DURL Project
Water Quality in Urban Rivers Conference

Improving the quality of the Seine: A focus on disconnections and misconnections

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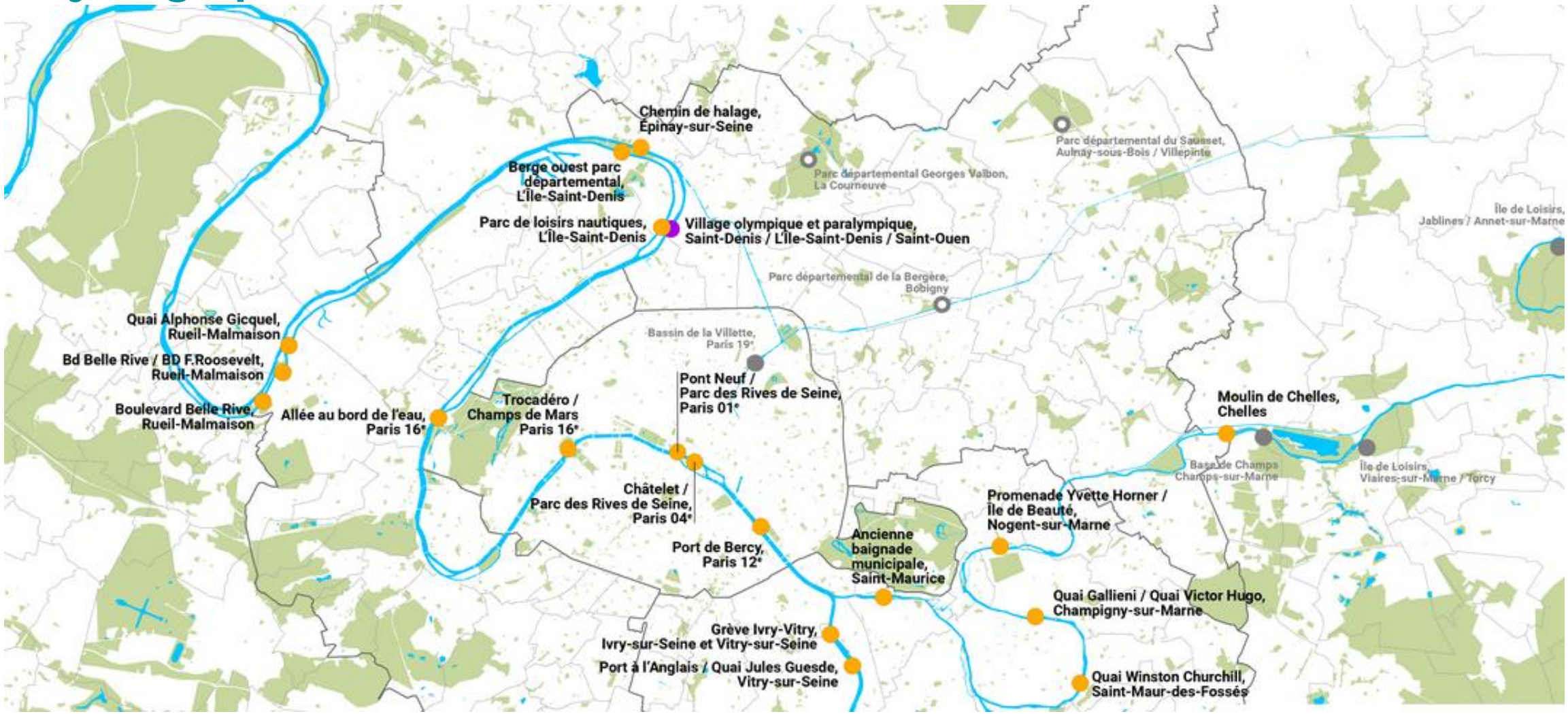
Reinventing the Seine :
Swimming in the Seine in 2025,
a legacy of the Olympic and Paralympic Games

Hydrographic context



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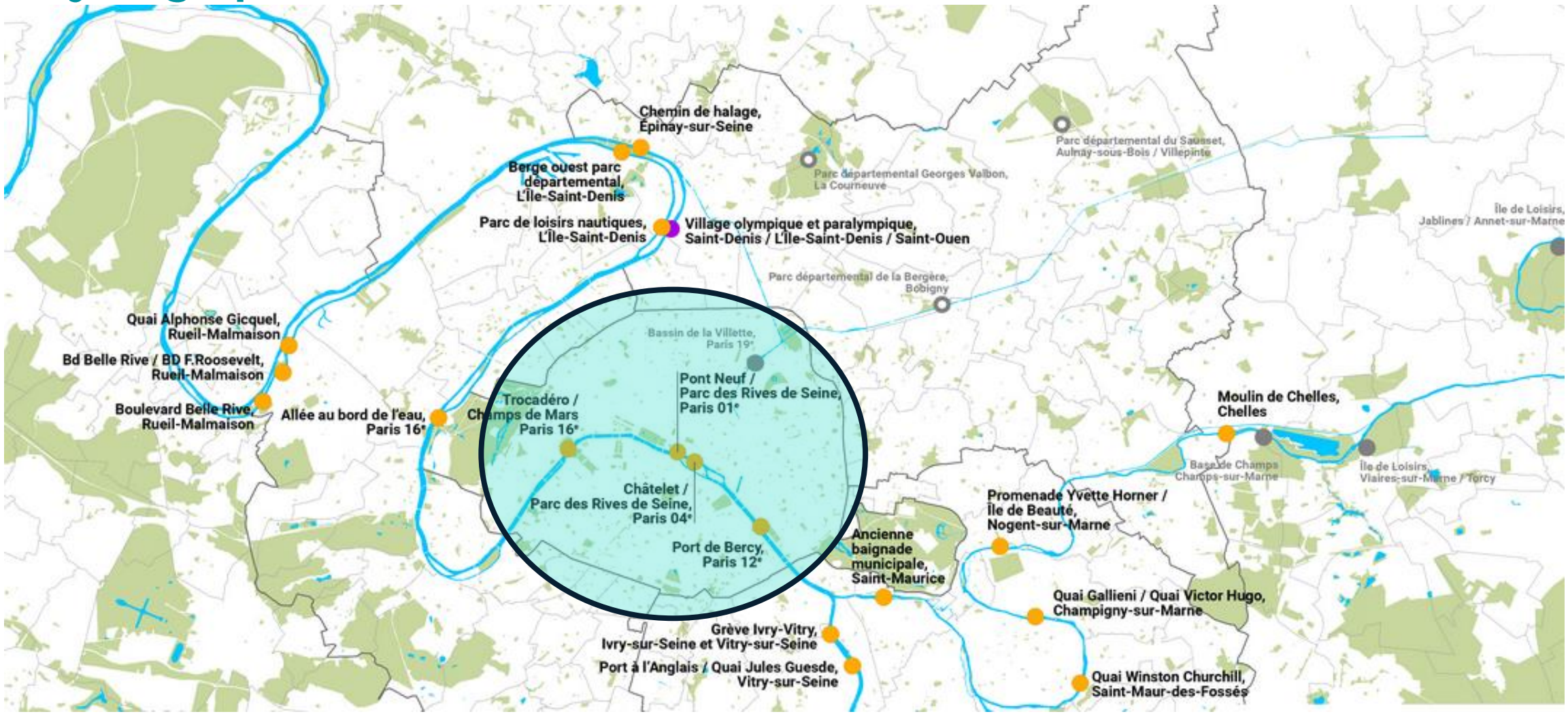

