

# 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) ?

# Outline

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

# Public water data (France)



The screenshot shows the homepage of the data.eaufrance.fr website. The header features the 'eaufrance' logo on the left, the site name 'data.eaufrance.fr' in the center, and navigation links 'Connexion', 'Contact', and 'Glossaire' on the right. Below the header is a banner with the text 'RÉPERTOIRE DES DONNÉES PUBLIQUES SUR L'EAU'. The main content area is divided into three columns. The left column contains three buttons: 'A propos de l'Opendata SIE', 'Rechercher un jeu de données', and 'Les usages des données du SIE'. The middle column has a 'Bienvenue sur le site des données publiques sur l'eau en France' section, followed by a paragraph about the site's purpose, a paragraph about the data being open, and a search section with a text input and a 'Rechercher' button. The right column has a 'Les dernières mises en ligne' section listing various water-related datasets. A small 'En bref' box is also present on the left side of the main content area.

**A propos de l'Opendata SIE**

**Rechercher un jeu de données**

**Les usages des données du SIE**

**En bref**

- 559 jeux de données
- 56 contributeurs
- dernière mise à jour : 27/07/2020

**Bienvenue sur le site des données publiques sur l'eau en France**

Ce site offre un accès libre aux données sur l'eau, les milieux aquatiques et leurs usages, publiées sur les sites de la toile **Eaufrance**.

Ces données sont proposées gratuitement, dans des formats électroniques exploitables, et sous **licence ouverte**.

Elles sont accompagnées de métadonnées (description de la donnée) qui les rendent facilement exploitables ; elles peuvent ainsi être analysées, agrégées, comparées avec d'autres données et réutilisées pour des besoins spécifiques par les acteurs de l'eau, les collectivités locales, les entreprises, les scientifiques, les associations, les citoyens ou les journalistes...

**Rechercher des jeux de données :**

Saisir un mot ou groupe de mots **Rechercher**

Au-delà des données ce site propose des **exemples d'exploitation des services et des applications spécifiques basés sur ces données**.

**Les dernières mises en ligne**

- 11ème PROGRAMME : CAPTAGES PRIORITAIRES
- ZONE A ENJEU ENVIRONNEMENTAL (ZEE)
- ZONE A ENJEU SANITAIRE (ZES)
- Stations de traitement des eaux usées - France entière
- Ouvrages de dépollution - ODP
- RSS

**Faire un commentaire**

## 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<sup>3</sup> (23 days of rainfall)  
500 m<sup>3</sup>/ inhabitant/year

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

**146 litres**



c'est la consommation moyenne  
d'**eau potable** par habitant et par  
jour en 2017

**Plus de 67 %**



du territoire métropolitain est  
concerné par des mesures de  
**restriction d'eau** en 2019

**Les 32 milliards de m<sup>3</sup>**

d'**eau douce prélevés** en 2017  
correspondent à 23 jours de pluie  
sur la France métropolitaine



# France

## **Drinking Water network**

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

## **Sewage network :**

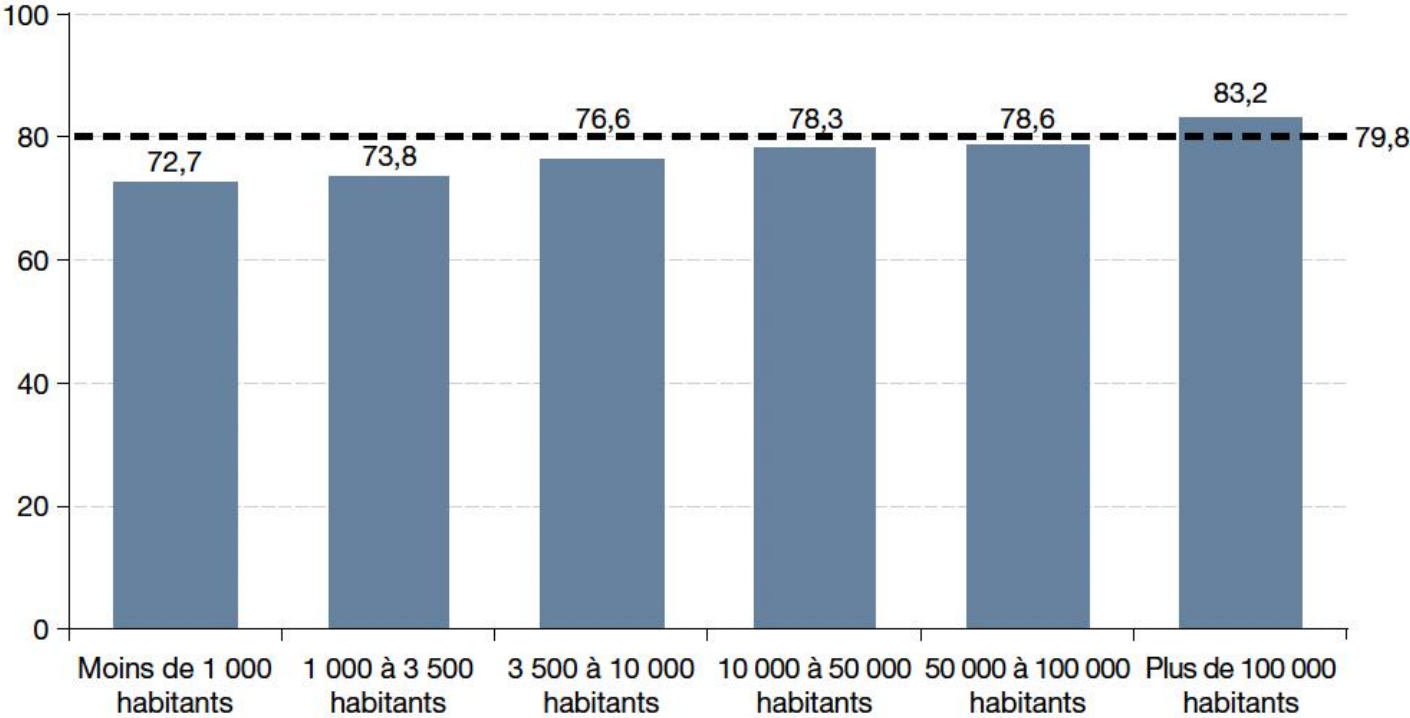
- 394 000 km (~ 70 billion €)
- Annual investment =: 0.8 to 1.3 billion €

# 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



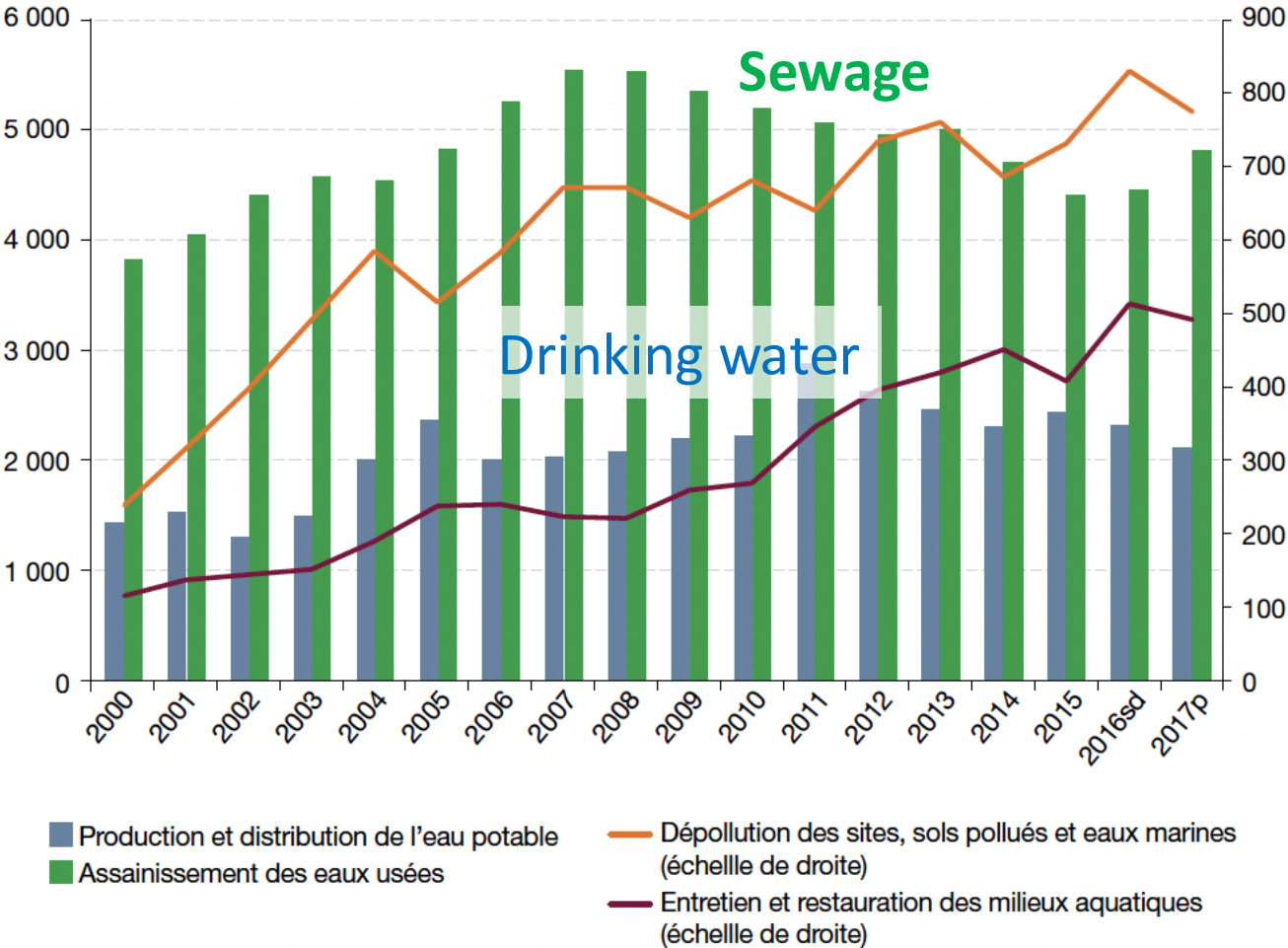
# Dépenses d'investissements en faveur de l'eau et des milieux aquatiques

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)

