LIFE17 ENV/FR/000398

Devenir des micropolluants issus du traffic routier dans un filtre planté de roseaux traitant les eaux de ruissellement – Importance des communautés microbiennes

Julia Roux

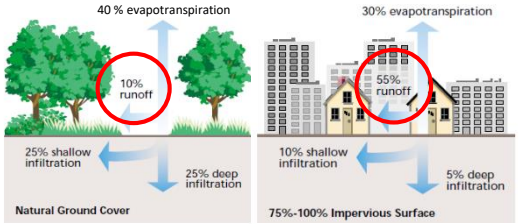
LEESU : Noureddine Bousserrhine, Martin Seidl

Ville de Paris : Pascale Neveu

LEESURIALES – 22 et 23 Juillet 2023

INTRODUCTION

Context



Relationship between impermeable cover and surface runoff - FISRWG, 1998

- Urban zones: **quantity** / **quality** of runoff water (Miller et al. 2014; Gasperi et al. 2010)
  - *Metallic and organic compounds*

INTRODUCTION

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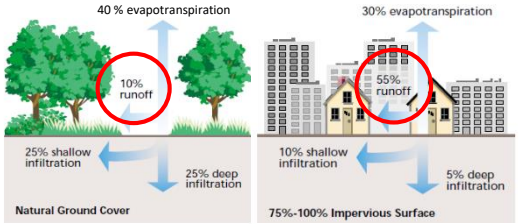

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Infiltration pond (Tedoldi, 2017)

Biofiltration swale (Roux, 2019)

- **Management of runoff (end of 20e c): Sustainable Drainage Systems (SuDS)**
  - ➔ Collect and treat runoff at the source (Fletcher et al. 2015)

Vegetative filter strips	Green roof	Infiltration pond	Biofilter, Bioretention cell	...

INTRODUCTION

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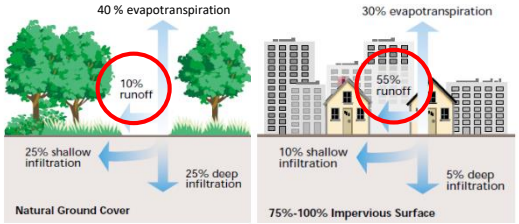

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➔ But also: **Reed Bed Filter** for urban runoff
  - ➔ Recent application

INTRODUCTION

Context: Bibliography

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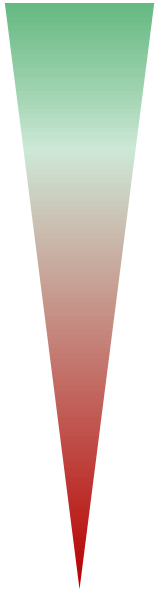

Reed Bed Filter for urban runoff

TSS = Total Suspended Solid / N = Nitrogen / P = Phosphorus

PAH = Polycyclic aromatic hydrocarbons / THC = Total Hydrocarbons / AP = Alkylphenols / PAE = Phthalates / BPA = Bisphenol-A

INTRODUCTION

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Reed Bed Filter for urban runoff

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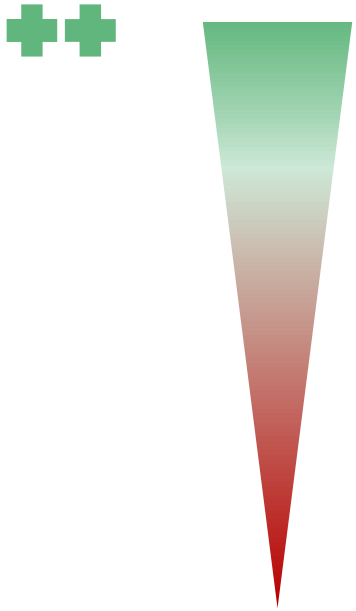

- Water treatment **efficiency** (TSS, N, P, metals, PAH/THC) (Walaszek et al. 2018, Mangangka et al. 2015)
- **Dissolved** pollutants less retained than particulate (LeFevre et al. 2015, Flanagan et al. 2018)

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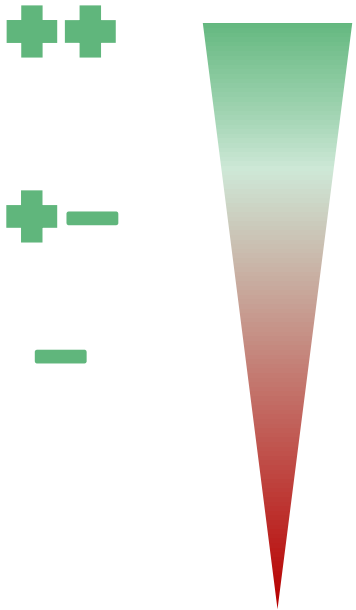

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- Fate of **metallic** micropollutants (MPs) (Dechesne et al. 2004, Gill et al. 2014, Walaszek et al. 2018)
- Process and operation of this filter for **runoff water** (Molle et al. 2013, Branchu et al. 2018)

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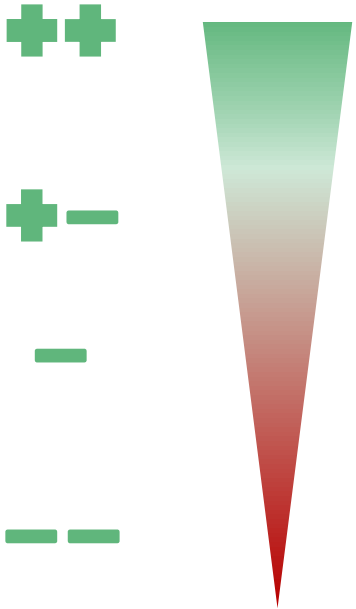

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- Fate of **organic** MP (PAH/THC…) (Zhou et al. 2005, Leroy et al. 2015, Walaszek et al. 2018)

- Fate of **emerging** organic MP (**AP**, **BPA**, PAE)
- Caracterization of **microbial communities** and their **roles** in the filter

➔ **No data** in Reed Bed Filter (few in other types of filtration systems)

TSS = Total Suspended Solid / N = Nitrogen / P = Phosphorus

PAH = Polycyclic aromatic hydrocarbons / THC = Total Hydrocarbons / AP = Alkylphenols / PAE = Phthalates / BPA = Bisphenol-A

INTRODUCTION

Context: European LIFE ADSORB Project

LIFE17 ENV/FR/000398
Life Adsorb

Construction of a **vertical flow reed bed filter** to treat **road** runoff = RBF
Built in 2019-2020

Life Adsorb RBF (2020)

INTRODUCTION

Context: European LIFE ADSORB Project

LIFE17 ENV/FR/000398
Life Adsorb

Construction of a **vertical flow reed bed filter** to treat **road** runoff = **RBF**
Built in 2019-2020

1 **conventional** RBF

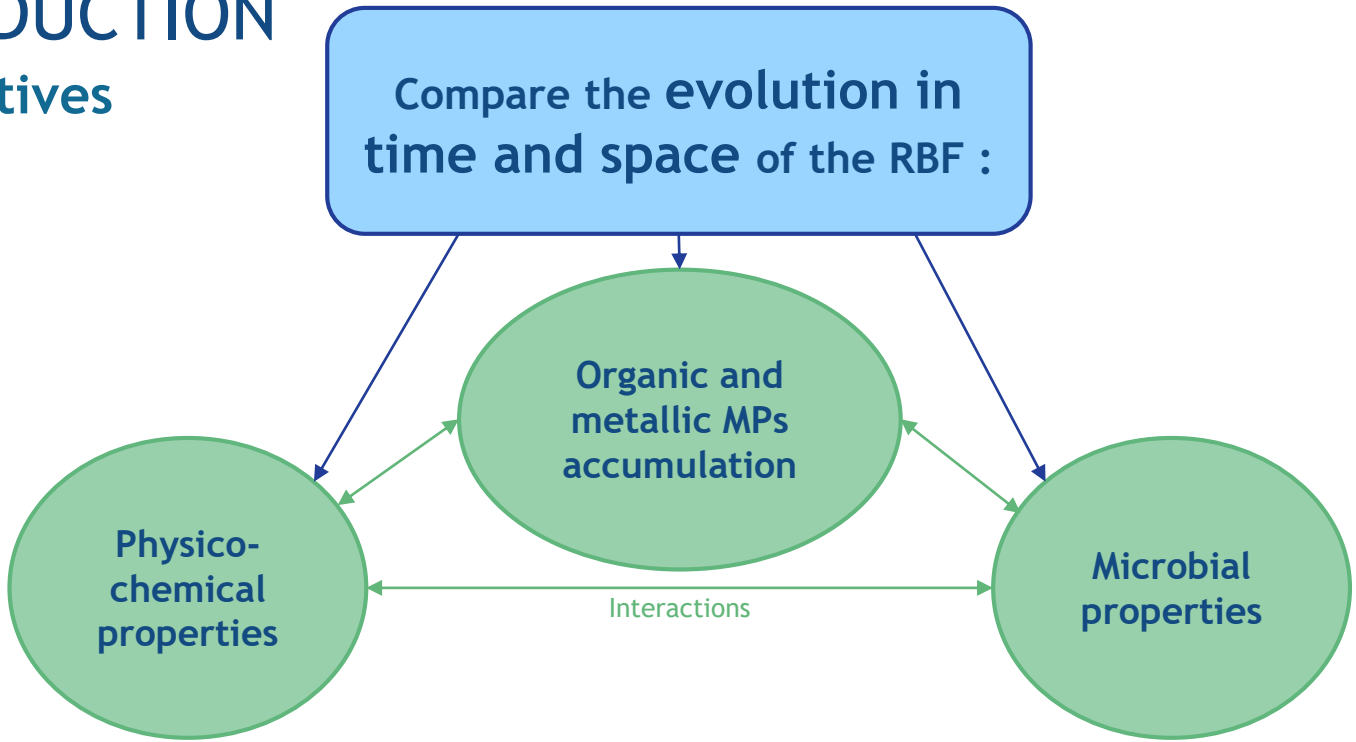
1 **innovative** RBF
→ **Dissolved pollution**

Life Adsorb RBF (2020)

Better uderstand processes involved during filtration
→ Fate of organic and metallic MPs