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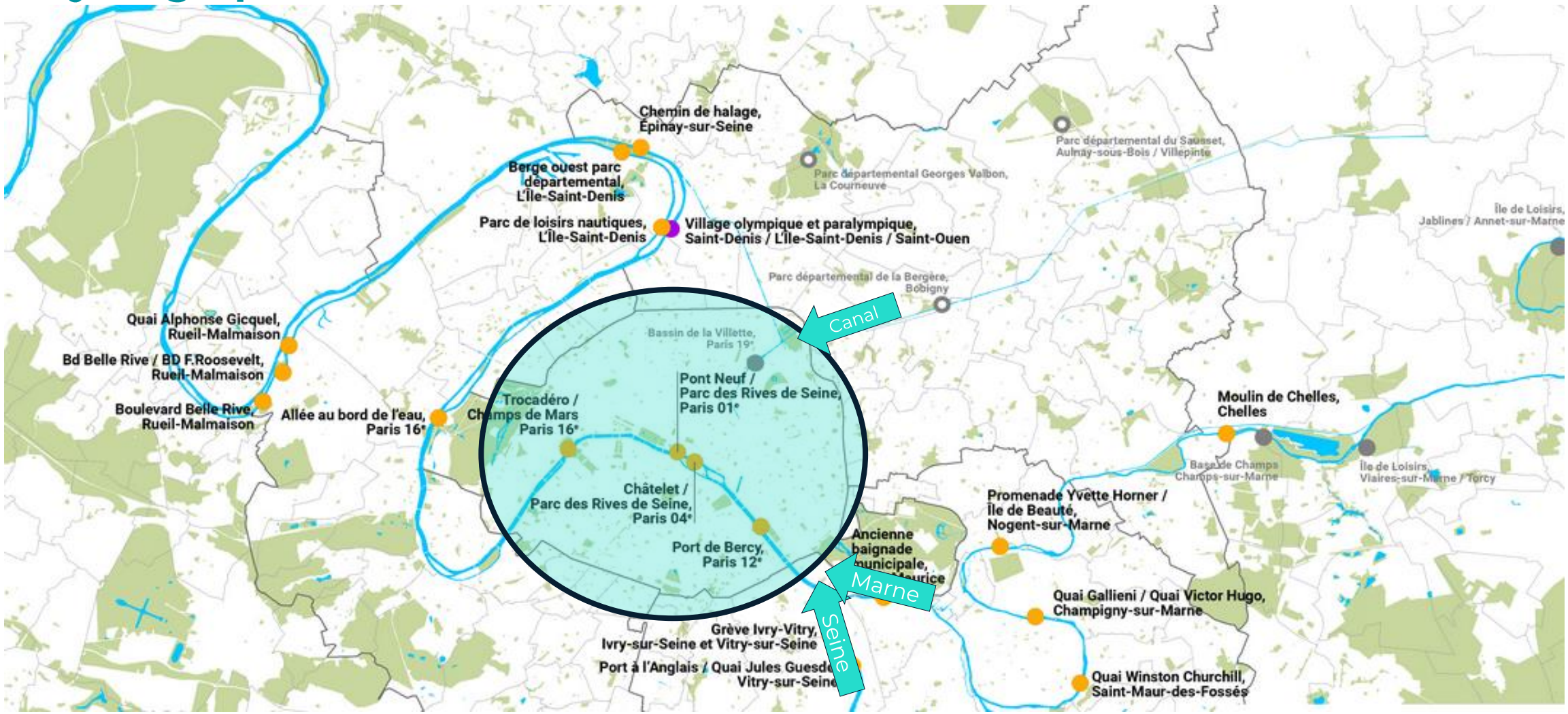


Leadership towards the water quality action plan

Meeting water quality requirements in view of the Olympic and Paralympic Games 2024

Initiated in 2016, a complex governance structure

- Steering committee led by the Mayor of Paris and the Prefect of the Ile-de-France Region
- 30 stakeholders
- 6 Working Groups
- 50 actions (rainy/dry weather)

2015
Candidacy for the 2024 OPG

2016
Call of interest
23 bathing areas
5 located in Paris

2018
Water quality action plan approval
Signature by the 25 partners

2018-2021
50 actions launched
Knowledge
Treatment plants
Communication
Misconnections
Stormwater management
Boats discharge

