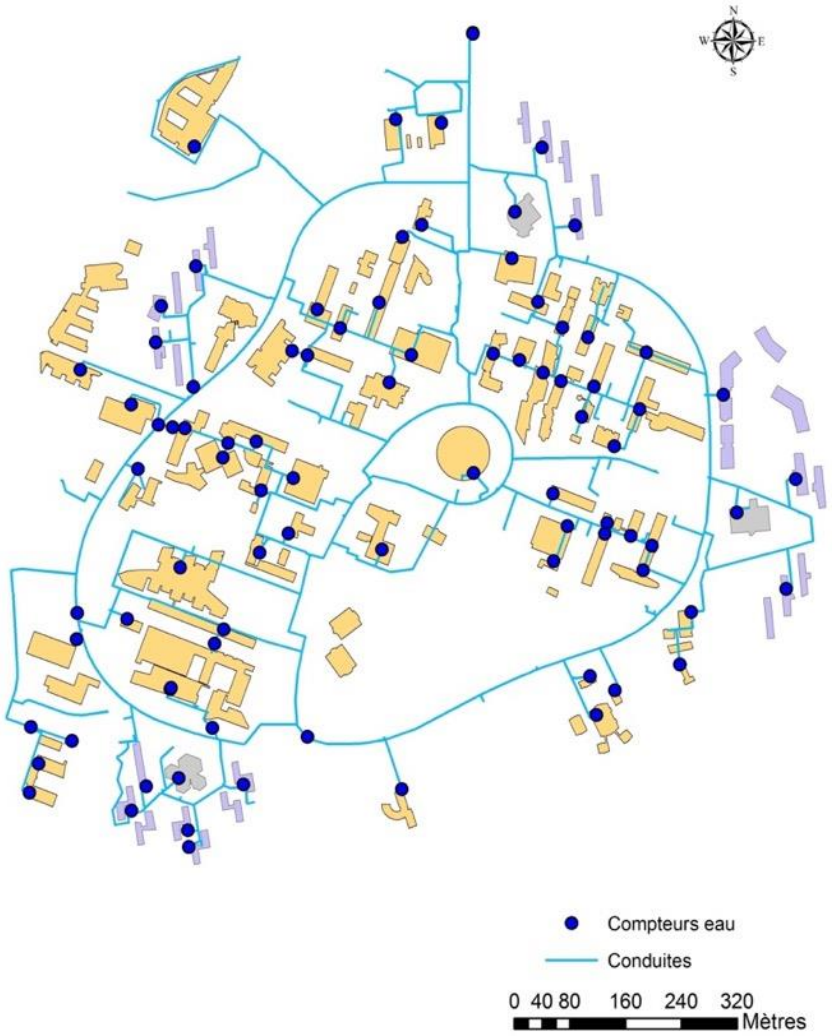
Data Storage Analysis

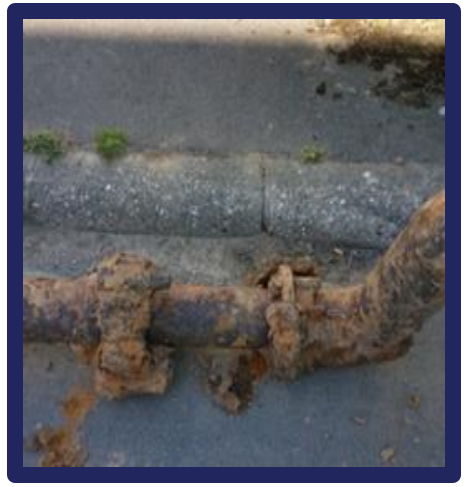
Staff

Users

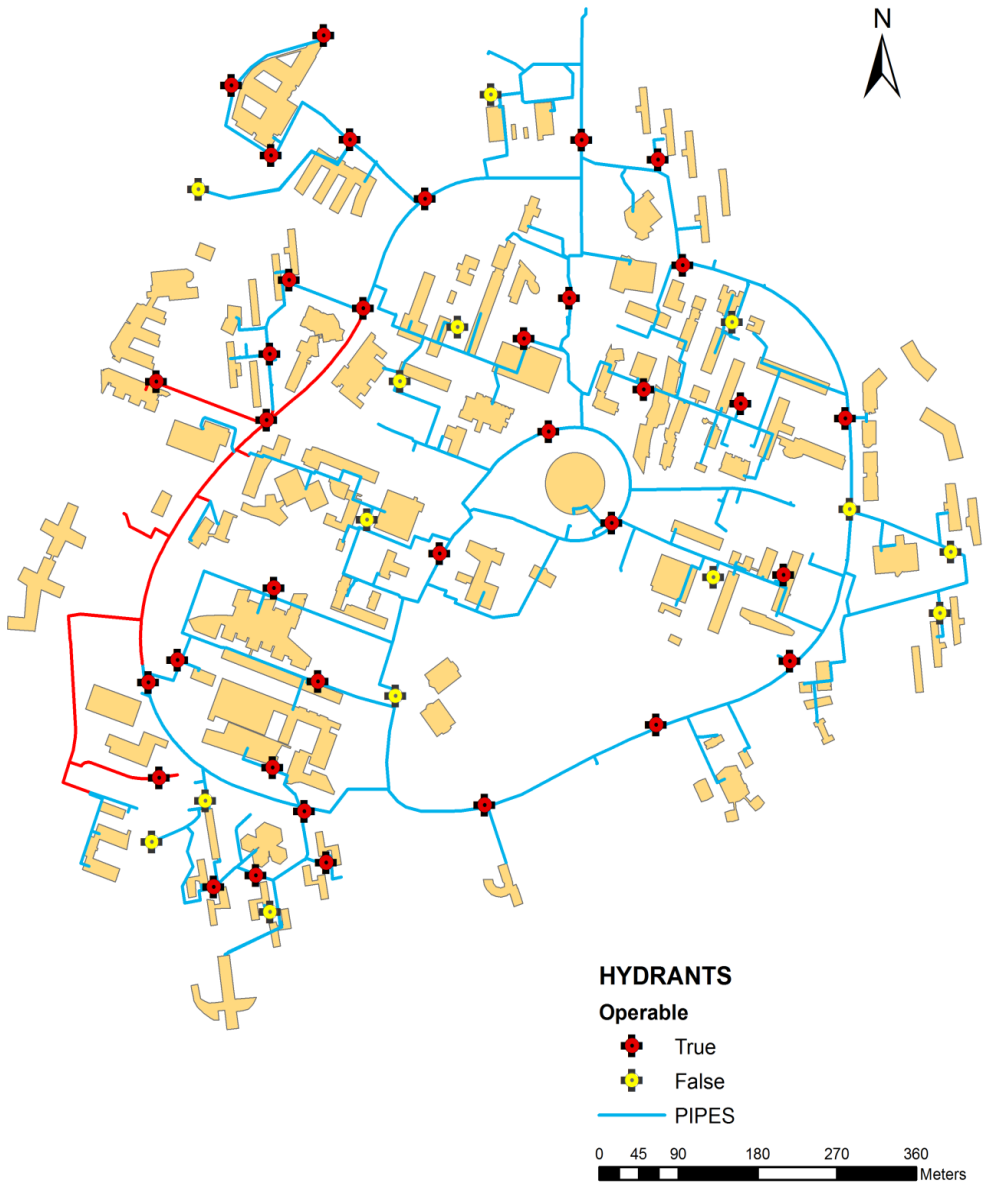
Drinking water system

- 15 km
- Complex
- 60 years old





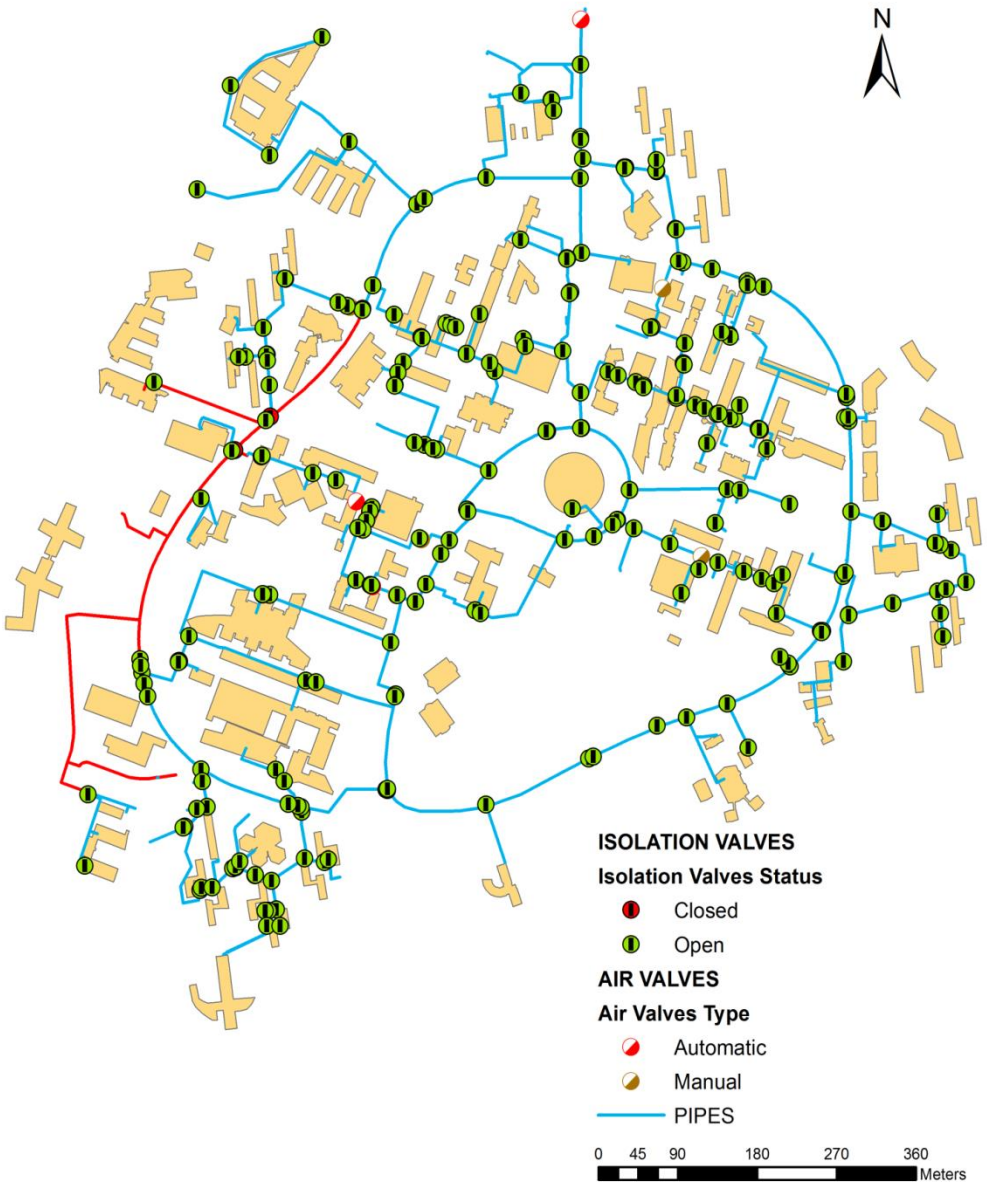
