Towards smart integrated management of the Greater Paris sanitation system

Metropolitan Climate C.A.R.E. Management Challenges

W-SMART – LIEGE Belgium, nov 5-6, 2019

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SIAAP

Greater Paris Sanitation Authority

www.siaap.fr

Smart integrated management of the Greater Paris sanitation system

1. **SIAAP presentation**
2. **An integrated approach**
3. **I-WWTP-COM project**

SIAAP presentation

The formally SIAAP

- 4 *départements* (administrative divisions of France)

The SIAAP Board (33 elected members)

- 124 municipalities
- 6.7 M inhabitants

Extended SIAAP limits

- **178 municipalities**
- **2.3 M inhabitants**

- **1820 km²**
- **2 500 000 m³/d**
- **Mainly a combined sewer system**
- **Outer suburb : separate system**

SIAAP :

- **302 municipalities**
- **9 M connected inhabitants**
- **400 industrial companies**
- **15 000 km of municipal sewers**

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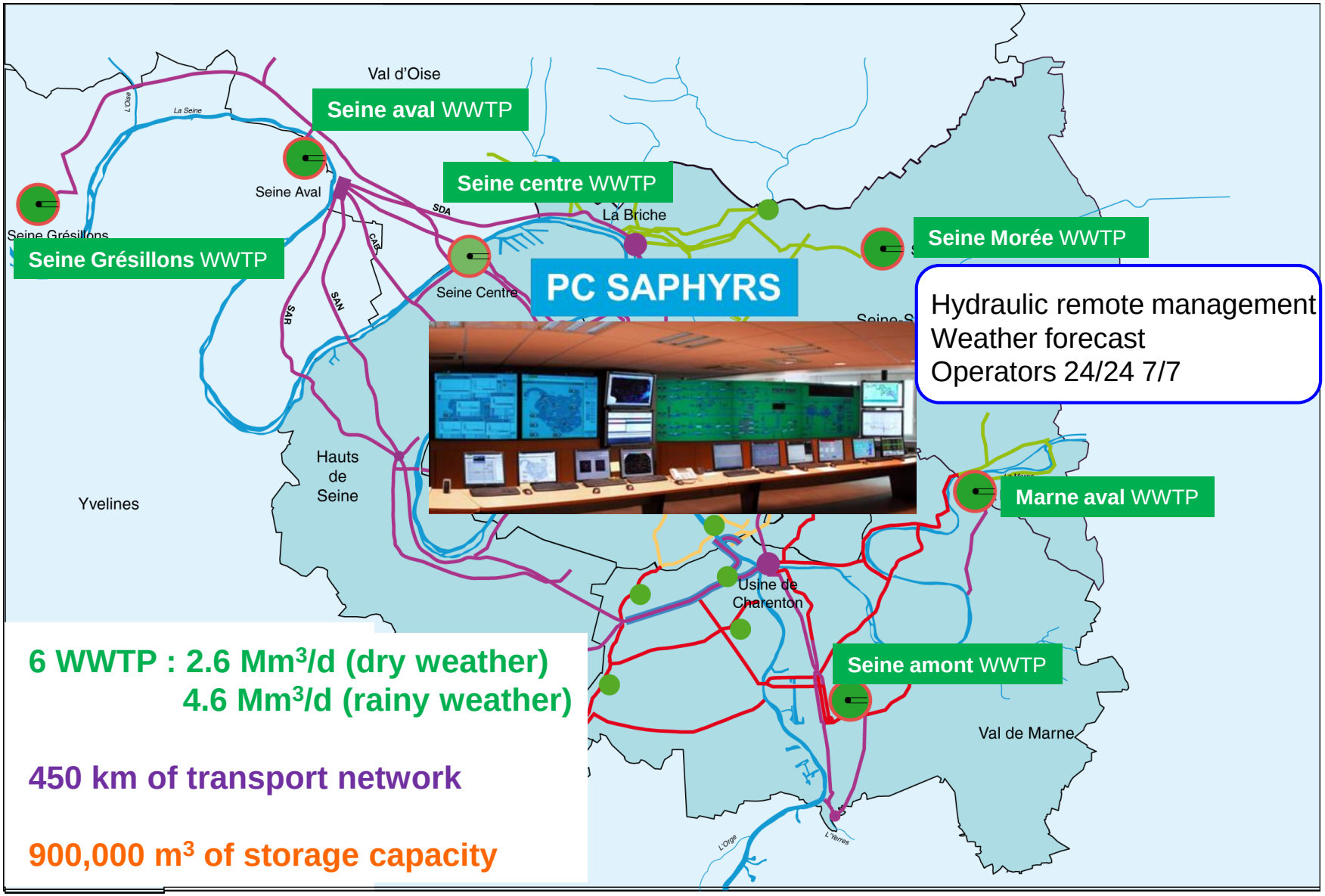
A global sanitation system