2023
Bathing in the river Marne
Go on with the 50 actions
100% of actions lauched

2023
Actions to be accelarated
Collection and misconnections
Discharge when raining
Pre-Olympic events in the Seine

2024
2024 OPG
Swimming events in open water

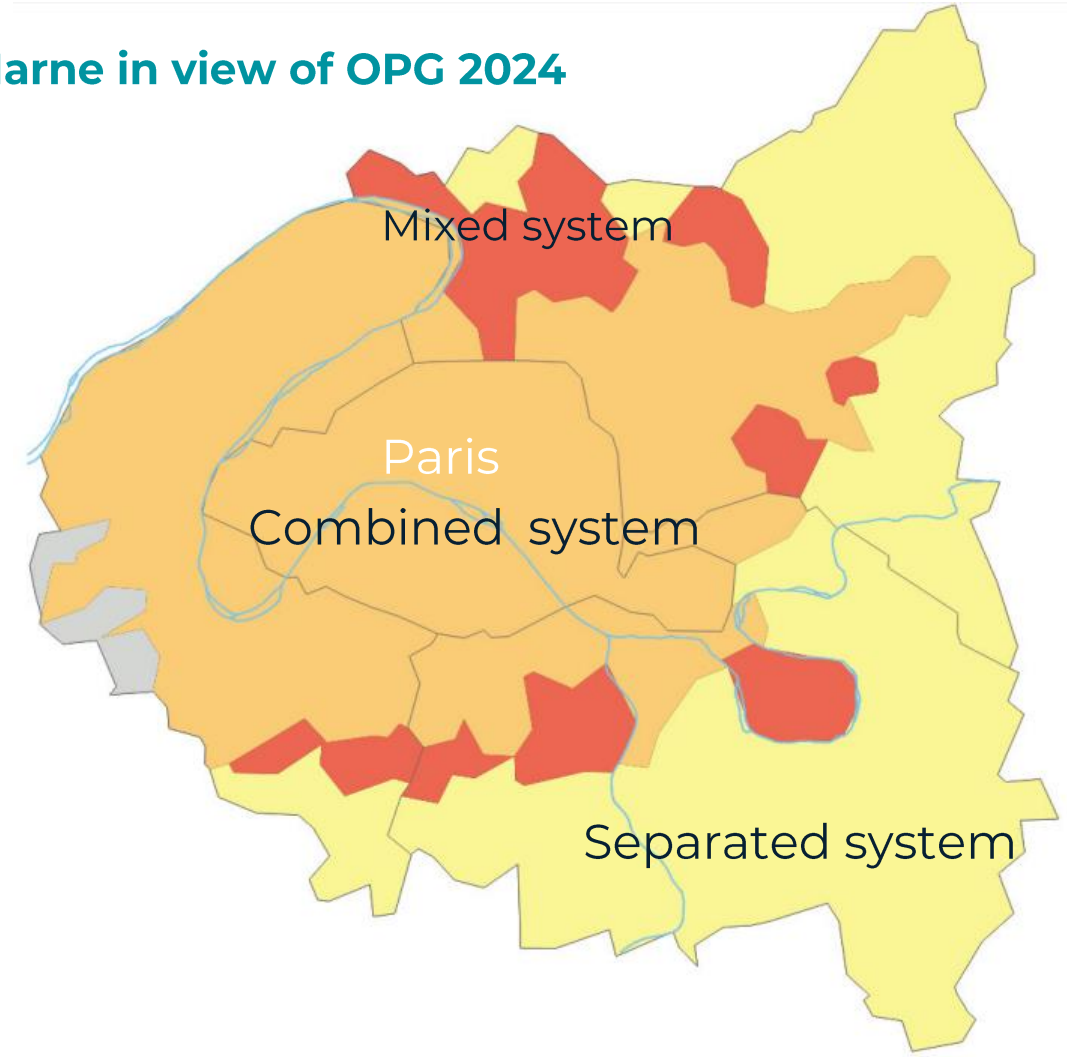
2025
Legacy
Bathing for all

Bathing in the Seine river Project

Action plan for achieving water quality in Seine and Marne in view of OPG 2024

Main lines of action:

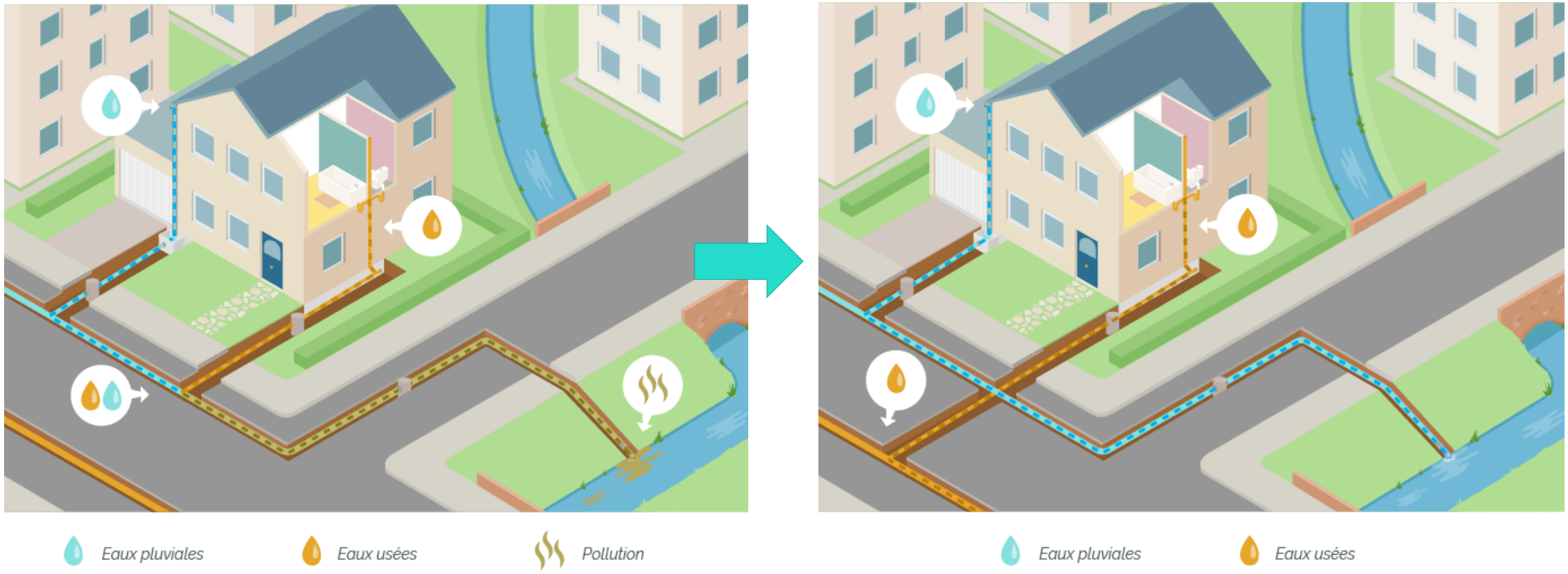
- Improving knowledge of water quality
- Reducing contamination from treated wastewater
- Reducing discharge of untreated wastewater from boats
- **Reducing discharge of untreated wastewater during dry weather periods**
- **Reducing discharge of untreated wastewater during rainy periods**



