https://life-adsorb.eu/fr/site

Simplified modelling of micropollutant removal in treatment wetlands for combined sewer overflows: the “Micropollutants” module of the ORAGE software

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CWS 2026 CHANIA

https://life-adsorb.eu/fr/site

The Life ADSORB project

Demonstrate the effectiveness of a nature-based solution for treating urban wet-weather discharges
Investigate and optimize micropollutant removal mechanisms
Develop a modelling and decision-support tool for treatment wetland design

Objective: to support engineers and designers in evaluating the treatment performances of VFCW to retain micropollutants and optimizing filter configurations (surface area, adsorbent type and layer thickness)

ORAGE software extended with a "Micropollutants" module

Simulation of the fate of metallic and organic micropollutants over several years within the VFCW, using adsorbent materials

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The ORAGE software

INRAE

ADEPTE Project (2013–2017) – Decision-Support for the Design of Extensive Stormwater Treatment Systems: Development of the ORAGE Software

A decision-support tool for the pre-design of stormwater treatment systems (strict stormwater runoff / combined sewer overflows) using VFCW

Objective: to provide designers and engineers key design parameters that account for the dynamics of rainfall events through a modelling approach

Principle: simulation of the operation of a treatment system at a fine time step (5–15 min) over a long period (one year)
Different surface areas and material selection tested

COD, TSS, NH_4-N, NO_3-N

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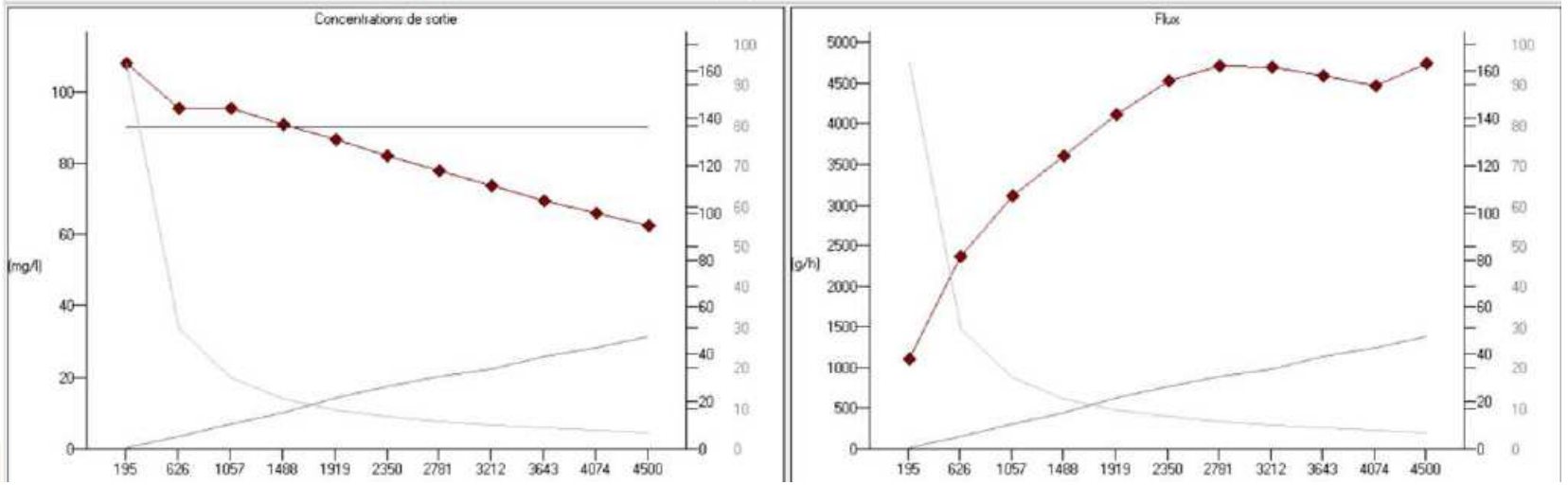
The ORAGE software

- Results - Representation of maximum concentrations and loads for all materials

COD



TW surface area (m^2)

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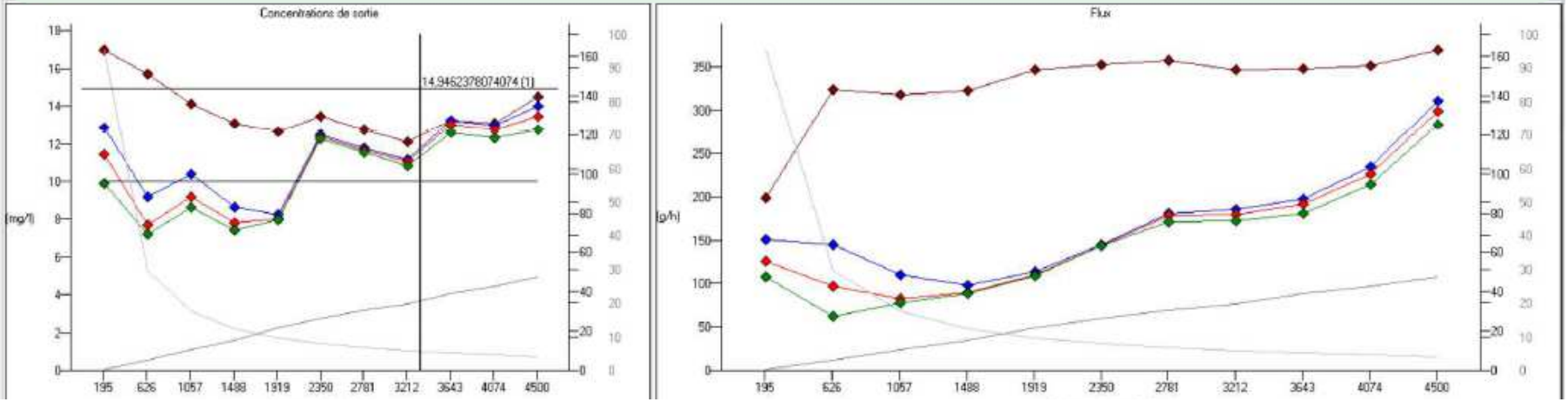
The ORAGE software

- Results - Representation of maximum concentrations and loads for all materials

NH_4-N



TW surface area (m^2)

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The “Micropollutants” module workflow

Parameter setting/Input data

1. Running Orage for COD, TSS, N

→

2. Results/Report for COD, TSS, N

Compilation of the worst year on record for hydrology AND nitrogen concentrations

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The “Micropollutants” module workflow

Parameter setting/Input data

1. Running Orage for COD, TSS, N

Compilation of the worst year on record for hydrology AND nitrogen concentrations