Digital model (GIS)



Pipes
• Diameter • Material • Roughness • Area

Hydrants
• Coordinates • Types • Compliance check tests - Test Date - Static Pressure - Pressure at 60 m^3/h - Flow at 1 bar

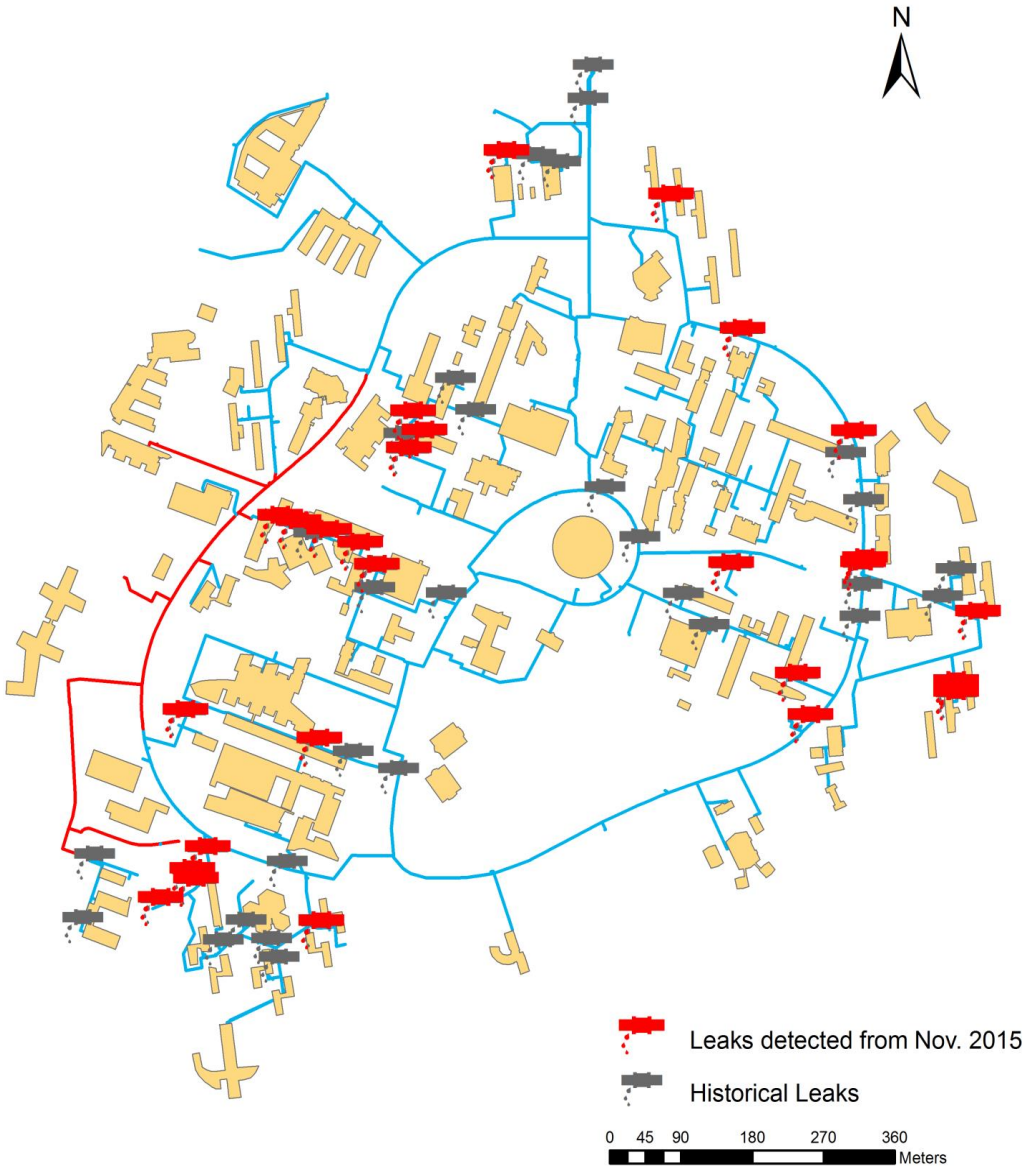
Digital model (GIS)