Fixing misconnections :
One of the most ambitous actions

Bathing in the Seine river Project

Reducing discharge of untreated wastewater during dry weather periods



Bathing in the Seine river Project

Reducing discharge of untreated wastewater during dry weather periods

Objective : suppression of 25 000 misconnections

- Wastewater into rainwater network
- Rainwater into wastewater network

A communication campaign and dedicated website : monbranchement.fr

Bathing in the Seine river Project

Reducing discharge of untreated wastewater during dry weather periods

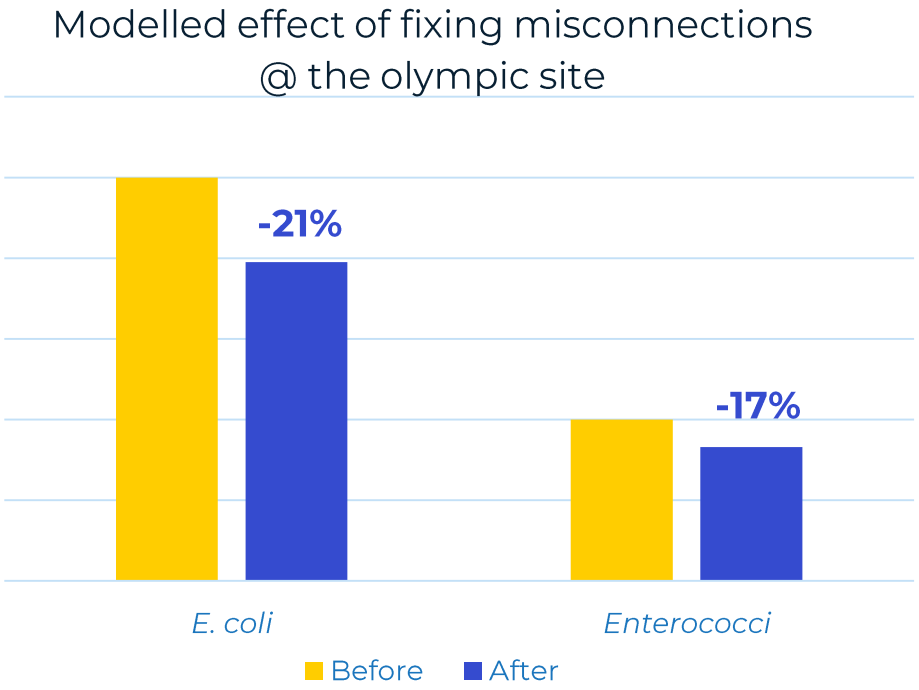
Several lines of actions as incentive :

- 2018 Olympic law : mandatory compliance certificate to allow real estate transactions
- Public buildings, hotels : systematic controls
- Public subsidies : 4200€ for works in individual houses and 420€/inh. in collective housings
- Additional subsidies : by the City of Paris to most vulnerable territories

Bathing in the Seine river Project

Reducing discharge of untreated wastewater during dry weather periods

We’ve reached approximately half of the objective.



Disconnections :
The example of the LIFE Adsorb project

Objectives

An innovative filter reducing pollution from roadwaters to the environment (2019-2025)

3 objectives:

- Reducing pollution rejected to the Seine by 95%,
- Testing an innovative system to treat roadwaters,
- Integrating the system in a classified natural site and increase its biodiversity.

Context

The vertical reed bed filters (RBFs)

Location of the RBFs

Location:
West of Paris: Bois de Boulogne park

RBF catchment area in rainy weather:
2,6 km of the ring road = 21,1 Ha
Dense roadways (200 000 vehicles/d)
+
Unitary catchment (72 Ha)

+ dry weather: uncontaminated groundwater
~56 % of water supplied to RBFs

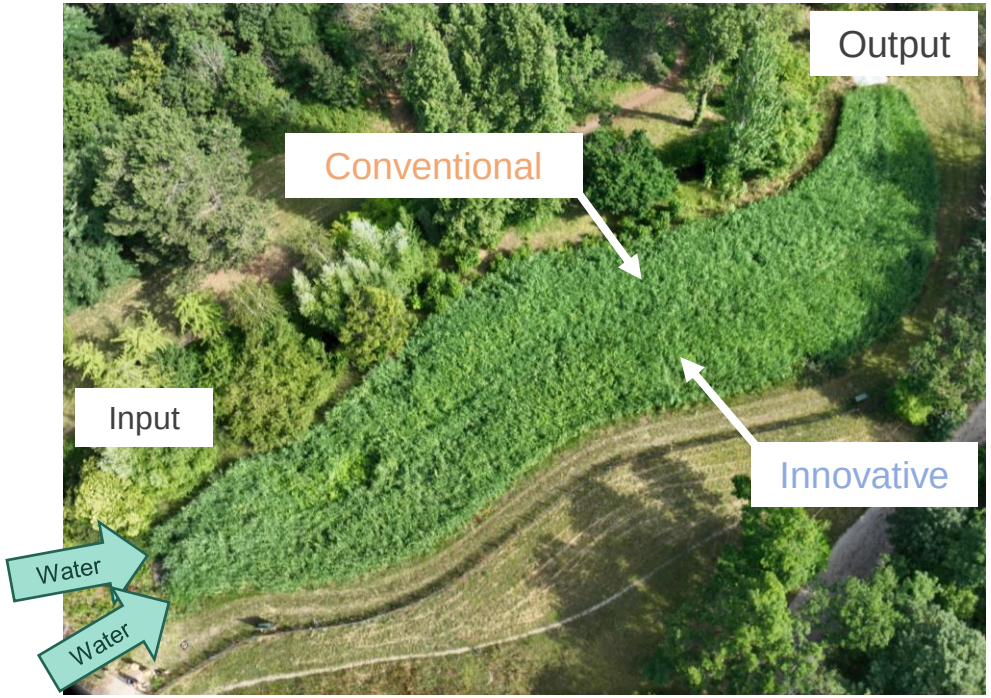
➔ Special hydraulic operation

Ring road → RBFs → Seine

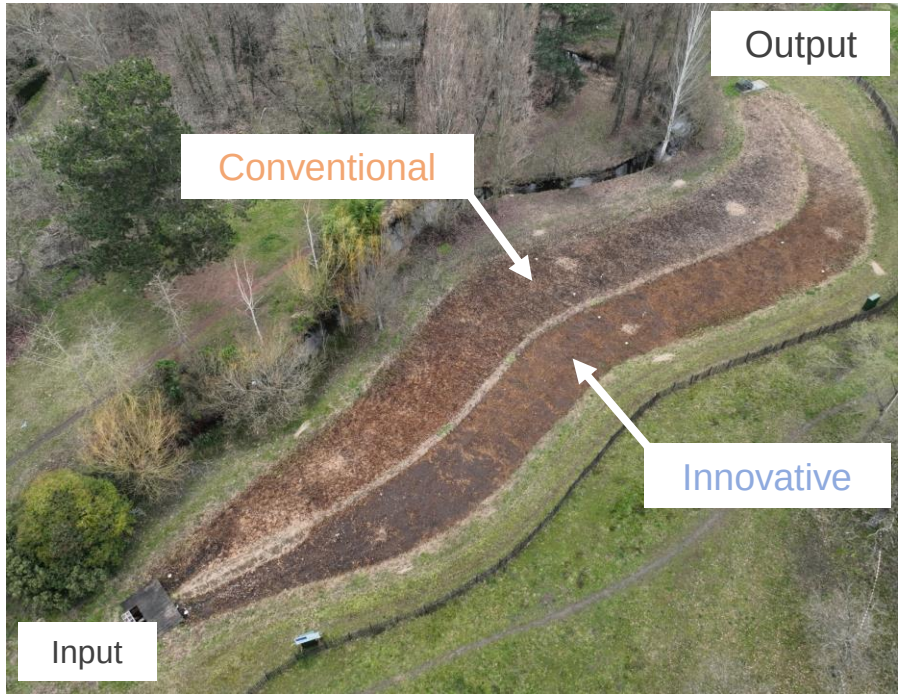
Slide adapted from Dr. Julia ROUX

Material & Methods

The vertical reed bed filters (RBFs)