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A need for artificial intelligence

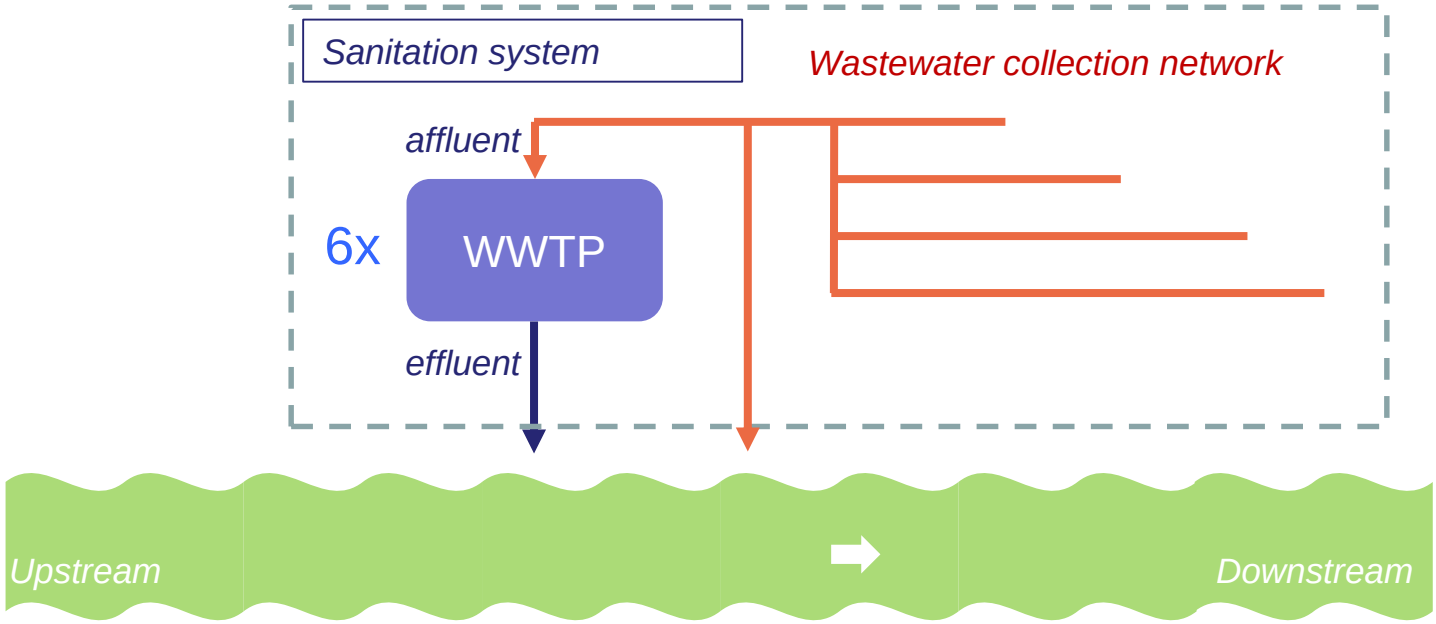
- **A vast, complex, reactive sanitation system (mainly combined) ;**
- **Many industrial tools for the wastewater treatment, modern, efficient, but demanding to operate ;**
- **An evolution of the EU regulatory context :**
  - From performance of WWTP to environmental quality objectives
- **Energy transition / operating costs / carbon footprint**
- **Anticipate the effects of climate change**
  - Lower water flows, more intense rainfall

Need to develop smart integrated management of the sanitation system

An integrated approach

Main objective : Definition of instructions for the operation of the sanitation system, in real time, according to observed and predicted quality of Seine river,