Valves

- Coordinates
- Diameter
- Reference pipe
- Types
  - Isolation Valves
    - Status (open/closed)
  - Air Valves
    - Automatic/Manual

Digital model (GIS)



Maintenance
• Date • Type • Reporting

Integrated solution – leakage

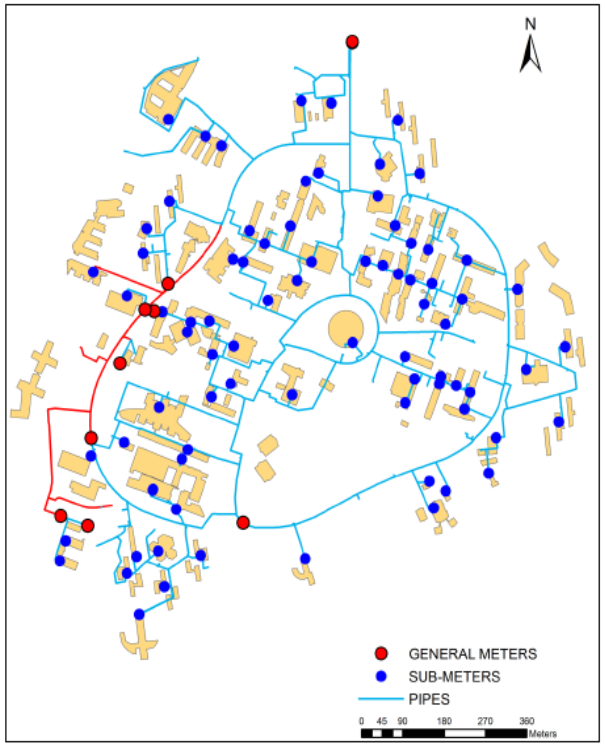
Monitoring | Data transmission | Platform Storage, Analysis | Display Visualization

LEAKAGE:

- **100 AMR (Electronic Counter)**
- **5 Pressure Cells**

Time interval

- AMR: 1 hour
- Pressure : 15 minutes



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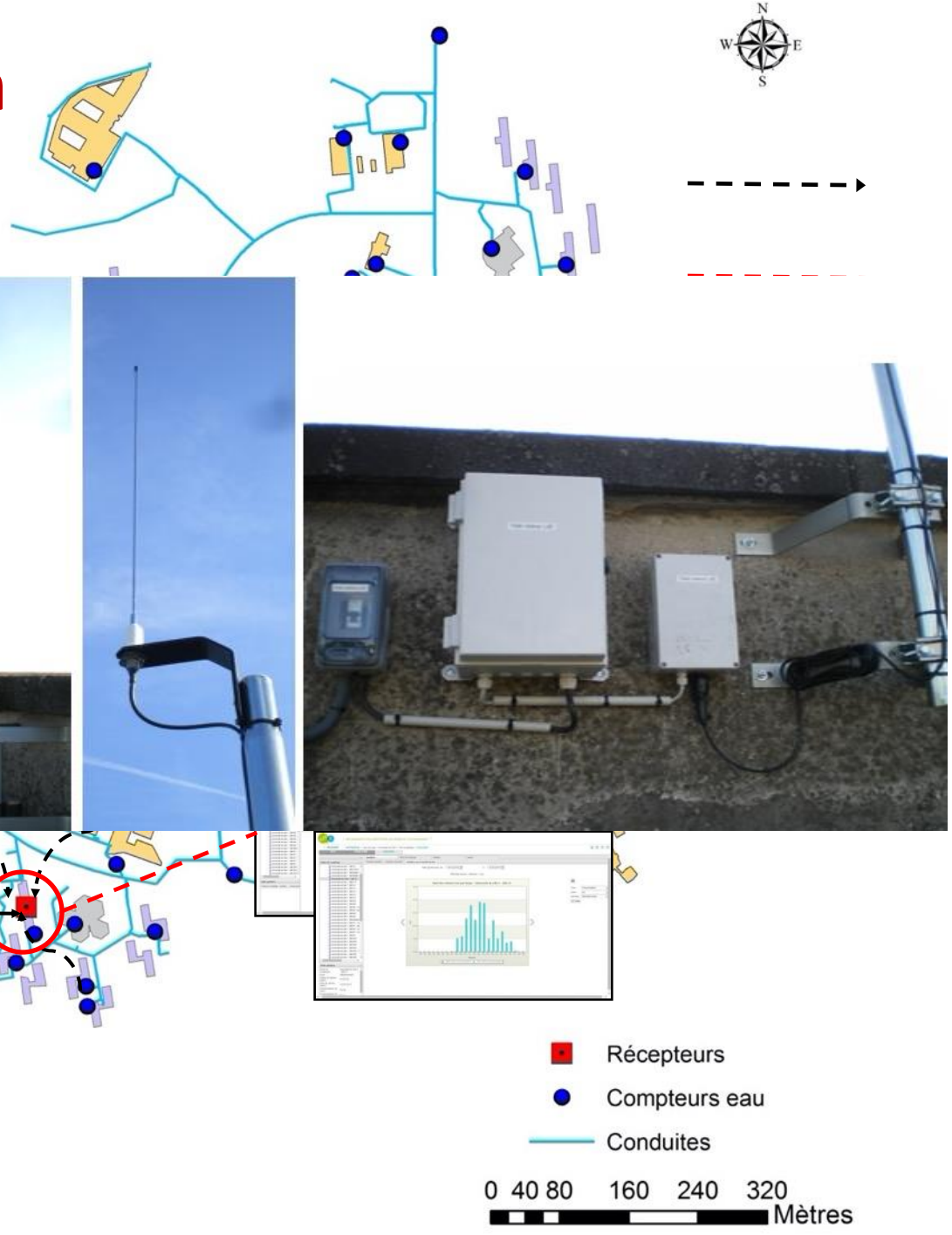
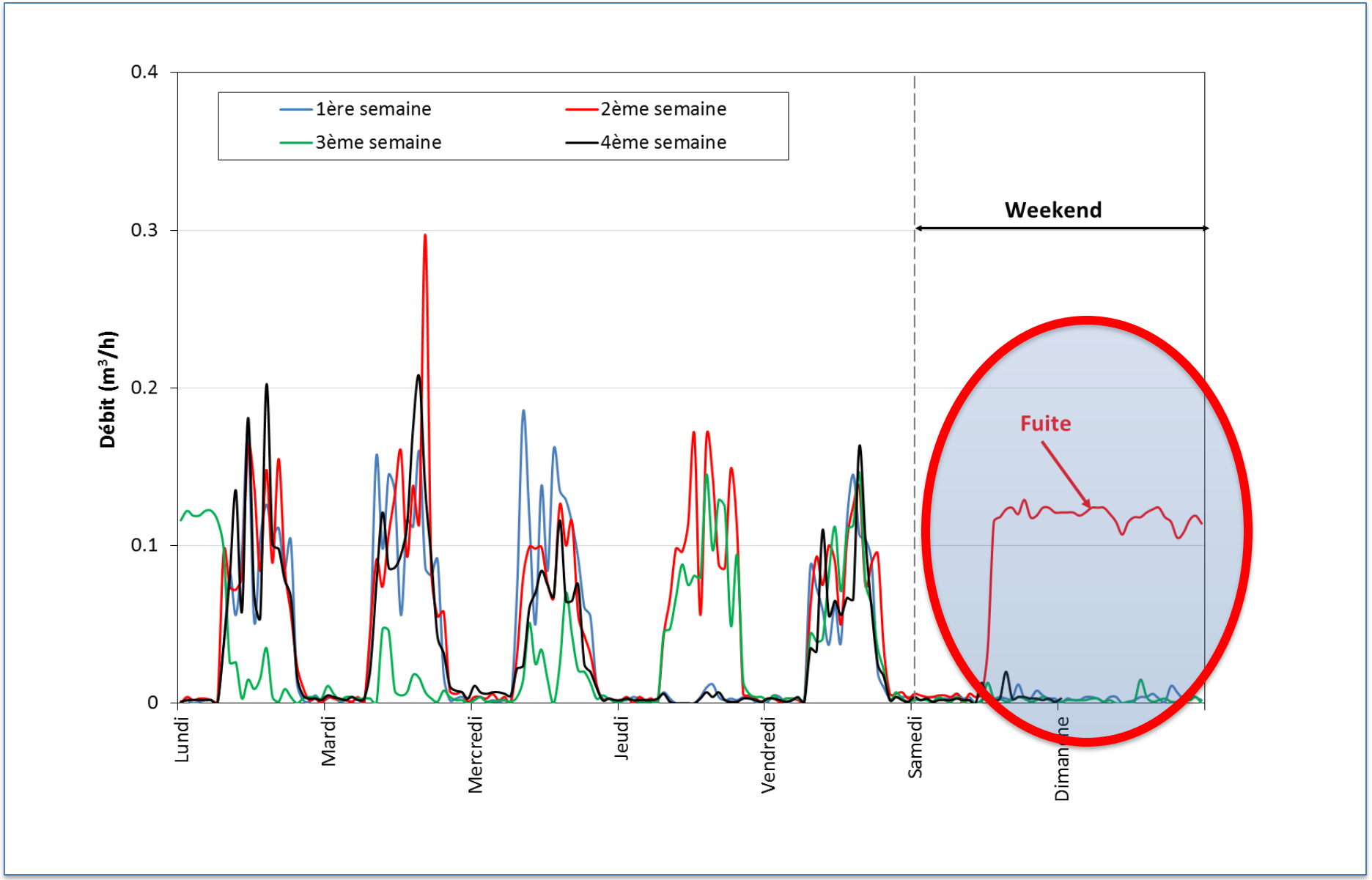
Data Transmission