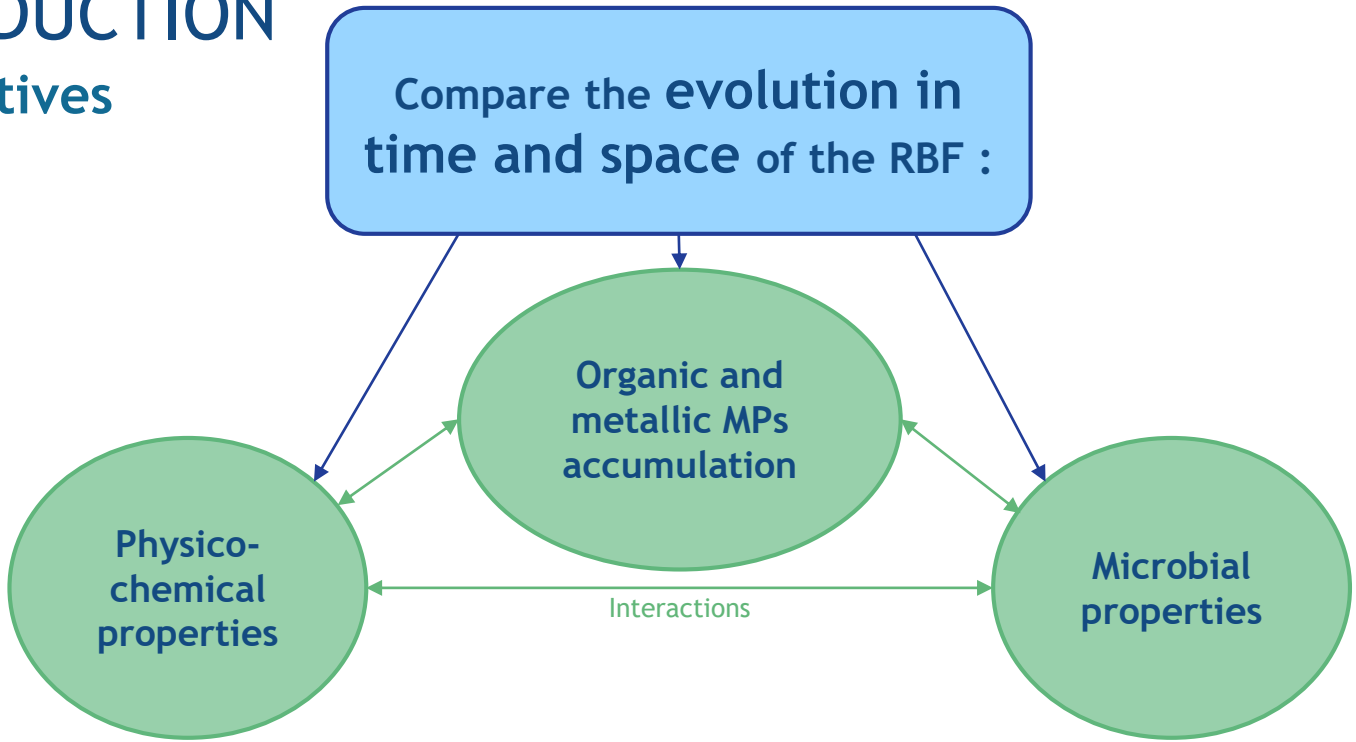
INTRODUCTION

Objectives



INTRODUCTION

Objectives

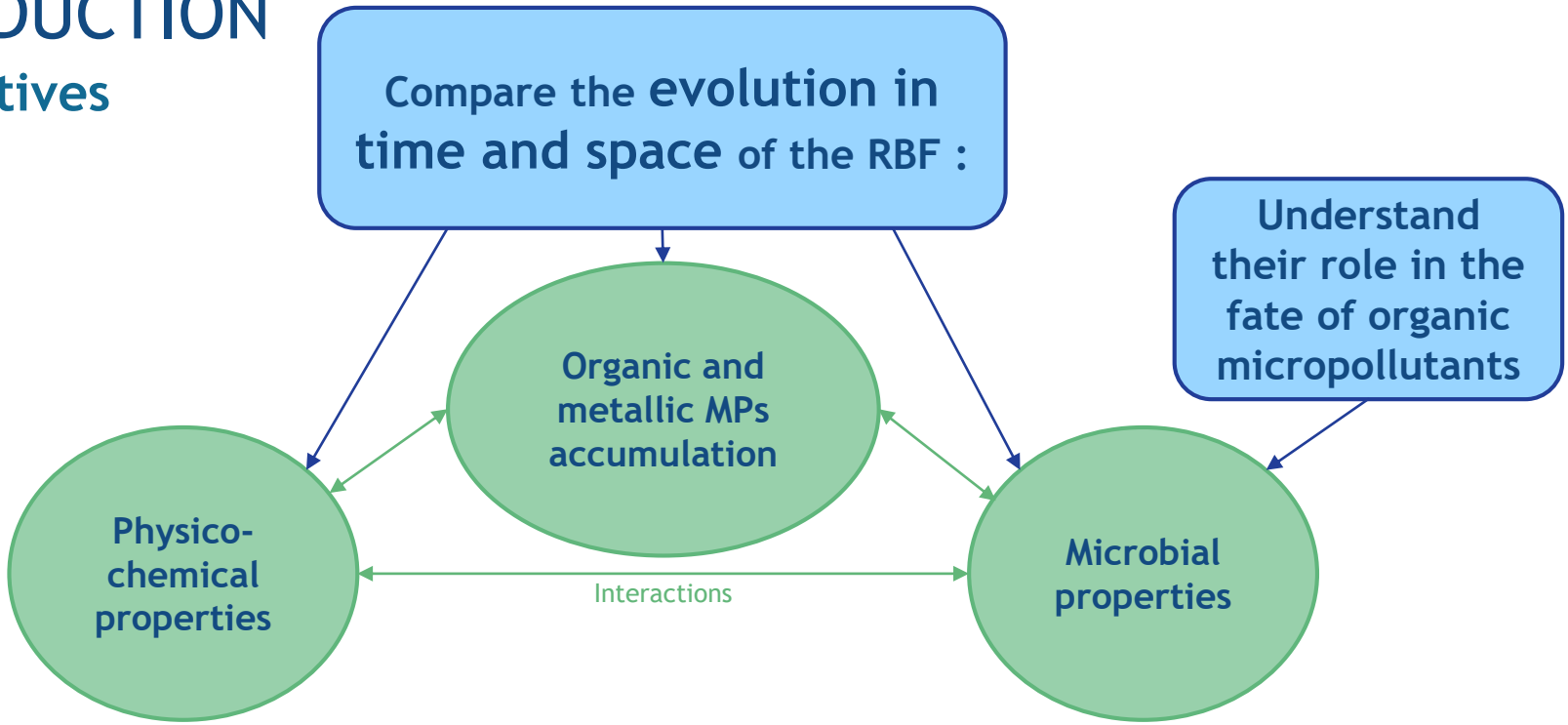


➔ Explain the accumulation of metallic and organic MPs

➔ Differences between the 2 RBF ?

INTRODUCTION

Objectives



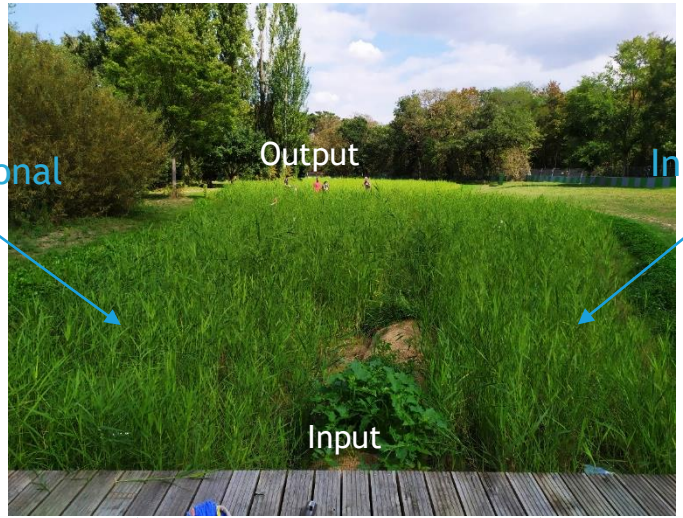
➔ Explain the accumulation of metallic and organic MPs

➔ Differences between the 2 RBF ?

METHODOLOGY

1- The vertical reed bed filter (RBF)

The RBF in September 2020



Runoff water :
Parisian west ring road
(+ groundwater)

In September 2021

In October 2022

- ~600 m² each
- 1 m deep

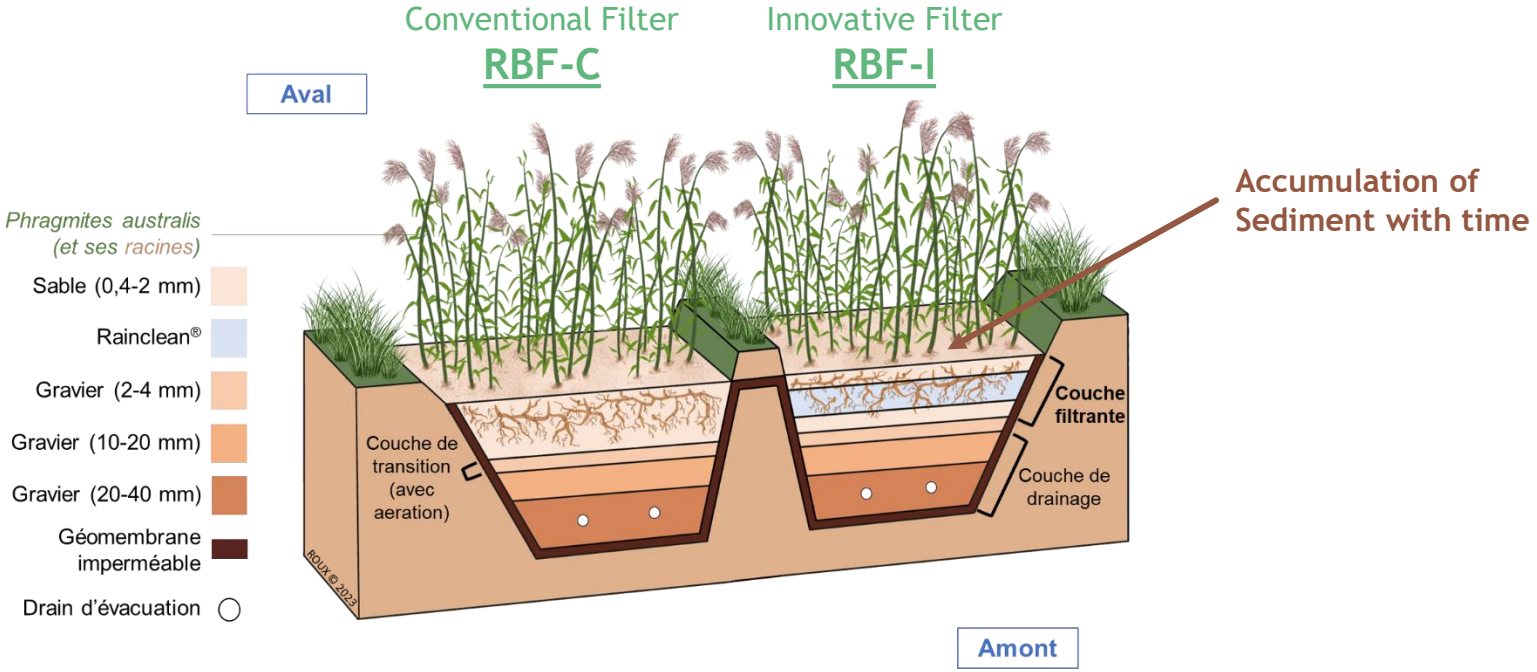
- Fed upstream alternatively
- ➔ Since february 2021

Bois de Boulogne Park
RBF

Localisation of the RBF

METHODOLOGY

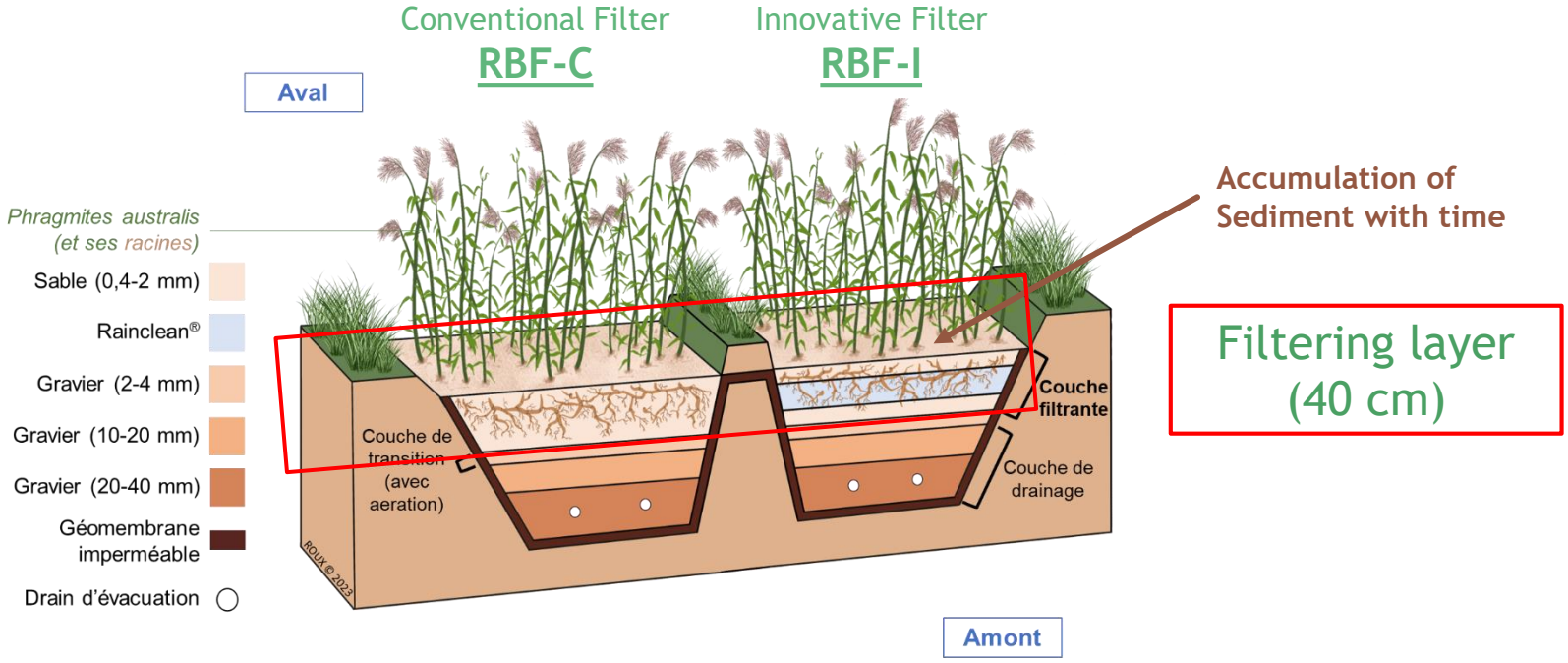
1- The vertical reed bed filter (RBF) : Subdivided in 2 RBF