Taking into account : WW routing (flow and quality) / weather forecasts / 6 WWTP performances and status / RIVER objectives / financial optimization (operating costs)



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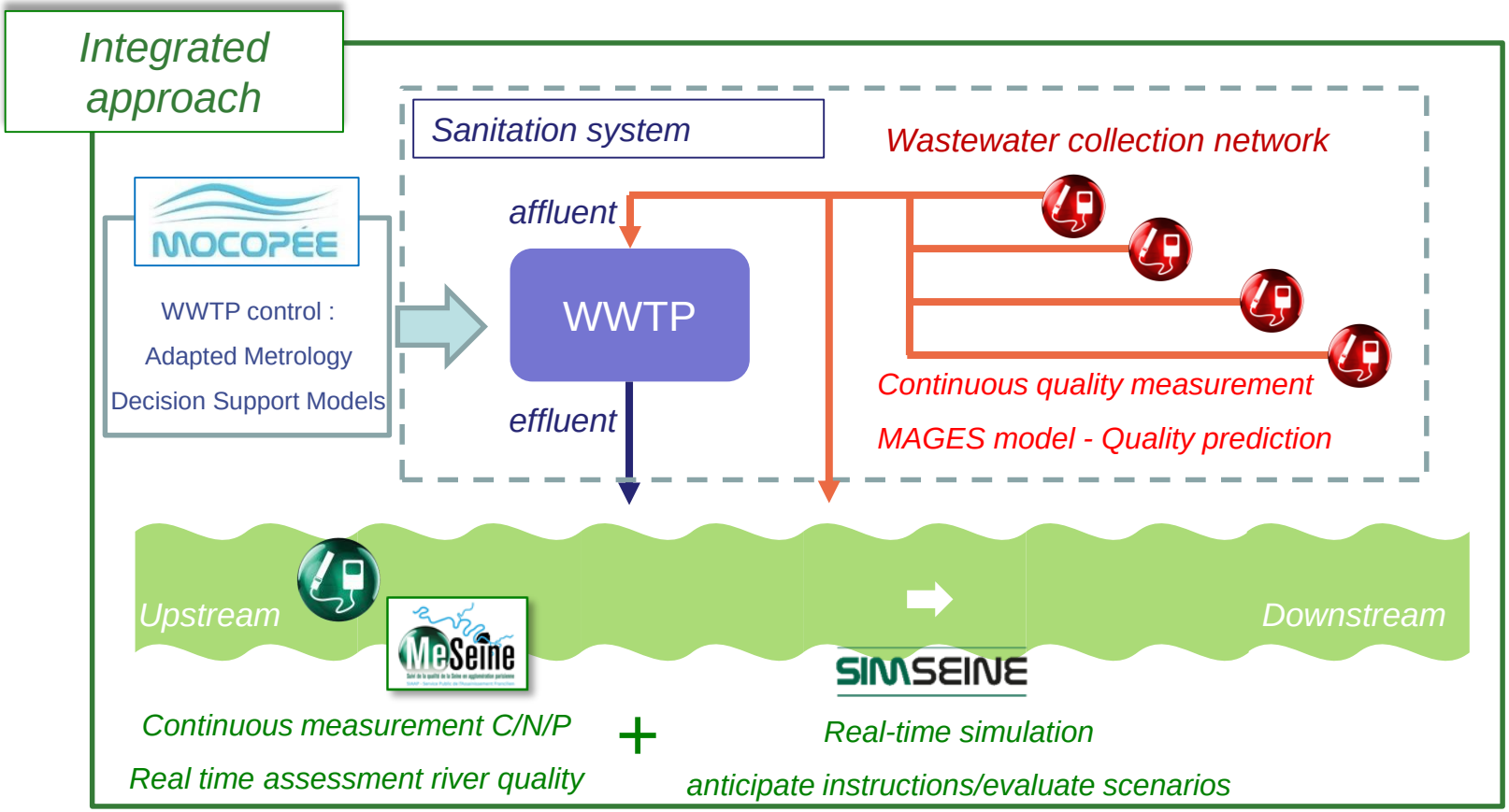