Example of leak - Research building, May 2014



Integrated solution

Monitoring | Data transmission | **Platform Storage, Analysis** | Display Visualization

DATA ANALYSIS

Water leakage:

- **Minimum Night Flow**
- **Water balance (DMA)**
- **Artificial Intelligence (AI)**

Water quality control:

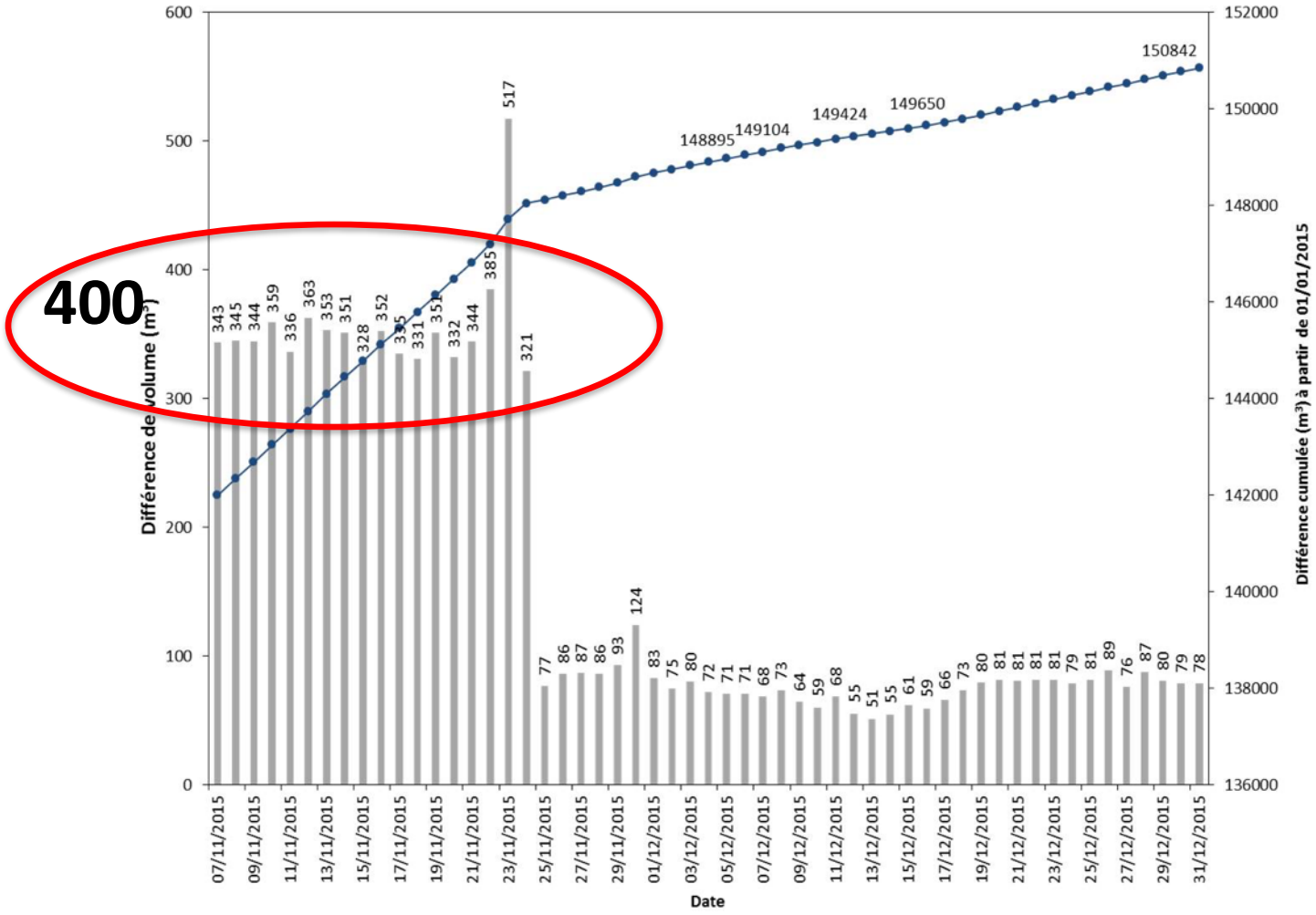
- Deviation from the baseline
- Artificial Intelligence (AI)