Vertical profile of the RBF

METHODOLOGY

1- The vertical reed bed filter (RBF) : Subdivided in 2 RBF

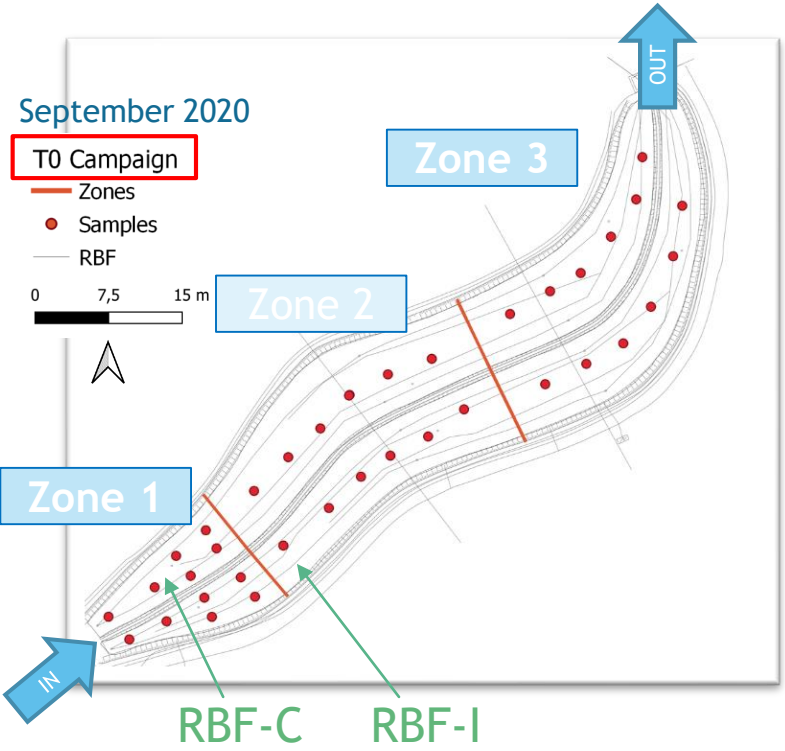


Vertical profile of the RBF

METHODOLOGY

Space and time evolution

2- Substrates Sampling campaigns

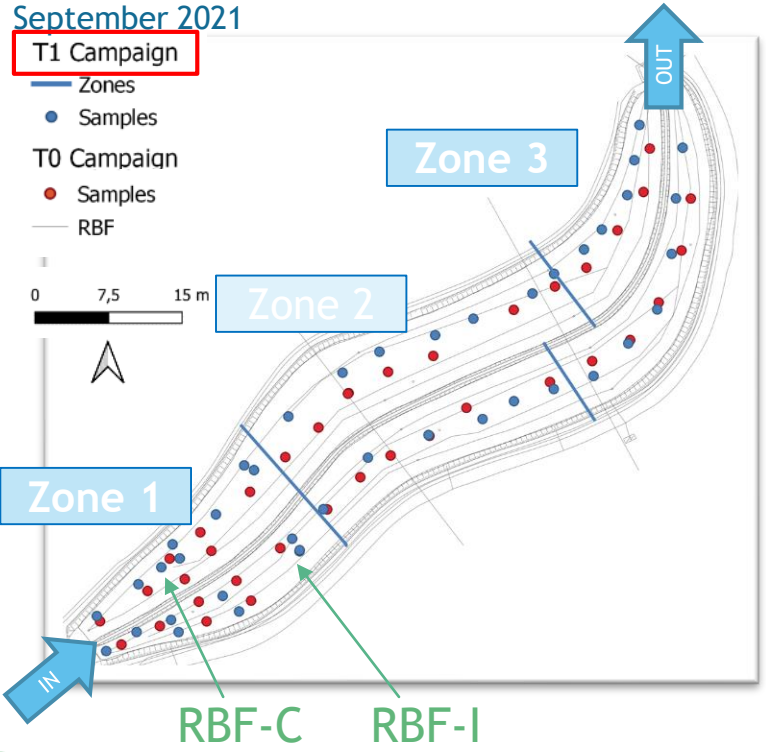


METHODOLOGY

Space and time evolution

2- Sampling campaigns

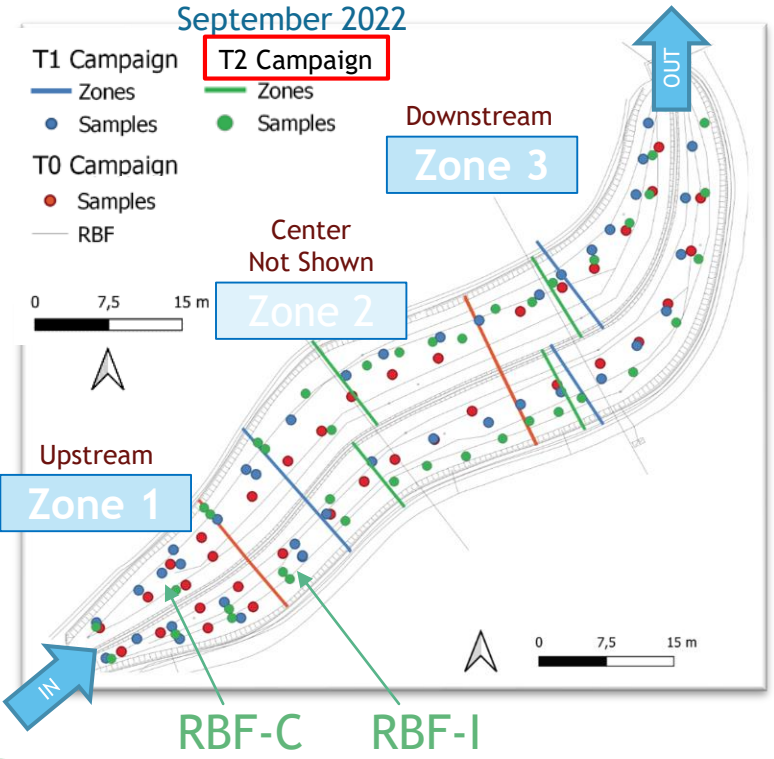
September 2021



METHODOLOGY

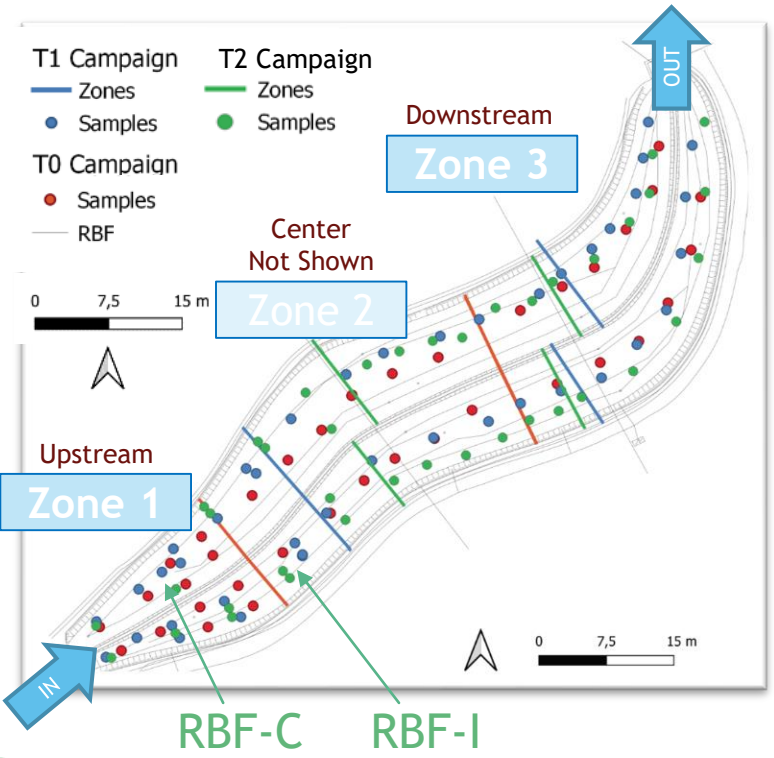
Space and time evolution

2- Sampling campaigns



METHODOLOGY

2- Sampling campaigns



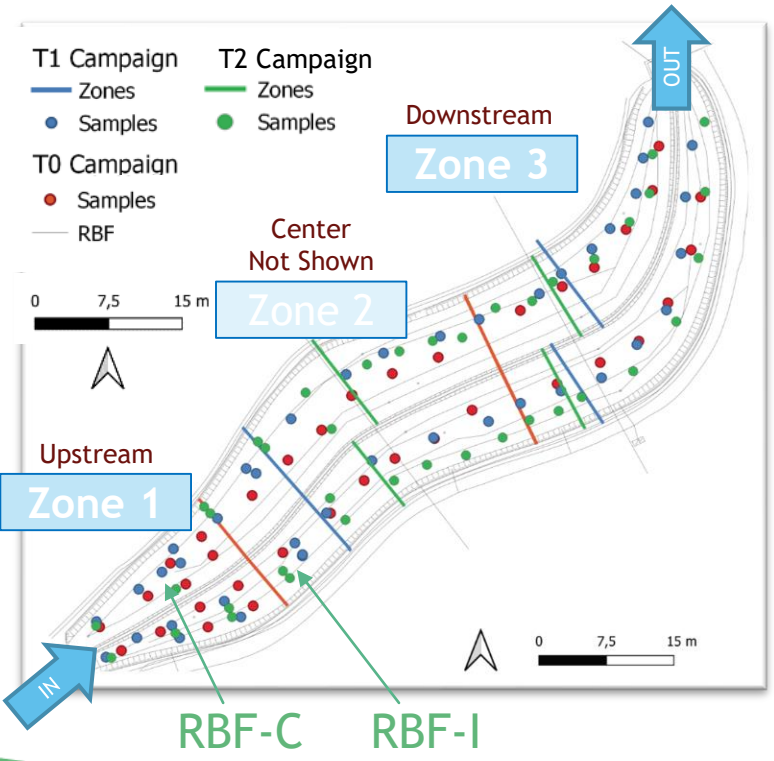
Space and time evolution

= 1 core sample

6 to 8 cores/zone

METHODOLOGY

2- Sampling campaigns



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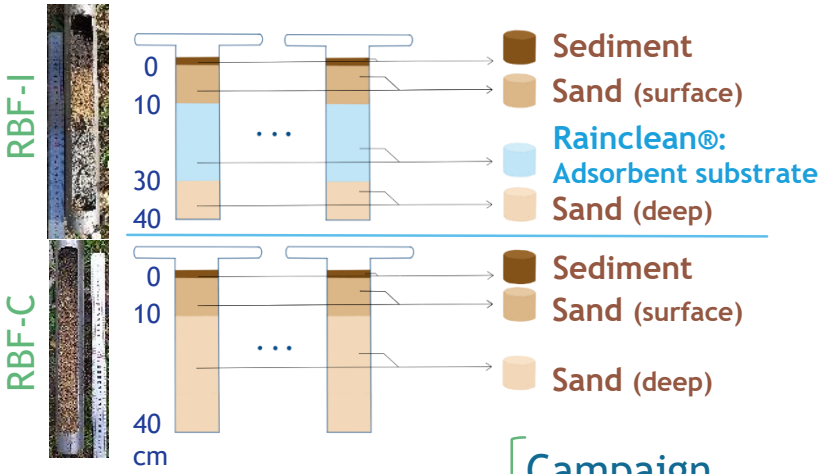


Composite samples for each:

- Campaign
- Filters
- Substrates/Depth
- Localisation

The different substrates

METHODOLOGY

3- Analysis

METHODOLOGY

3- Analysis

Substrates physico-chemistry :

pH, CEC, particule size distribution, TOC, N, CaC03 …

Substrates microbial communities

Abondance of bacteria and fungi (MNP method)

Genetic diversity (Next Generation Sequencing)

Functional diversity (Enzymatic assays and EcoPlates®)

METHODOLOGY

3- Analysis

Substrates physico-chemistry :

pH, CEC, particule size distribution, TOC, N, CaC03 …

Metallic micropollutants (MPs)

Contents of : **Cd, Cr, Cu, Ni, Pb, Zn**
Aqua regia + ICP-AES

+ fine mapping of Metals in sediments

Organic micropollutants (MPs)

Contents of : **Polycyclic Aromatic Hydrocarbons** (PAH), **Total Hydrocarbons** (THC), **Bisphenol-A** (BPA), **Alkylphenols** (AP: OP, NP, …) and **Phthalates** (DEHP, …)
Solvent extraction + GC-MS or UPLC-MS-MS

Substrates microbial communities

Abondance of bacteria and fungi (MNP method)

Genetic diversity (Next Generation Sequencing)