Summer



Winter

<u>Two RBFs</u>
Conventional: 680 m²
Innovative: 610 m²

➔ Supply via an **upstream pipe**

Slide adapted from Dr. Julia ROUX

Material & Methods

Composition of the RBFs

Similar conception:

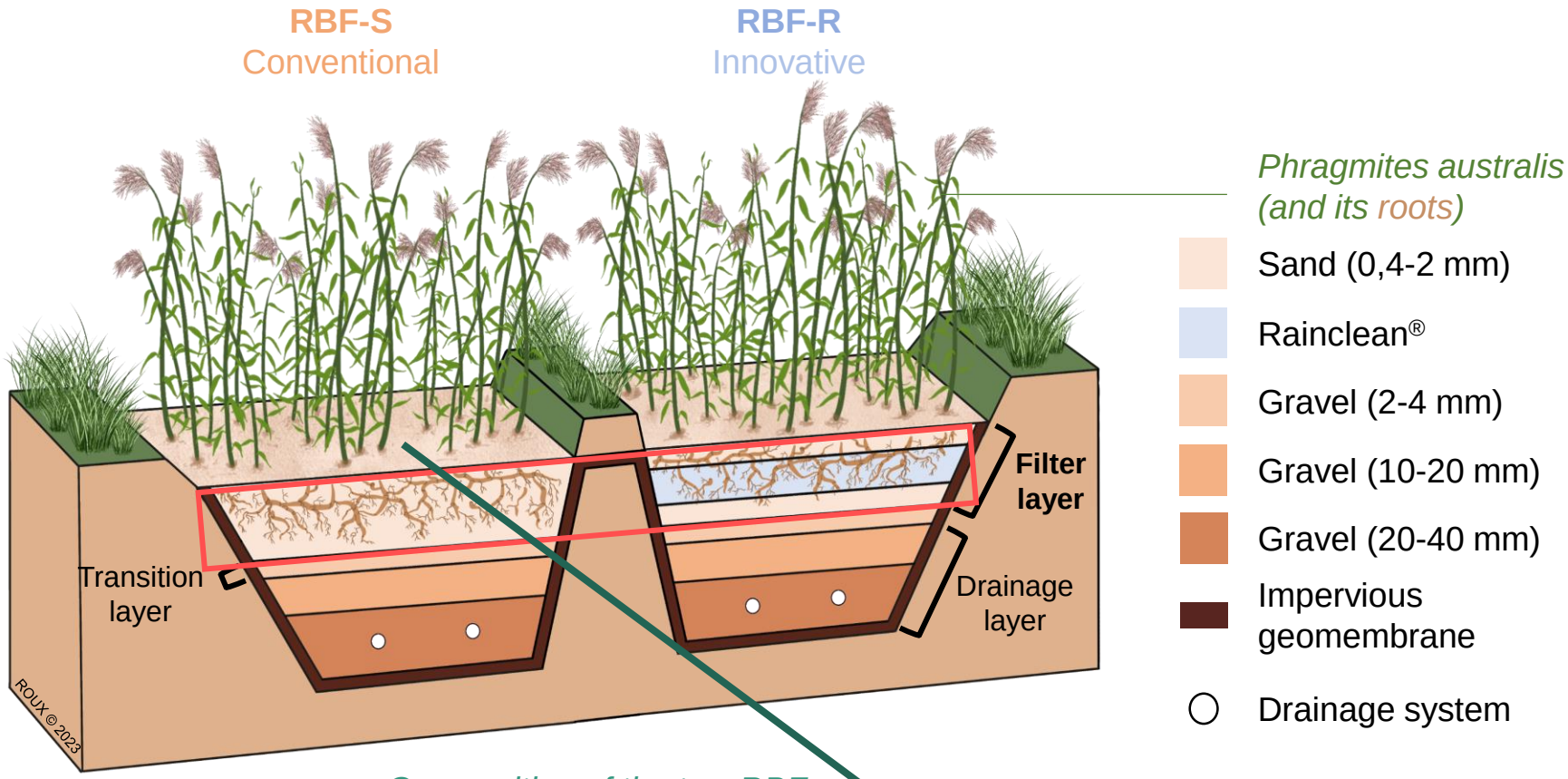
Filter layer : **40 cm**
Transition layer: 10 cm
Drainage layer: 50 cm
Planted with ***P. australis***

Different composition:

RBF-S: **Sand** (40 cm)

RBF-R: Sand (10 cm)
Rainclean® (20 cm)
Sand (10 cm)

Industrial **adsorbent** substrate:
Carbonates, coconut fibers, pumice stones, zeolites, activated charcoal...