→

2. Results/Report for COD, TSS, N

→

User question

3. Q° : Simulation of the fate of micropollutants ?

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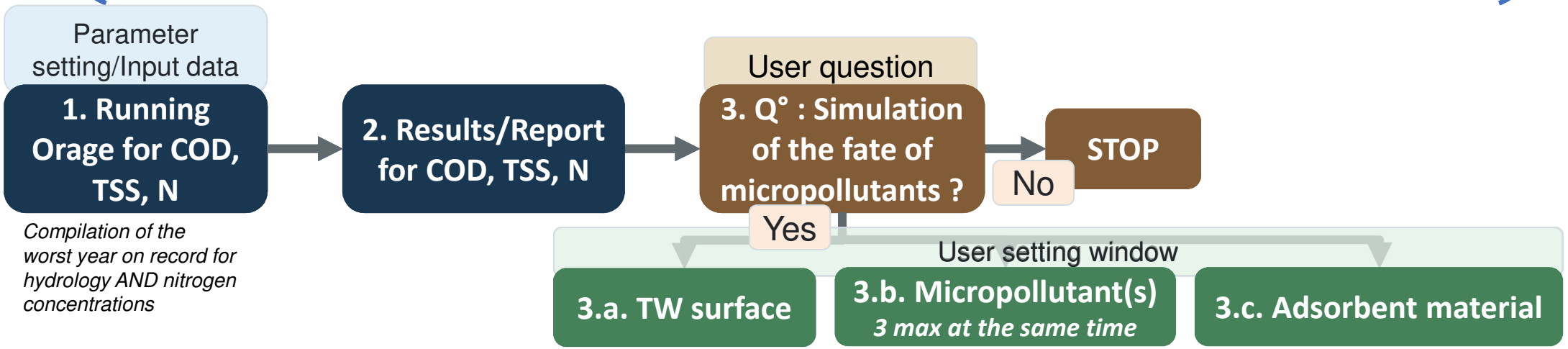
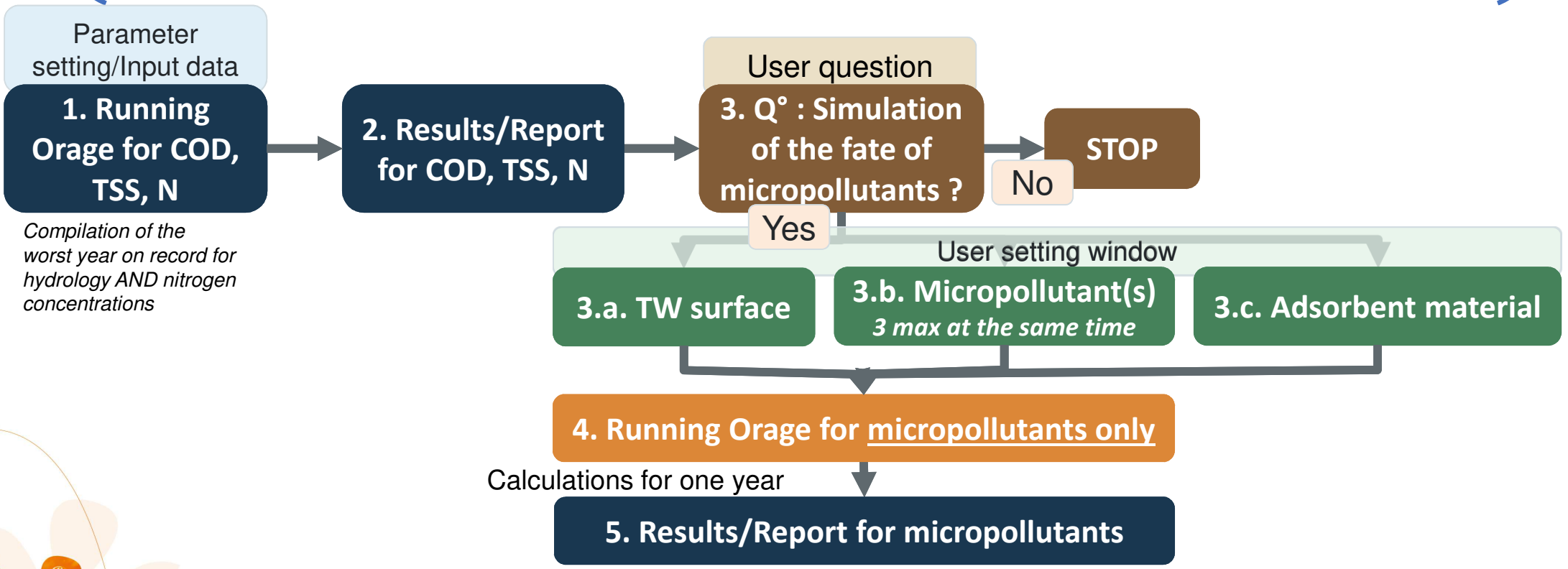
The “Micropollutants” module workflow



The “Micropollutants” module workflow



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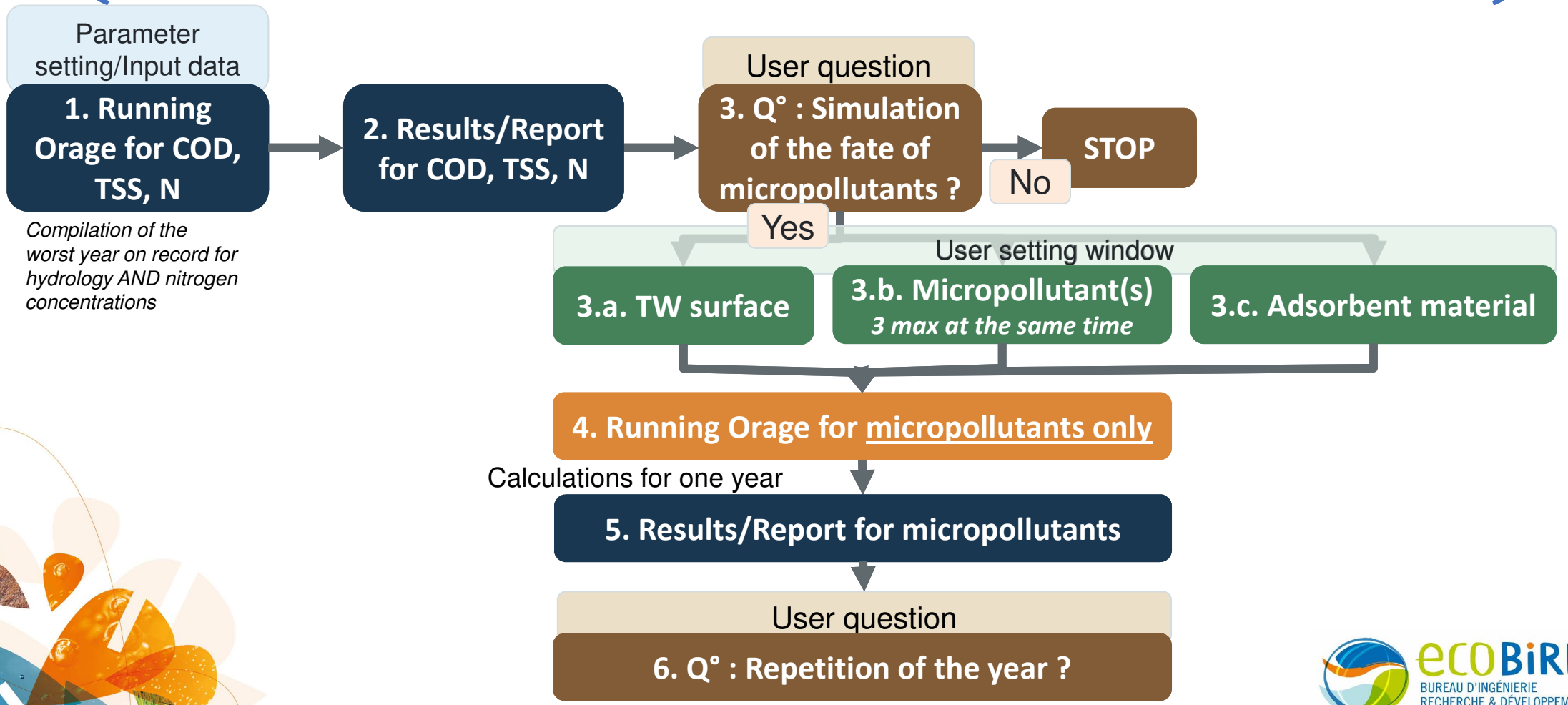
The “Micropollutants” module workflow