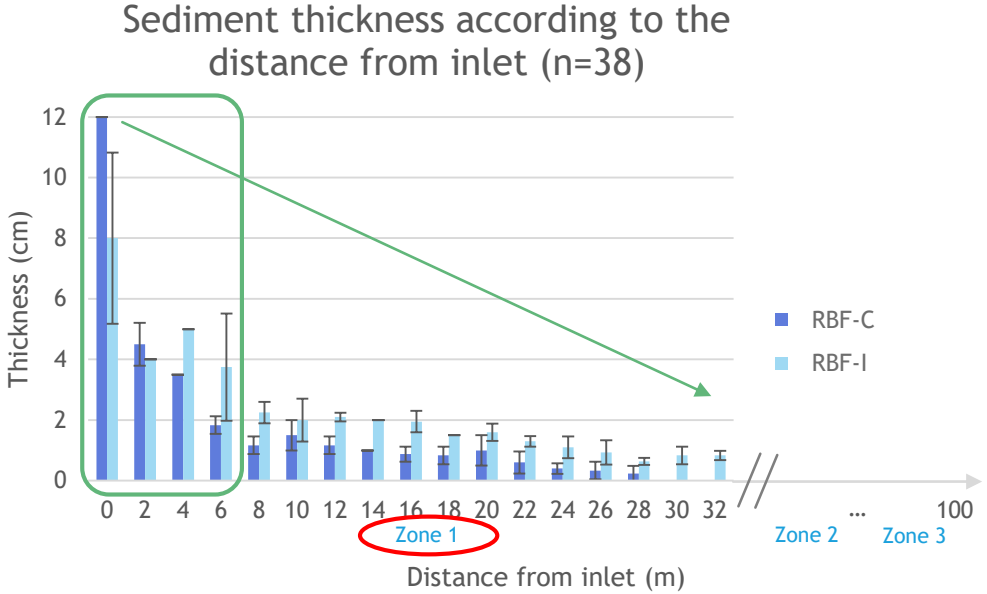
Functional diversity (Enzymatic assays and EcoPlates ®)

RESULTS

RESULTS 1) Sediment distribution

- **Thickness of sediment**

  Zone 1 : Thickness every 2 m (T1 campaign)



Only in zone 1

↘ with distance from inlet

<2cm after 6m from input

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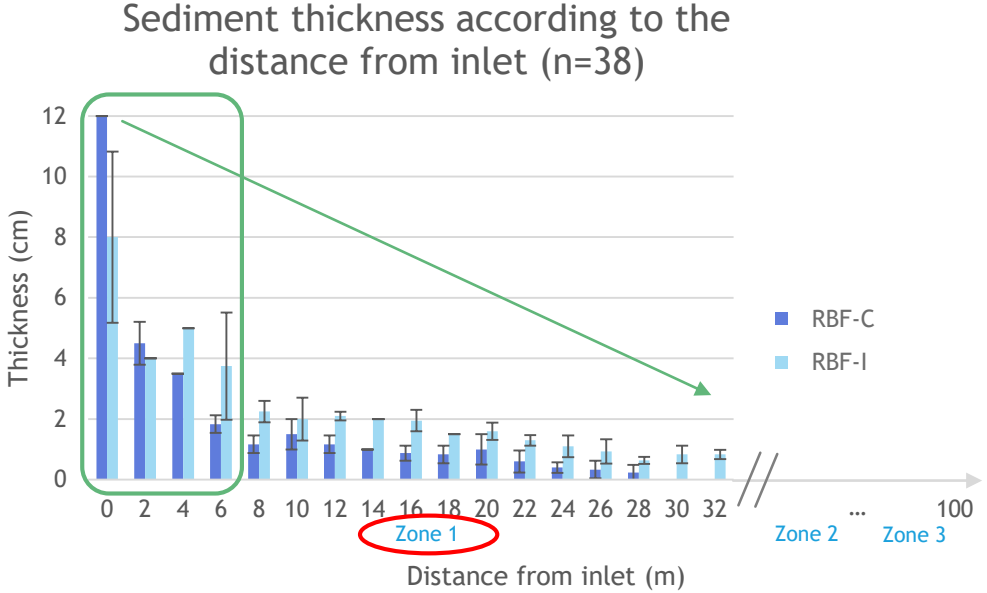
Water inlet



Only in zone 1

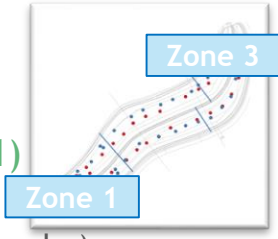
↘ with distance from inlet

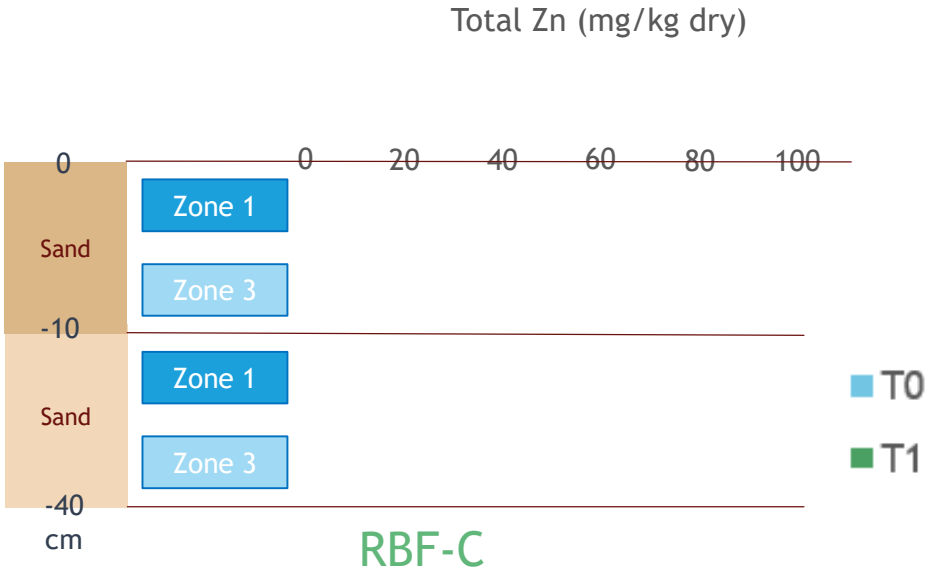
<2cm after 6m from input

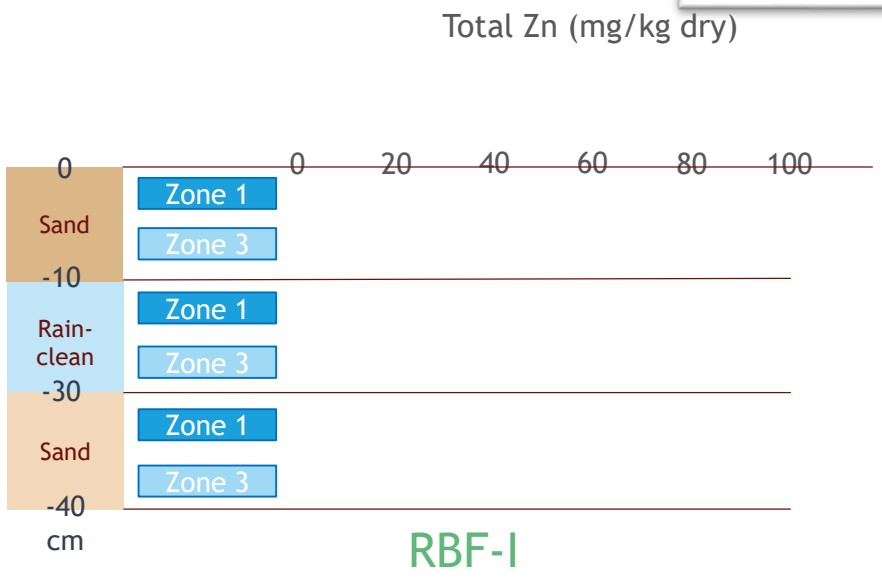
➔ Runoff particulate mater directly filtered in surface by sand

RESULTS 2) Space-time evolution of Metals

- **Vertical profile of Zinc** content in RBF-C and RBF-I between T0/T1 and zone 1/3 (n=1)







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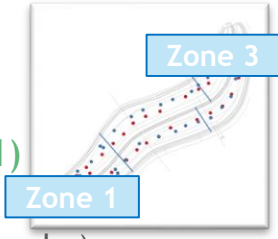
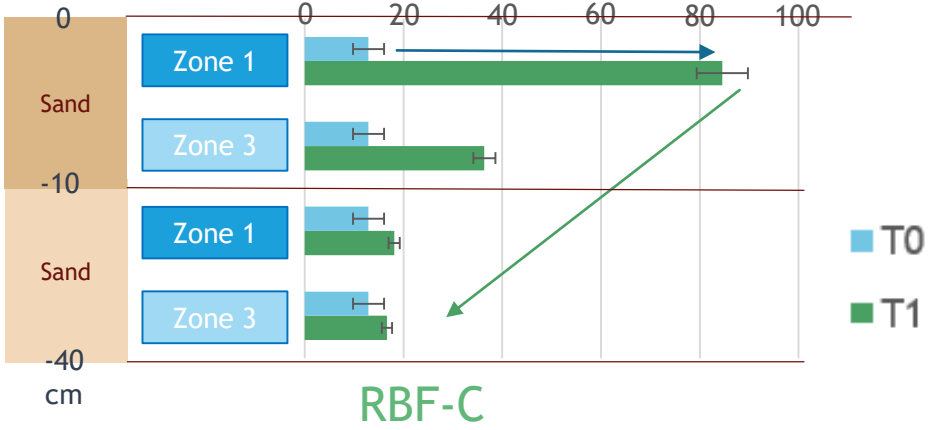


- **Vertical profile of Zinc** content in RBF-C and RBF-I between T0/T1 and zone 1/3 (n=1)

Total Zn (mg/kg dry)



RBF-C

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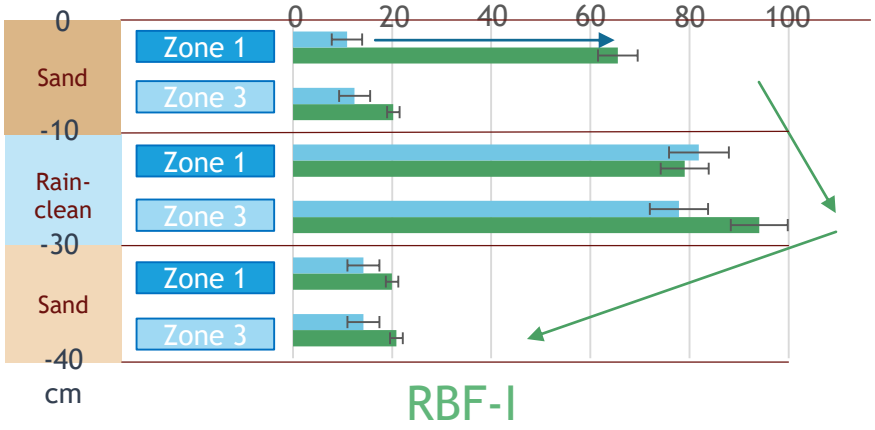


