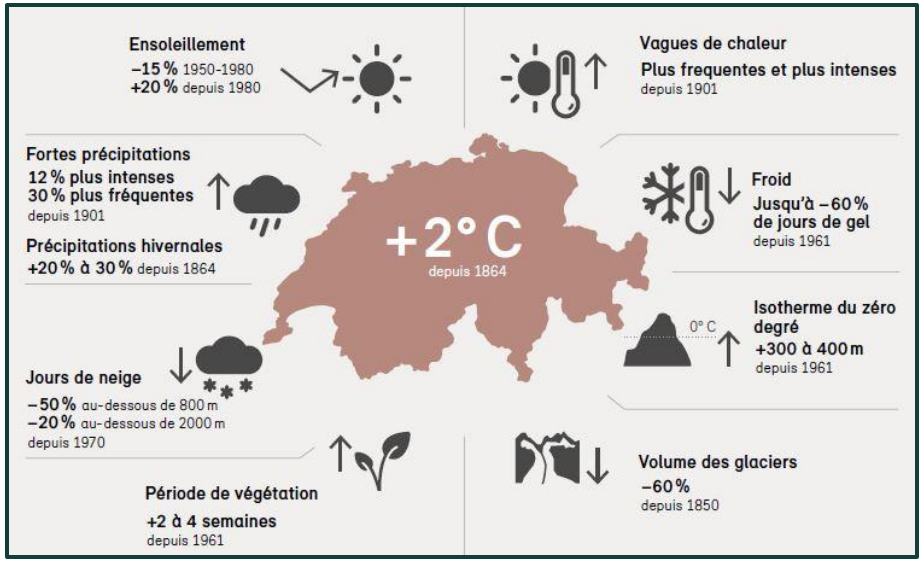
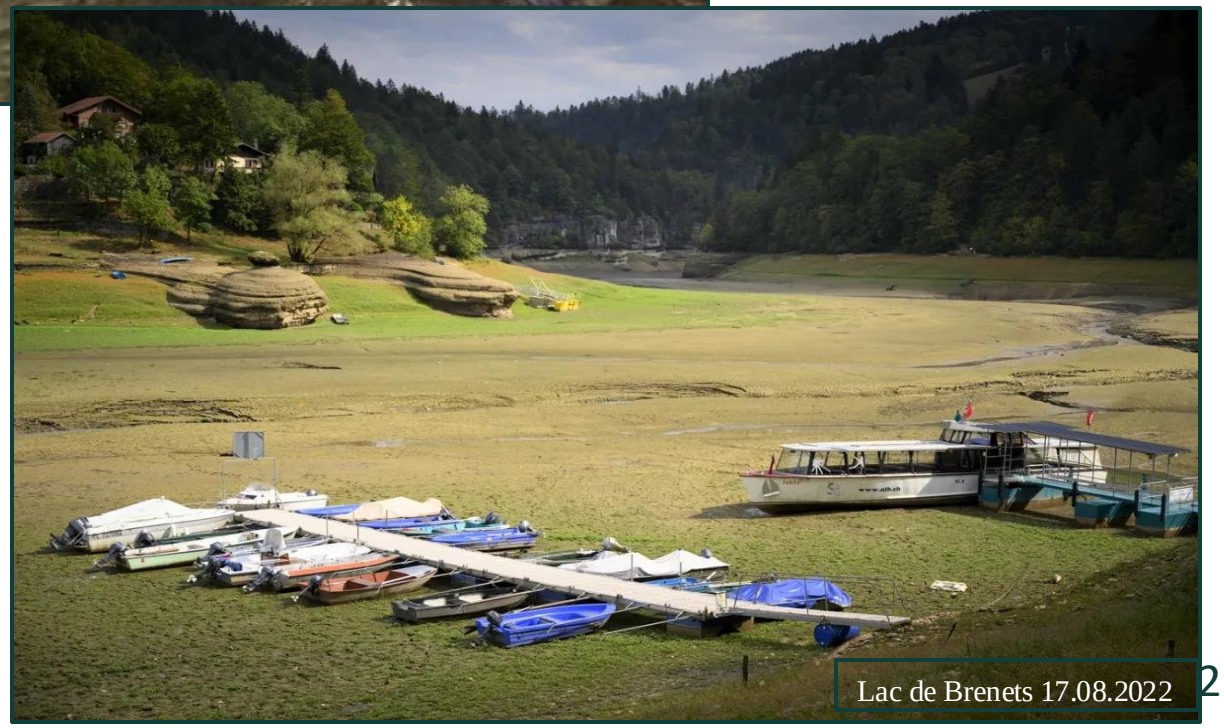
Urban Twin Project
Storm and industrial water management on the EPFL campus (Ecublens)

Dan Andersson

Context:

- Due to climate change, storm events are expected to be more intense, and dry season lasting longer
- This induces flood risks as well as water availability issues
- One solution: **Water infiltration / Sponge City**





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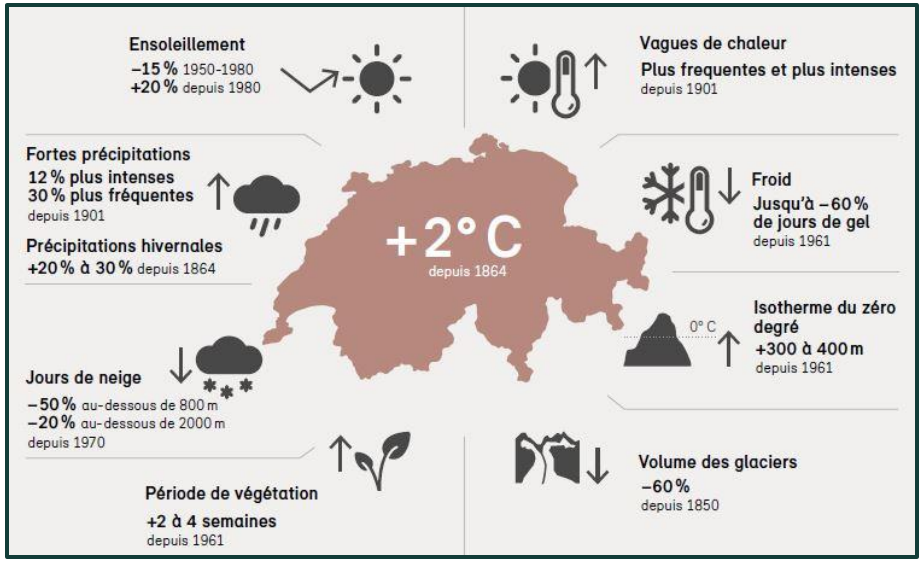