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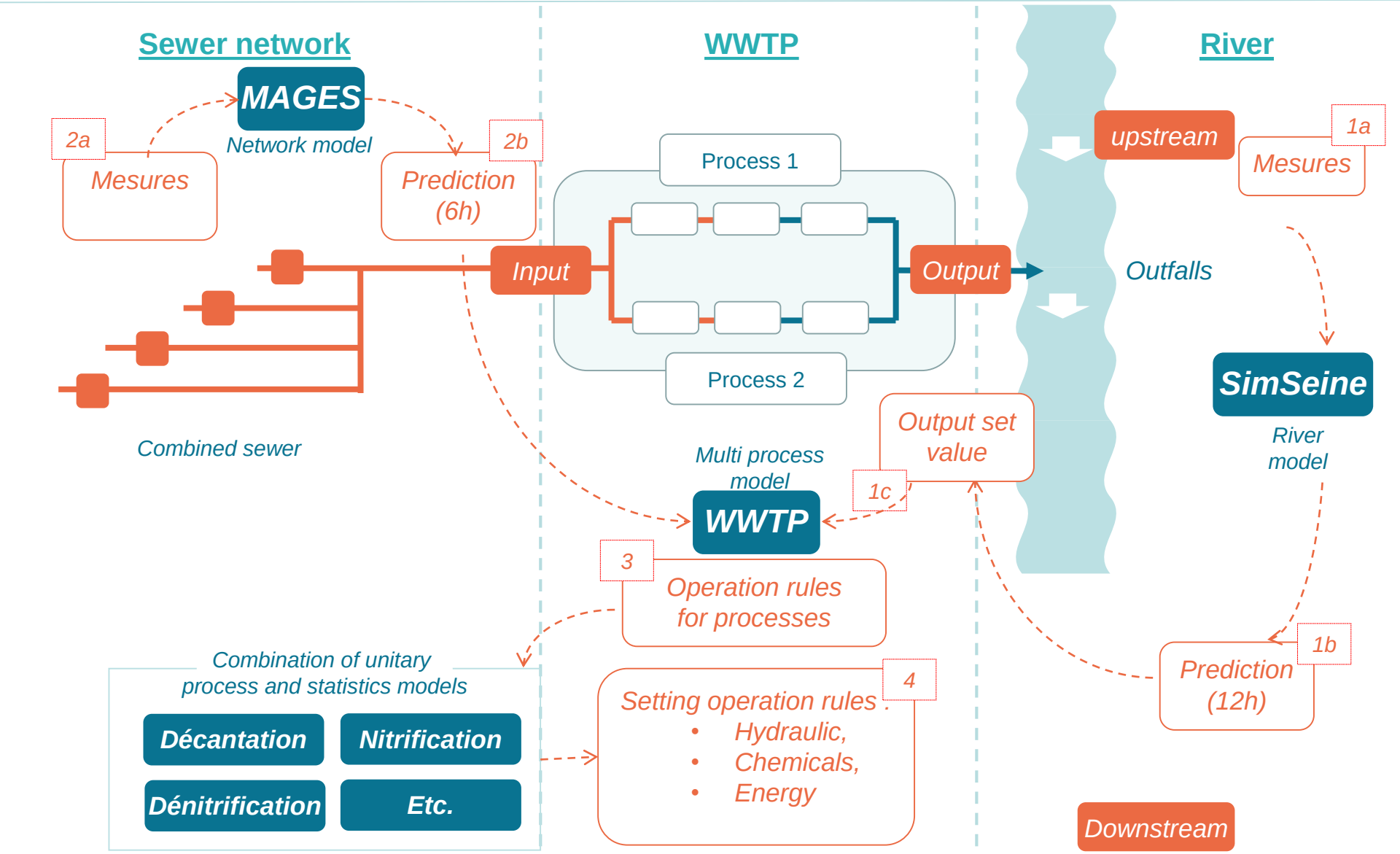
Smart Integrated Management : the bricks of the project