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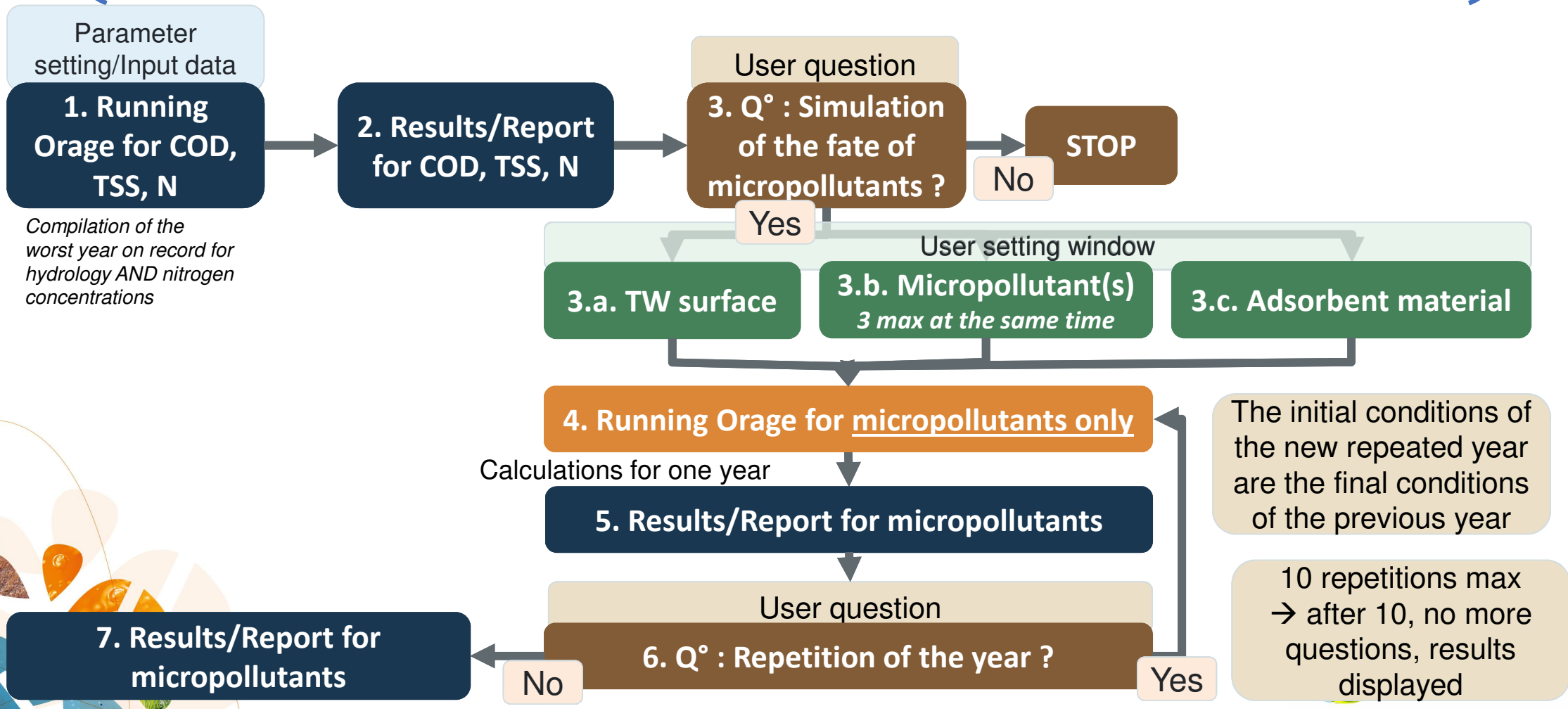
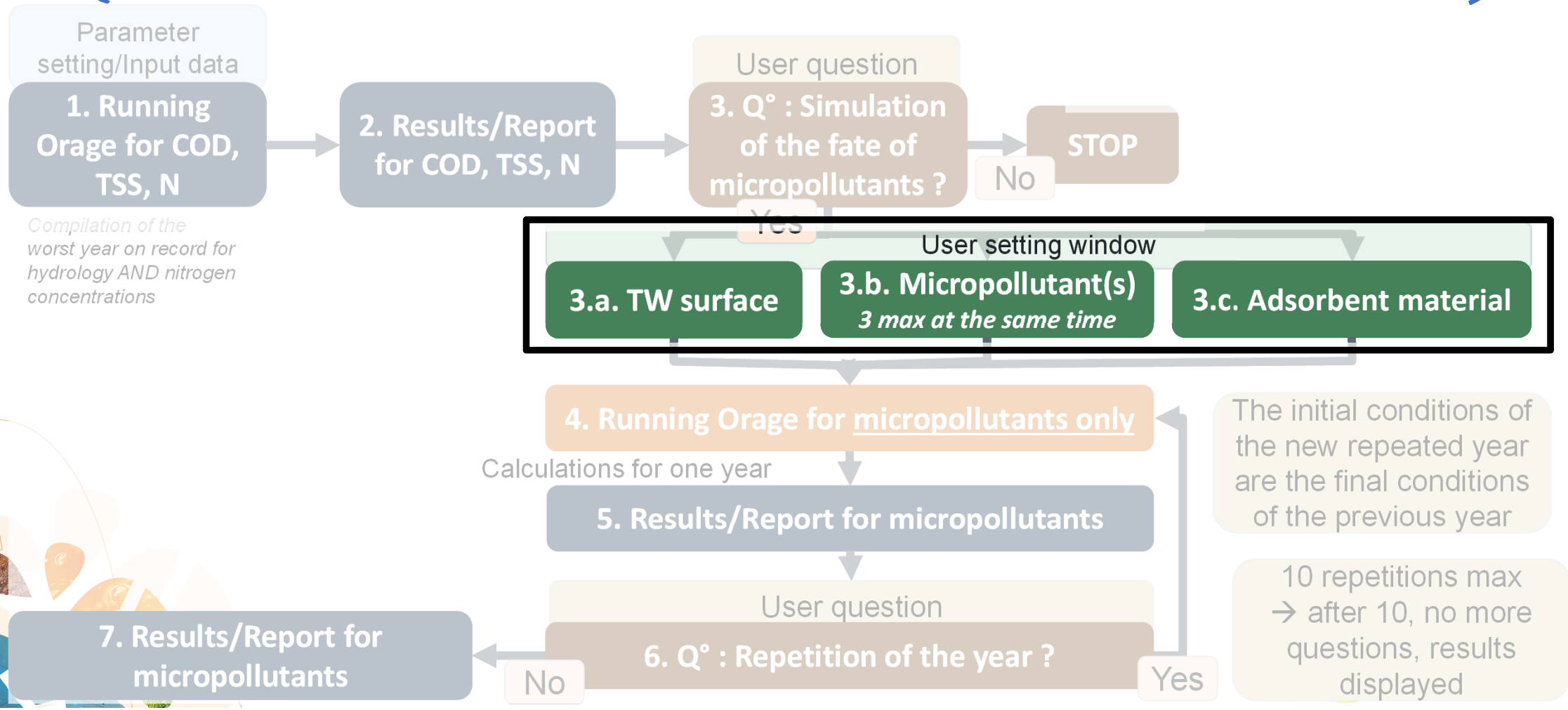
The “Micropollutants” module workflow