Gare de Morges 2024

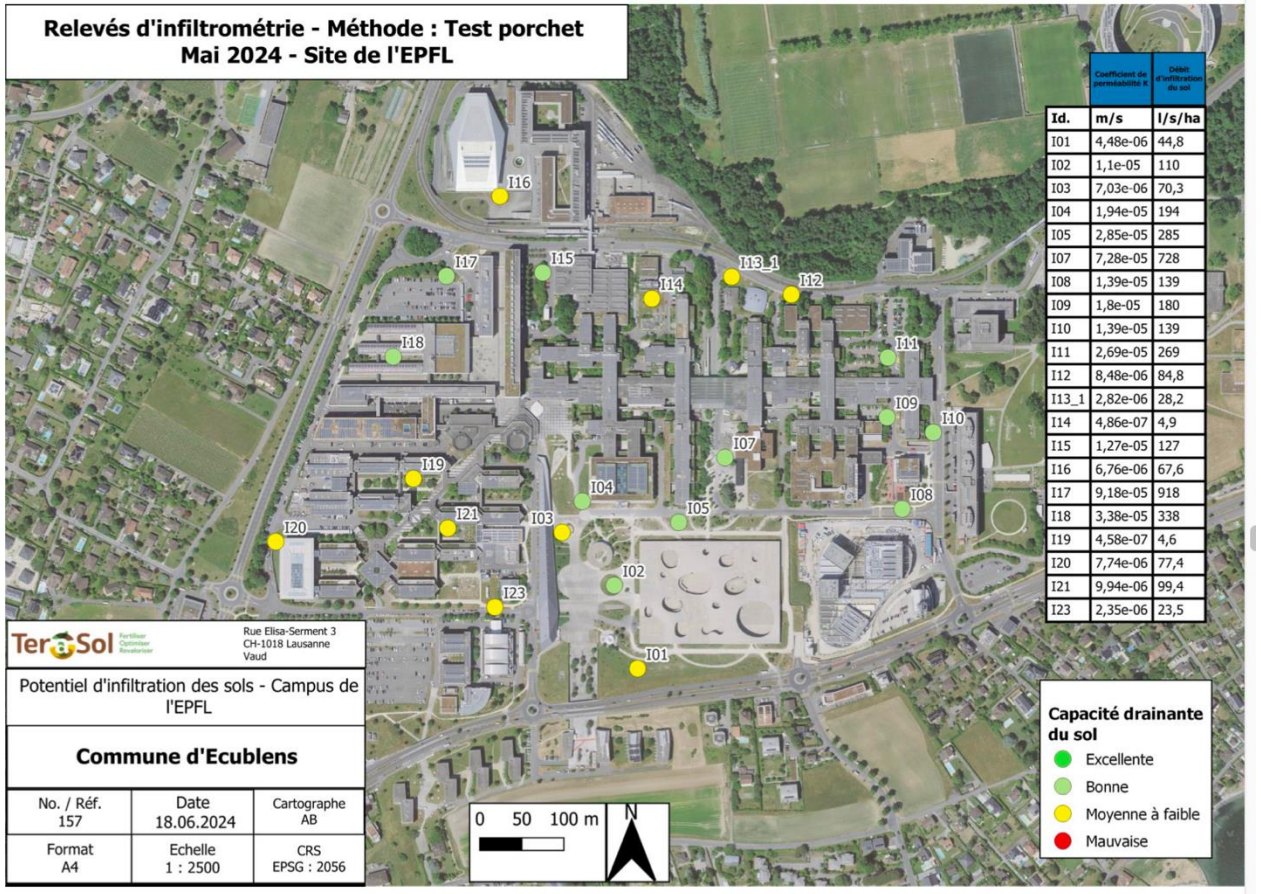

Lac de Brenets 17.08.2022

Context:

- EPFL low runoff coefficient

Réalisé par Jeanne Estienne - Octobre 2022 - Source : orthophoto swisstopo

- EPFL Campus infiltration rate



Context:

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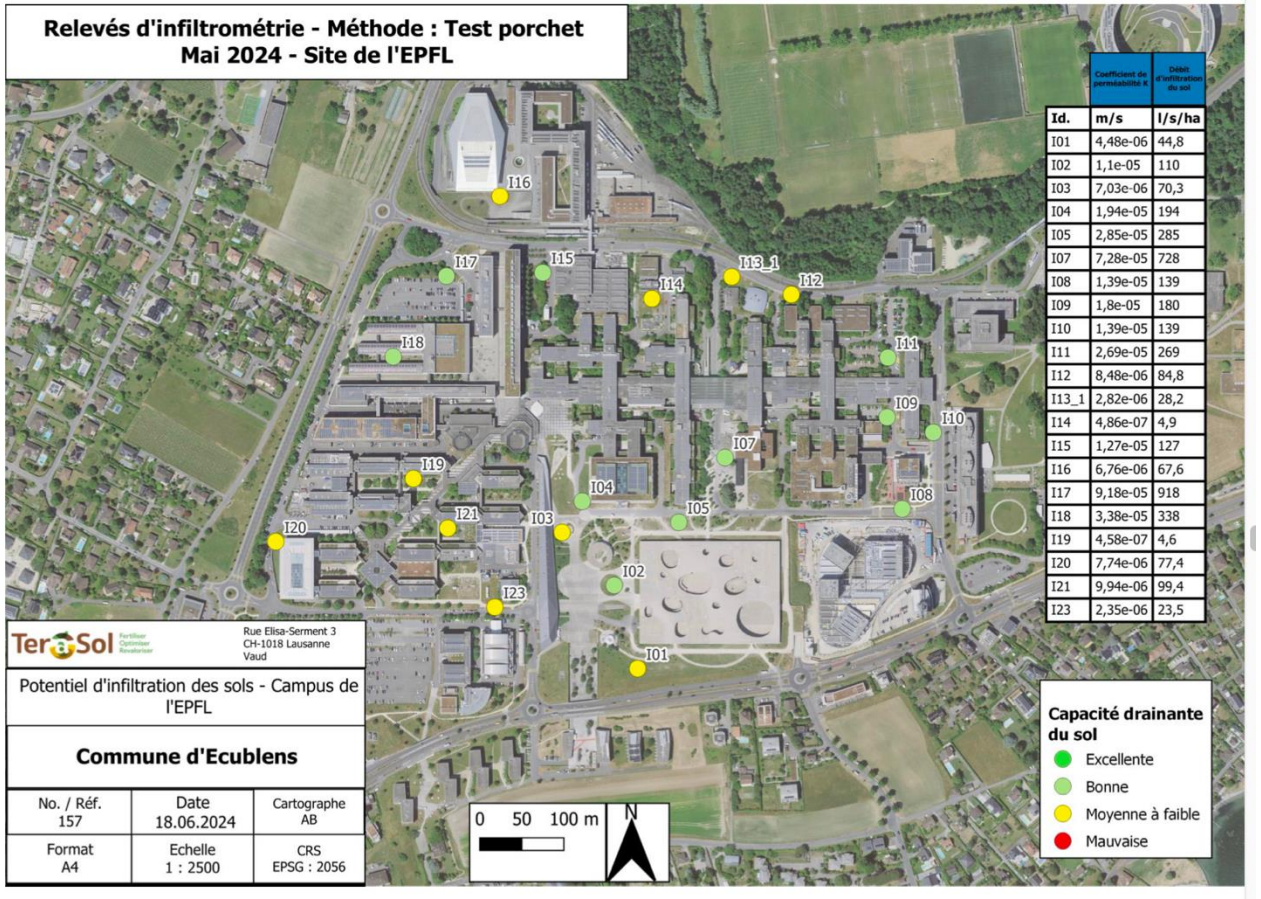

EPFL Campus: Where does it's water go?

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Runoff wat

We want it to
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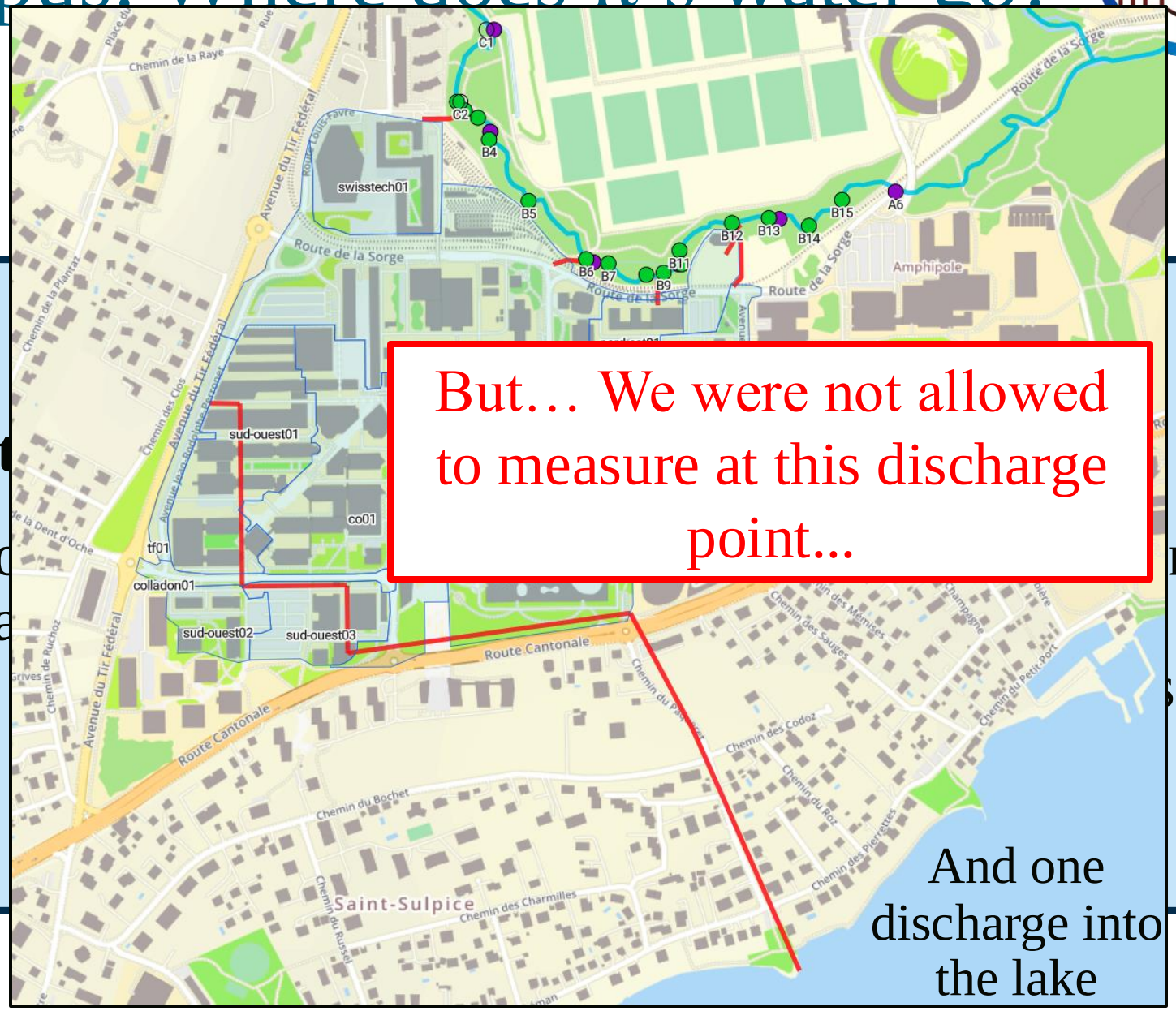
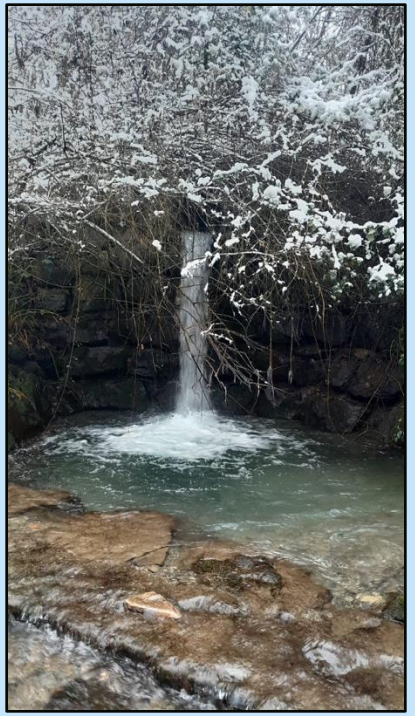
s)