Leakage control : Daily base

Water balance : Supply – Computed consumption

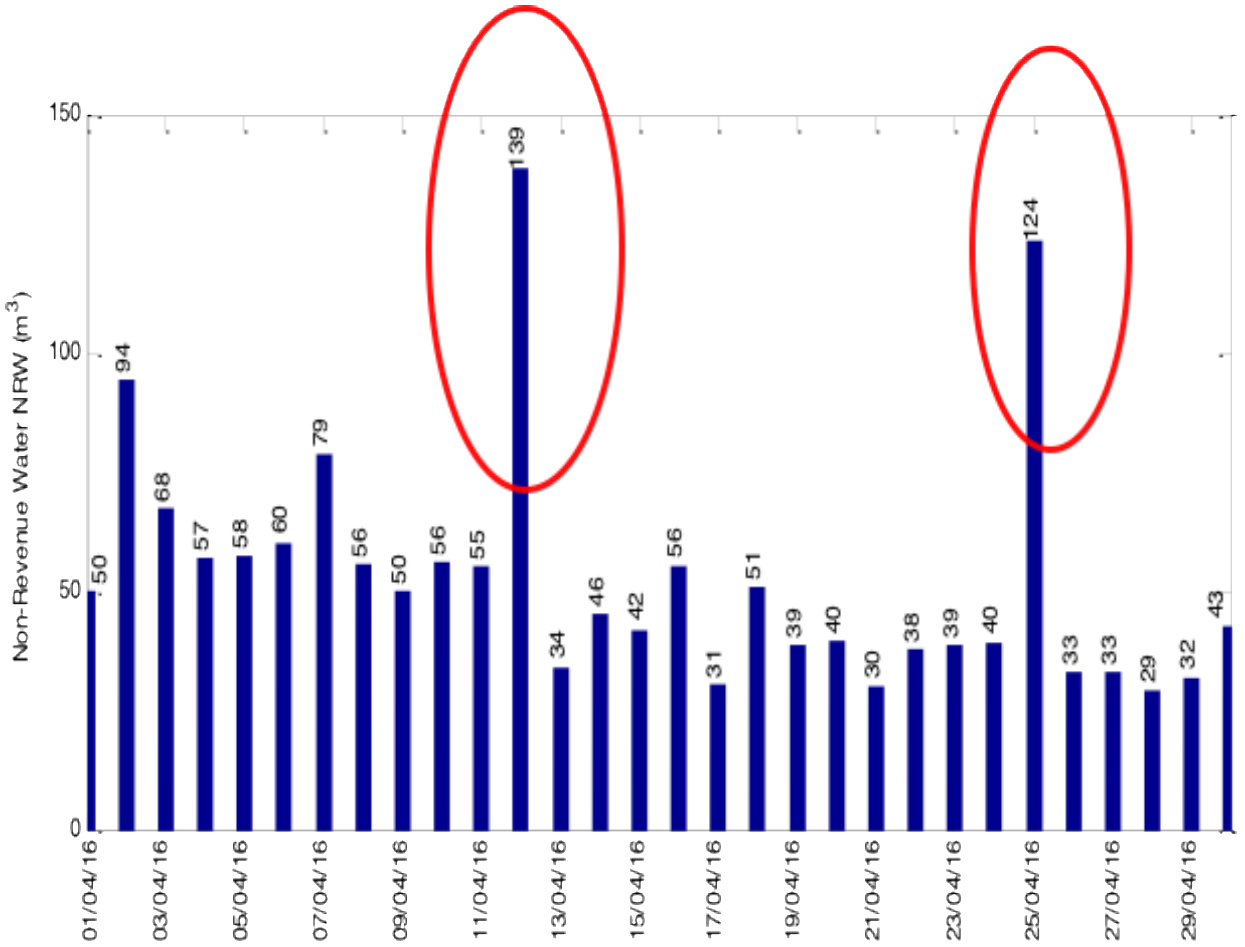
Water losses/Day (m^3)