## ÉVOLUTION DES DÉPENSES D'INVESTISSEMENTS EN FAVEUR DE L'EAU ET DES MILIEUX AQUATIQUES

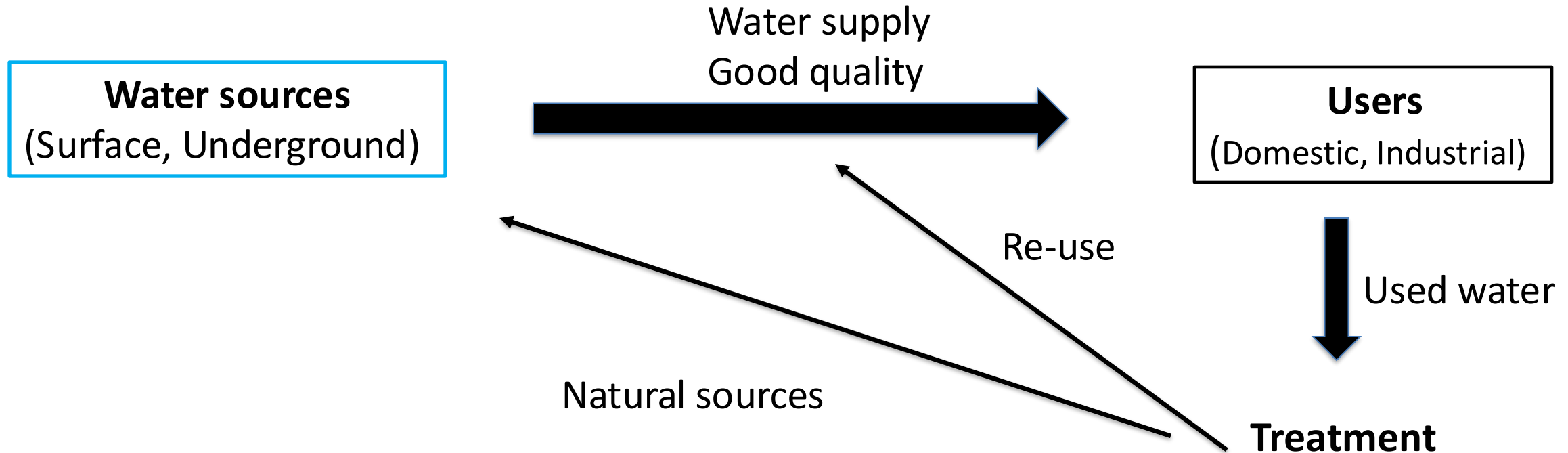
En M€ courants

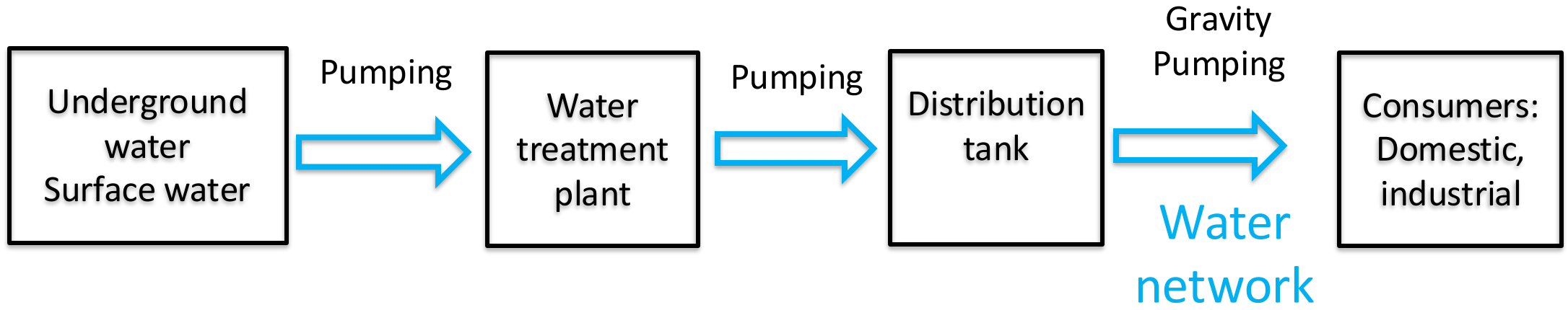


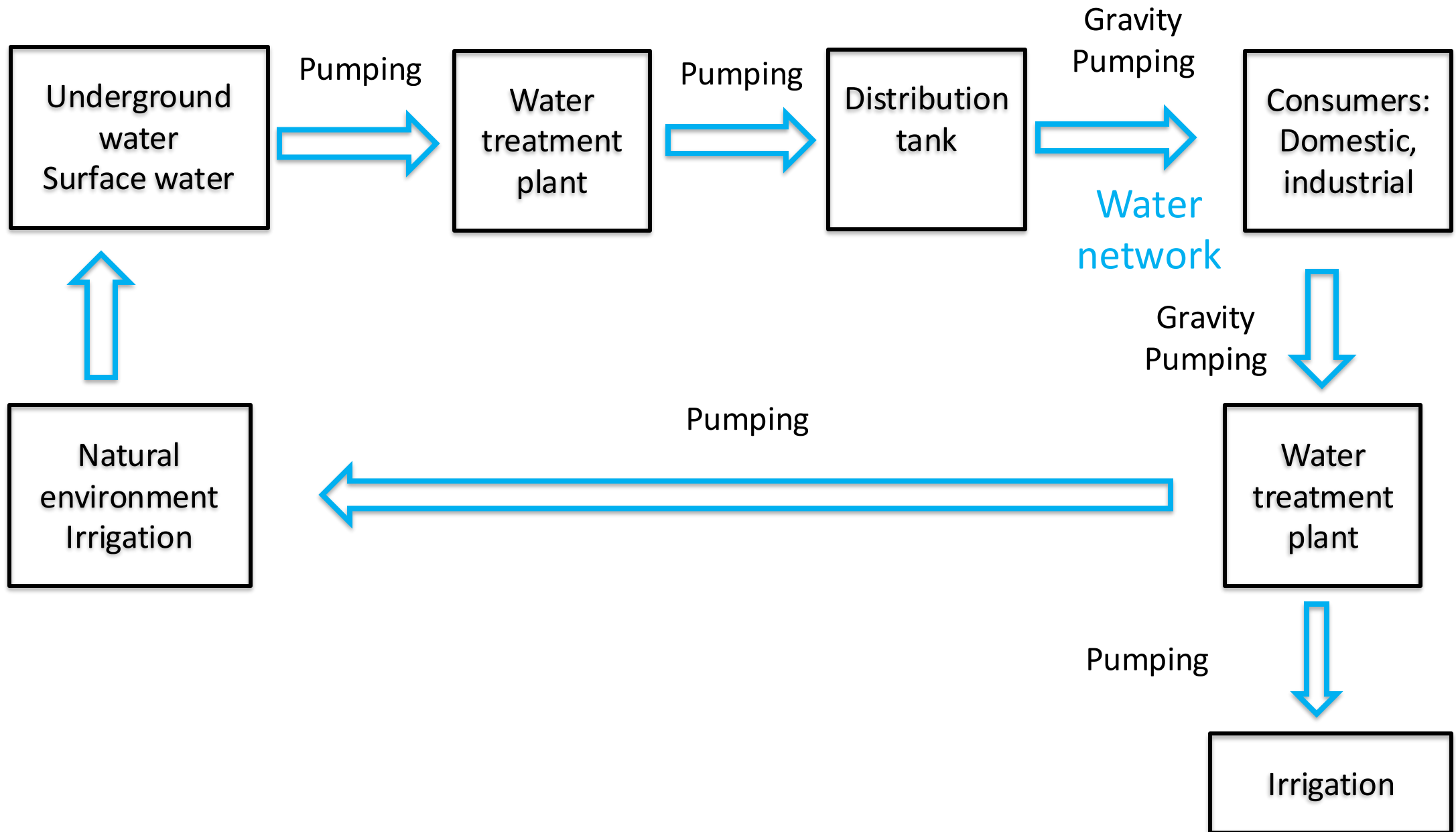
# Outline

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

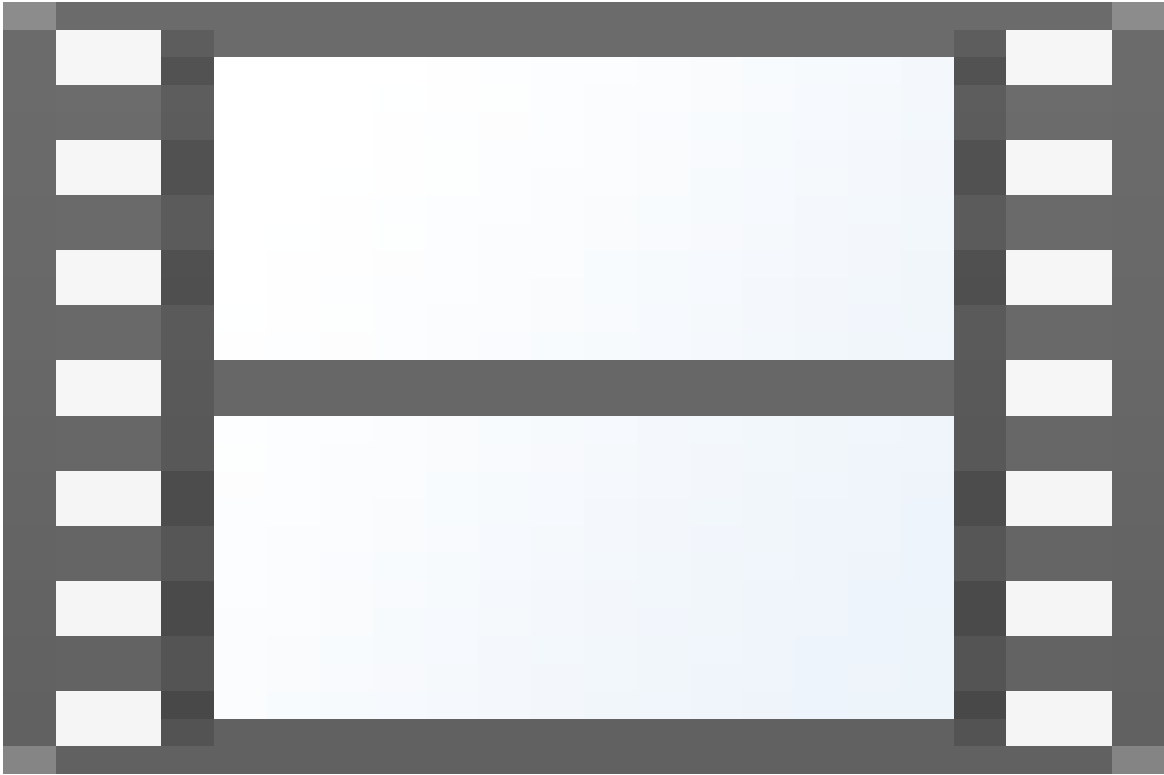
# Objective of the water supply system







# Water Distribution system



# Water pipes

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









# Valves



# water counter

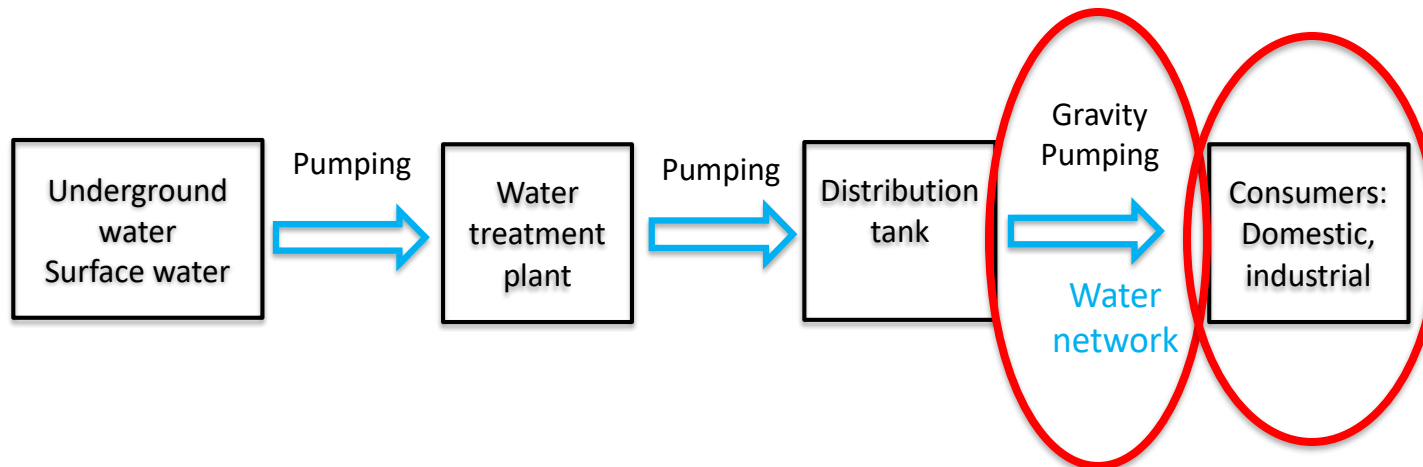


# Challenges :

## 1) Water quality :

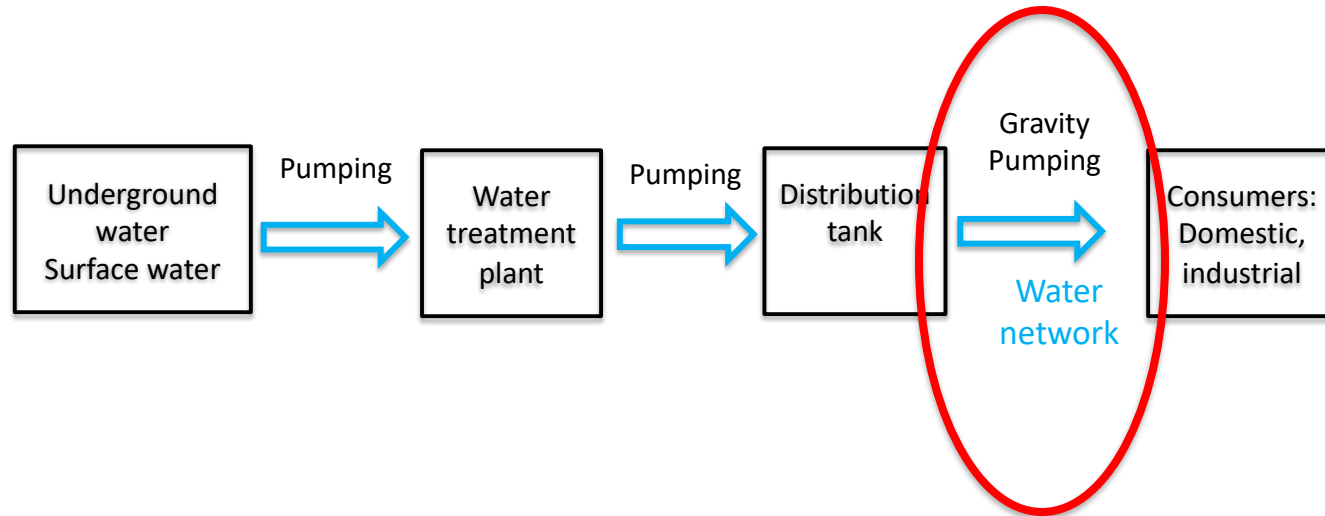
Contamination could occur at :

- 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 supply**



**When is  
water safe to  
drink - Mia  
Nacamulli**



# Water Quality and Pollution - Am I Drinking Safe Water

What qualities are important to test?