EPFL Campus: Where does it’s water go?

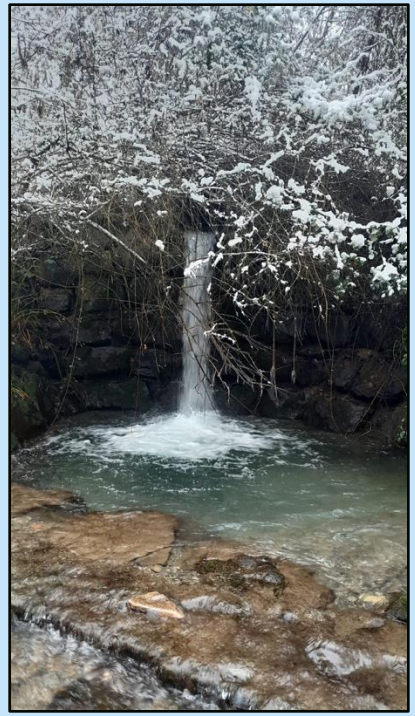
2 types of discharges into the river :

Runoff water

We want it to be infiltrated if at all possible

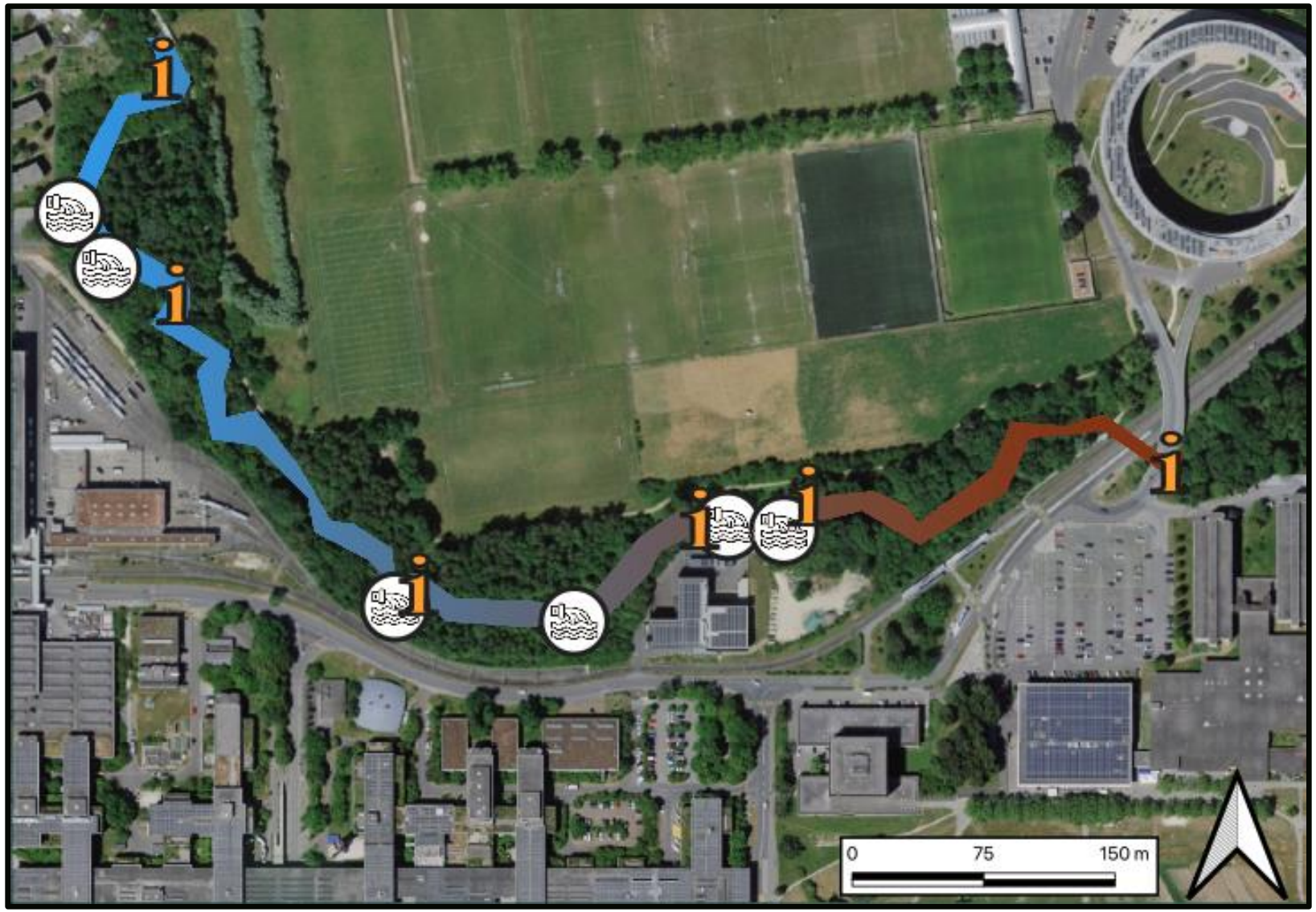
Industrial water

→ is the management of this water well done? (Swiss Laws)