Composition of the two RBFs

+ Over time: accumulation of **sediment** on the surface

3 substrates studied: sand, Rainclean (Rc) and sediment

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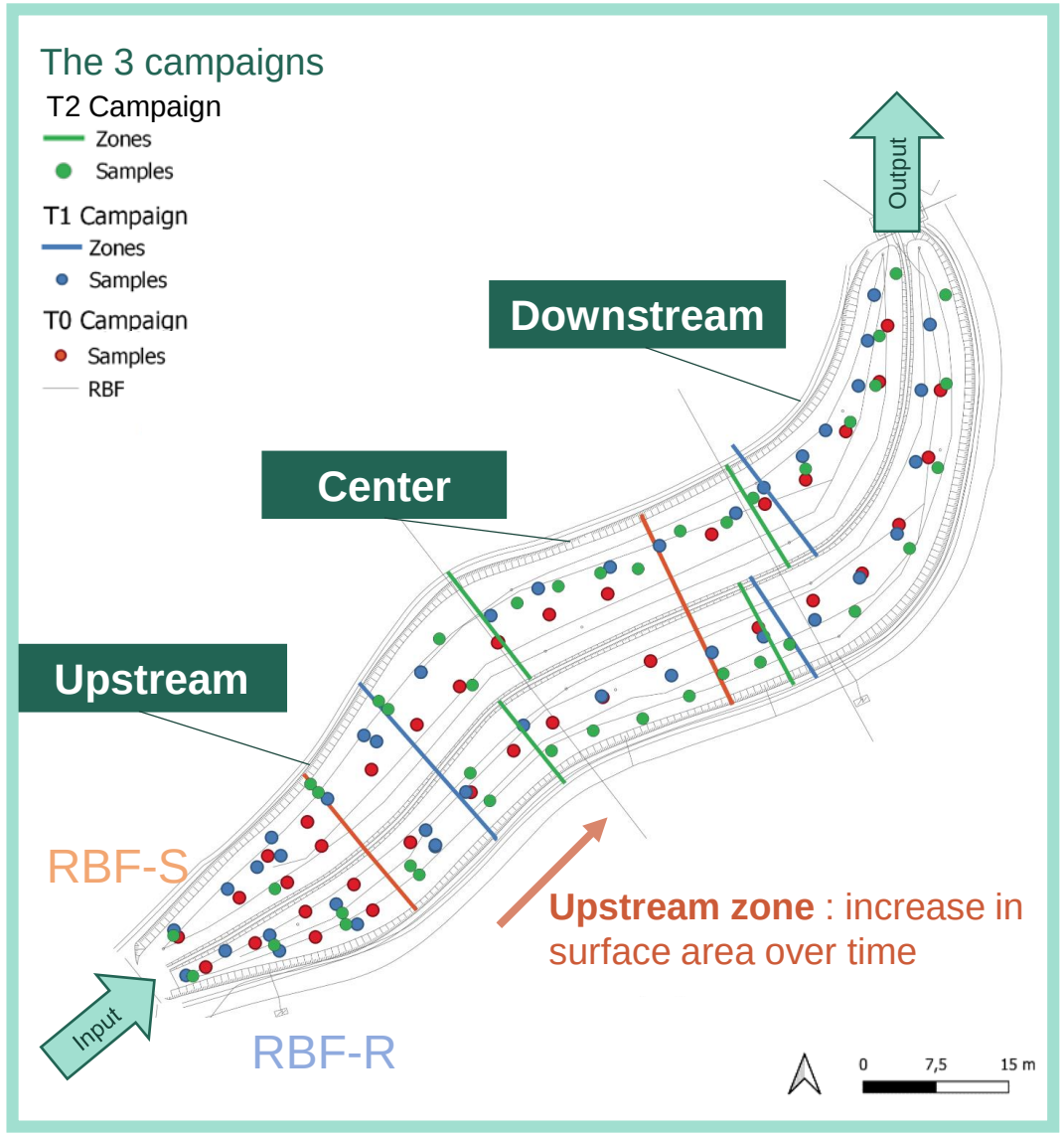
Material & Methods

Substrates sampling campaigns

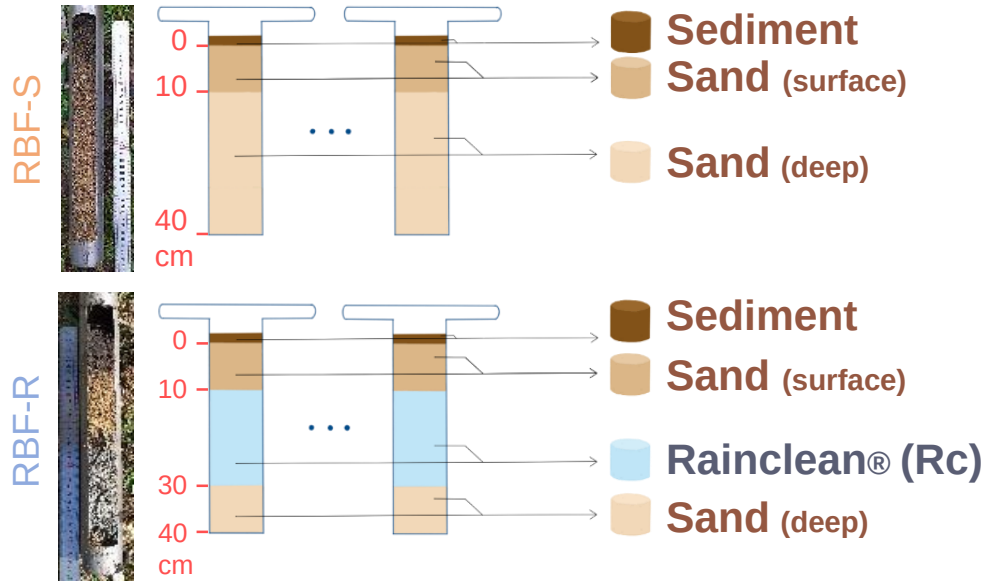


Sampling campaigns

3 campaigns: 2020, 2021, 2022 (sept-oct)
3 zones: According to surface condition

= 1 core sample (40 cm)

6 to 8 cores/zone



The different substrates

Composite samples: N=43

- Campaign (T0, T1, T2)
- Filter (RBF-S, RBF-R)
- Horizontal location(Up, C, Do)
- Vertical location (substrates)

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Material & Methods

Substrate analysis: space-time evolution of the RBFs

Physico-chemical properties

pH, CEC, particule size, TOC, N, C/N, CaCO3, density, moisture …

+ fine mapping of **sediment** thickness and trace metals

Trace metals (TMs)

Cd, Cr, Cu, Ni, Pb, Zn

Aqua regia + ICP-AES

Organic micropollutants (OMPs)

PAH, HC index, **Bisphenol-A, Alkylphenols**

Extraction + UPLC-MS-MS or GC-MS

Microbial communities

Bacterial and fungal abundance (*MPN*)

Functions (*Enzymatic activities and Biolog EcoPlates®*)

Genetic diversity (*Illumina Mi-Seq 16S and 18S*)