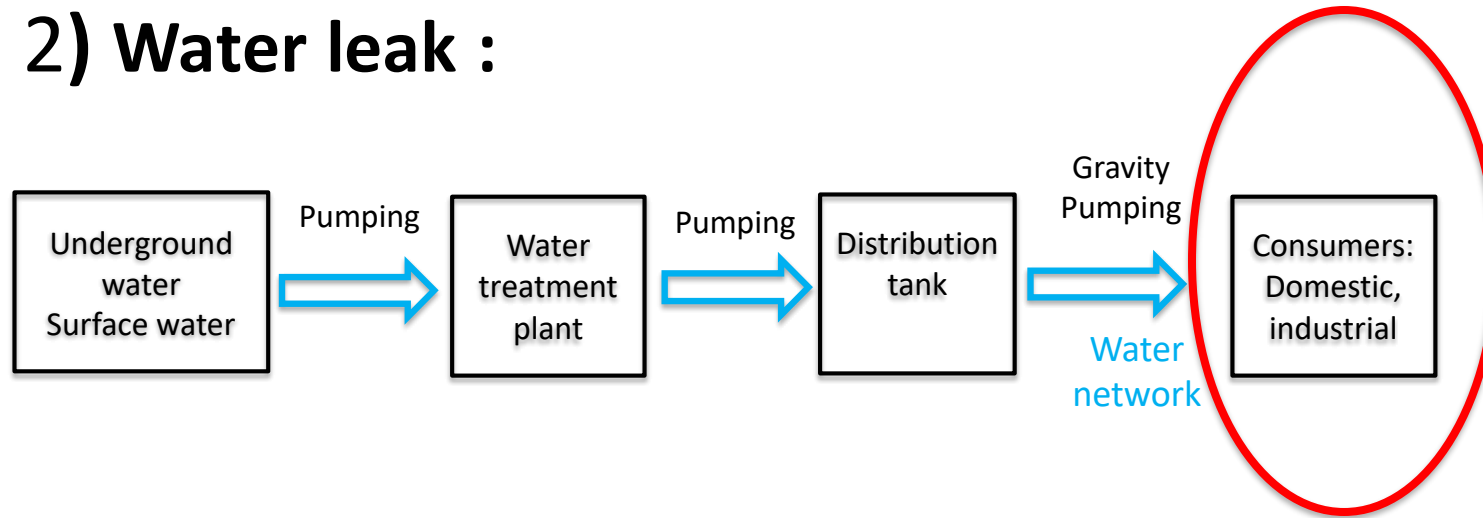
- Total Suspended Solids (TSS)
- Total Dissolved Solids (TDS)
- Turbidity
- pH
- Conductivity
- Dissolved Oxygen (DO)
- Temperature
- Phosphate
- Nitrate/Nitrite
- Fecal Coliform





# Challenges :

## 2) Water leak :



### Tap drip

**44 m<sup>3</sup>/year**  
**175 € (France)**



### Toilet flush

**220 m<sup>3</sup>/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

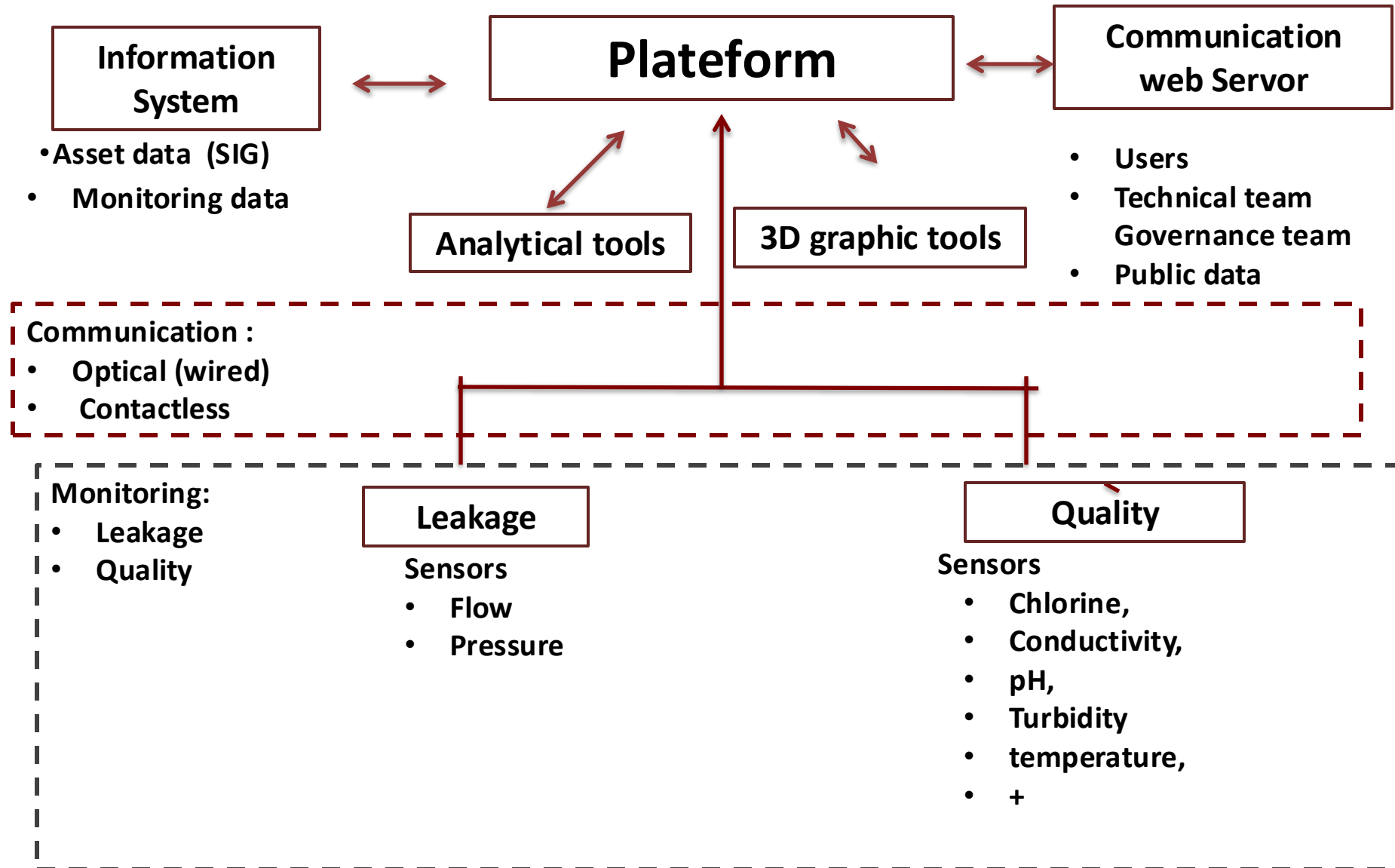
- Water key figures
- Drinking water system (how the system works ?)
- **Smart water system**
- Smart water pilot (SunRise)

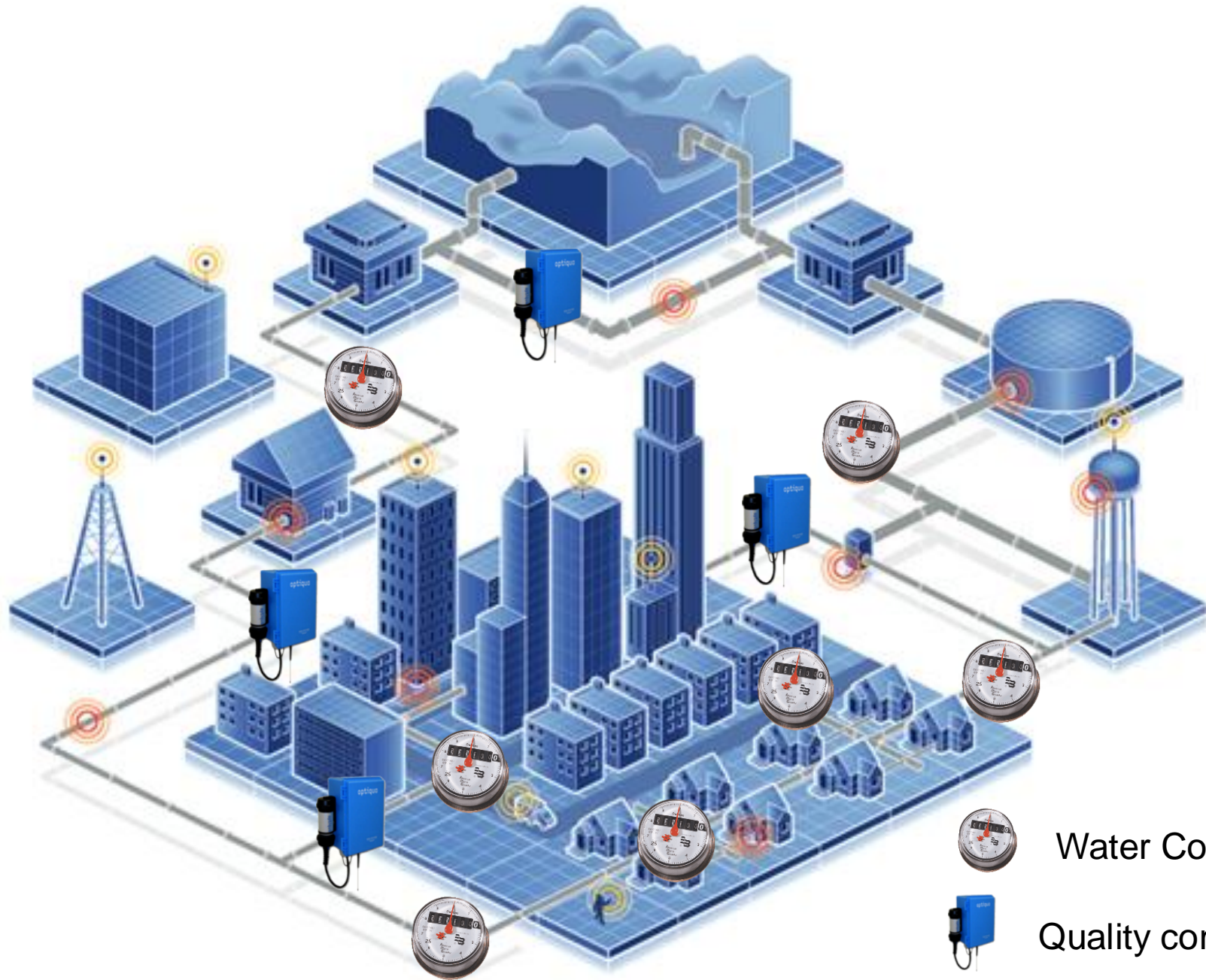
# Objective of the smart water system



## **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 :

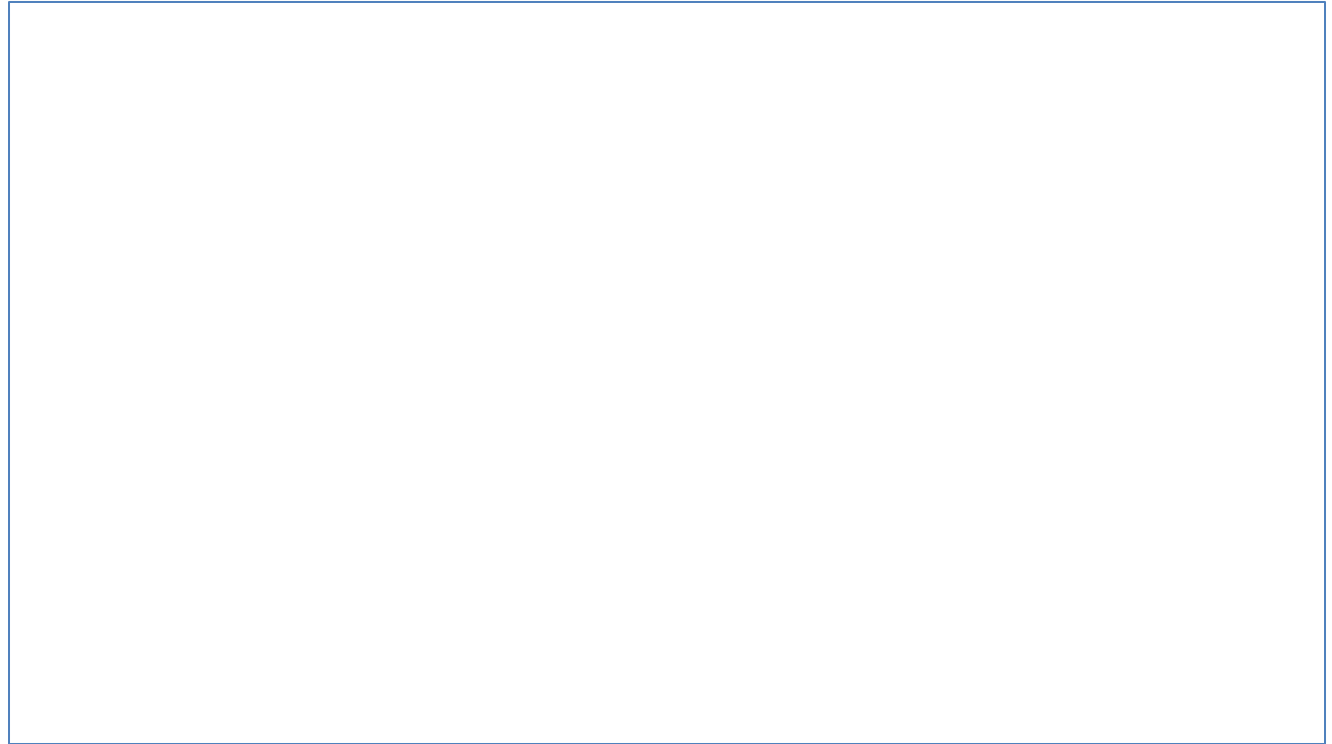


# Smart meters



[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)