User setting window



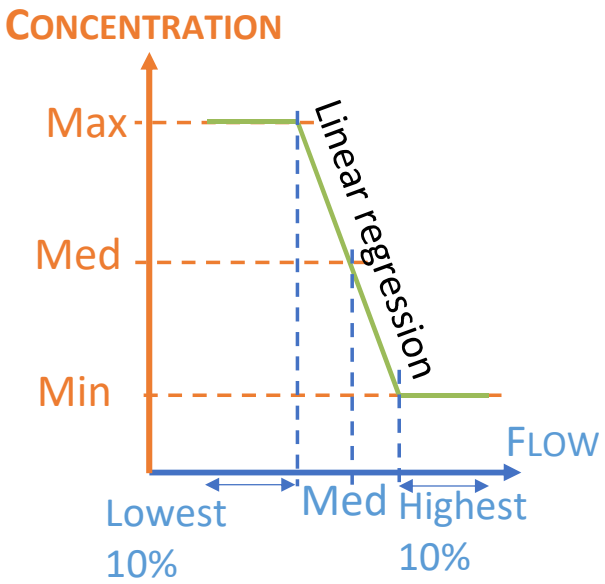
User setting window

3.a. TW surface

3.b. Micropollutant(s)
3 max at the same time

Choice can be made on the basis of the results obtained in step **1. Running Orage for COD, TSS, N**

- Metallic or organic micropollutant (As, Cd, Cr, Cu, Ni, Pb, V, Z, NP, OP, BPA, other)
- Enter median/maximum/min concentrations
- Enter percentage of particulate fraction



→ The software creates a pattern that simulates changes in concentrations as a function of the flows compiled in step **1. Running Orage for COD, TSS, N** (most unfavourable year)

→ Pattern : dilution rule established such as :

- Flow = 0 → concentration = 0
- 0 < flow <= 10% → concentration = max concentration
- 10% <= median flow → concentration max → median concentration via linear regression
- Median flow <= 90% → median concentration → min concentration via linear regression
- 90% < flow <= 100% → concentration = min concentration

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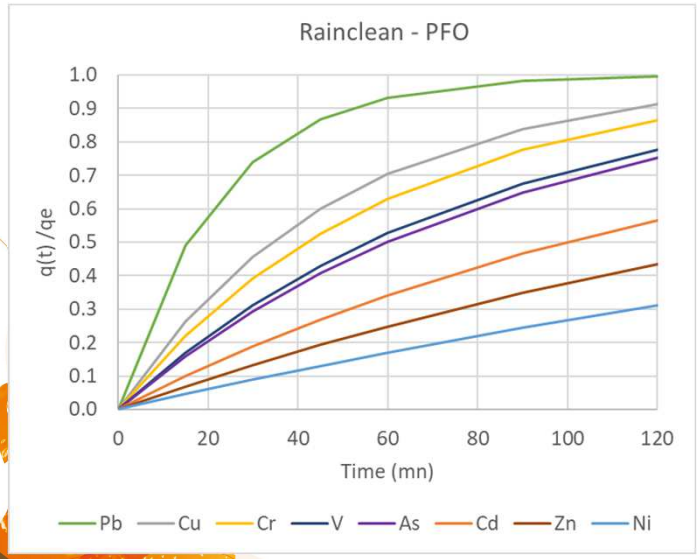
User setting window

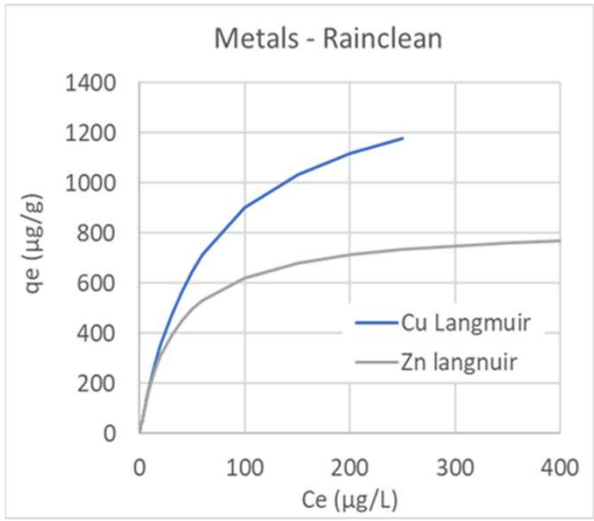
3.c. Adsorbent material

- Simulation of only 1 adsorbent material at a time
- By default → Rainclean® (isotherm/kinetic)
- Option to choose another adsorbent material → enter isotherm/kinetic parameters
- Option to choose height