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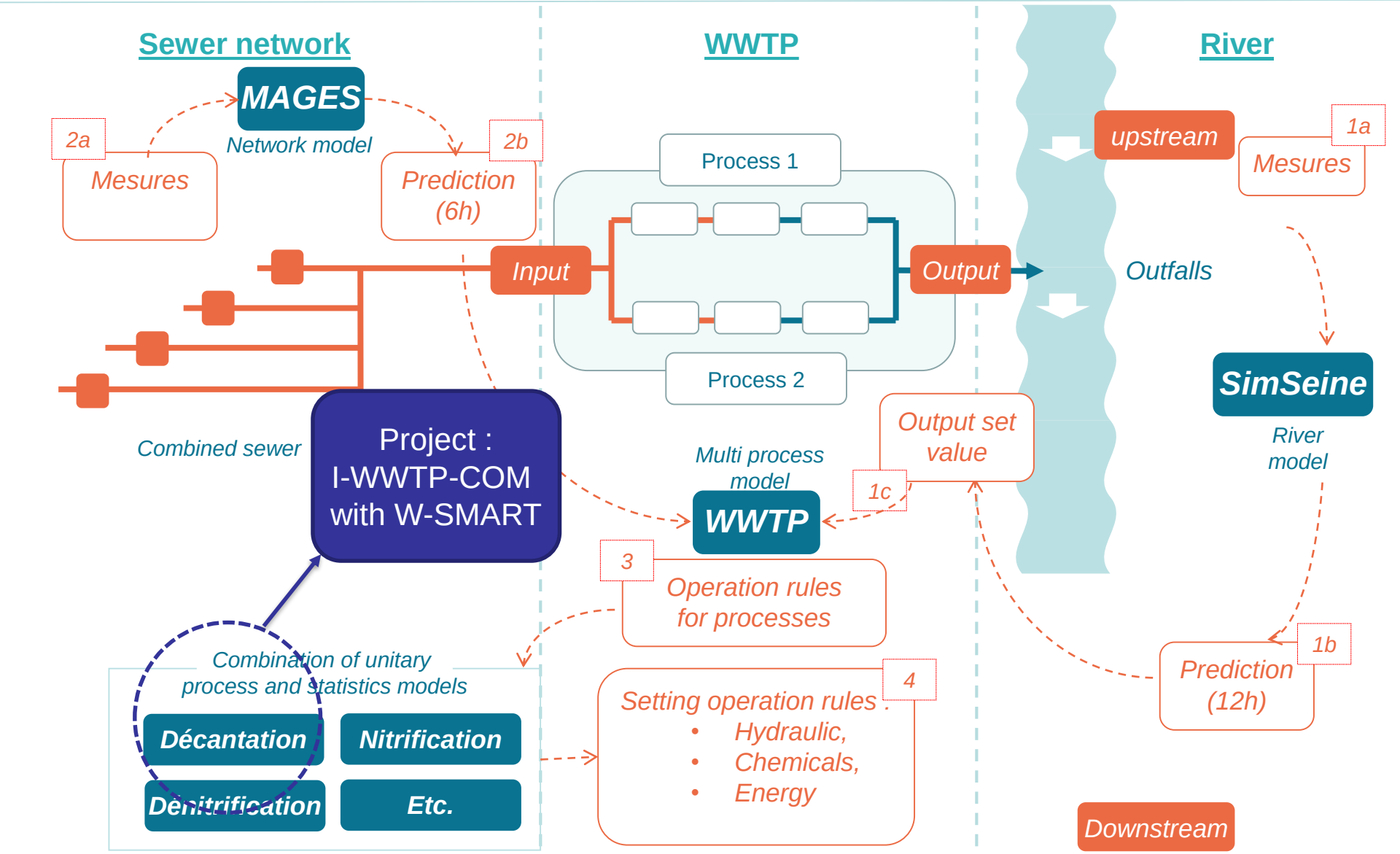
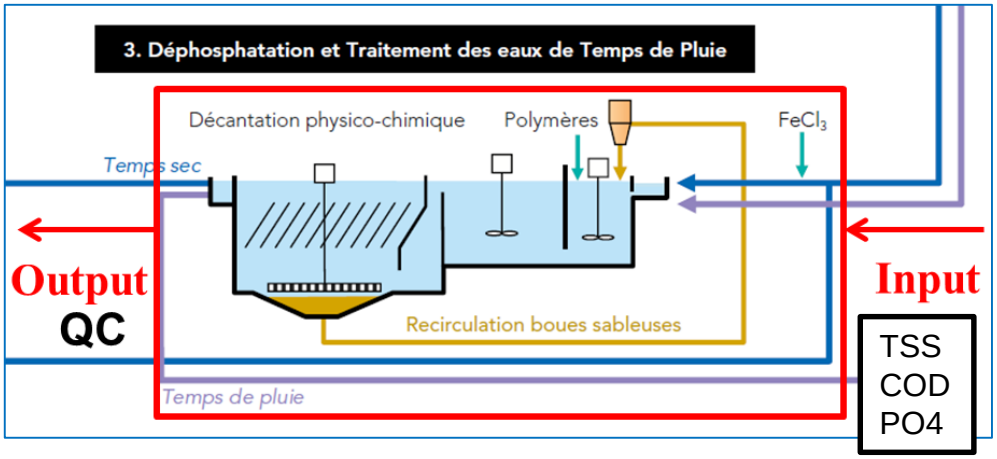
Smart Integrated Management : bricks of the project