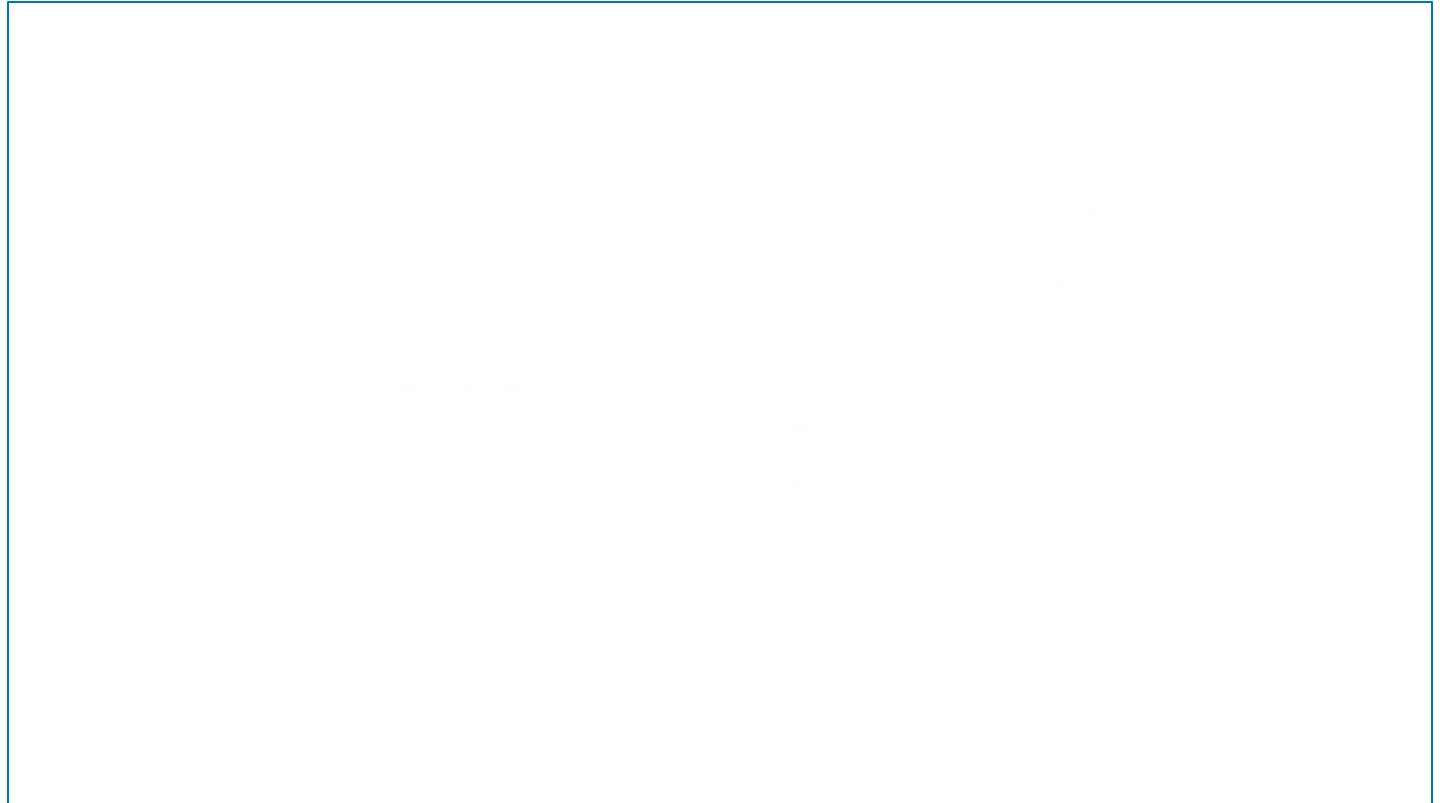
## S::Scan

AOC, BOD, BTX, COD, color, DOC, FTU/NTU, H<sub>2</sub>S,  
NO<sub>2</sub>-N, NO<sub>3</sub>-N, O<sub>3</sub>, 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

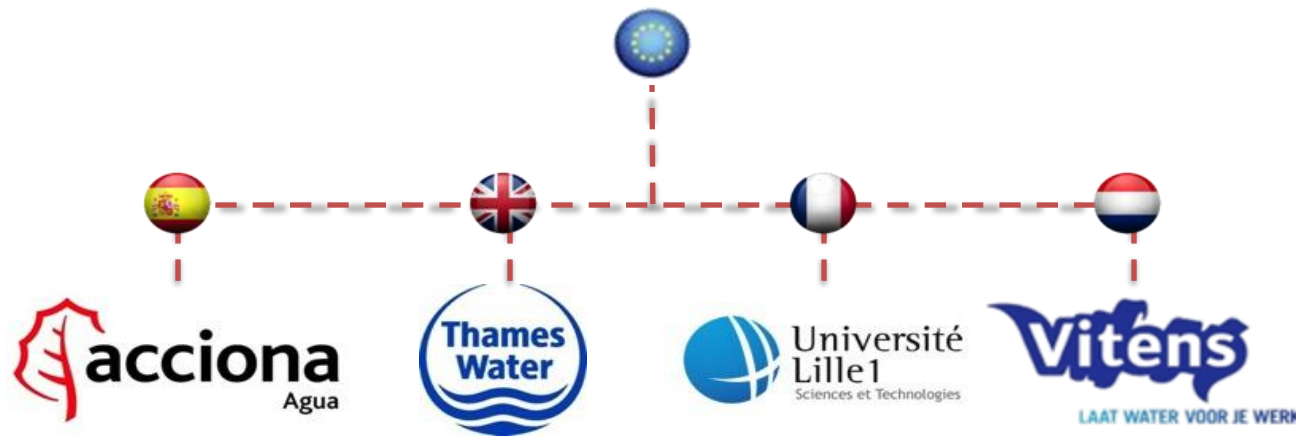


## 100 km of urban networks

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

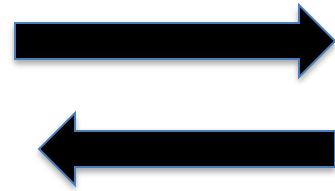
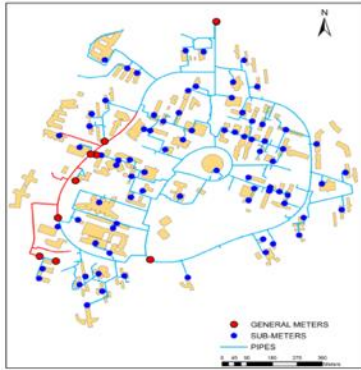
# European Smart Water Demonstrator