→ 3 isotherms available : Linear, Langmuir, Freundlich
The desorption isotherm is the same as the adsorption isotherm



→ 1 single kinetic is proposed: pseudo-first-order



→ 1 single biodegradation kinetic is proposed (organic micropollutants):
Single First-Order model

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User setting window

Setting parameters for micropollutant fate

TW surface: 100 m2

Percentile : 70 %

Number of micropollutants (*3 max*) 1

Micropolluant 1

Type : Metallique

Nom : Ni

Nom si autre :

Concentration : Médian : 10,00 ug/L Maximum : 50,00 ug/L Minimum : 1,00 ug/L

Particular fraction : 10 %

Matériau adsorbant : Rainclean

Nom si autre :

Height (cm): 30 cm

Bulk density: 646 kg/m3

Adsorption kinetics : 0,00311 1/min

Isotherme : Linéaire

Kd : 73 L/g

Settings to be repeated for each micropollutant

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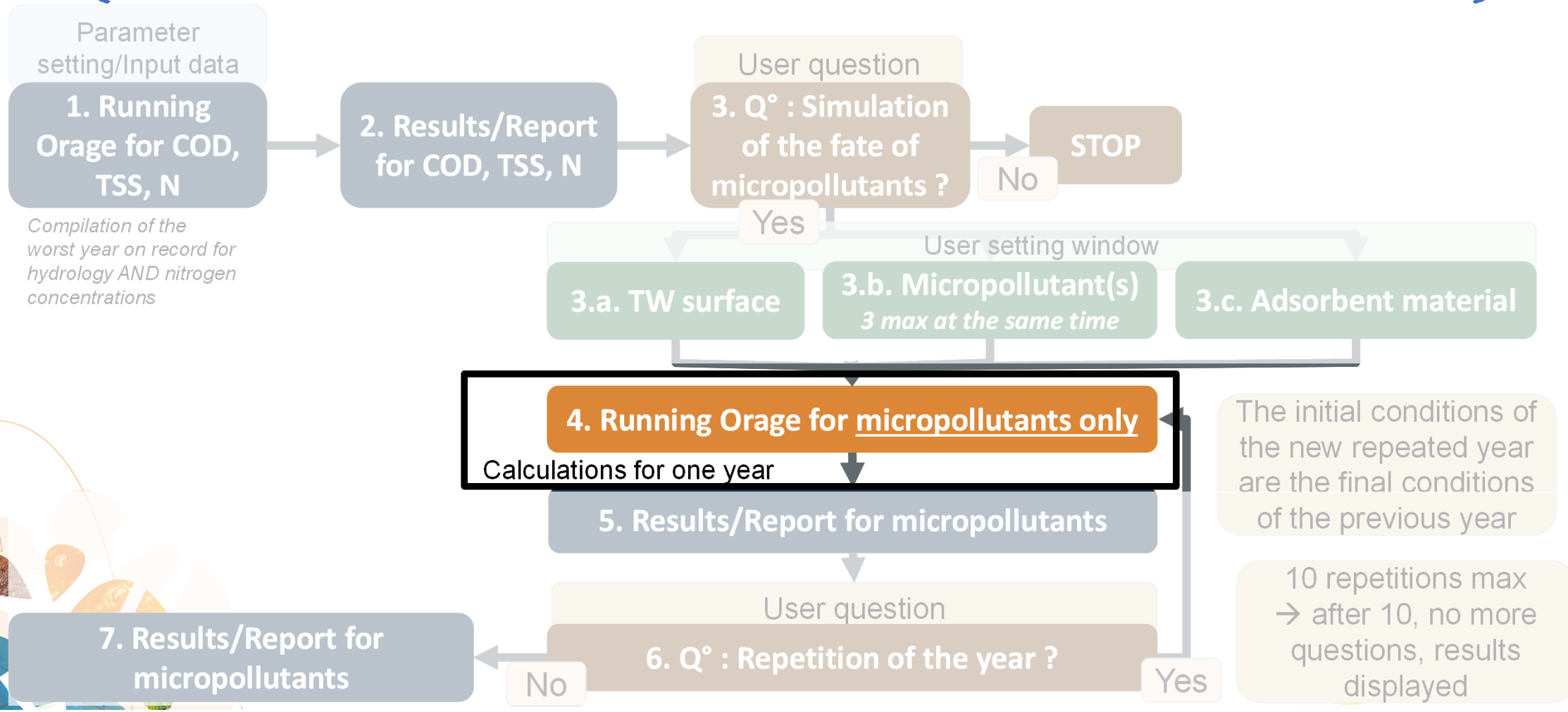
Running ORAGE

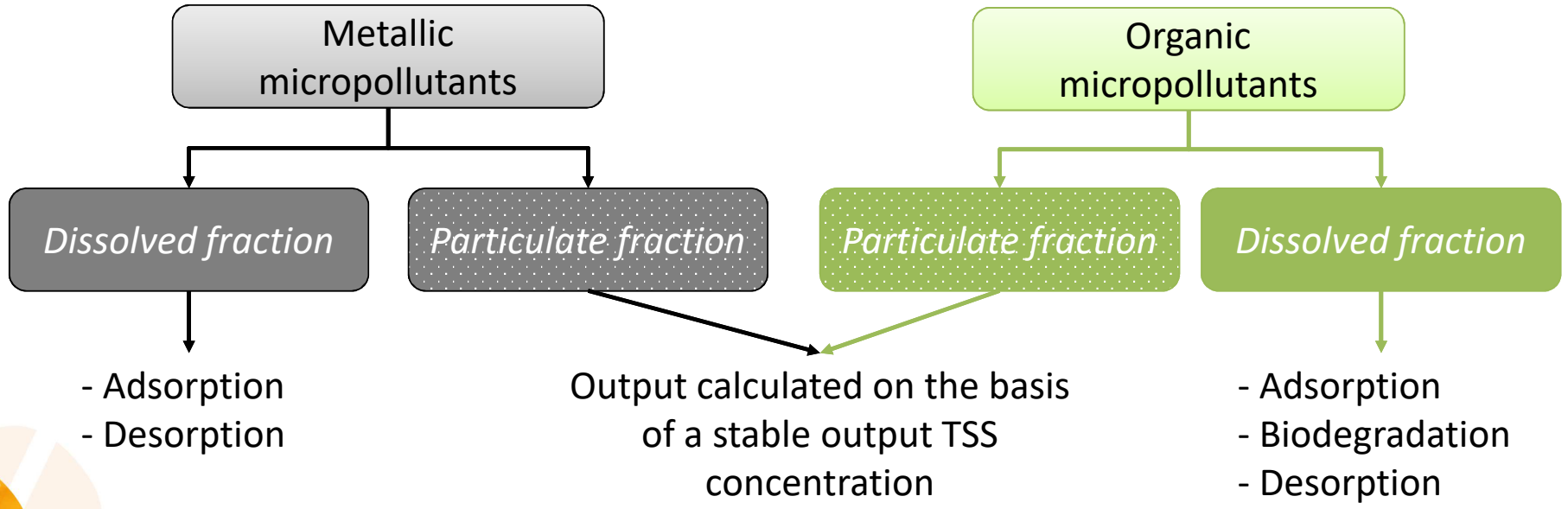


Processes taking into account

4. Running Orage for micropollutants only

- No hydraulic calculations: only the previously calculated volumes and heights of water in the filter are used
- The processes will only occur in the layer of adsorbent material (deposit layer not taken into account)