I-WWTP-COM with W-SMART (1/4)

Seine-Aval Wastewater Treatment Plant in Achères



I-WWTP-COM

Intelligence based Waste Water Treatment Process - Control & Optimization Management

Feasibility Assessment of AI Algorithm Application to process control and optimization management of tertiary treatment :

- **To improve the energy-efficiency-cost ratios** for TSS Removal for dry and rainy configurations with phosporus removal control
- **To optimize injection** of chemical during Physico-chemical settling on the Seine Aval clarifloculation process;
- **To develop AI based Application** for Process Control & Optimization Management, using off-line simulations of operational scenarios with field data.

https://www.water-technology.net/projects/seine-aval/

I-WWTP-COM with W-SMART (2/4)

Concept Demo-illustration

I. **Statistical off-line Effluent Data Analysis** of the tertiary process – Database of effluent input & output parameters

II. **AI Application (SVM; ANN)** for Anomaly Detection – Output Effluent Quality Control (Training & Testing)

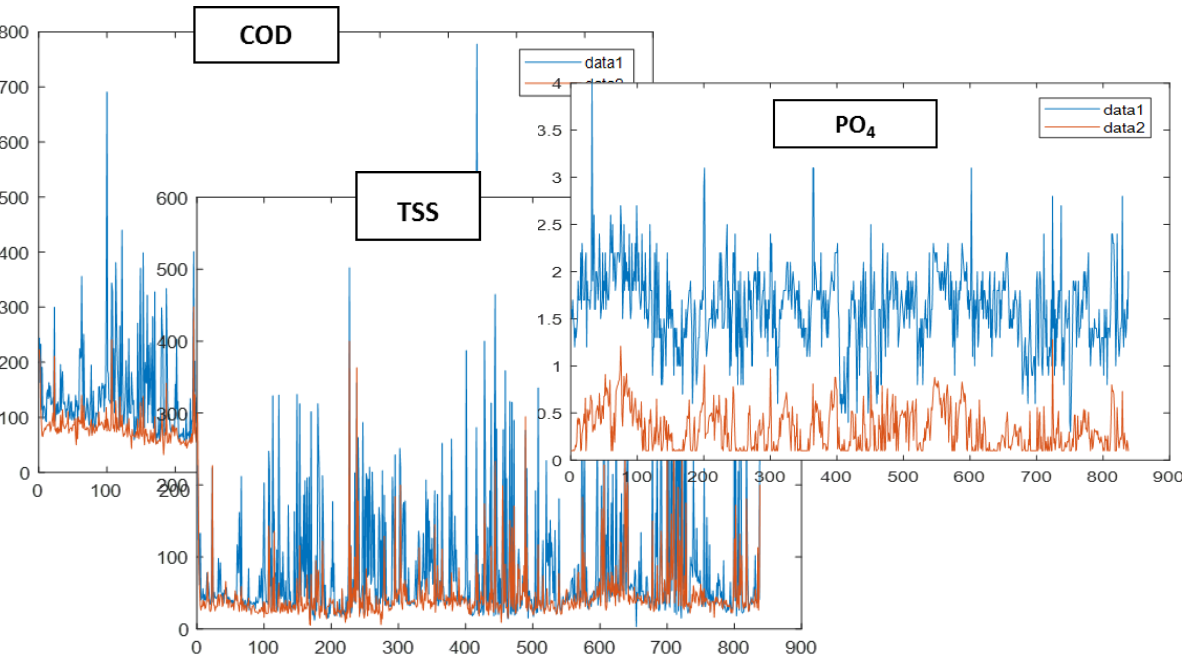
III. **Statistical Treatment Data Analysis** of expected process efficiency (i.e. TSS; COD Reduction) Vs. concentration of treatment parameters – Process database