RBF-I

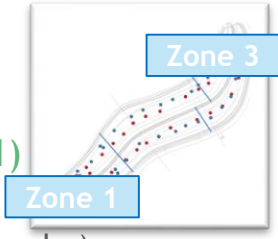
T0 < T1

Horizontal: Contents zone 1 > zone 3

Vertical: Surface content > Deep content

Few increase in Adsorbing substrate

RESULTS 2) Space-time evolution of Metals



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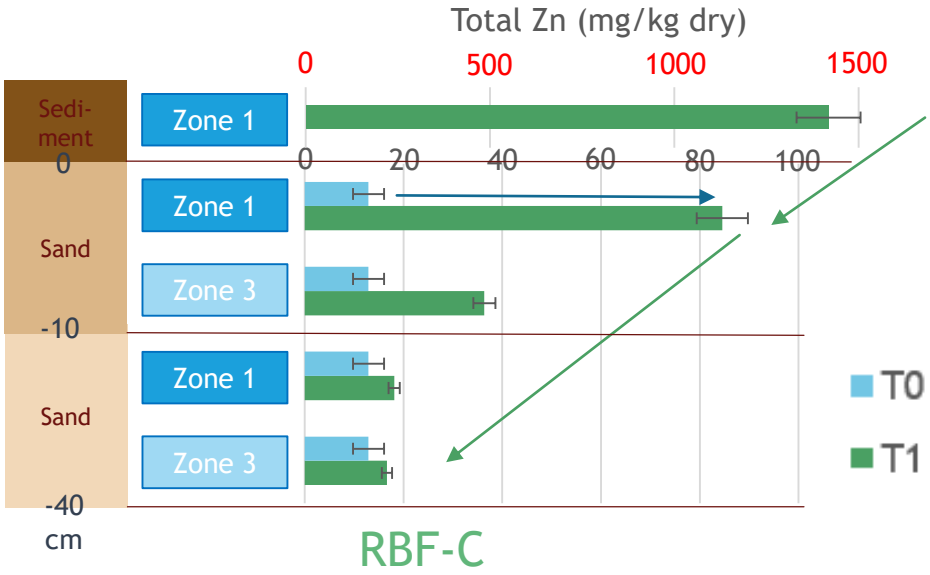
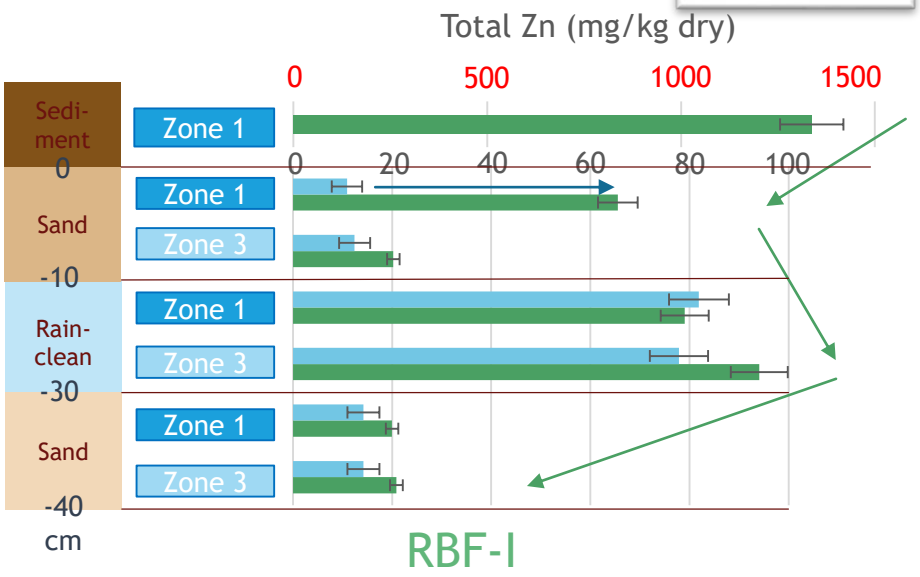




T0 < T1

Horizontal: Contents zone 1 > zone 3

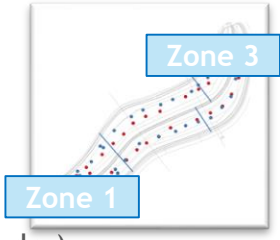
Vertical: Surface content > Deep content

Few increase in Adsorbing substrate

Sediment : majority of metals

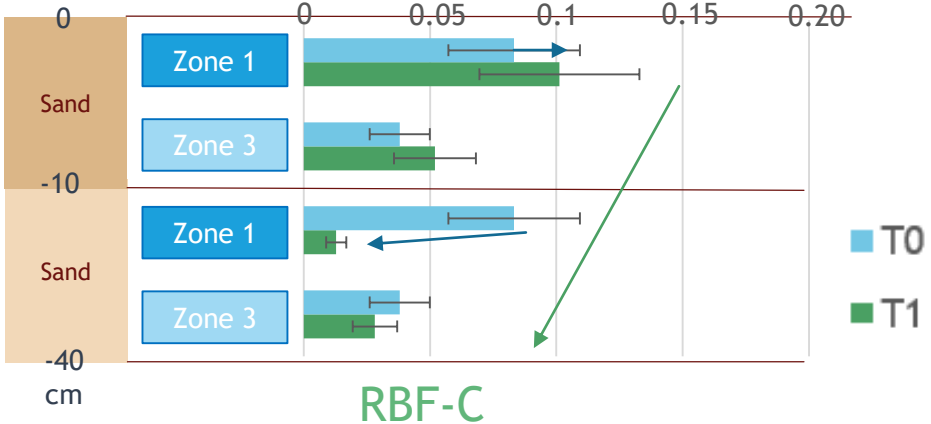
→ 17 to 20 time more than surface sand

RESULTS 3) Space-time evolution of Organic MPs



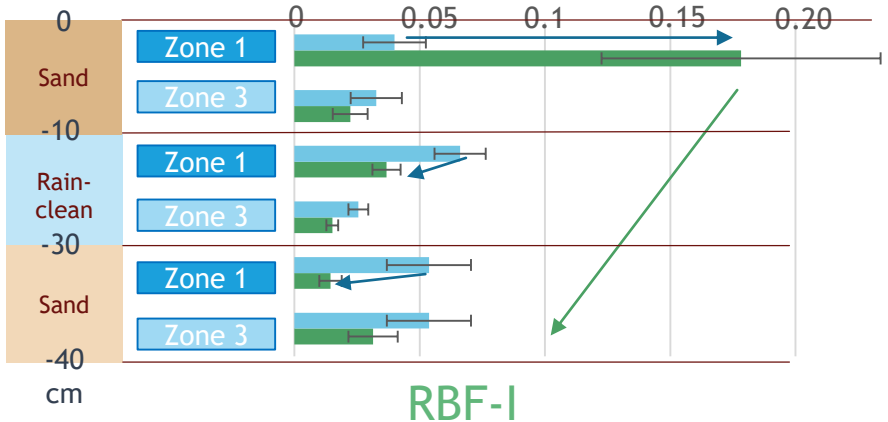
- **Vertical profile of <u>Nonylphenol</u>** content in RBF-C and RBF-I between T0/T1 and zone 1/3 (n=1)

Total NP (mg/kg dry)



RBF-C

Total NP (mg/kg dry)



RBF-I

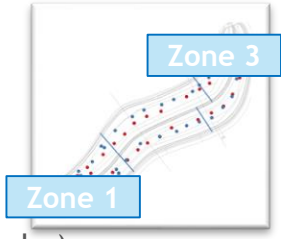
T0 > T1 except for **surface** sand

Less increases than metals

Horizontal: Contents zone 1 > zone 3

Vertical: Surface content > Deep content

RESULTS 3) Space-time evolution of Organic MPs



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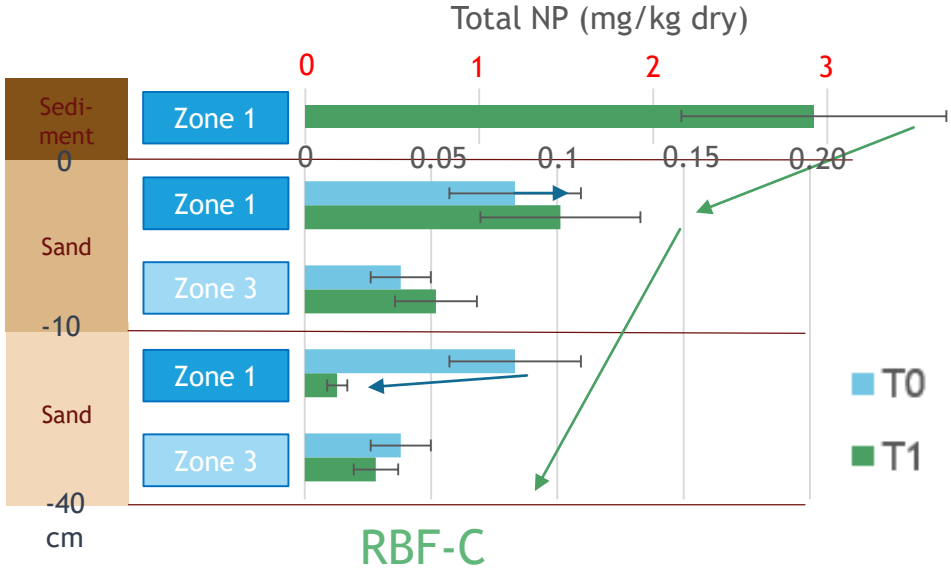
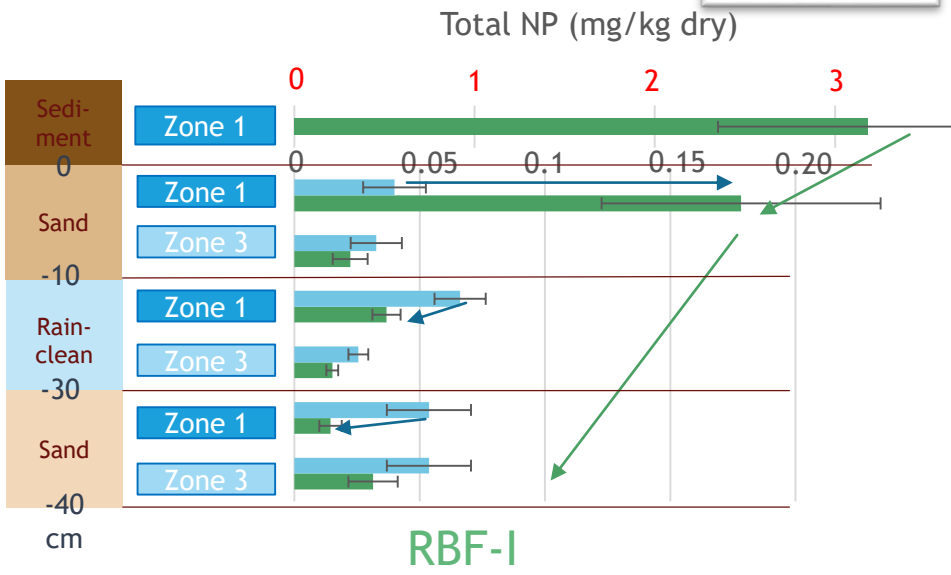


RBF-C



RBF-I

T0 > T1 except for **surface** sand

Less increases than metals

Horizontal: Contents zone 1 > zone 3

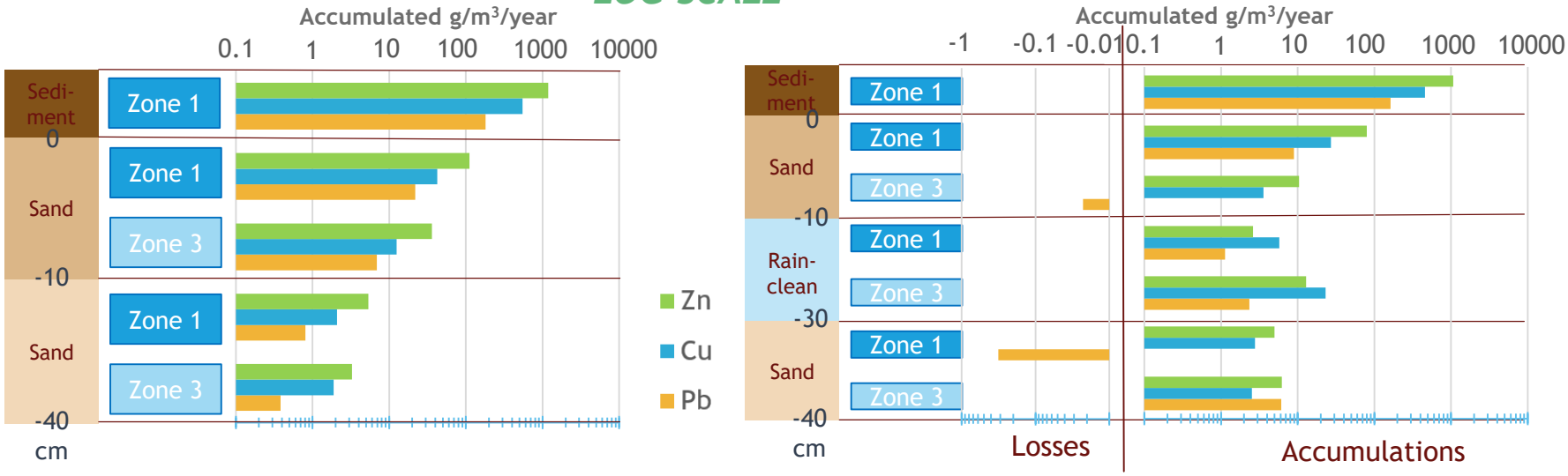
Vertical: Surface content > Deep content

Sediment : majority of Organic MPs

→ 18 to 28 time more than surface sand

RESULTS 4) Accumulation of Organic and Metallic MPs

- **Metals accumulation (g/m³/year)** in RBF-C and RBF-I between T0/T1 and Zone 1/3 - *LOG SCALE*