Calculations for one year



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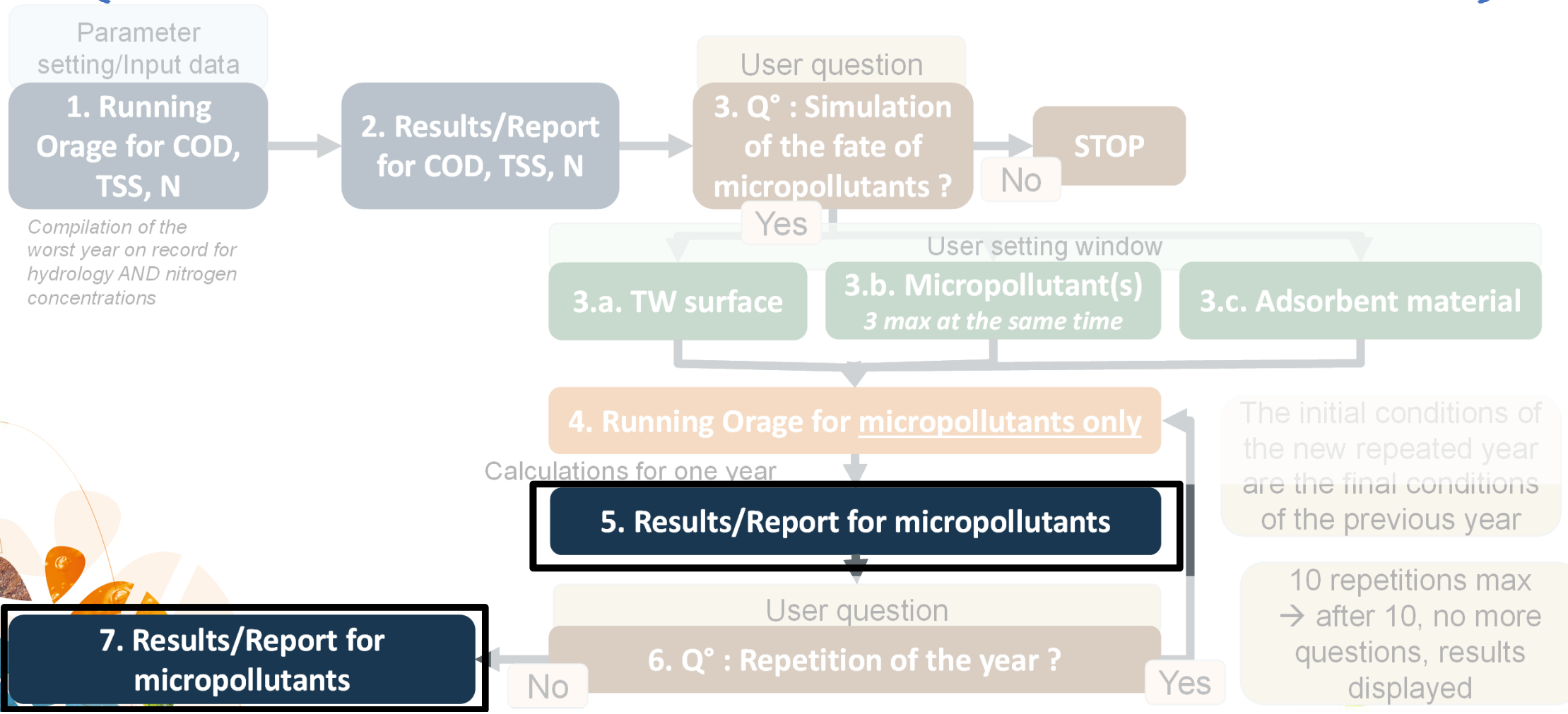
Results