November – December 2015



Day

Detection of water leakage



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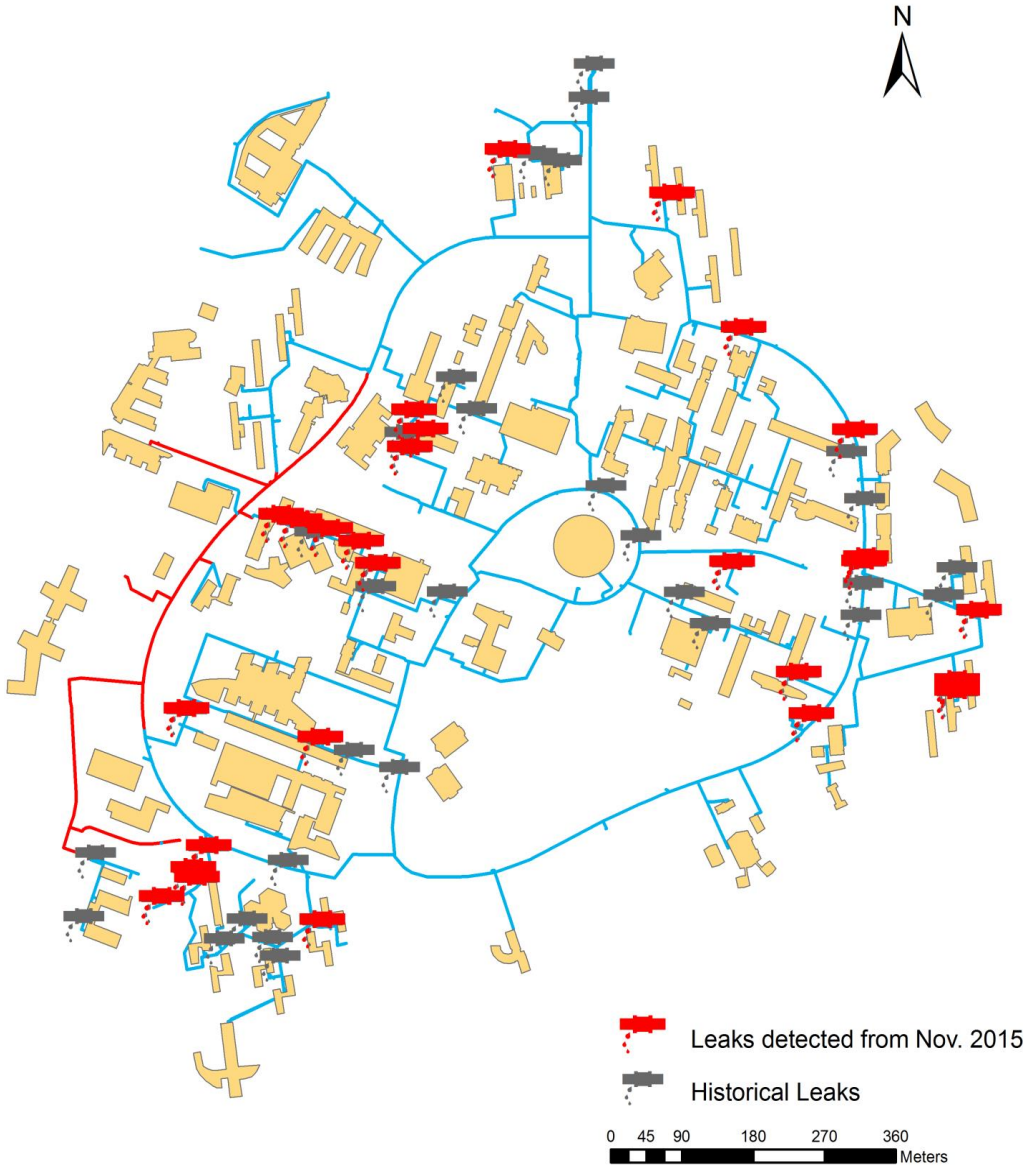
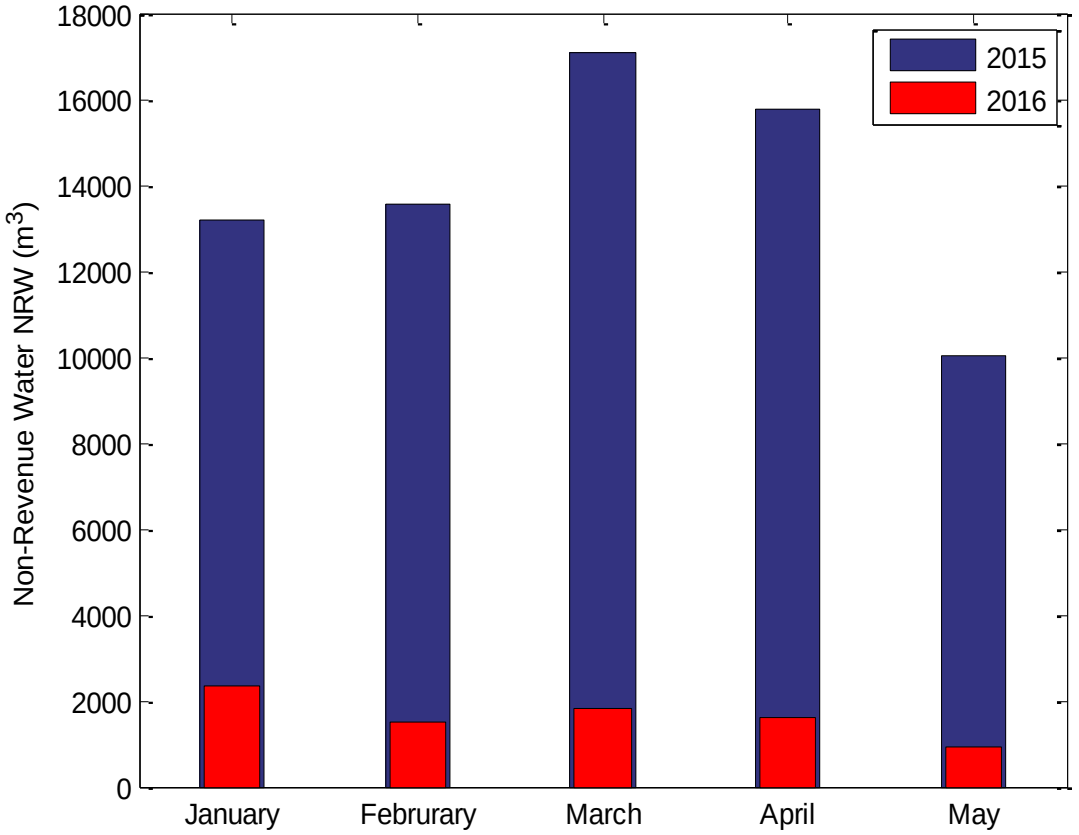
Leak detected in the campus



Impact of the Smart System



Jan to May 2015
NRW = 43%

Jan to May 2016
NRW = 7%

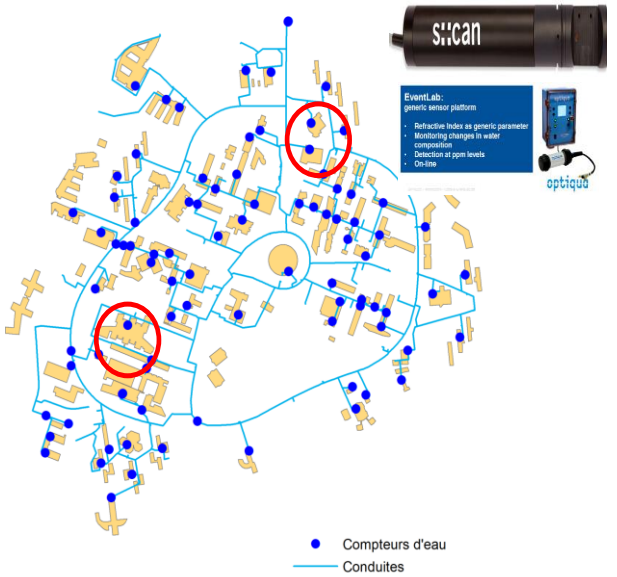
Integrated solution – Water Quality control

Monitoring | Data transmission | Platform Storage, Analysis | Display Visualization

WATER QUALITY:

- **2 S::CAN**
- **2 Event Lab**

Time interval : 2 minutes



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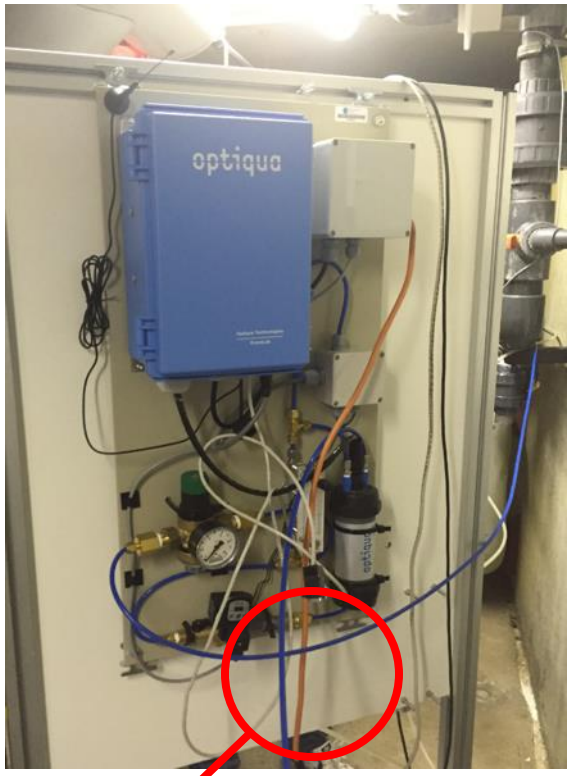
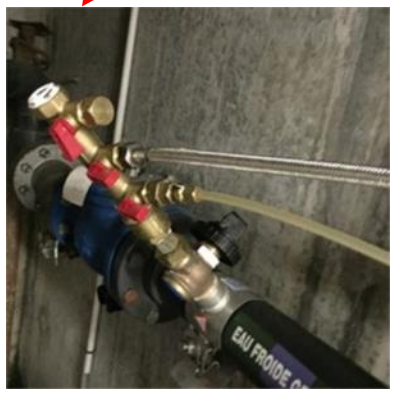
Field implementation





Integrated solution

Monitoring | Data transmission | **Platform Storage, Analysis** | Display Visualization

DATA ANALYSIS

Water leakage:

- Minimum Night Flow
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Water quality control:

- **Deviation from the baseline**
- **Artificial Intelligence (AI)**

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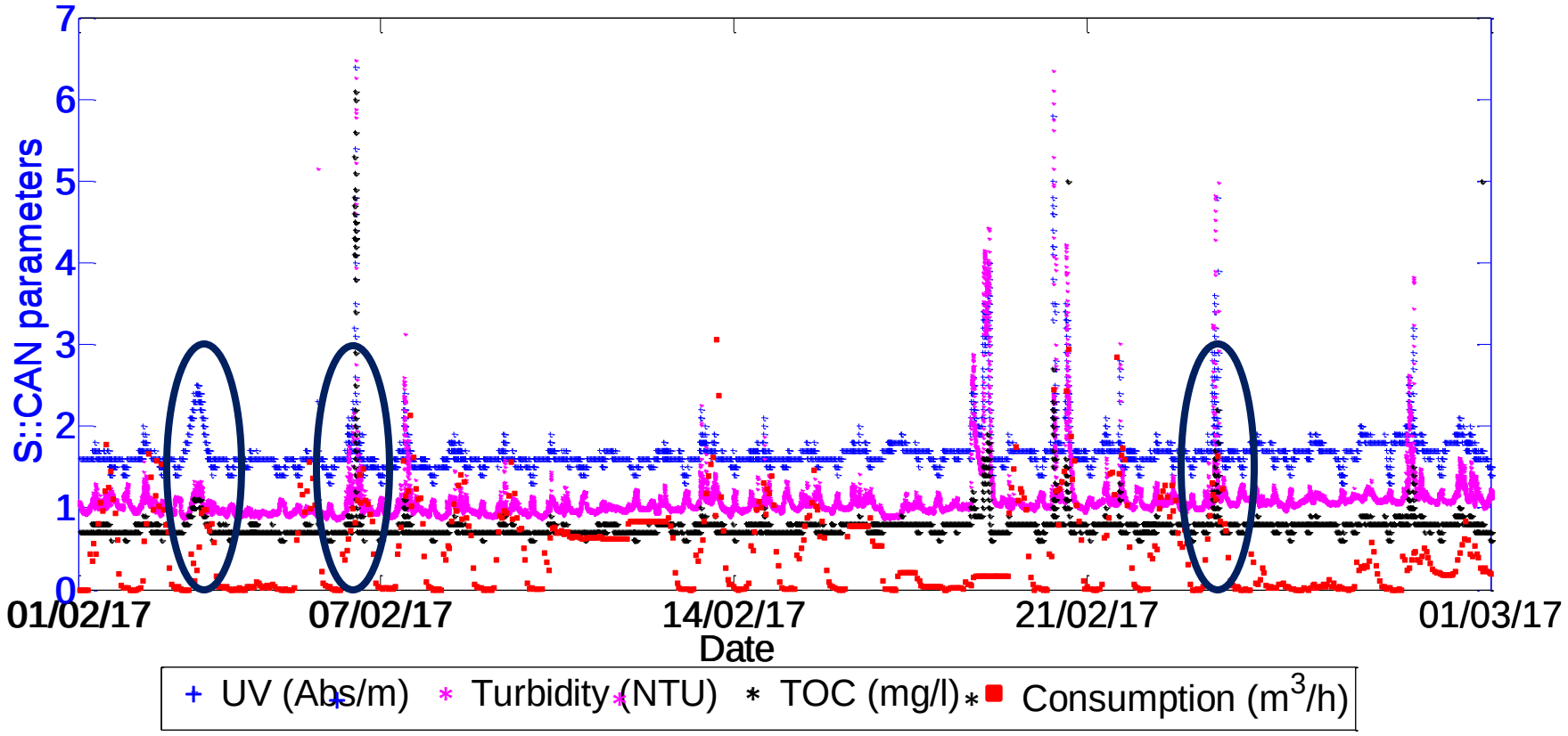
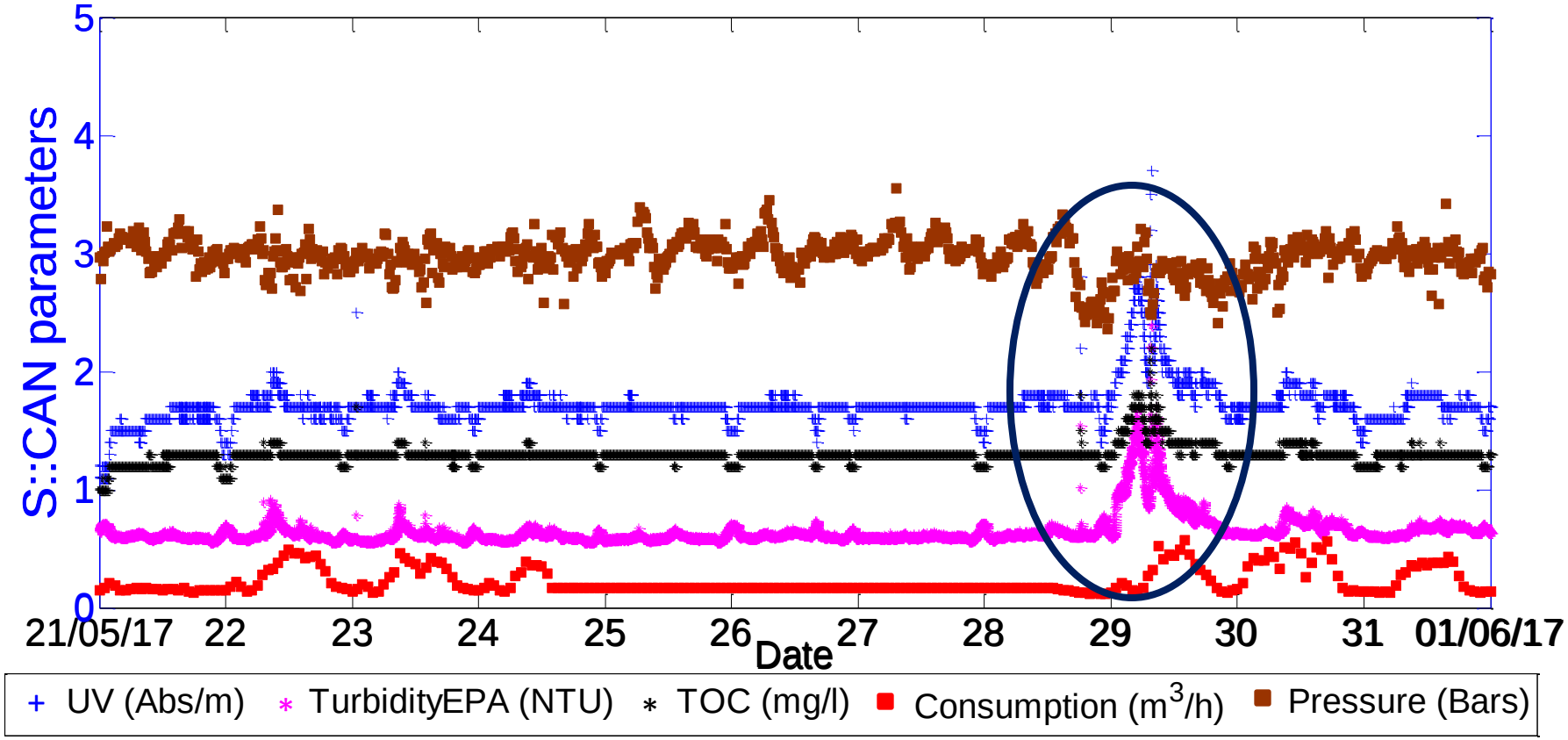
Polytech Results

➢ **S::CAN**



Polytech Results

Impact of pressure drop



The Customer Benefits of Smart Water Networks

Resume and conclusion

Urban water supply:

Major social, economic and environmental issue

Could you imagine the city without water supply ?