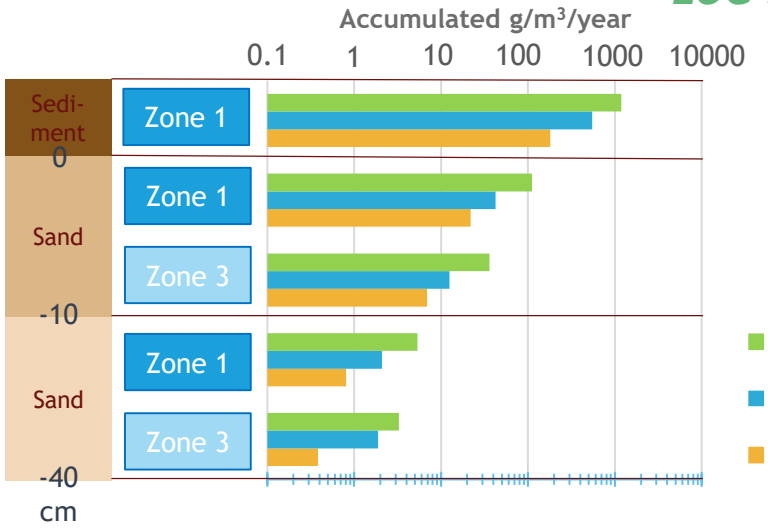
RBF-C

RBF-I

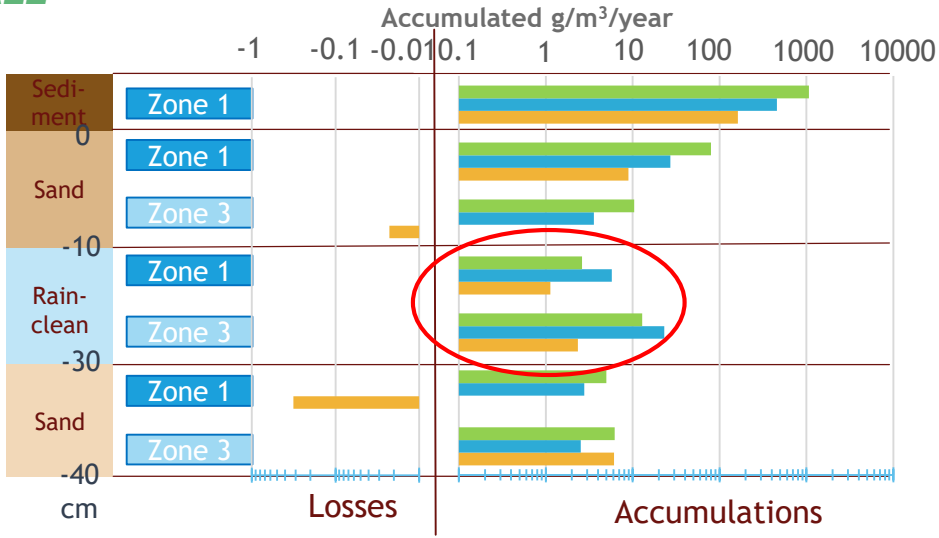
Mass/volume (g/m³) = Content (mg/kg) * volumic mass (kg/m³) ; **Accumulated mass (g/m3/y)** = Mass T1 (g/m³) - Mass T0
Total accumulated mass/surface (g/m²) = Σ accumulated masses (g) / total surface of filter (m²)

RESULTS 4) Accumulation of Organic and Metallic MPs

- **Metals accumulation (g/m³/year)** in RBF-C and RBF-I between T0/T1 and Zone 1/3 - *LOG SCALE*



RBF-C

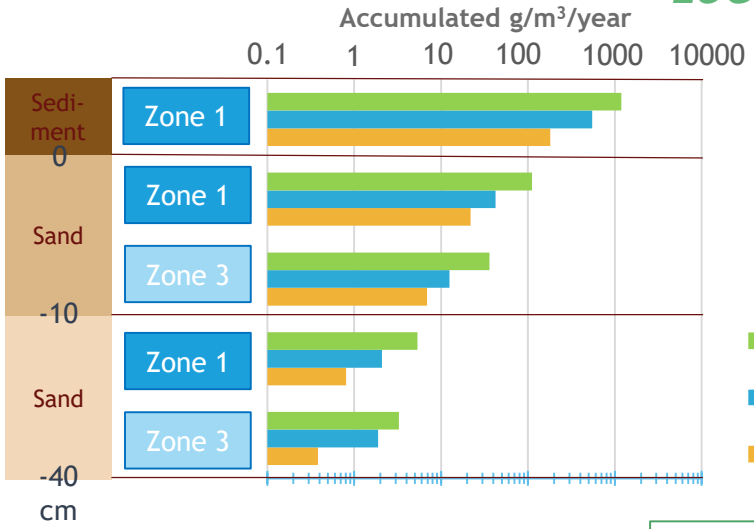


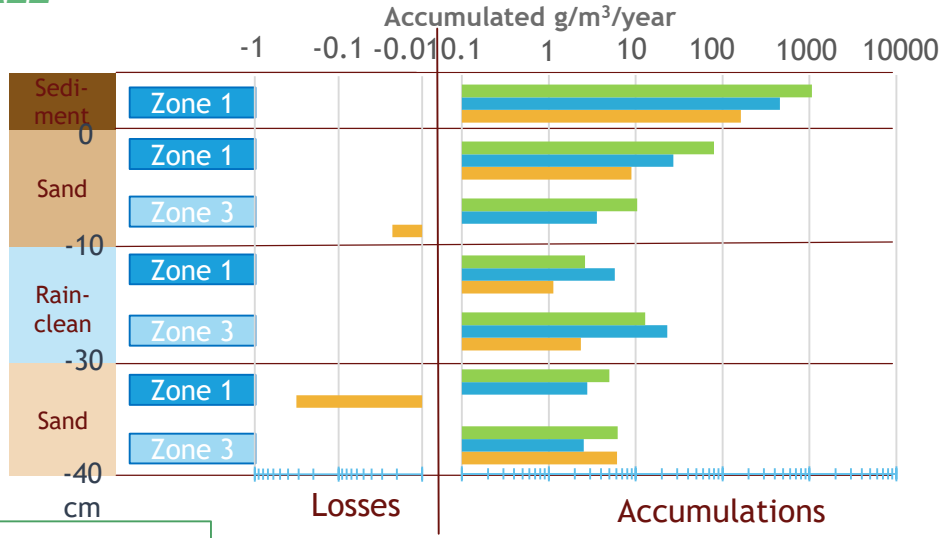
RBF-I

Mass/volume (g/m³) = Content (mg/kg) * volumic mass (kg/m³) ; **Accumulated mass (g/m3/y)** = Mass T1 (g/m³) - Mass T0
Total accumulated mass/surface (g/m²) = Σ accumulated masses (g) / total surface of filter (m²)

RESULTS 4) Accumulation of Organic and Metallic MPs

- **Metals accumulation (g/m³/year)** in RBF-C and RBF-I between T0/T1 and Zone 1/3 - *LOG SCALE*





RBF-C ➡ Cu: 2,02 g/m²/y
Pb: 0,67 g/m²/y
Zn : 4,94 g/m²/y

Sediment :
1% volume
35-45% contribution

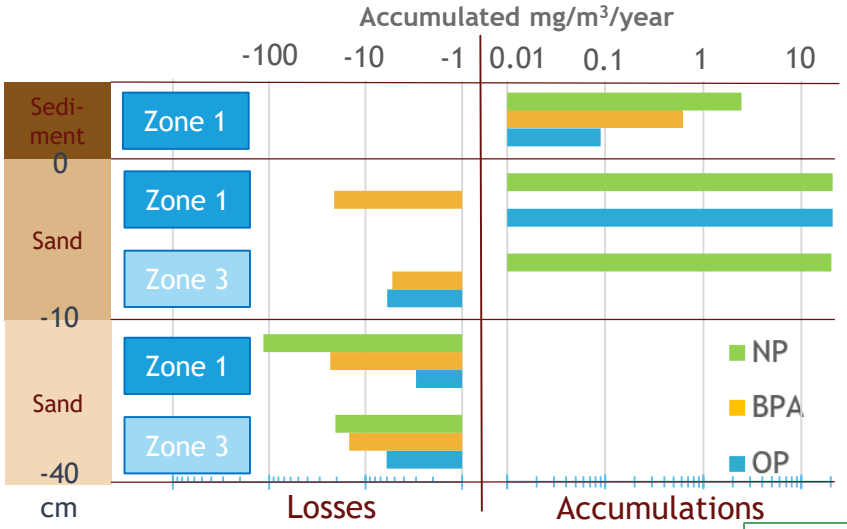
RBF-C > RBF-I

RBF-I ➡ Cu: 1,74 g/m²/y
Pb: 0,57 g/m²/y
Zn : 3,21 g/m²/y

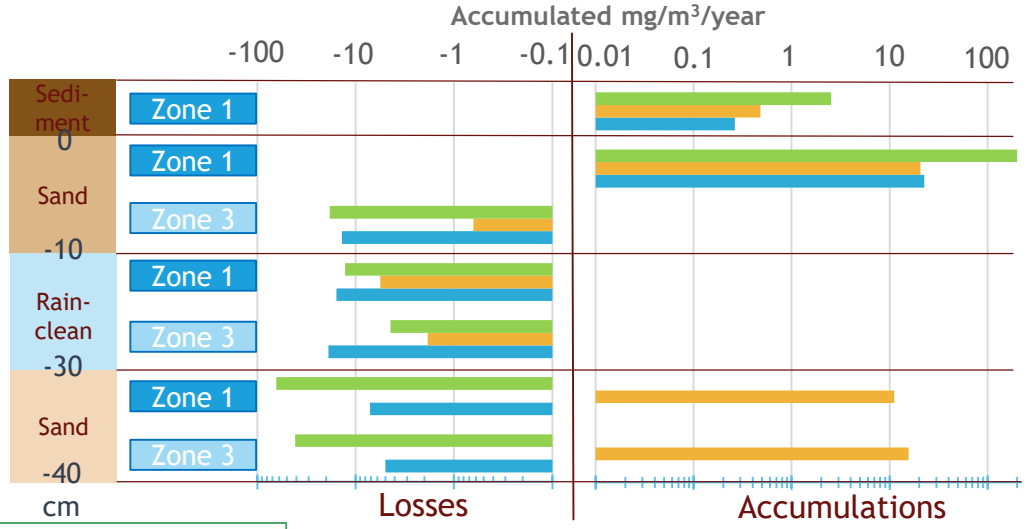
Mass/volume (g/m³) = Content (mg/kg) * volumic mass (kg/m³) ; **Accumulated mass (g/m3/y)** = Mass T1 (g/m³) - Mass T0
Total accumulated mass/surface (g/m²) = Σ accumulated masses (g) / total surface of filter (m²)

RESULTS 4) Accumulation of Organic and Metallic MPs

- **Emerging Organic MPs accumulation (mg/m3/year)** in RBF-C and RBF-I between T0/T1 and Zone 1/3 - ***LOG SCALE***



RBF-C



RBF-I

Surface sand and Sediment = accumulation

BPA = Bisphenol A ; NP = Nonylphenol ; OP = Octylphenol

RESULTS 4) Accumulation of Organic and Metallic MPs

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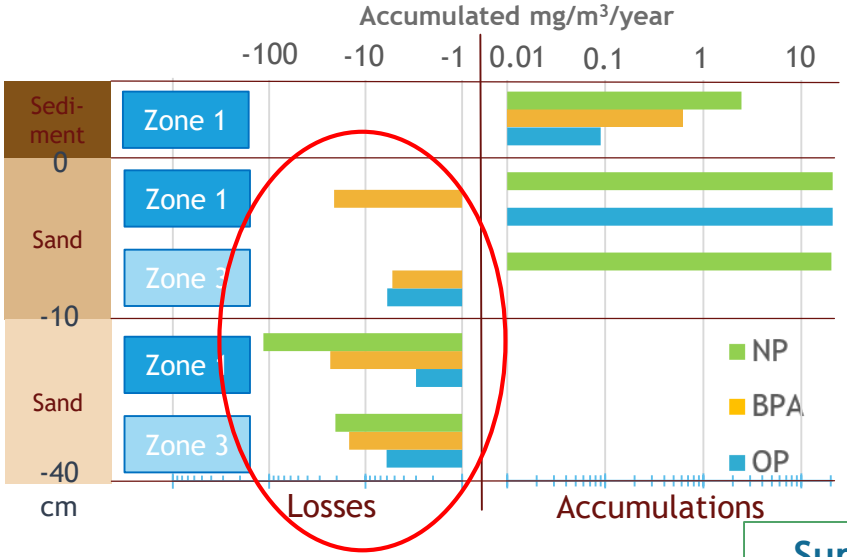
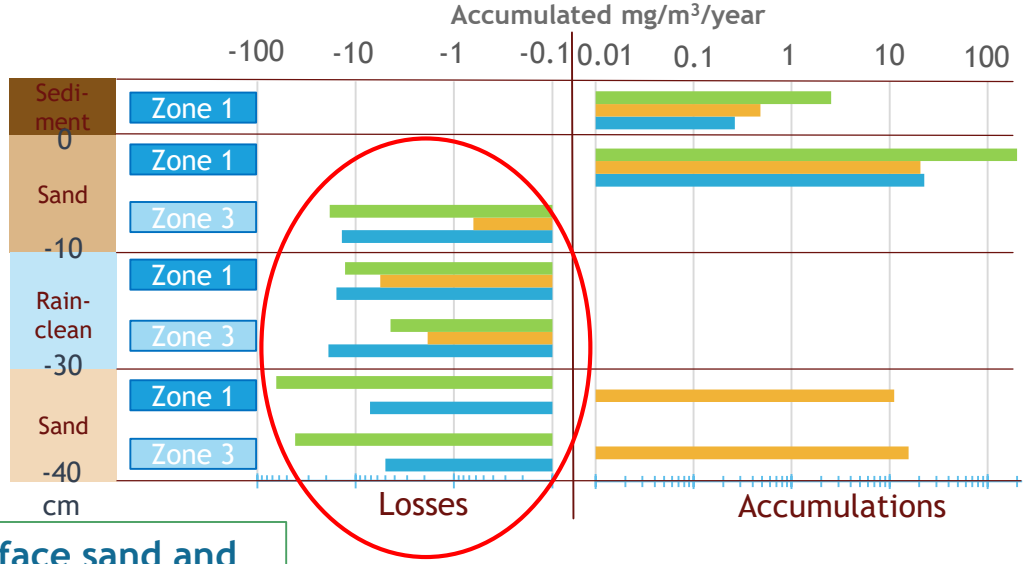


RBF-C



RBF-I

Surface sand and Sediment = accumulation

Biodegradation ?