Context:

- 6 points of water discharge from EPFL into the river Sorge
- 5 include heating/cooling water and runoff and the 6th only runoff water
- **Goal**: improve our understanding of these discharges (flow, water quality, temperature) to reduce their impact on the river and improve storm and industrial water management



Swiss Laws

There are many laws on water in Switerland, if you want to know more about them you can check **LEaux** and **OEaux**

- Swiss laws on water discharges and water infiltration

*«Non-polluted waste water **must** be discharged by **infiltration** according to the instructions of the cantonal authority. If local conditions do not permit this, such non-polluted water may be discharged into surface waters; in this case retention measures must be taken if possible so as to ensure a steady discharge in the event of high inflow. (…)» LEaux Art. 7*

- What about the industrial water that the campus discharges into the river?

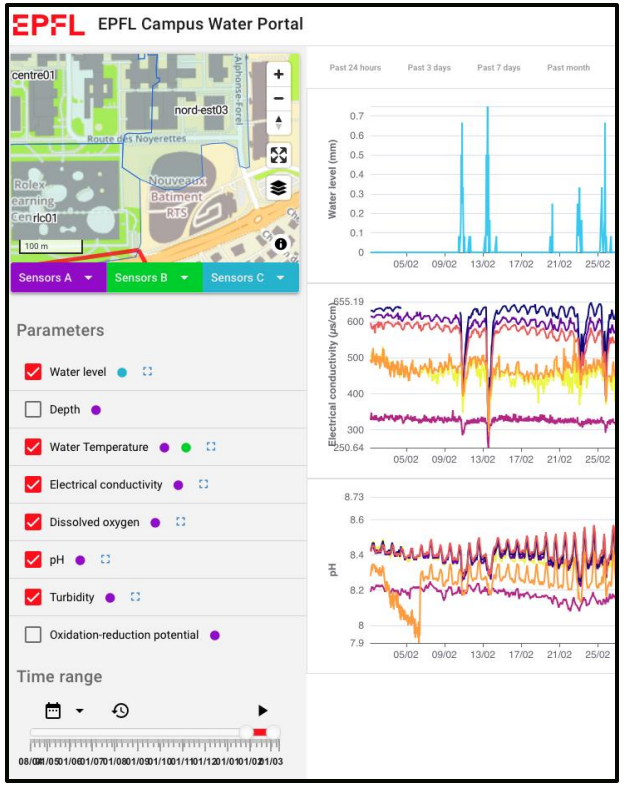
«*The **introduction** (…) of heat must not alter the temperature in a watercourse by **more than 3** (…). These requirements apply after thorough **mixing**.»* OEaux Annex 2.12

Tools:

Sensors

Laboratory analyses

Digital Twin / modelisation / scenario testing



Sensors installed

Multiparameter sensors : T / DO / EC / Turb. / ORP / pH

Temperature

Discharge/ water level

Auto-sampler

Since November, we also have a pluviometer

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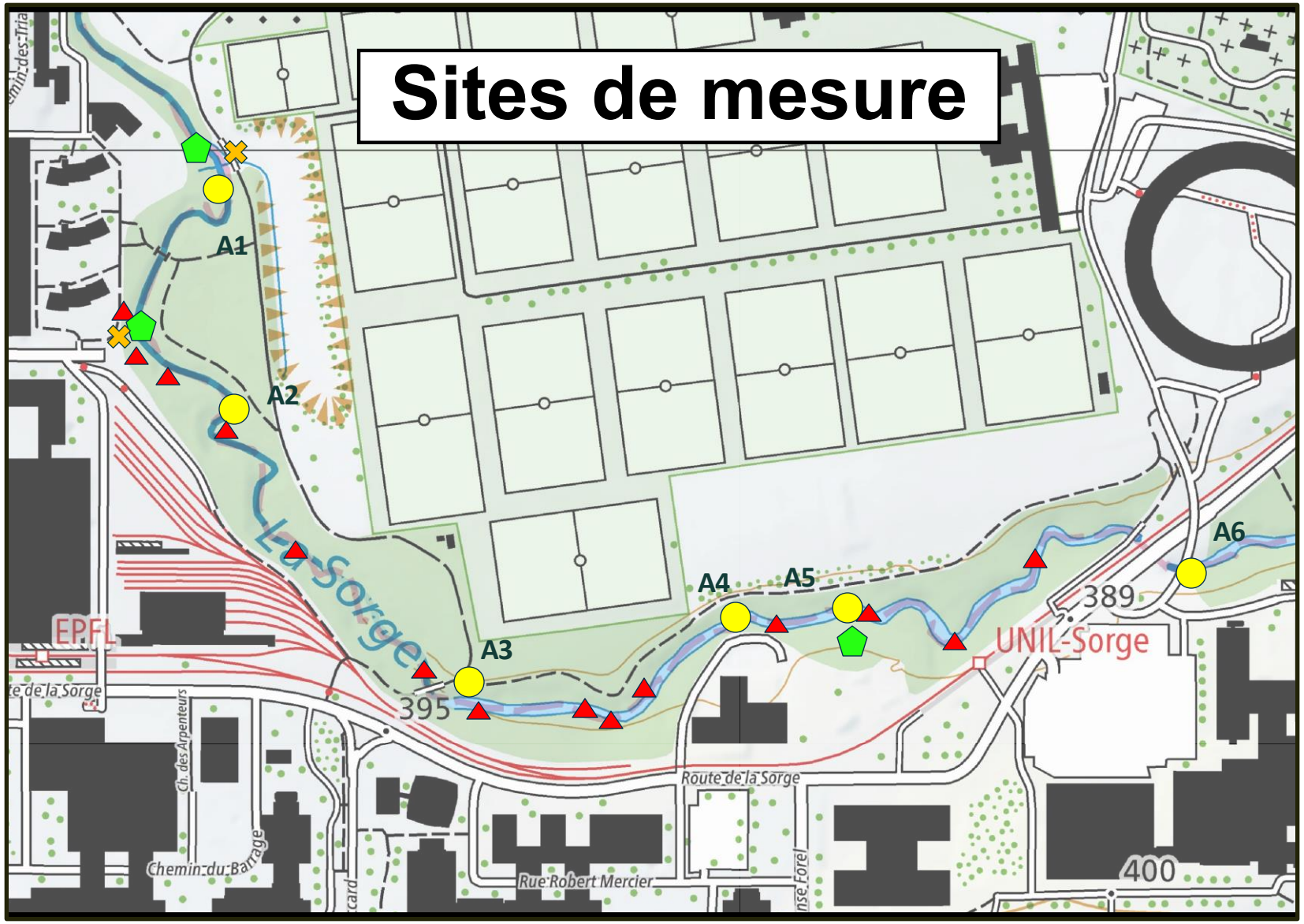
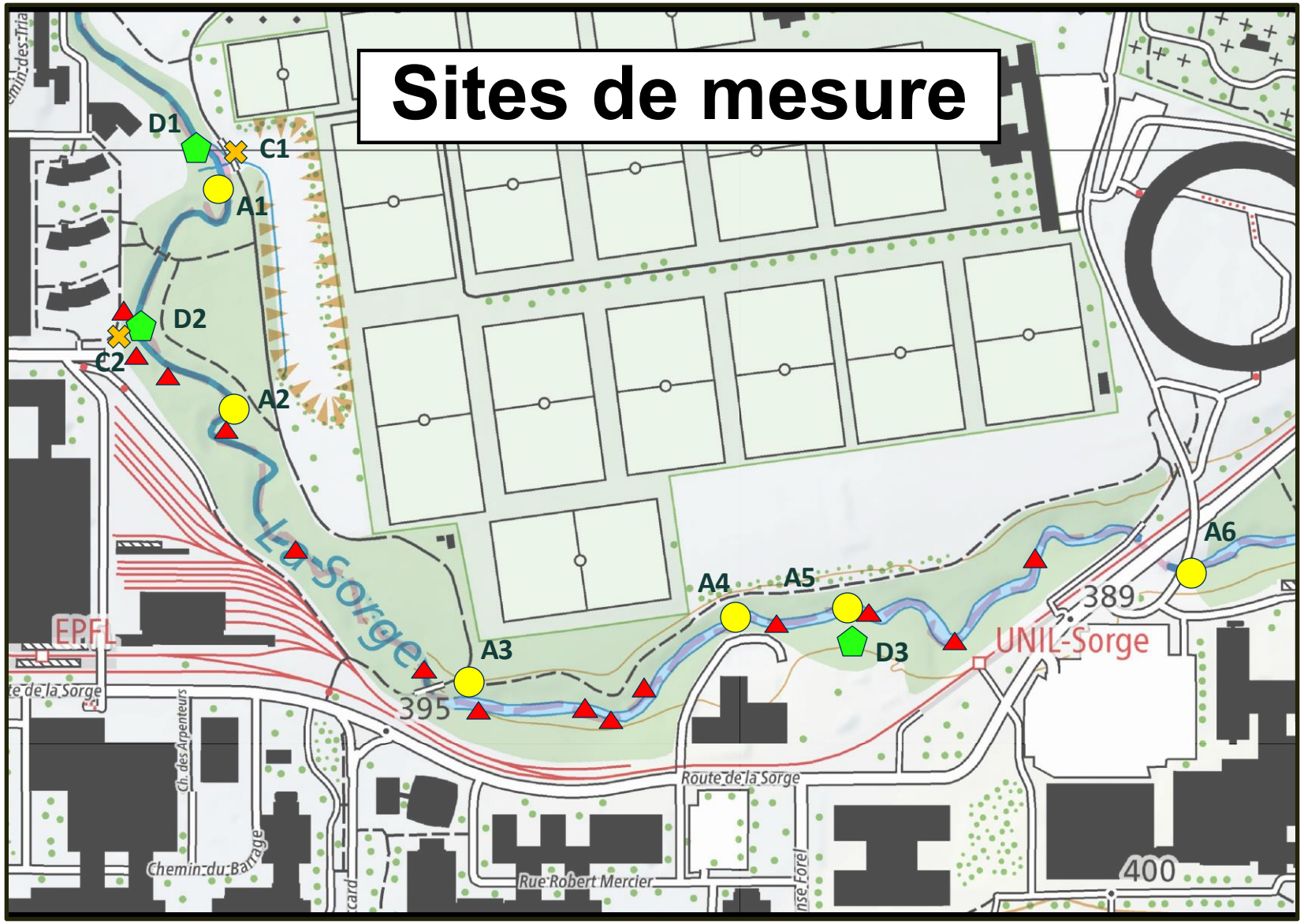