## SmartWater4Europe



# Smart Water solution

## Asset Digital model (GIS)



**Data  
transmission**



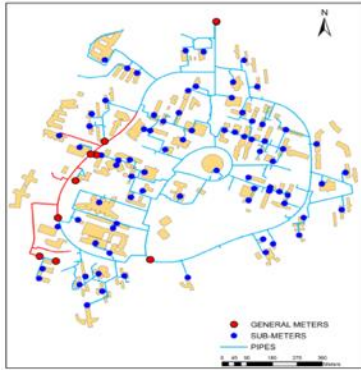
**Data Storage  
Analysis**

## Monitoring

- Sensors
- Actuators

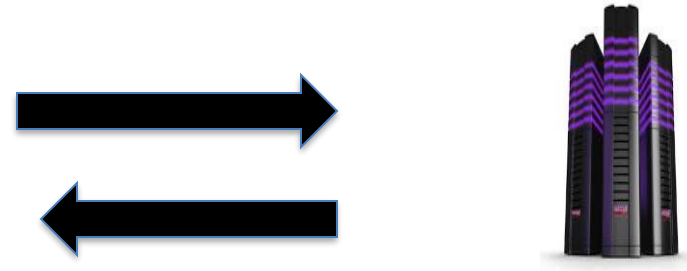
# Smart Water solution

## Asset Digital model



## Monitoring

- Sensors
- Actuators



Data  
transmission

Data Storage  
Analysis



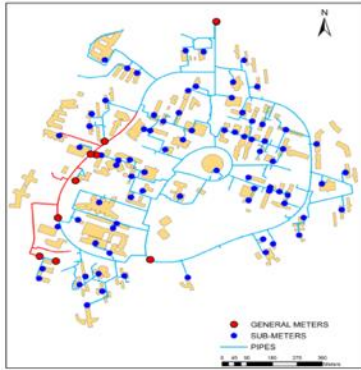
Users





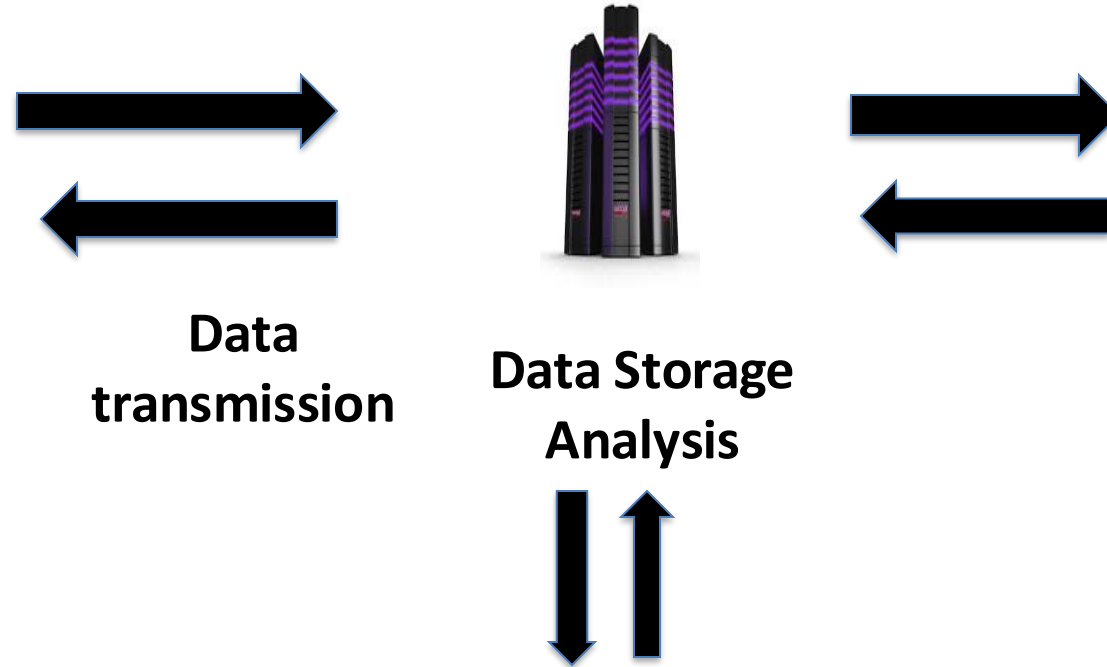
# Smart Water solution

## Asset Digital model



## Monitoring

- Sensors
- Actuators



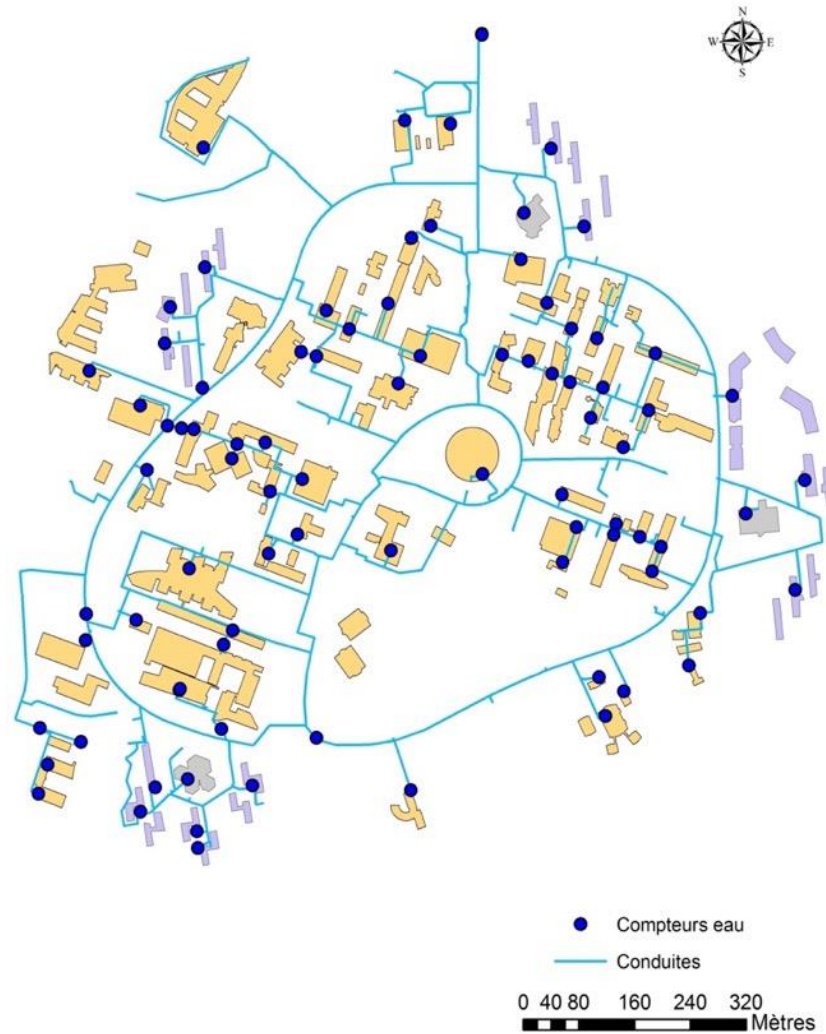
**Users**

**Staff**

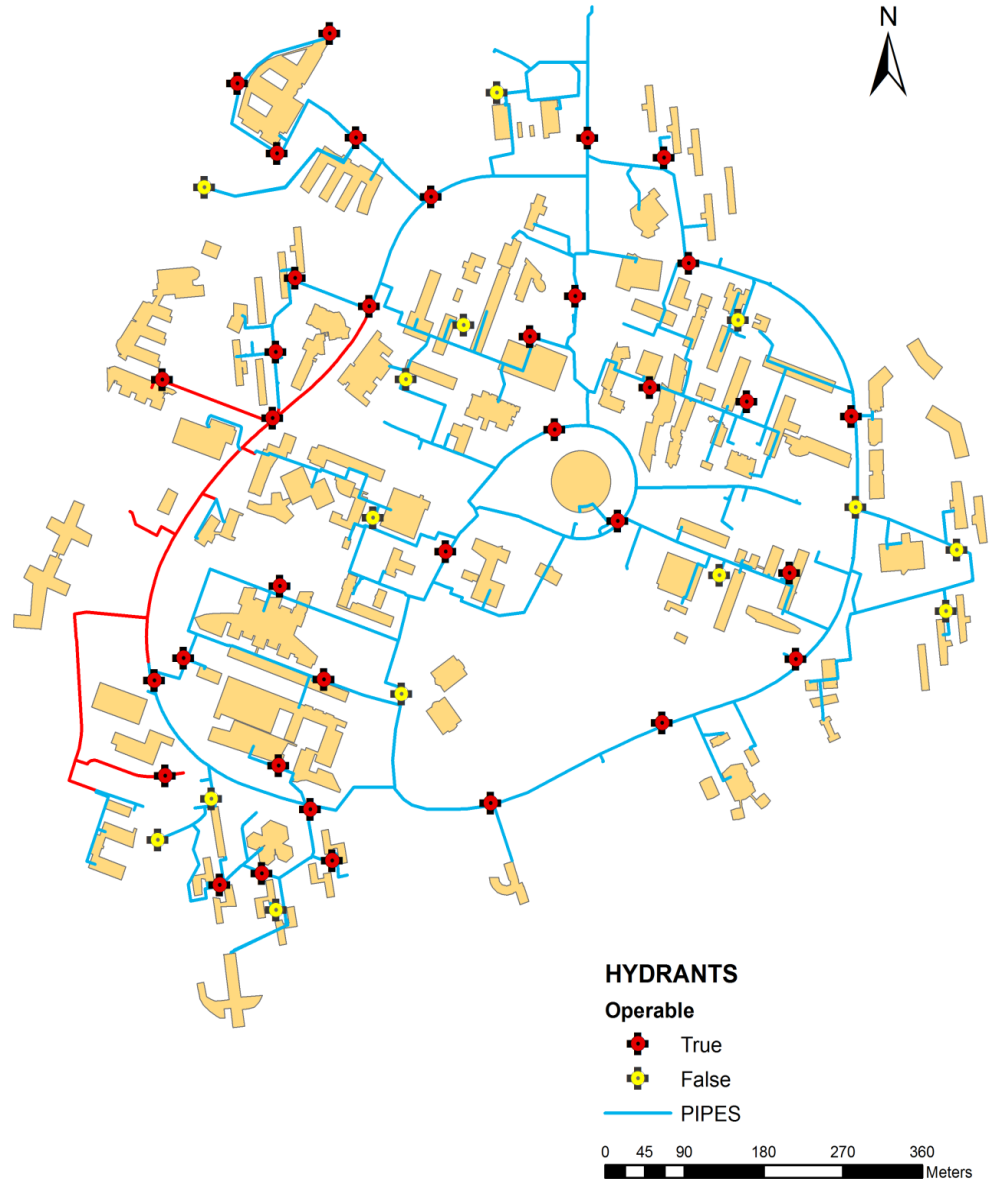


# Drinking water system

- 15 km
- Complex
- 60 years old



# Digital model (GIS)



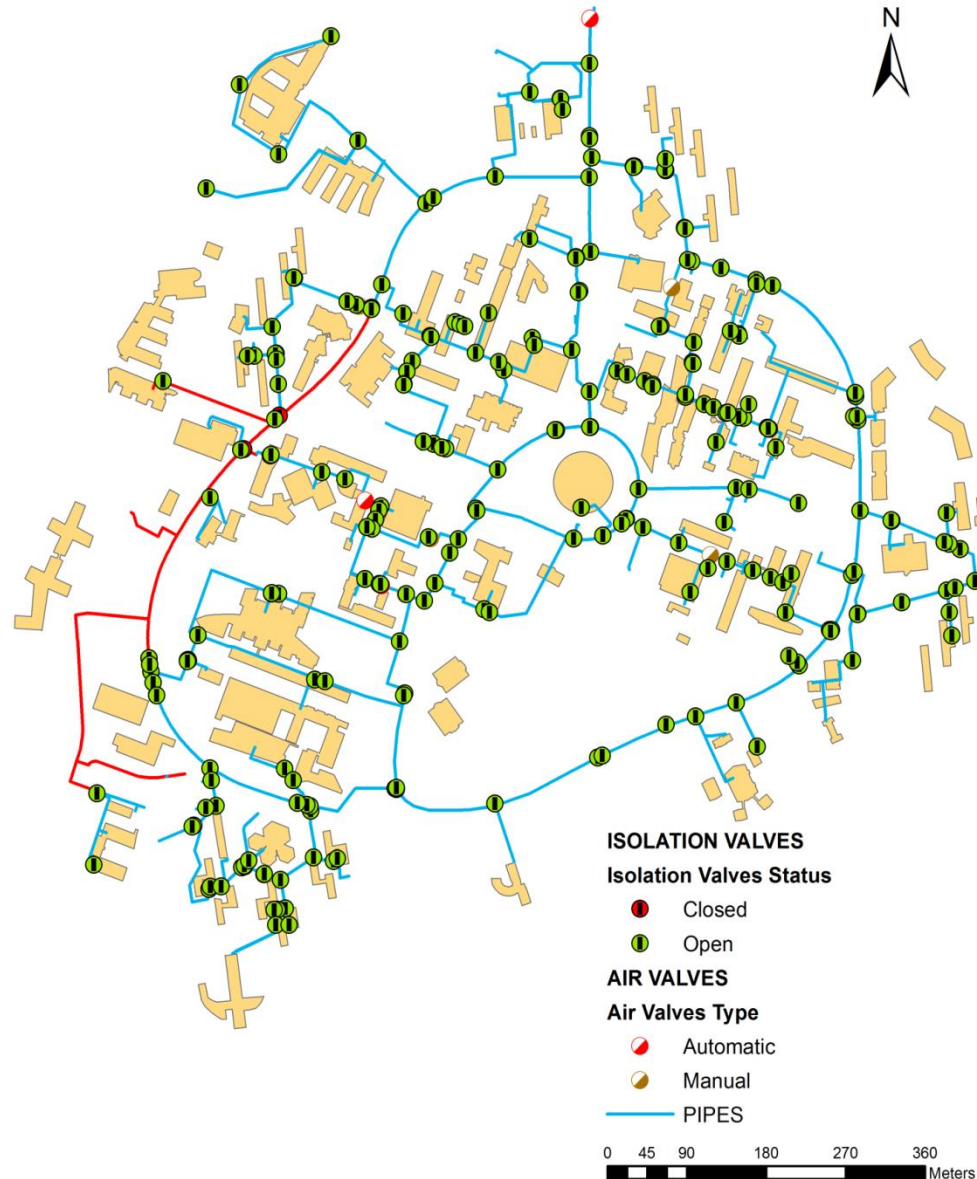
## Pipes

- Diameter
- Material
- Roughness
- Area

## Hydrants

- Coordinates
- Types
- Compliance check tests
  - Test Date
  - Static Pressure
  - Pressure at 60 m<sup>3</sup>/h
  - Flow at 1 bar