BPA = Bisphenol A ; NP = Nonylphenol ; OP = Octylphenol

RESULTS 4) Accumulation of Organic and Metallic MPs

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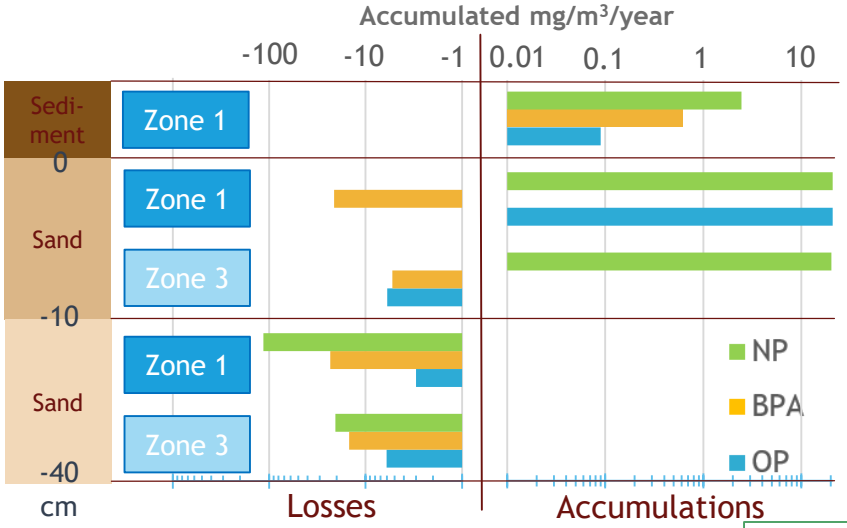
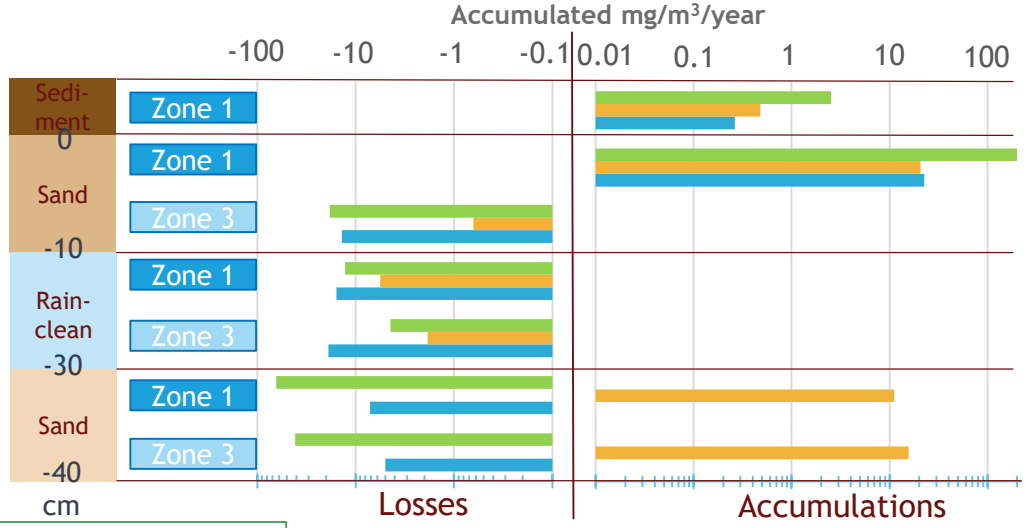




RBF-C ➡ BPA: -2,51 **mg**/m²/y
NP: -2,49 **mg**/m²/y
OP : -1,34 **mg**/m²/y

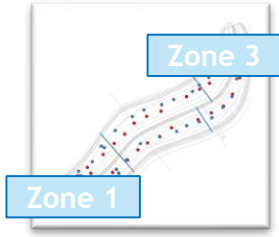
Surface sand and Sediment = accumulation

RBF-C < RBF-I

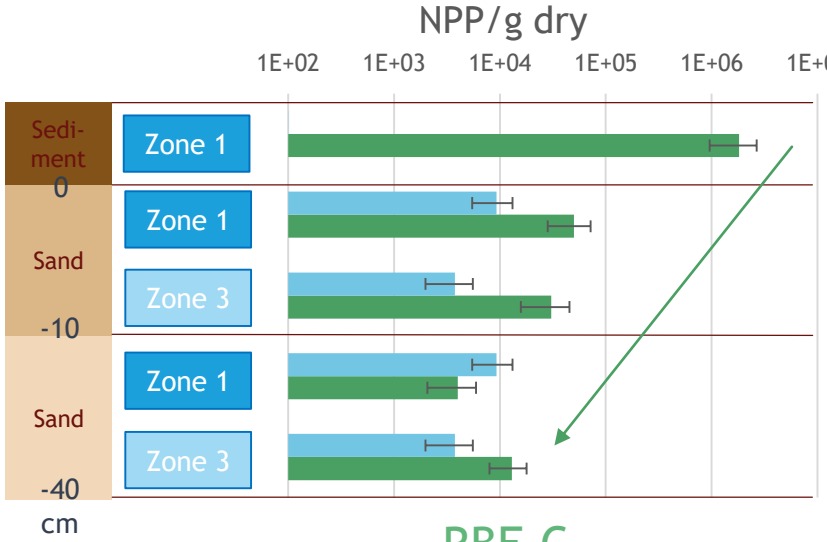
RBF-I ➡ BPA: 1,11 **mg**/m²/y
NP: 2,95 **mg**/m²/y
OP : -2,4 **mg**/m²/y

BPA = Bisphenol A ; NP = Nonylphenol ; OP = Octylphenol

RESULTS 5) Microbial communities



- **Abundance:** Evolution of **bacterial biomass** (NPP/g dry) between T0/T1 and Zone 1/3 (n=3) - ***LOG SCALE***

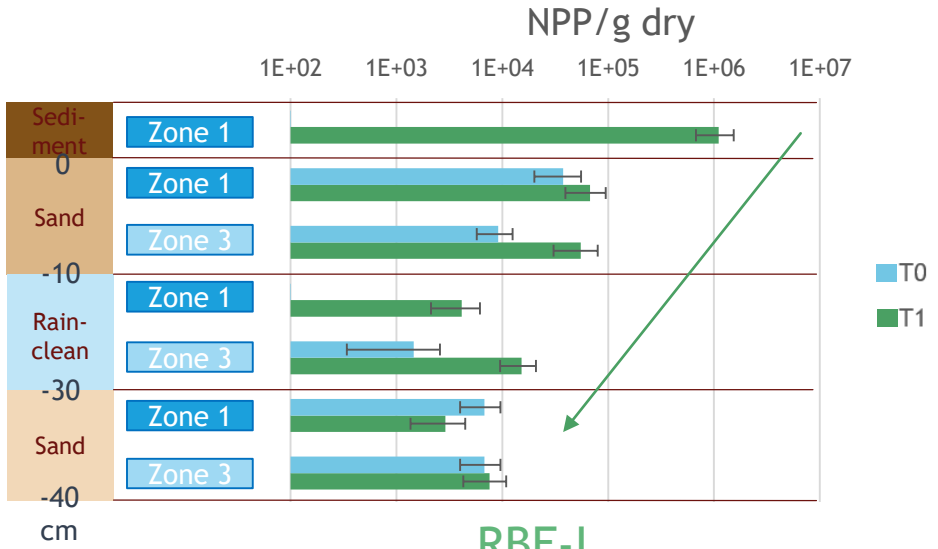


RBF-C

T0 < T1 → Colonization

Horizontal: zone 1 > zone 3

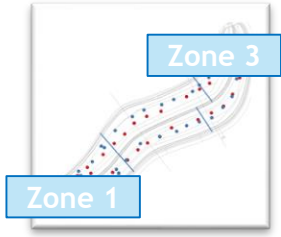
Vertical: Surface content > Deep content



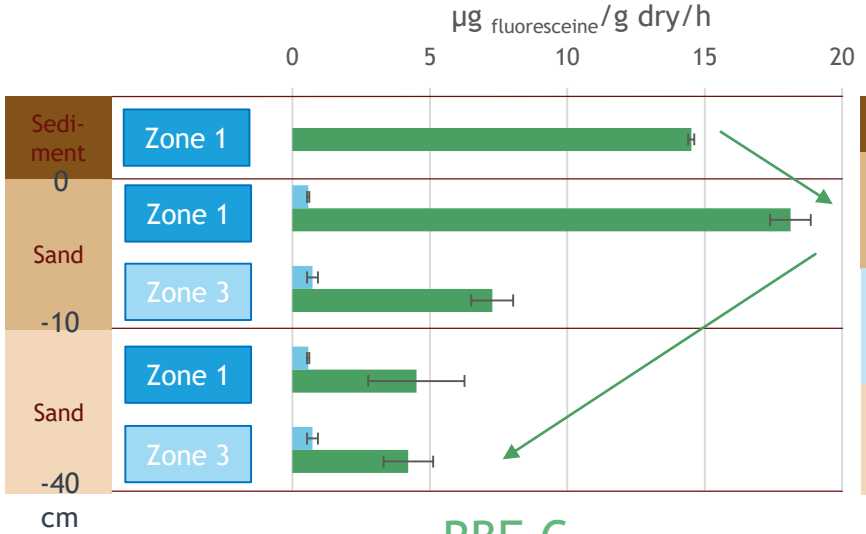
RBF-I

Sediment : most organic substrate
→ Higher abundance

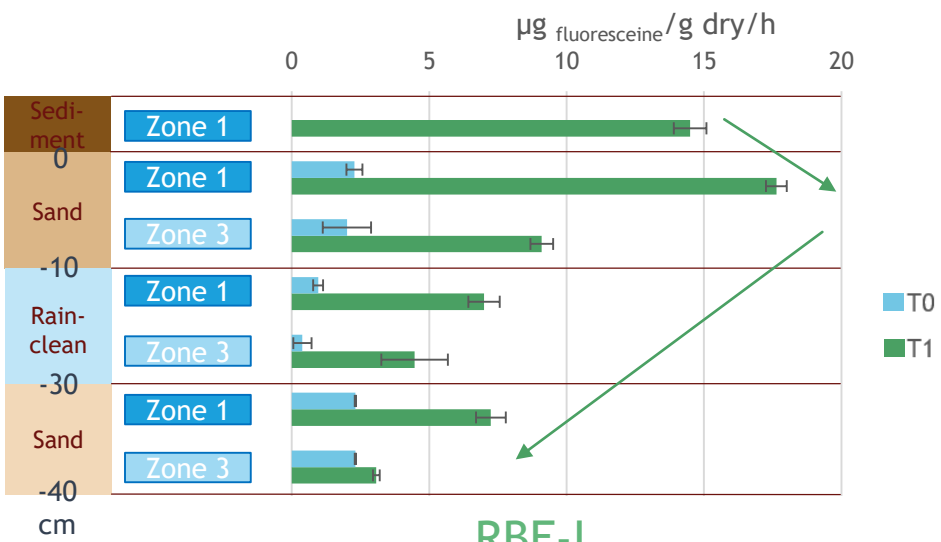
RESULTS 5) Microbial communities



- **Function:** Evolution of **global enzymatic activity (GEA)** between T0/T1 and Zone 1/3 (n=3)