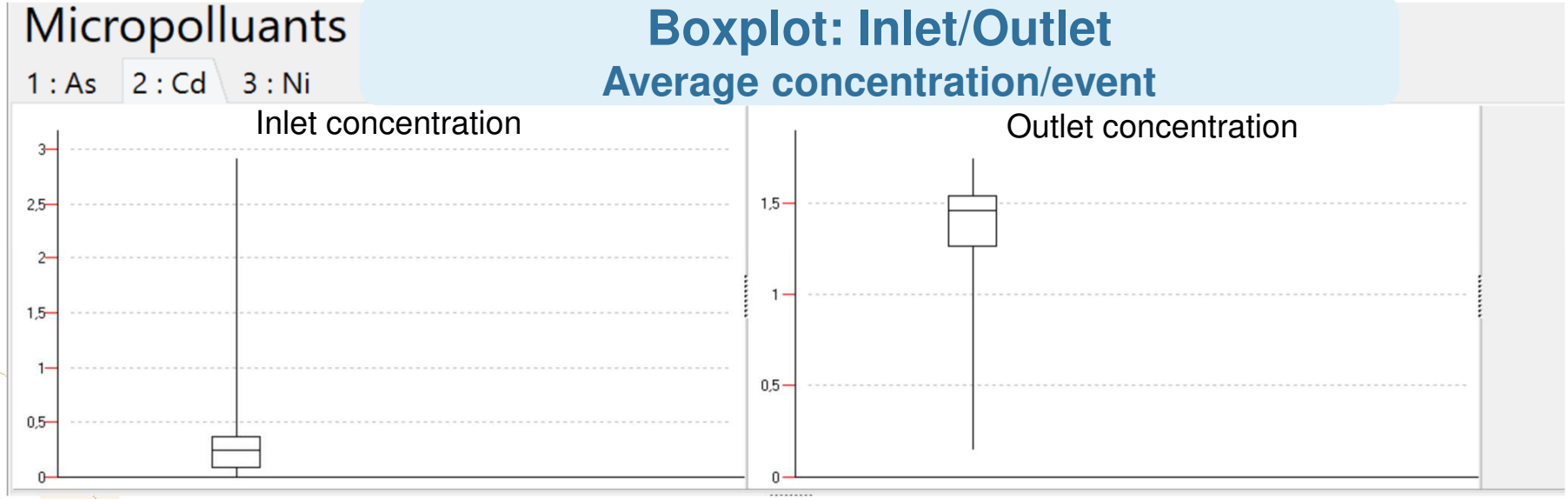

Parameter setting/Input data
1. Running Orage for COD, TSS, N
Compilation of the worst year on record for hydrology AND nitrogen concentrations
2. Results/Report for COD, TSS, N
User question
3. Q° : Simulation of the fate of micropollutants ?
No
STOP
Yes
User setting window
3.a. TW surface
3.b. Micropollutant(s)
3 max at the same time
3.c. Adsorbent material
4. Running Orage for micropollutants only
Calculations for one year
5. Results/Report for micropollutants
The initial conditions of the new repeated year are the final conditions of the previous year
User question
6. Q° : Repetition of the year ?
No
Yes
10 repetitions max → after 10, no more questions, results displayed
7. Results/Report for micropollutants

Results

7. Results/Report for micropollutants

OUTPUT FOR EACH MICROPOLLUTANT

Boxplot: Inlet/Outlet
Average concentration/event



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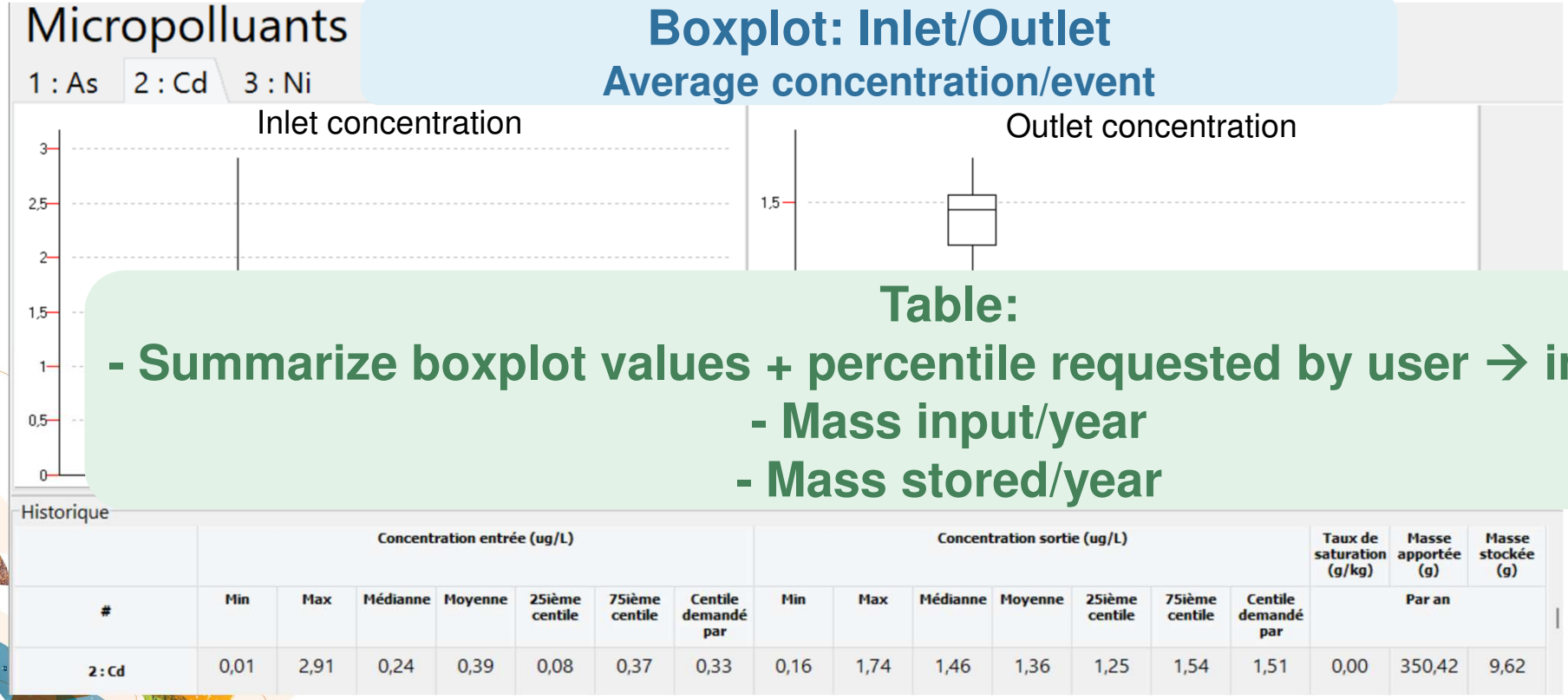
Results

7. Results/Report for micropollutants

OUTPUT FOR EACH MICROPOLLUTANT



Boxplot: Inlet/Outlet

Average concentration/event

Table:

- Summarize boxplot values + percentile requested by user → inlet/outlet

- Mass input/year

- Mass stored/year

Historique

	Concentration entrée (ug/L)							Concentration sortie (ug/L)							Taux de saturation (g/kg)	Masse apportée (g)	Masse stockée (g)
#	Min	Max	Médianne	Moyenne	25ième centile	75ième centile	Centile demandé par	Min	Max	Médianne	Moyenne	25ième centile	75ième centile	Centile demandé par		Par an	
2 : Cd	0,01	2,91	0,24	0,39	0,08	0,37	0,33	0,16	1,74	1,46	1,36	1,25	1,54	1,51	0,00	350,42	9,62