# Digital model (GIS)

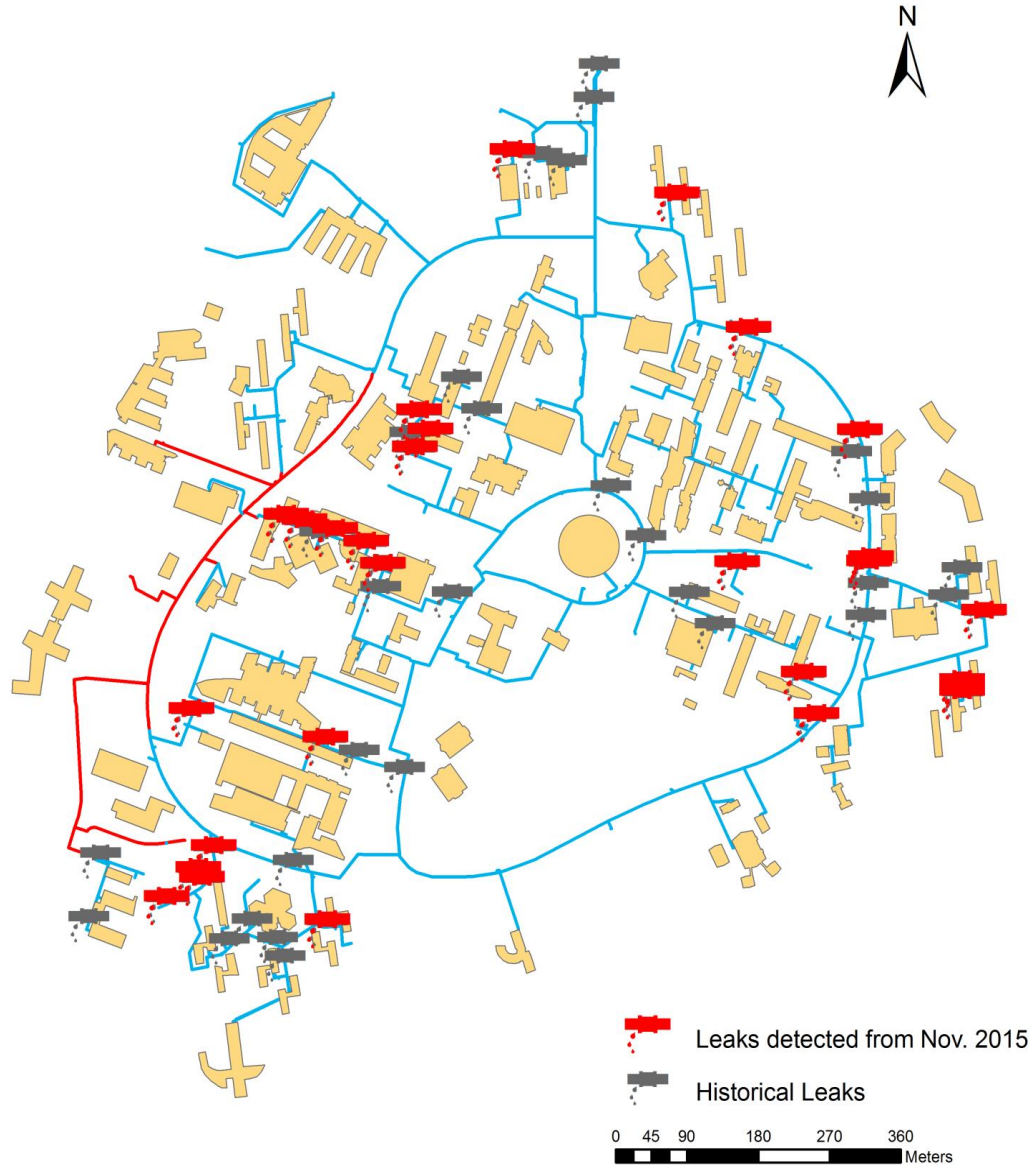


## Valves

- 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

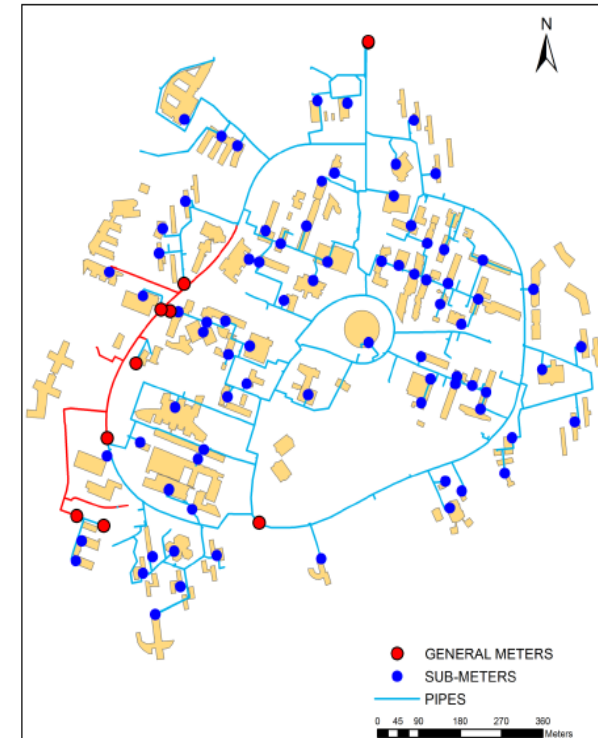
Display  
Visualization

## LEAKAGE:

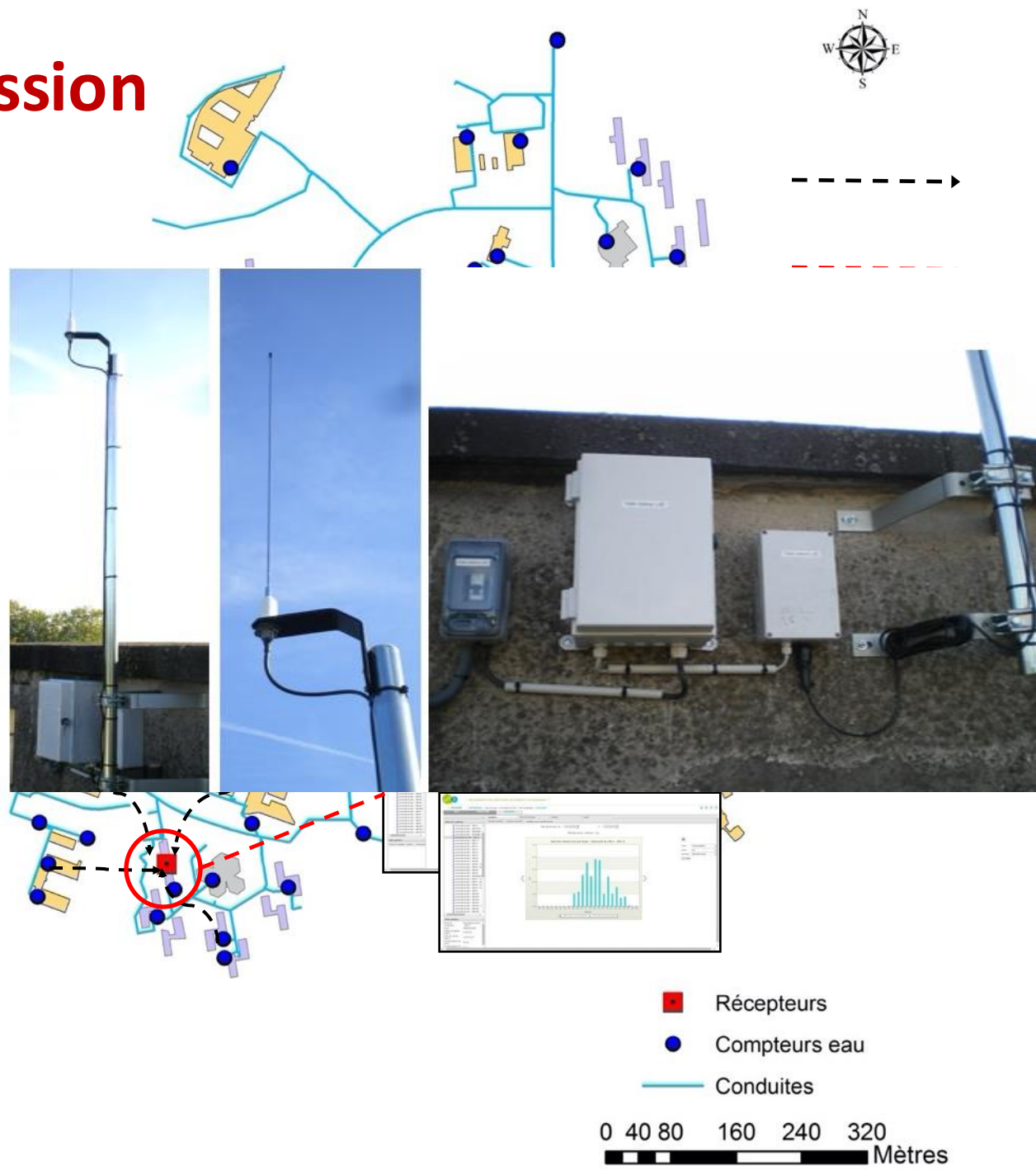
- 100 AMR (Electronic Counter)
- 5 Pressure Cells