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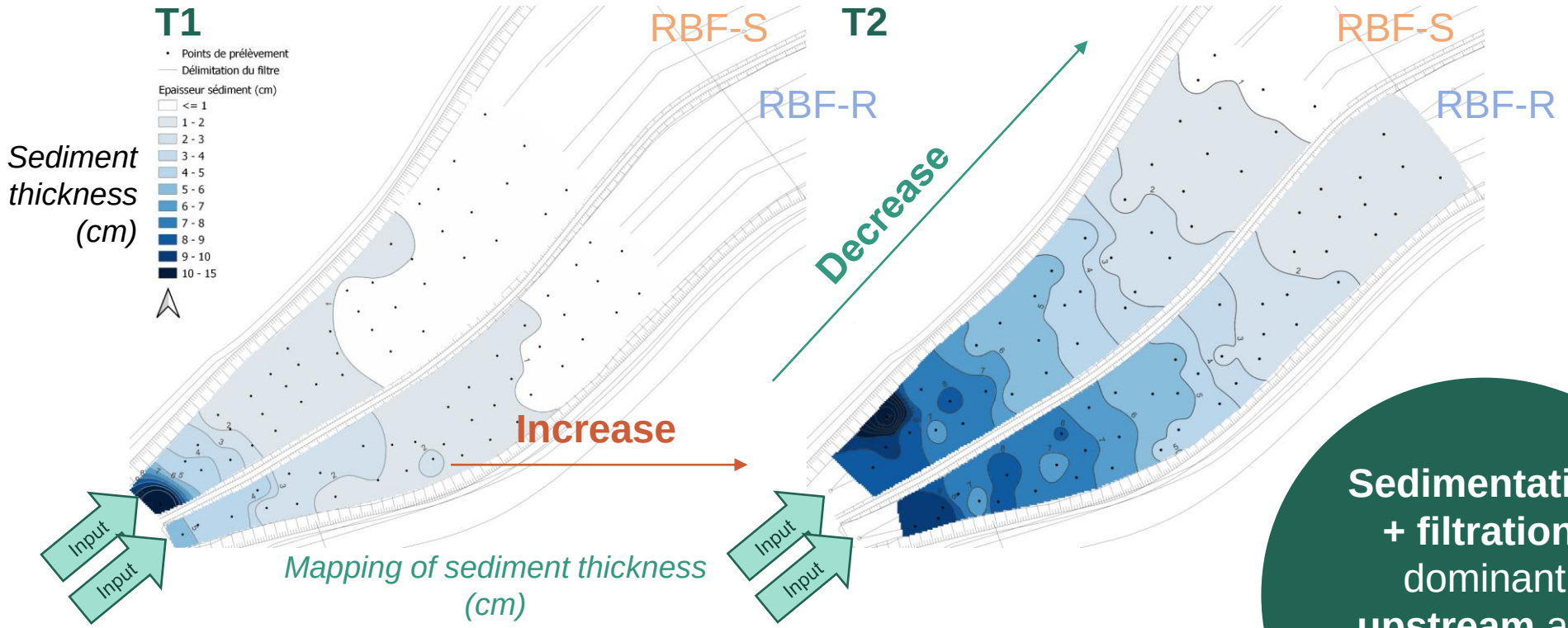
Results & Discussion

Evolution of RBFs: Sediment accumulation (upstream zone)



Sedimentation + filtration: dominant **upstream** and **surface** processes

➔ **Decrease** with distance: 12 to < 2 cm from 30 m

➔ **Increase** with time

➔ **Sediment** exclusively upstream : **32-42%** of total RBF surface at T2

➔ Average annual accumulation rate: **4,1 m³/y** (± 0,37)

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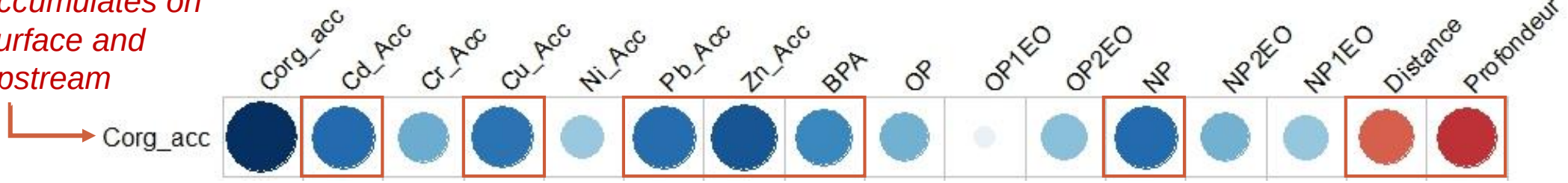
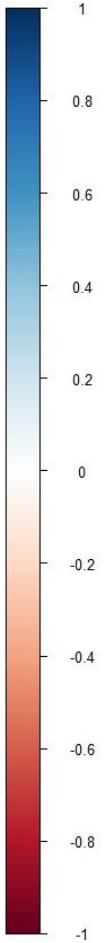
Results & Discussion

Evolution of RBFs: Accumulation of micropollutants after 2 years of operation (T2)

Spatial Evolution: Correlations between accumulated OMPs/TMs and accumulated organic carbon

Proxy of location: accumulates on surface and upstream





p-value < 0,01

Spearman correlation between accumulated TMs/OMPs and accumulated organic carbon between T0 and T2 in the different samples (n = 20)

Correlation: **r between 0.65 and 0.85**

➔ Most micropollutants = associated with particles + low mobility (except Ni and Cr)
➔ **Sedimentation and filtration** ➔ sediment and surface sand upstream

➔ Water supply and micropollutant properties = **Spatial heterogeneity** of accumulation

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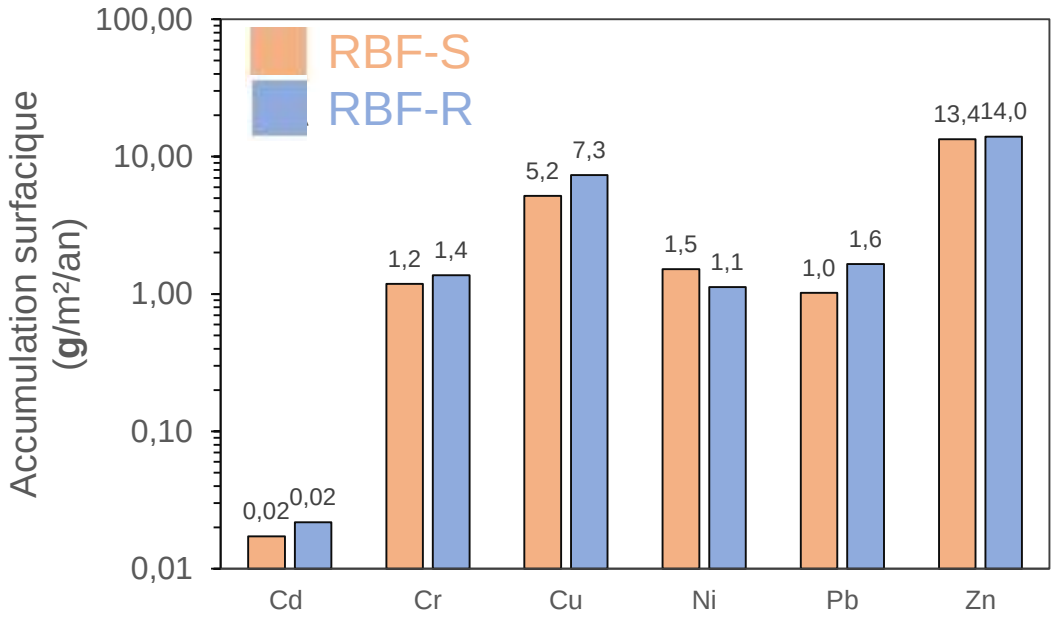
Results & Discussion