Sensors installed

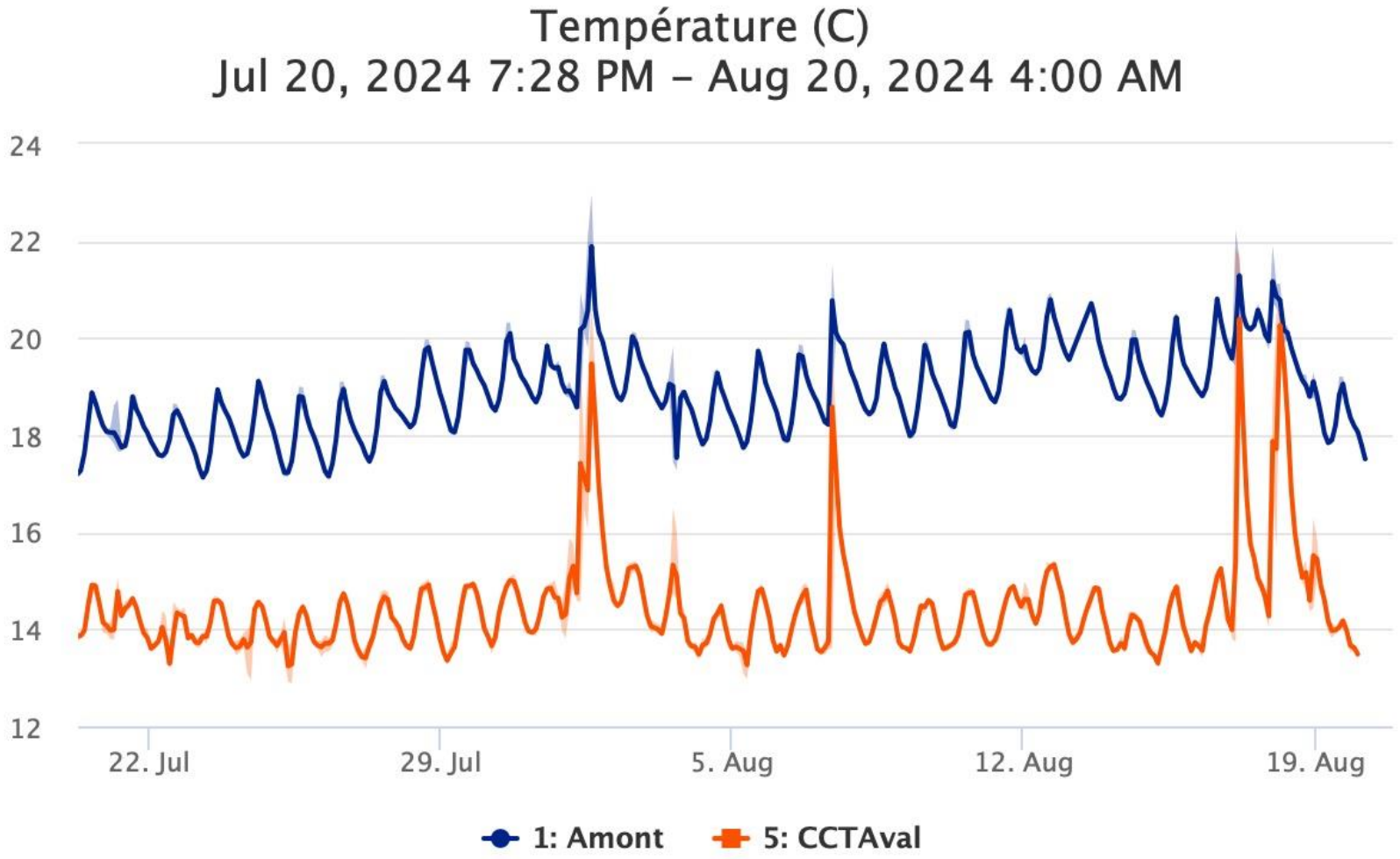
- Measure: Temp. / DO / EC / Turb. / pH / ORP / water depth and rain
- Online measurements since mid-June, every 5 or 15 minutes.
- Measurement of chemical water quality for runoff and river water since mid-August



Results Sensors:

(site 1: “Amont”, upstream from Epfl; site 5: “CCTAval” impacted by all discharges)

- Impact of heating/cooling water on the Sorge river
  - Decrease of 3 to 5°C in water temperature during the summer



Fish can cope with a T variation of around 0.5 to 1°C per hour without being affected. (Oliver and Fidler 2001)