## Time interval

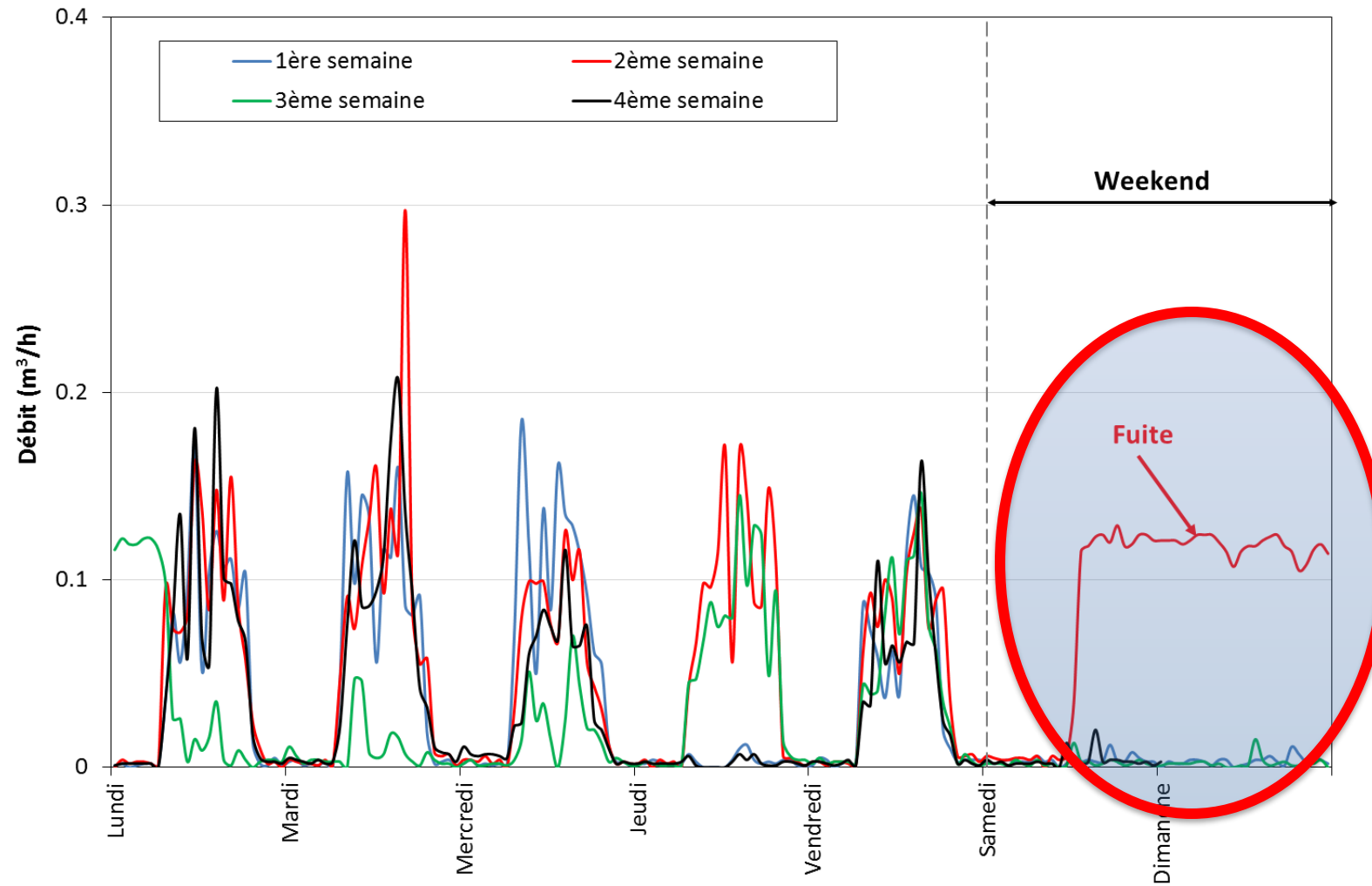
- AMR: 1 hour
- Pressure : 15 minutes



# 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)

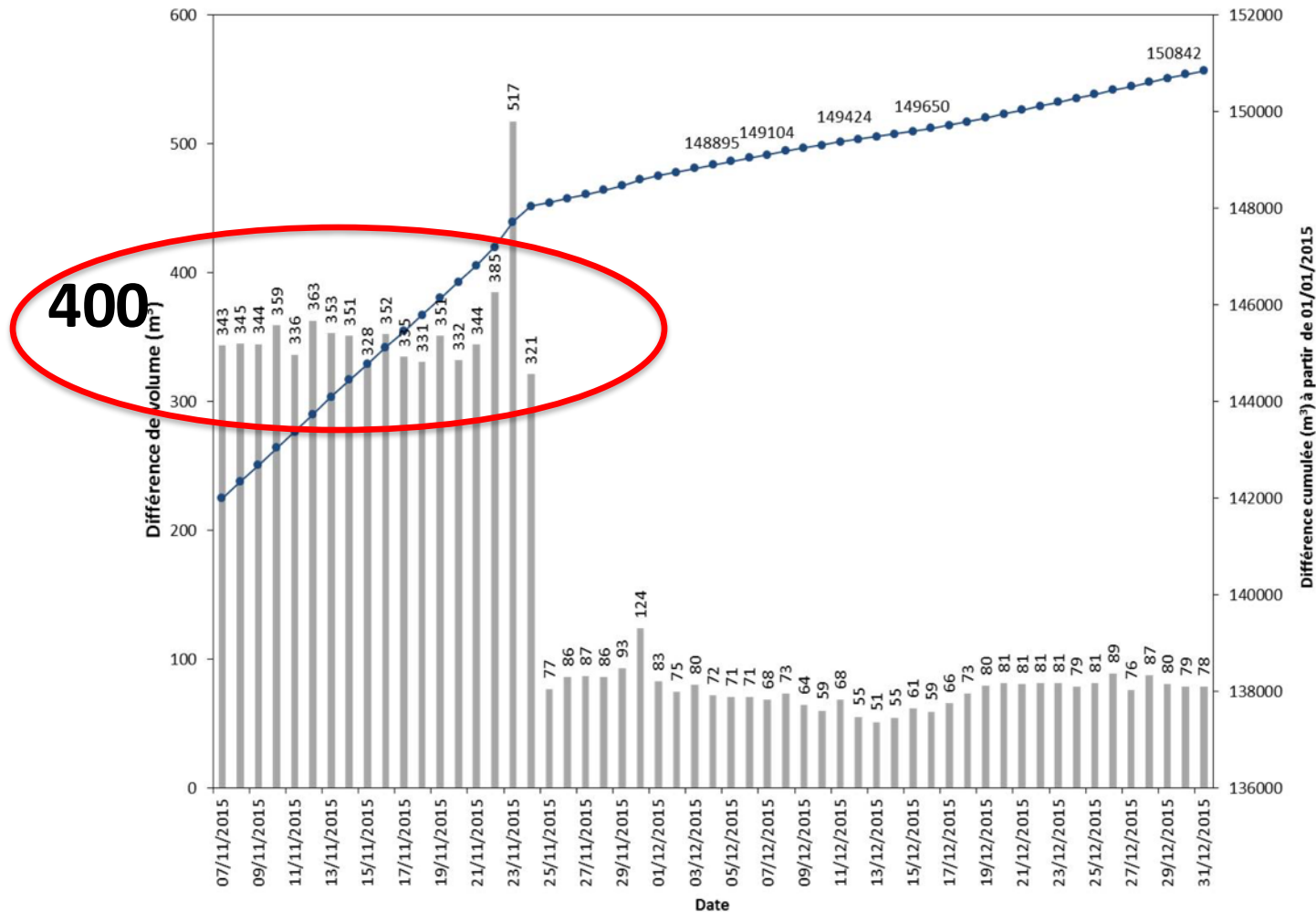


# Leakage control : Daily base

Water balance : Supply – Computed consumption

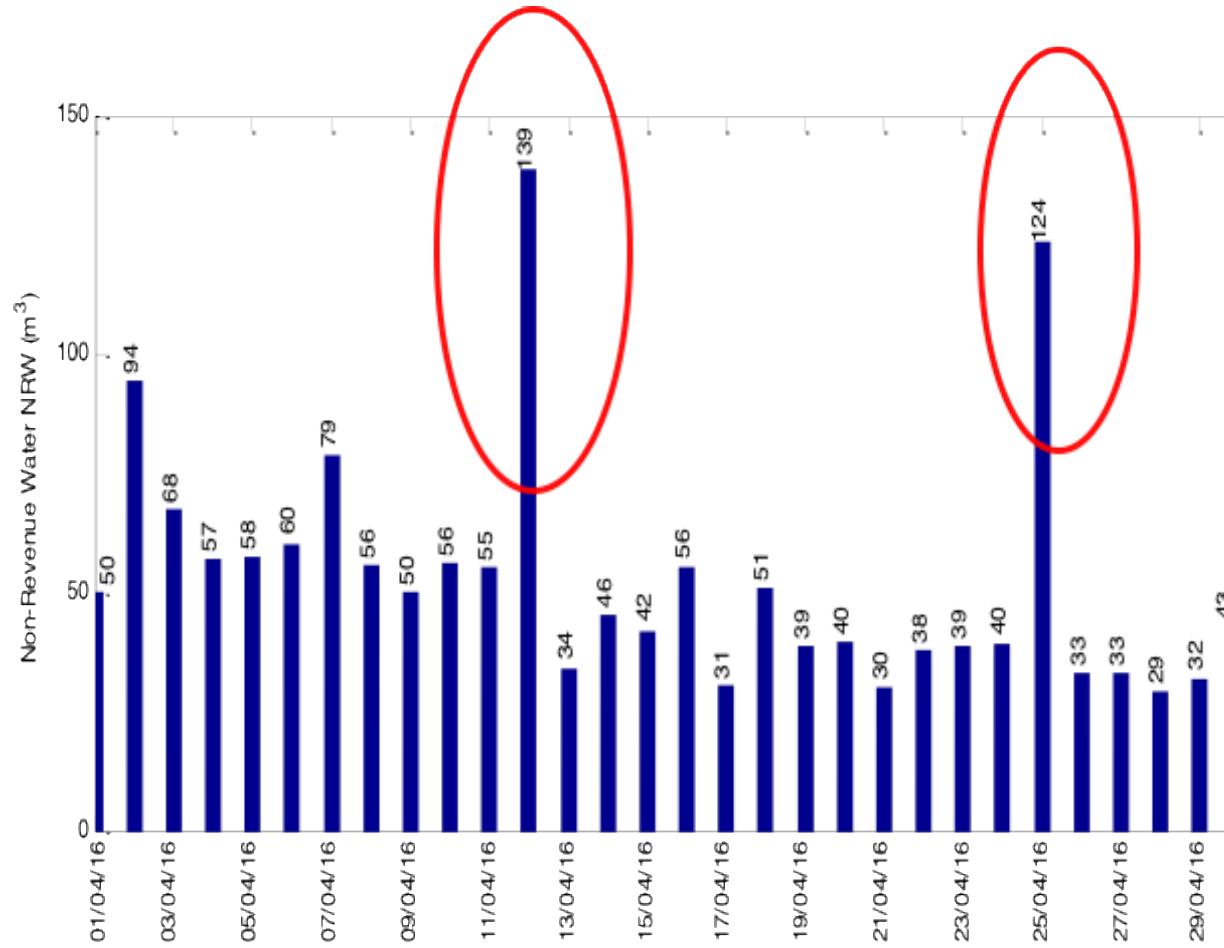
Water losses/Day ( $\text{m}^3$ )

November – December 2015

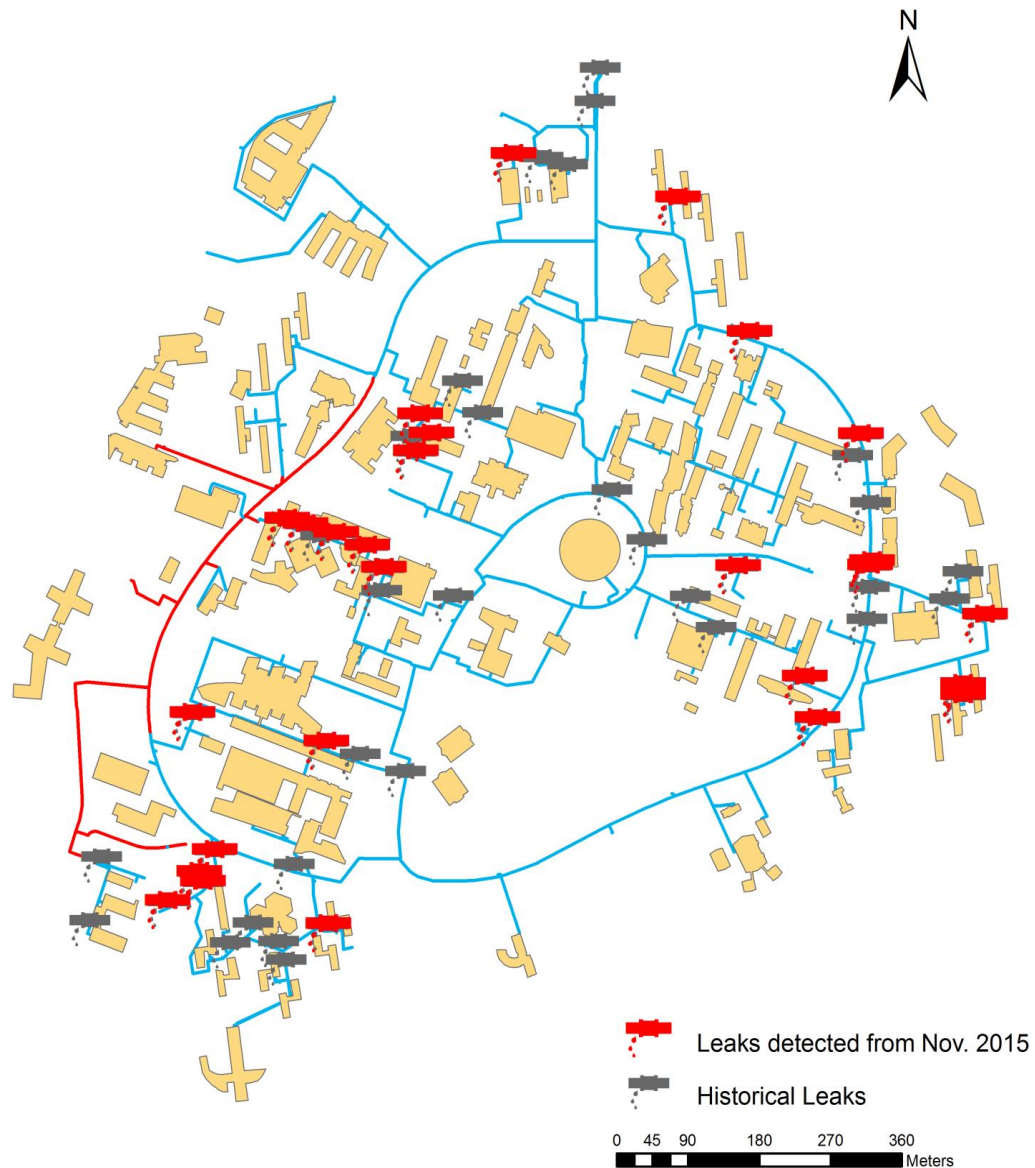


Day

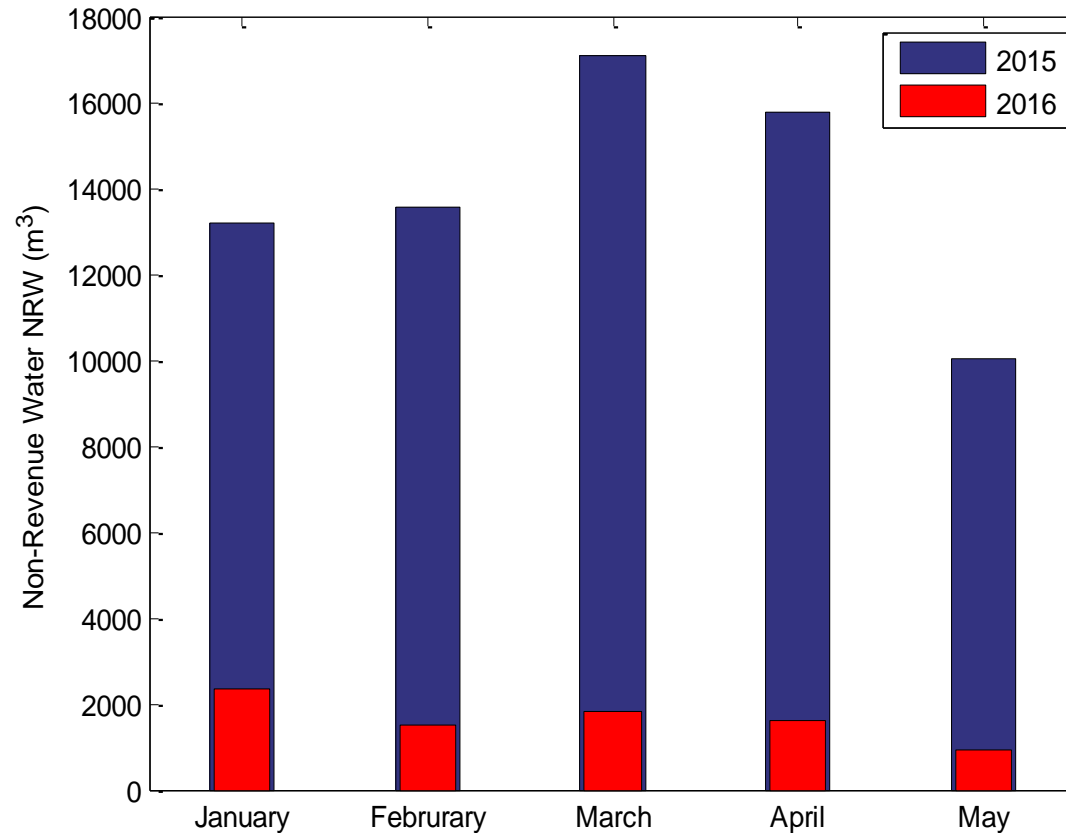
# Detection of water leakage



# 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

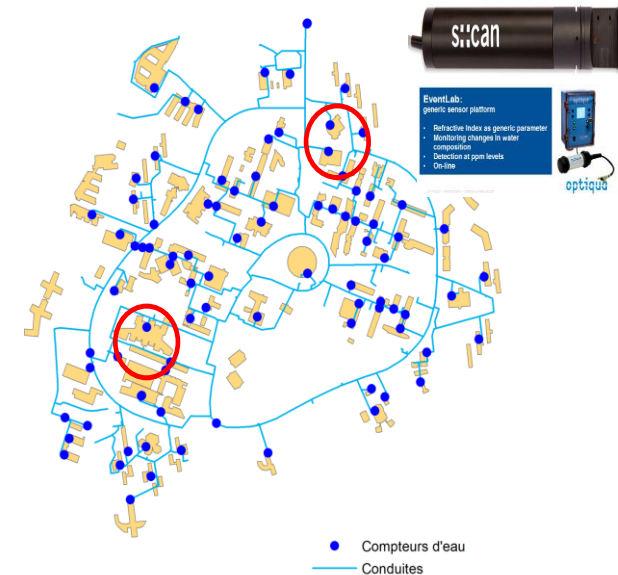
Platform  
Storage, Analysis

Display  
Visualization

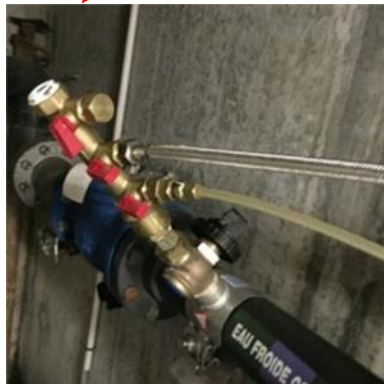
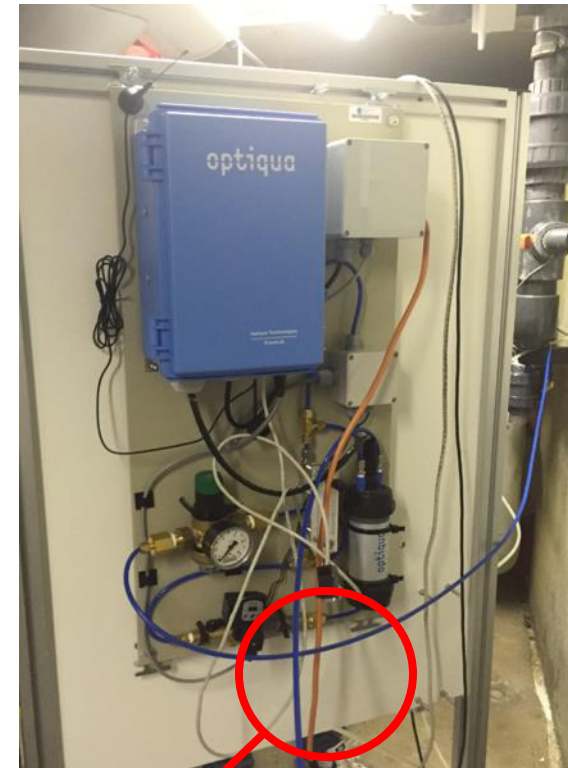
## WATER QUALITY:

- 2 S::CAN
- 2 Event Lab

Time interval : 2 minutes



## Field implementation



# Integrated solution

Monitoring

Data transmission

**Platform  
Storage, Analysis**

Display  
Visualization

## DATA ANALYSIS

### Water leakage:

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

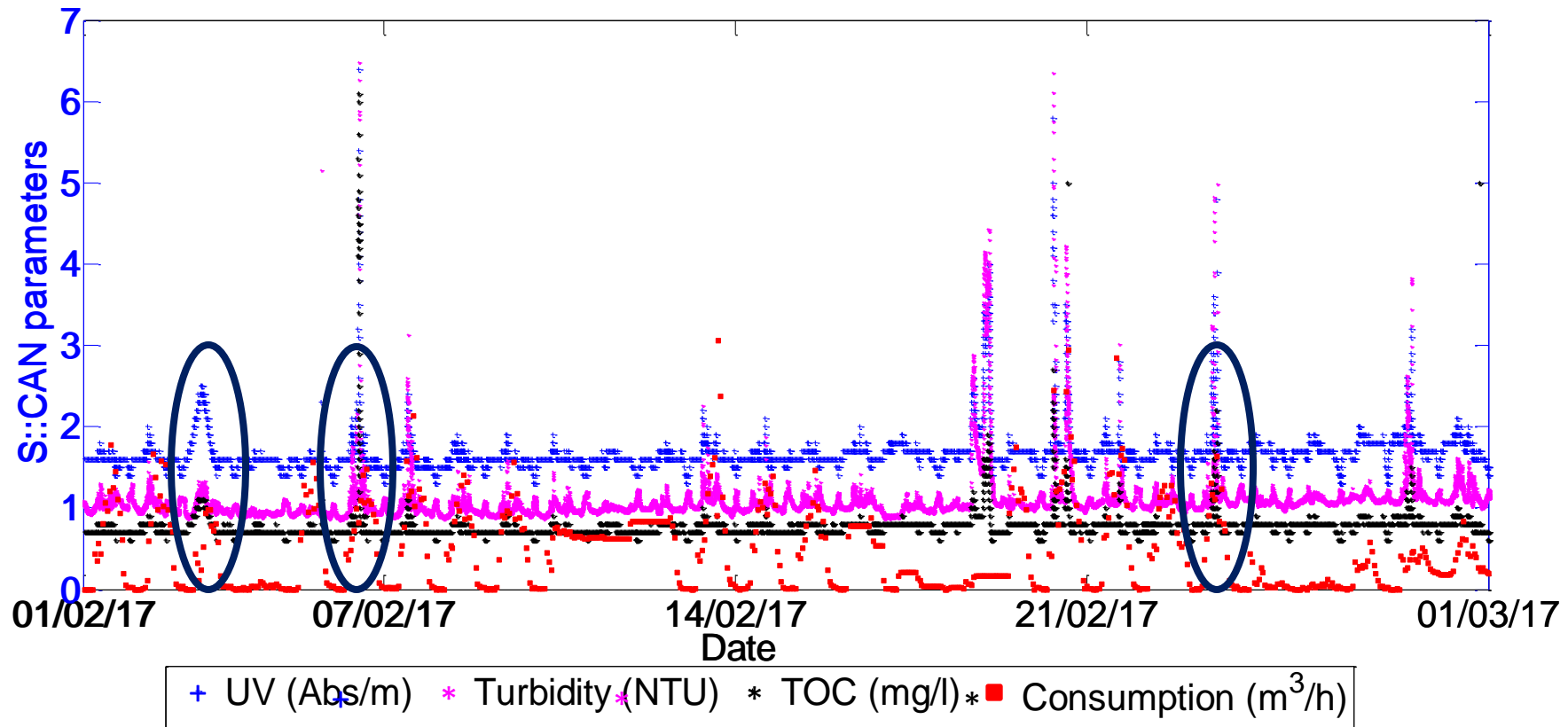
### Water quality control:

- Deviation from the baseline
- Artificial Intelligence (AI)



# Polytech Results

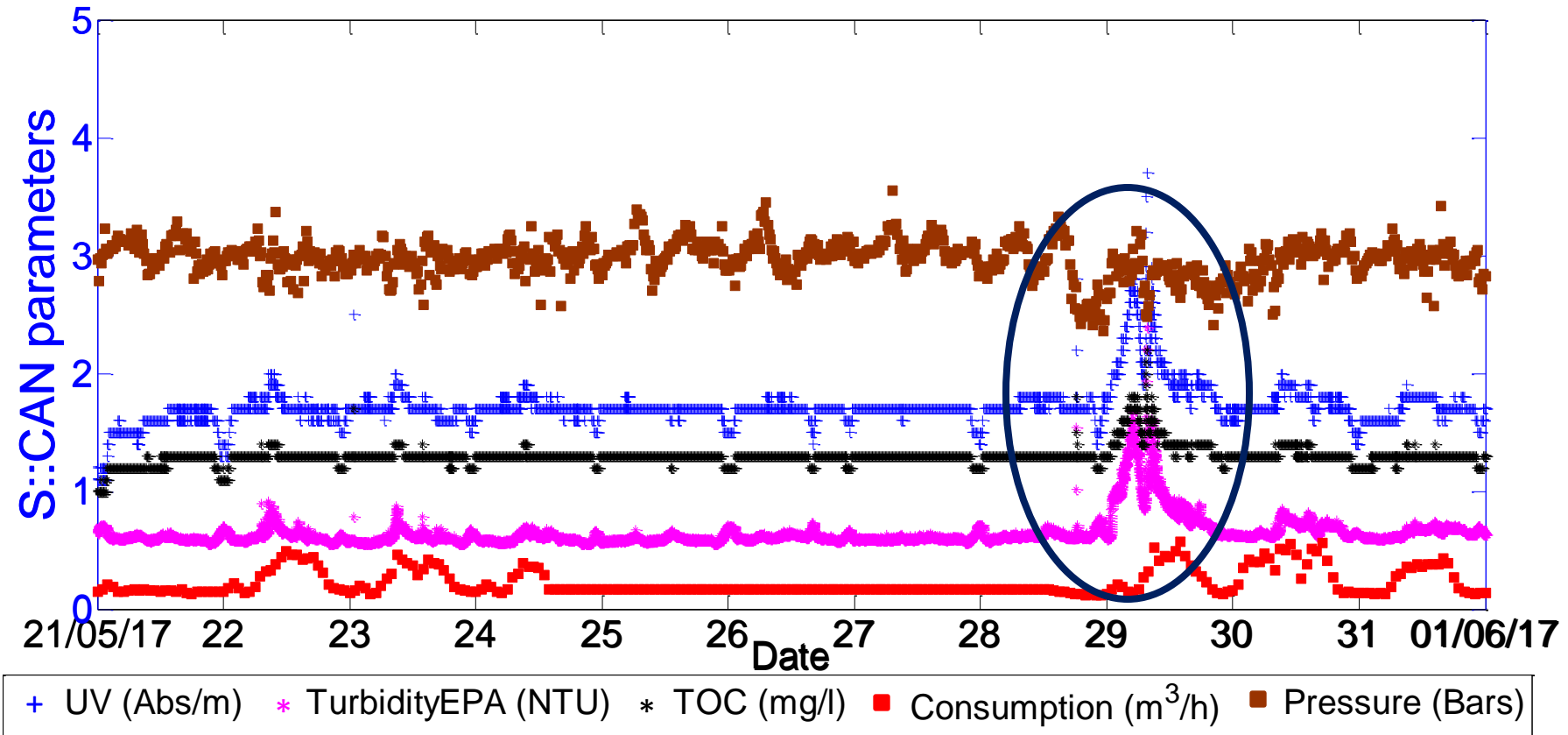
## ➤ S::CAN





# 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**

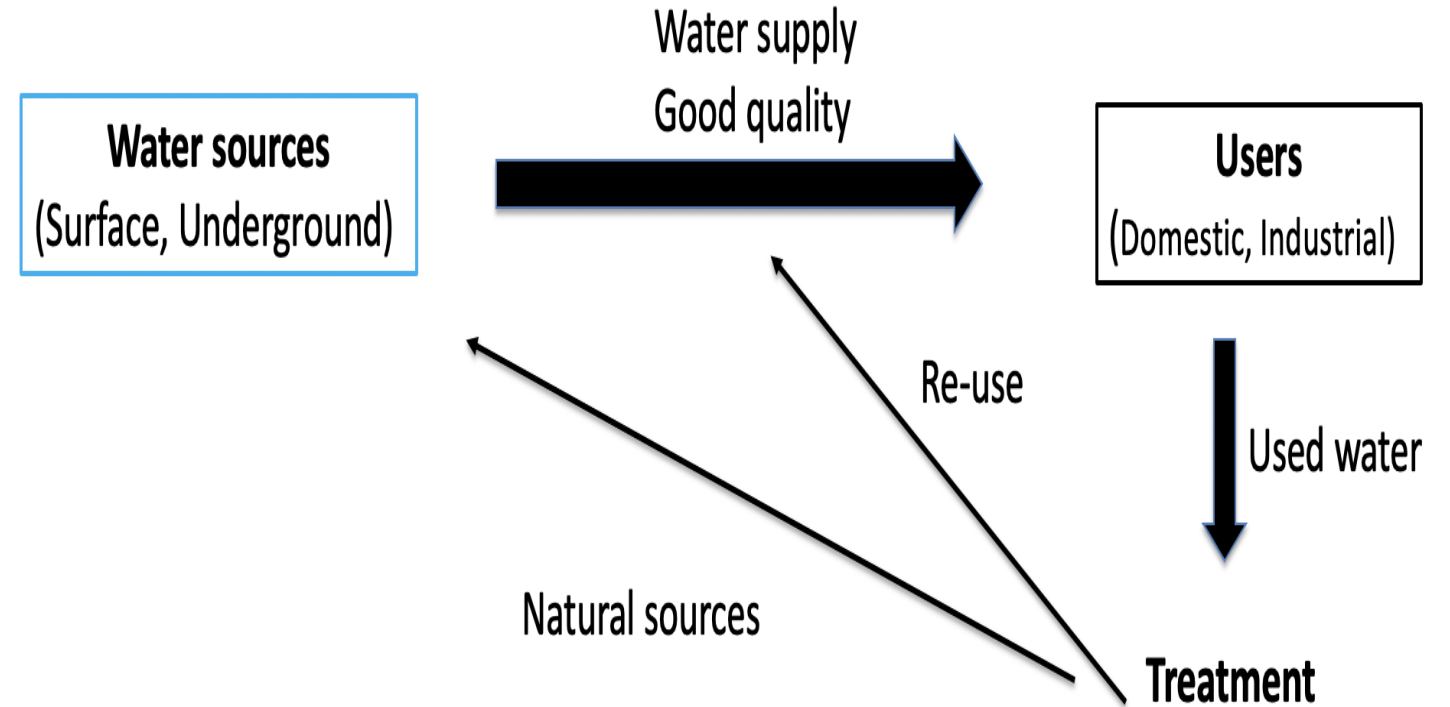
- 906 000 km (value: ~ 80 billion €)
- Annual investment = 1.5 billion €

**Sewage network :**

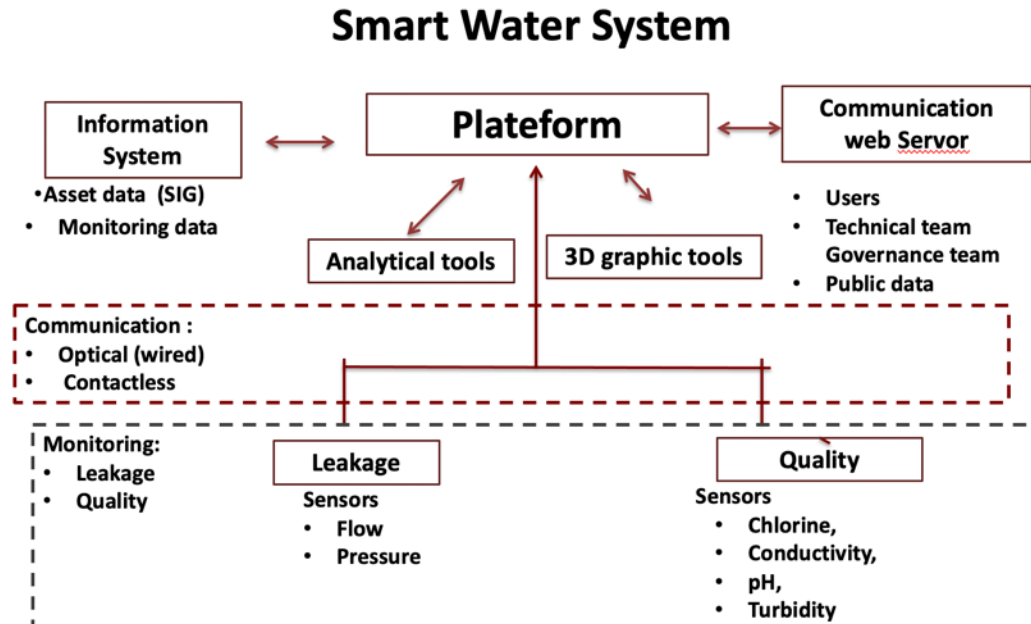
- 394 000 km (~ 70 billion €)
- Annual investment =: 0.8 to 1.3 billion €

# 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*