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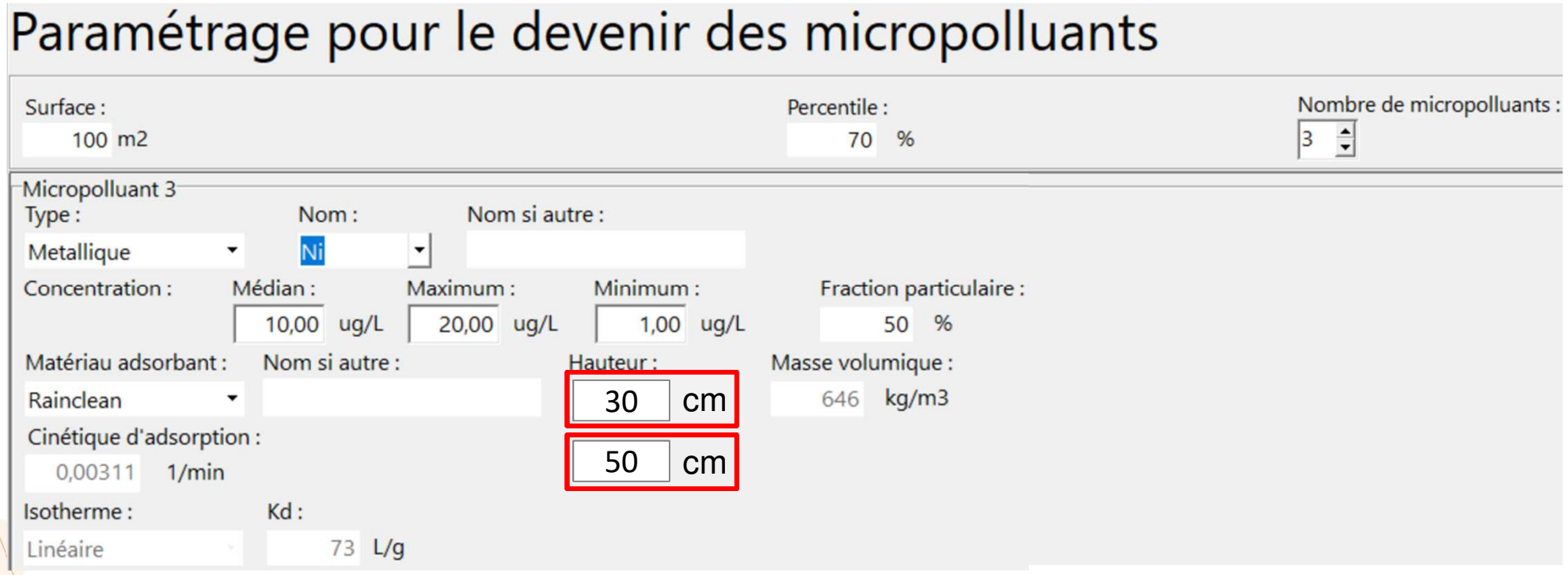
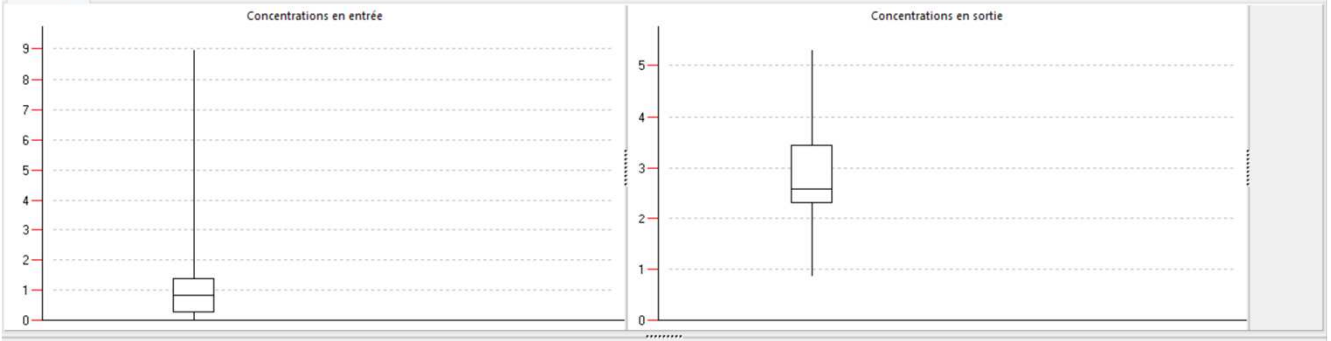
Example


Paramétrage pour le devenir des micropolluants
Surface :
100 m2
Percentile :
70 %
Nombre de micropolluants :
3
Micropolluant 3
Type :
Metallique
Nom :
Ni
Nom si autre :
Concentration :
Médian :
10,00 ug/L
Maximum :
20,00 ug/L
Minimum :
1,00 ug/L
Fraction particulaire :
50 %
Matériau adsorbant :
Rainclean
Nom si autre :
Hauteur :
30 cm
50 cm
Masse volumique :
646 kg/m3
Cinétique d'adsorption :
0,00311 1/min
Isotherme :
Linéaire
Kd :
73 L/g

30 cm

1 : Ni

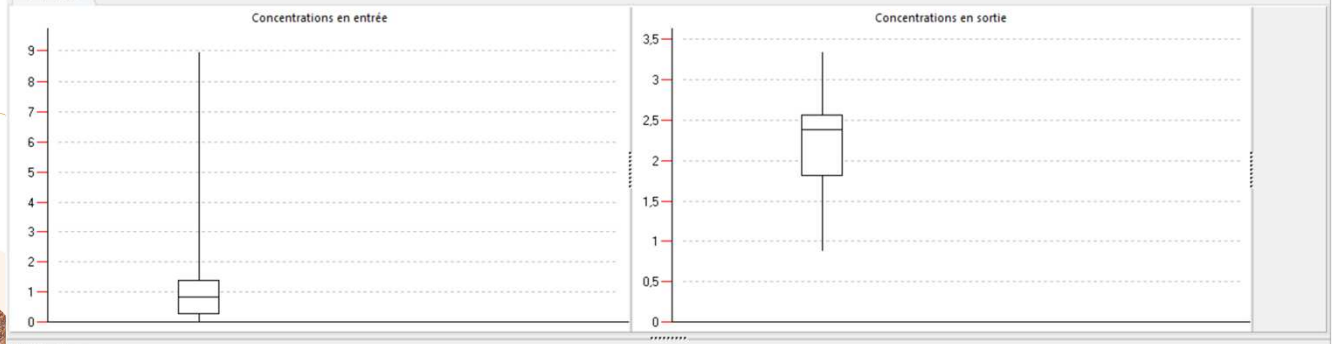


Historique

#	Concentration entrée (ug/L)							Concentration sortie (ug/L)							Taux de saturation (g/kg)	Masse apportée (g)	Masse stockée (g)
	Min	Max	Médianne	Moyenne	25ième centile	75ième centile	Centile demandé par	Min	Max	Médianne	Moyenne	25ième centile	75ième centile	Centile demandé par	Par an		
1 : Ni	0,02	8,95	0,82	1,31	0,25	1,37	1,01	0,89	5,29	2,59	2,90	2,30	3,44	3,38	0,00	1168,33	3,03

50 cm

1 : Ni



Historique

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1 : Ni	0,02	8,95	0,82	1,31	0,25	1,37	1,01	0,89	3,33	2,38	2,18	1,81	2,55	2,52	0,00	1168,33	5,01

Thickness of the Rainclean layer ↗

Concentrations at the outlet ↘

Mass stored ↗

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Conclusions

The micropollutant module significantly enhances the ORAGE software

Simulation of trace contaminants in constructed wetlands under dynamic wet-weather conditions

Estimation of treatment performance and adsorbent lifespan

The software facilitates design decisions: ability to test multiple configurations and evaluate their impact on the removal of micropollutants

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Thank you
for your attention