High economic value

Drinking Water network

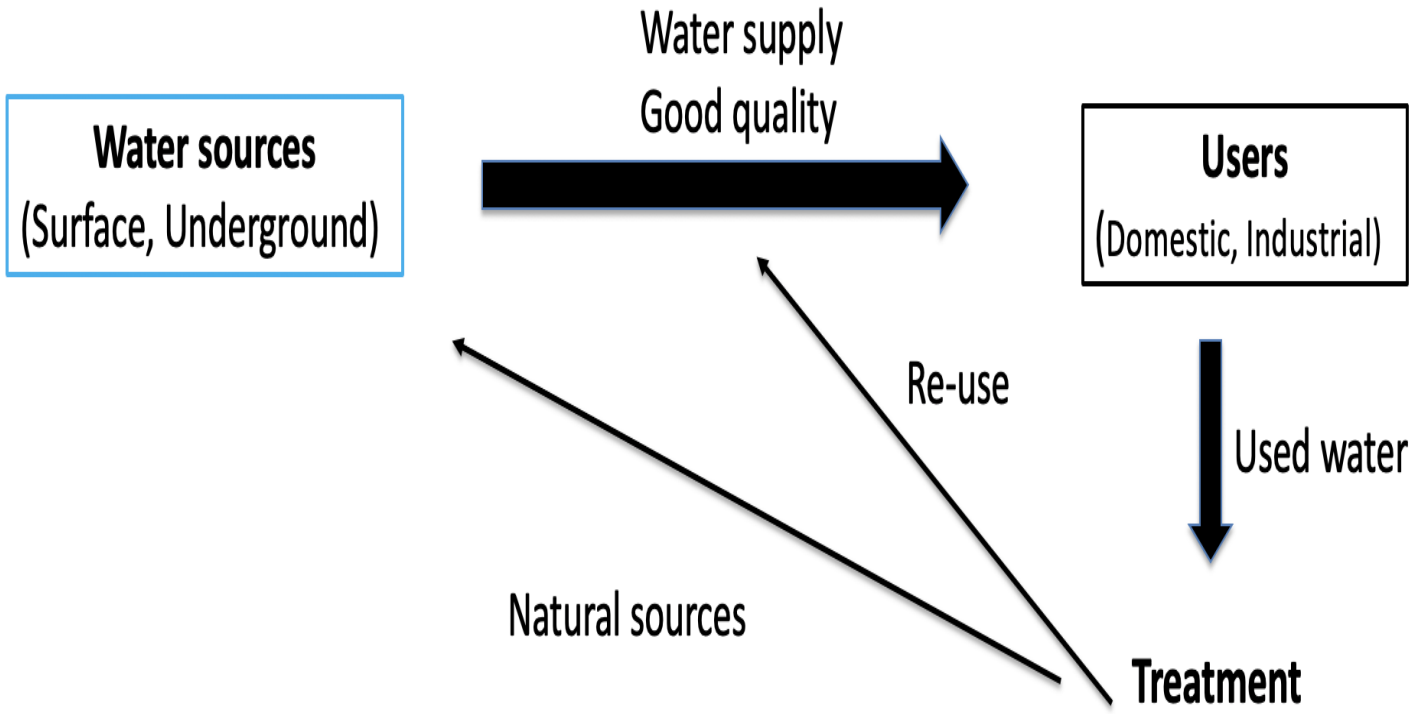
- 906 000 km (value: ~ 80 billion €)
- Annual investment = 1.5 billion €

Sewage network :

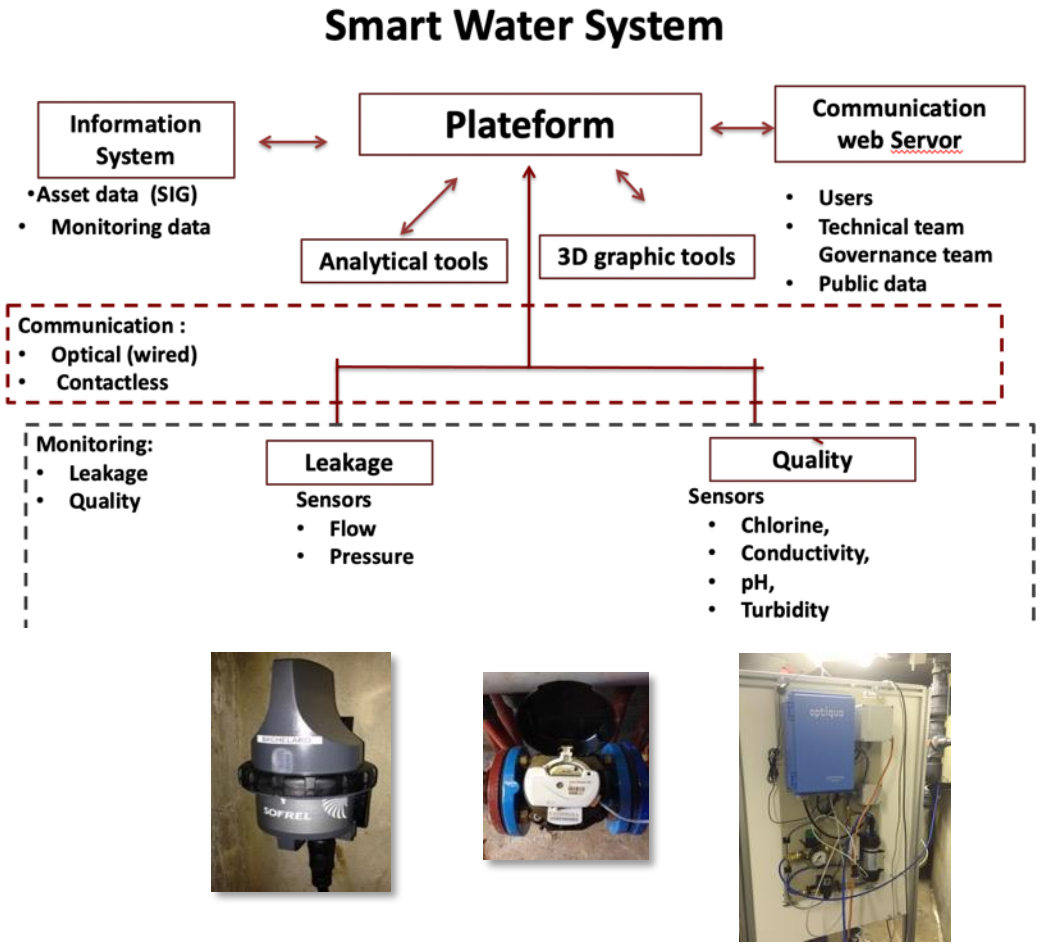
- 394 000 km (~ 70 billion €)
- Annual investment =: 0.8 to 1.3 billion €

Major challenges

- Water quality
- Water leak
- Asset management
- Service quality



Smart Water System



- Efficient for asset management
- Efficient for leakage detection as well as for users' information.
- At the phase of development for water quality control


Thank
you