IV. **AI Application for Treatment Optimization** – concept demonstration of the feasibility of an AI based application for an automated process

V. **System Integration** for “Beta” site testing planning & performance measures for feasibility assessment (ROI)

I-WWTP-COM with W-SMART (3/4)

Very large database : effluent input & output parameters



AI Application & Mono-parameter Analysis for Quality Control

Statistical tools used to establish Anomaly Severity Thresholds

Vector used

Mono-parameter Analysis		
	COD	TSS
avg ± 1*STD	Non anomaly	Non anomaly
avg (±1*STD ± 2*STD)	Low	Low
avg (±2*STD ± 3*STD)	Moderate	Moderate
>avg ± 3STD	Severe	Severe

SVM Results

True Label Training Phase			TrueLabel	PredictedLabel	Predicted Label Validation Phase		
Date	*Tested Severity*	*Classified Output*			*Date*	*Tested Severity*	*Classified Output*
01/01/2012	4	Severe	true	false	30/04/2013	4	Non anomaly
02/01/2012	4	Severe	true	false	01/05/2013	4	Low
03/01/2012	4	Low	false	false	02/05/2013	4	Non anomaly
04/01/2012	4	Non anomaly	false	false	06/05/2013	4	Non anomaly
05/01/2012	4	Non anomaly	false	false	07/05/2013	4	Non anomaly
06/01/2012	4	Non anomaly	false	false	08/05/2013	4	Non anomaly
07/01/2012	4	Non anomaly	false	false	10/05/2013	4	Non anomaly
08/01/2012	4	Non anomaly	false	false	11/05/2013	4	Non anomaly
10/01/2012	4	Non anomaly	false	false	12/05/2013	4	Non anomaly
11/01/2012	4	Non anomaly	false	false	13/05/2013	4	Non anomaly
12/01/2012	4	Non anomaly	false	false	16/05/2013	4	Non anomaly

I-WWTP-COM with W-SMART (4/4)

I-WWTP-COM Network of Beta sites

The I-WWTP-COM Network Purpose :

- **Concept Demonstration & Feasibility Assessment** of AI based algorithms for upgrading and automating the treatment process control to meet performance & QC requirements.
- **Leveraging Experience and Resources** by creating several “Beta” sites for the adaptation, demonstration and pilot testing of AI based Process Control customized to utility needs.
- **Promoting a Network of Local University Centers** to support AI driven Innovation for the development of the I-WWTP-COM
- **Current AI Applications** for
  - **Drinking Water:** Bio & Flow Anomaly Detection (SW4EU)
  - **Wastewater Treatment**: Process Control, Energy Efficiency (SIAAP)
  - **Reduced Energy for Sludge** – AI & Monitoring (MEKOROT)

where we are, where we are going

- **Today, consolidate these models, generalize their use to :**
  - Help in the operating decisions, for process operators ...
  - Conduct optimization studies of treatment systems and rules
    - Increased process control (residual control)
    - Limiting consumption in fluid (energy/reagents)

Station SAV (Achères) Actiflo

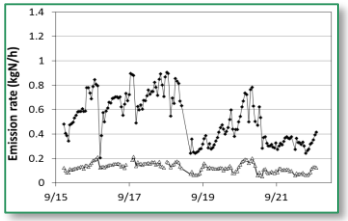
Station SAV (Achères)
Unité de nitrification / dénitrification

- **Tomorrow, build complete modeling chains**
  - Models of treatment chains (water/sludge)
  - Coupling models : Sewer – WWTP - River

Integration of models into plant supervision tools

PC SAPHYR-Hydraulic control systems for SIAAP networks

- **Capitalize the fruits of the R&D work, in operating projects.**



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thank you for your attention

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