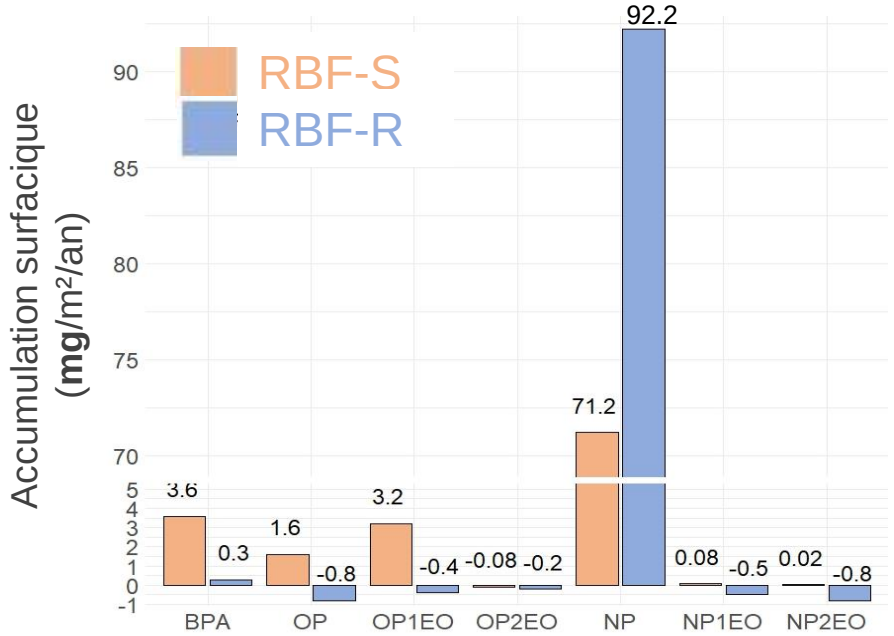
Evolution of RBFs: Annual accumulation at the RBFs level

Accumulation rates between T1 and T2

RBFs comparison: surface ratio



*Surface accumulation (**g/m²/year**) of TMs on the scale of RBFs*



*Surface accumulation (**mg/m²/year**) of OMPs on the scale of RBFs*

TMs accumulation > OMPs (only 4-NP) : similar to runoff water quality *(Flanagan et al., 2018 ; Gasperi et al., 2022)*
+ dissipative processes for OMPs only *(Lefevre et al., 2012)* ➔ *BIODEGRADATION*

TMs : Slight differences in accumulation between the 2 RBFs
RBF-R vs RBF-S : **Limited role of Rc** after 2 years

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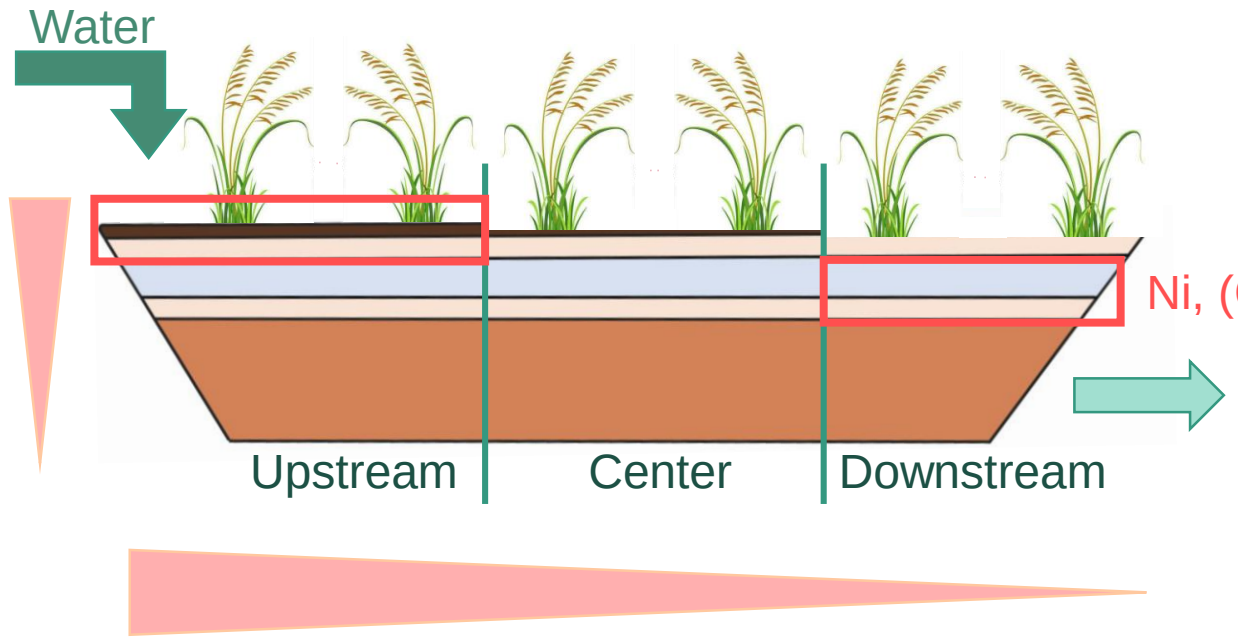
Conclusion

Micropollutant retention processes

Sedimentation and filtration dominate + Adsorption of OMP in sediment

TM (g/m²/y) (Zn dominates) > OMP (mg/m²/y) (4-NP dominates)

Spatial heterogeneity of contamination:
Cd, Cu, (Cr, Ni), Pb, Zn, 4-NP, BPA



Limited role of Rc at RBF level

Water quality required

After 2 years of operation: Sediment only layer considered as polluted
➔ Sand monitoring within 3 to 6 years (upstream)
➔ Plants can be composted (green waste)

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Olympic and paralympic Games

July-September 2024

PARIS 2024

2025 Legacy bathing

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