RBF-C



RBF-I

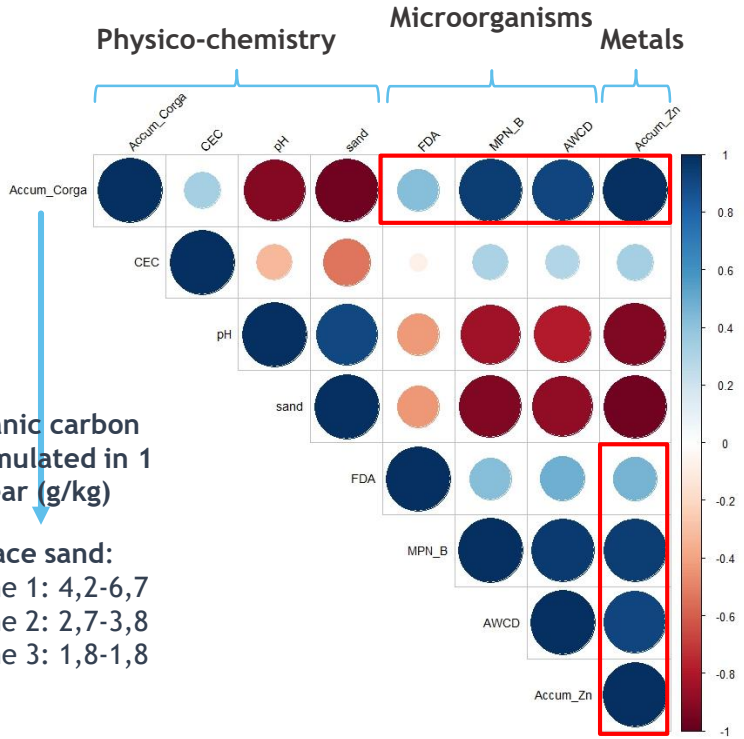
T0 << T1 → High increase of activity

Horizontal: zone 1 > zone 3

Vertical: Surface content > sediment > Rainclean and deep sand

RESULTS 6) Correlation between parameters

- **Pearson matrix correlation : T1 campaign**



Organic carbon accumulated in 1 year (g/kg)

Surface sand:
- Zone 1: 4,2-6,7
- Zone 2: 2,7-3,8
- Zone 3: 1,8-1,8

➔ **Water supply** significantly and positively **promotes** microbial development and micropollutant accumulation

More water filtered
↓
More **organic carbon** retained
↓
More microbial development

CONCLUSION AND PERPECTIVES

Metallic and Organic MPs

Accumulation: ➔ **zone 1**
➔ **surface: sediment** + sand

Metals: accumulation but few losses = **Leaching ?**

Organic MPs: losses exept in surface/zone 1 = **Biodegradation ?**

↳ **Microbial communities :** progressive colonization and spatial heterogeneity ➔ Which role ?

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Filter Substrates

Sediment: low volume/High contamination and microbial activity

Rainclean: retention capacities not (yet) demonstrated

CONCLUSION AND PERPECTIVES

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Accumulation

RBF-C > RBF-I for Metals ; opposite for Organic MPs ➔ Water data needed

CONCLUSION AND PERPECTIVES

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➔ surface: sediment + sand

Metals: accumulation but few losses = **Leachi**

Organic MPs: losses exept in surface/zon

Microbial communities : pro
heterogeneity ➔ Which rôle ?

Laboratory experiments : **biodegradation kinetics + genetic diversity**

Filter Substrates

Sediment: low volume/High contamination a

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Accumulation

RBF-C > RBF-I for Metals ; opposite for Organic MPs ➔ Water data needed

CONCLUSION AND PERPECTIVES

Metallic and Organic MPs

Accumulation: ➔ zone 1
➔ surface: sediment + sand

Metals: accumulation but few

Organic MPs: losses

Microbial
heterogen

tial

➔ Input/output water analysis + contents in reeds : **global mass balance**

➔ **T2 campaign**

Filter Substrates

Sediment: low

Rainclean: retention

Accumulation

RBF-C > RBF-I for Metals ; opposite for Organic MPs ➔ Water data needed


Thank you for your attention !

BIBLIOGRAPHY

Boesten, J. J. T. I, K Aden, C Beigel, M Dust, J. S Dyson, et G Soulas. 2014. « Guidance document on estimating persistence and degradation kinetics from environmental fate studies on pesticides in EU registration. Report of the FOCUS Work Group on Degradation Kinetics, EC Doc. »

Branchu, P., Quiniou, G., Foucart, T. (2018) Suivi hydraulique et qualitatif du filtre planté de Leuville sur Orge

Dechesne, M., Barraud, S., & Bardin, J. P. (2004). Spatial distribution of pollution in an urban stormwater infiltration basin. *Journal of contaminant hydrology*, *72*(1-4), 189-205.

Flanagan, K., Branchu, P., Boudahmane, L., Caupos, E., Demare, D., Deshayes, S., ... & Gromaire, M. C. (2018). Field performance of two biofiltration systems treating micropollutants from road runoff. *Water Research*, *145*, 562-578.

Fletcher, Tim D., William Shuster, William F. Hunt, Richard Ashley, David Butler, Scott Arthur, Sam Trowsdale, et al. 2015. « SUDS, LID, BMPs, WSUD and More – The Evolution and Application of Terminology Surrounding Urban Drainage ». Urban Water Journal 12 (7): 525 42.

Gasperi, J, S Garnaud, V Rocher, et R Moilleron. (2010). Polluants prioritaires dans les rejets urbains de temps de pluie : cas de la ville de Paris. Paris, France. https://hal.archives-ouvertes.fr/hal-01115309.

Gasperi, J, Le Roux, J, Deshayes, S, Ayrault, S, Bordier, L, Boudahmane, L, Budzinski, H, et al. 2022. « Micropollutants in Urban Runoff from Traffic Areas: Target and Non-Target Screening on Four Contrasted Sites ». Water 14 (3): 394.

Gill, L. W., Ring, P., Higgins, N. M., & Johnston, P. M. (2014). Accumulation of heavy metals in a constructed wetland treating road runoff. *Ecological engineering*, *70*, 133-139.

LeFevre, G. H., Paus, K. H., Natarajan, P., Gulliver, J. S., Novak, P. J., & Hozalski, R. M. (2015). Review of dissolved pollutants in urban storm water and their removal and fate in bioretention cells. *Journal of Environmental Engineering*, *141*(1), 04014050.

Leroy, M. C., Legras, M., Marcotte, S., Moncond'Huy, V., Machour, N., Le Derf, F., & Portet-Koltalo, F. (2015). Assessment of PAH dissipation processes in large-scale outdoor mesocosms simulating vegetated road-side swales. *Science of the Total Environment*, *520*, 146-153.

Mangangka, I. R., Liu, A., Egodawatta, P., & Goonetilleke, A. (2015). Sectional analysis of stormwater treatment performance of a constructed wetland. *Ecological Engineering*, *77*, 172-179.

Miller, J, H Kim, T Kjeldsen, J Packman, S Grebby, et R Dearden. (2014). Assessing the impact of urbanization on storm runoff in a peri-urban catchment using historical change in impervious cover. *Journal of Hydrology* 515 (juillet): 59-70. https://doi.org/10.1016/j.jhydrol.2014.04.011.

Molle, P., Fournel, J., Meyer, D., Troesch, S., Clement, F., Brelot, E., ... & Esser, D. (2013). Système extensif pour la gestion et le traitement des eaux urbaines de temps de pluie.

Walaszek, M., Bois, P., Laurent, J., Lenormand, E., & Wanko, A. (2018). Micropollutants removal and storage efficiencies in urban stormwater constructed wetland. *Science of the Total Environment*, *645*, 854-864.

Zhou, Q. H., Wu, Z. B., Cheng, S. P., He, F., & Fu, G. P. (2005). Enzymatic activities in constructed wetlands and di-n-butyl phthalate (DBP) biodegradation. *Soil Biology and Biochemistry*, *37*(8), 1454-1459.

Appendix

- **Rainclean composition : carbonates, coconut fibre, pumice stone, coal …**
- **Physico-chemical properties of substrates**

	pH T1	CaCO3 T1 (g/kg)	TOC T1 (g/kg)	CEC T1 (me/kg)
Sediment	7.5	22.3	151.0	138
Surface sand	9.0	0.6	4.6	15
Rainclean	9.1	15.1	20.7	192
Deep sand RBF-C	8.8	<1	1.9	10
Deep sand RBF-I	9.4	0.4	2.4	48

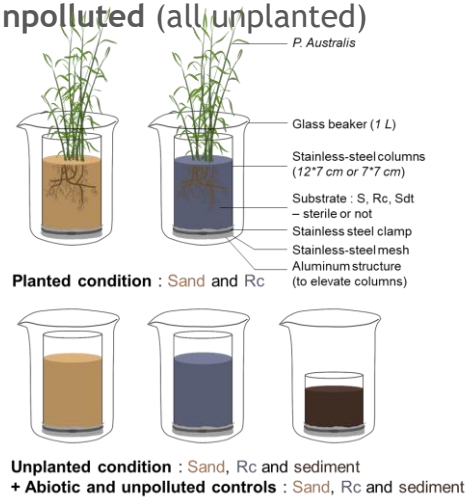
- **Flow of the filter** The output flow is regulated to a maximum of 20 L/s during rain periods

METHODOLOGY

3- Biodegradation experiments

1 Columns set-up (triplicate)

- 3 substrates: **sand**, **Rc** and **sediment** ➔ Different microbial and physico-chemical properties
- 3 OMPs : **BPA**, **NP**, **OP**
- 2 OMPs exposition: **planted** (*Phragmites australis*) and **unplanted**.
- 2 controls: **Abiotic** and **Unpolluted** (all unplanted)



The different columns set-up for the experiment

OMP :Organic MicroPollutant
Rc: Rainclean

METHODOLOGY

3- Biodegradation experiments

The growth chamber used

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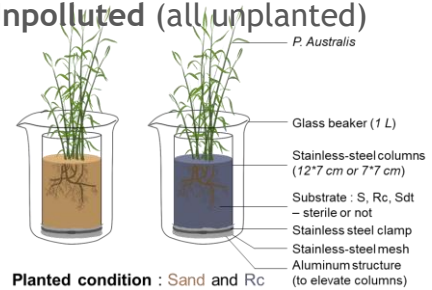


The different columns set-up for the experiment

2 Preincubation of 2 weeks

- 16h light ; 8h dark
- 20°C day ; 15°C night
- 60% humidity
  Watering / 2 days

Growth chamber

3 Contamination of columns by saturating with waters

Concentration (mg/L) (Gasperi et al. 2021)

- BPA : 2,57
- 4-NP : 3,5
- 4-OP : 1

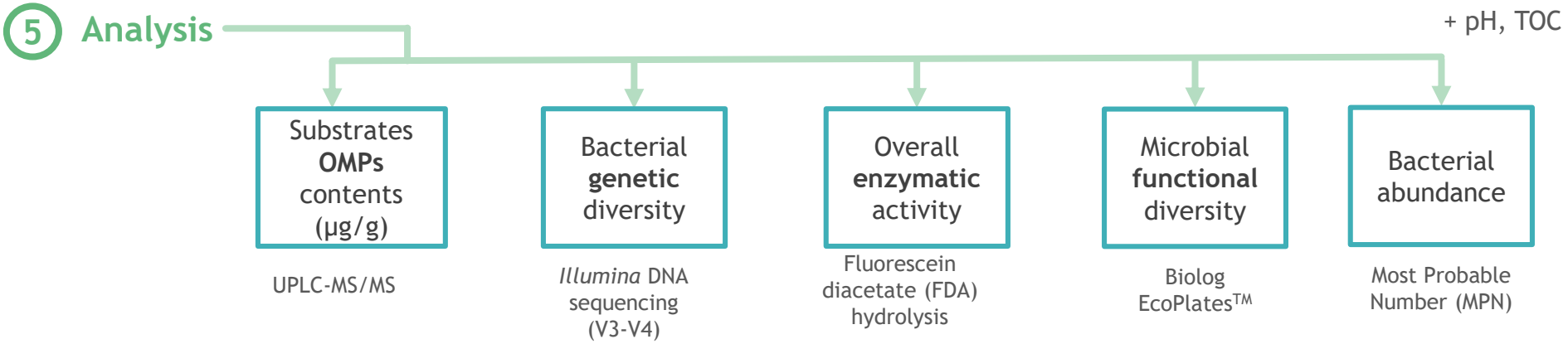
4 Incubation of 30 days

Column sampling at 0 ; 1 ; 4 ; 7 ; 14 ; 30 days

OMP :Organic MicroPollutant
Rc: Rainclean

METHODOLOGY

3- Biodegradation experiments



METHODOLOGY

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