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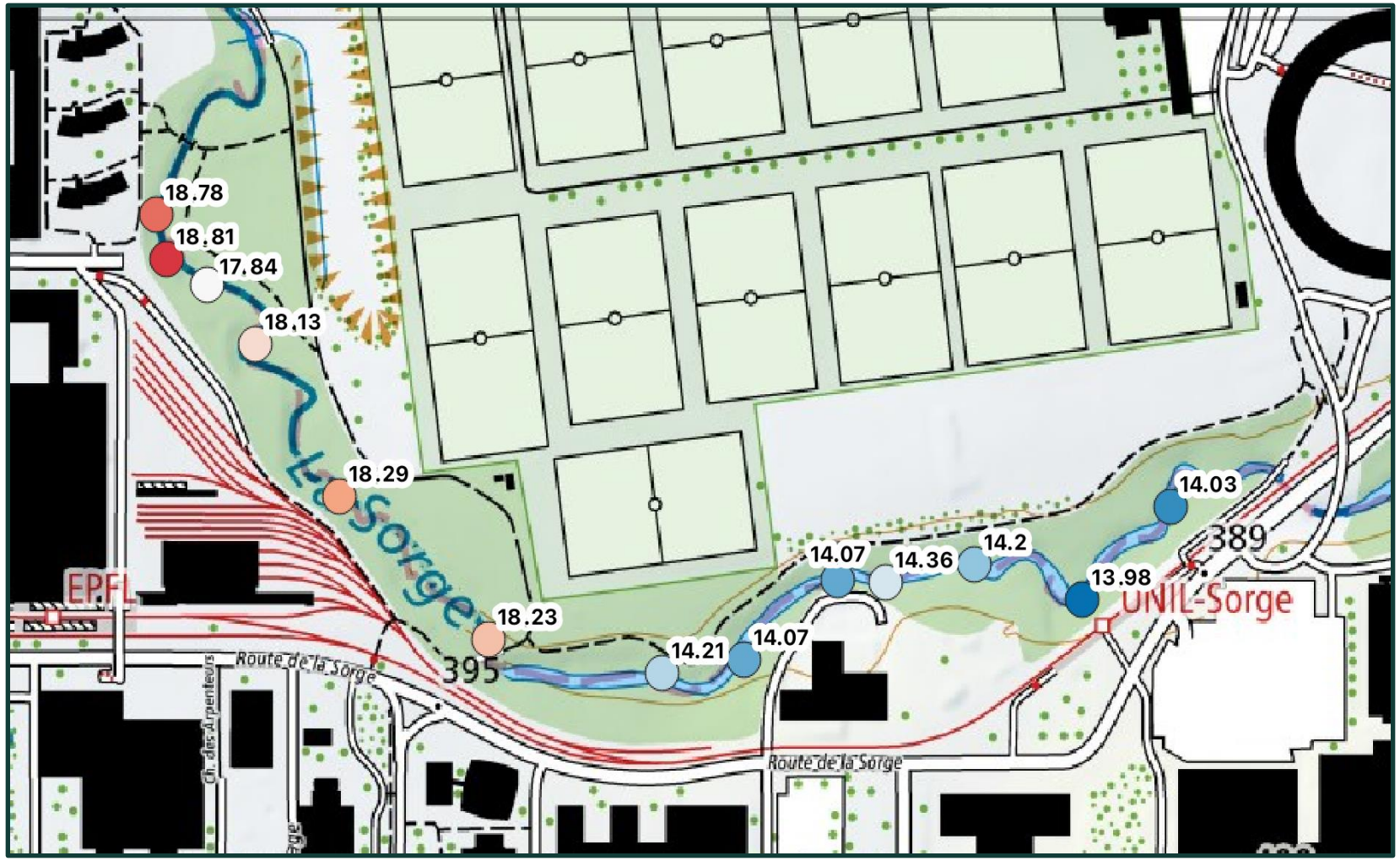

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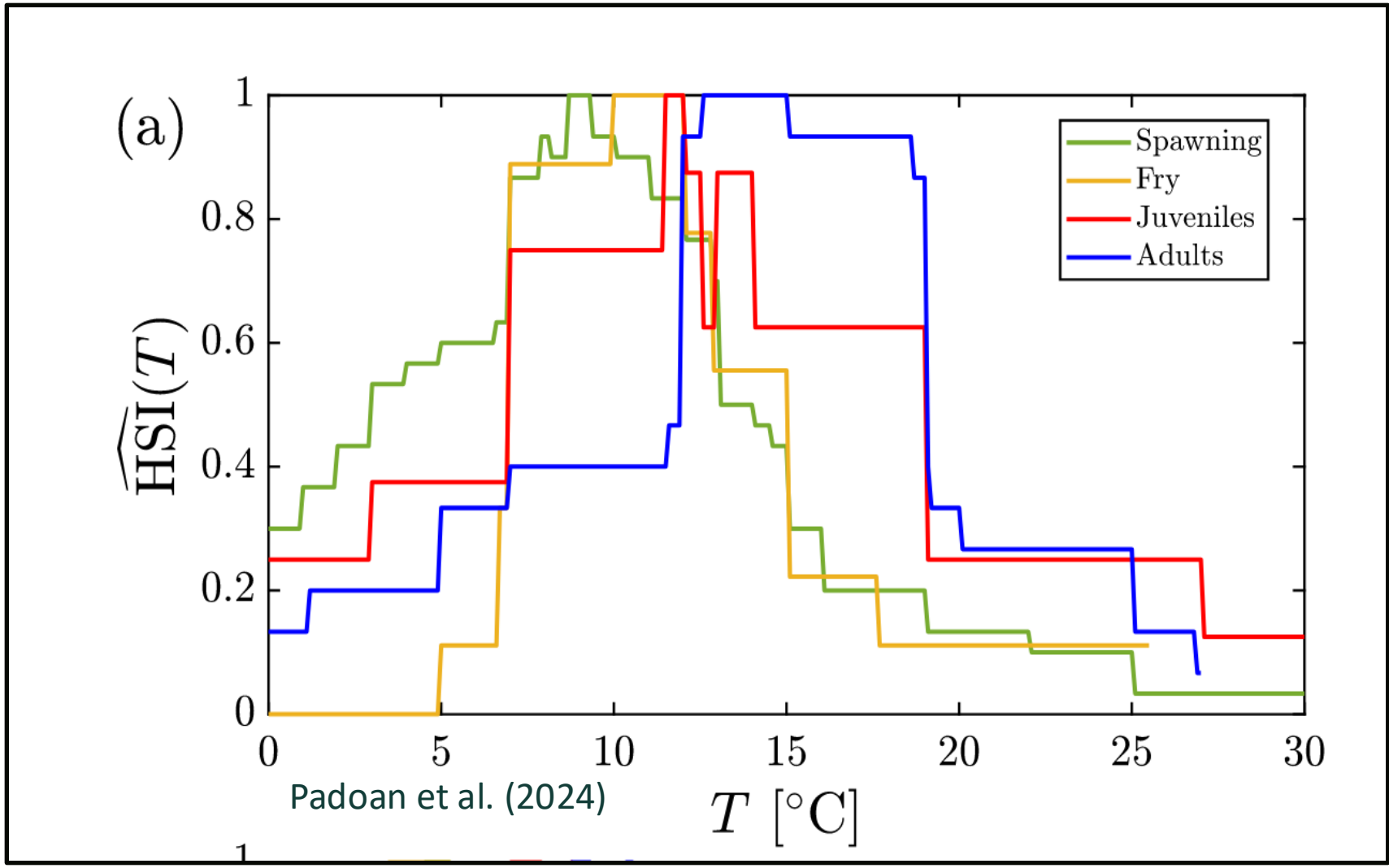

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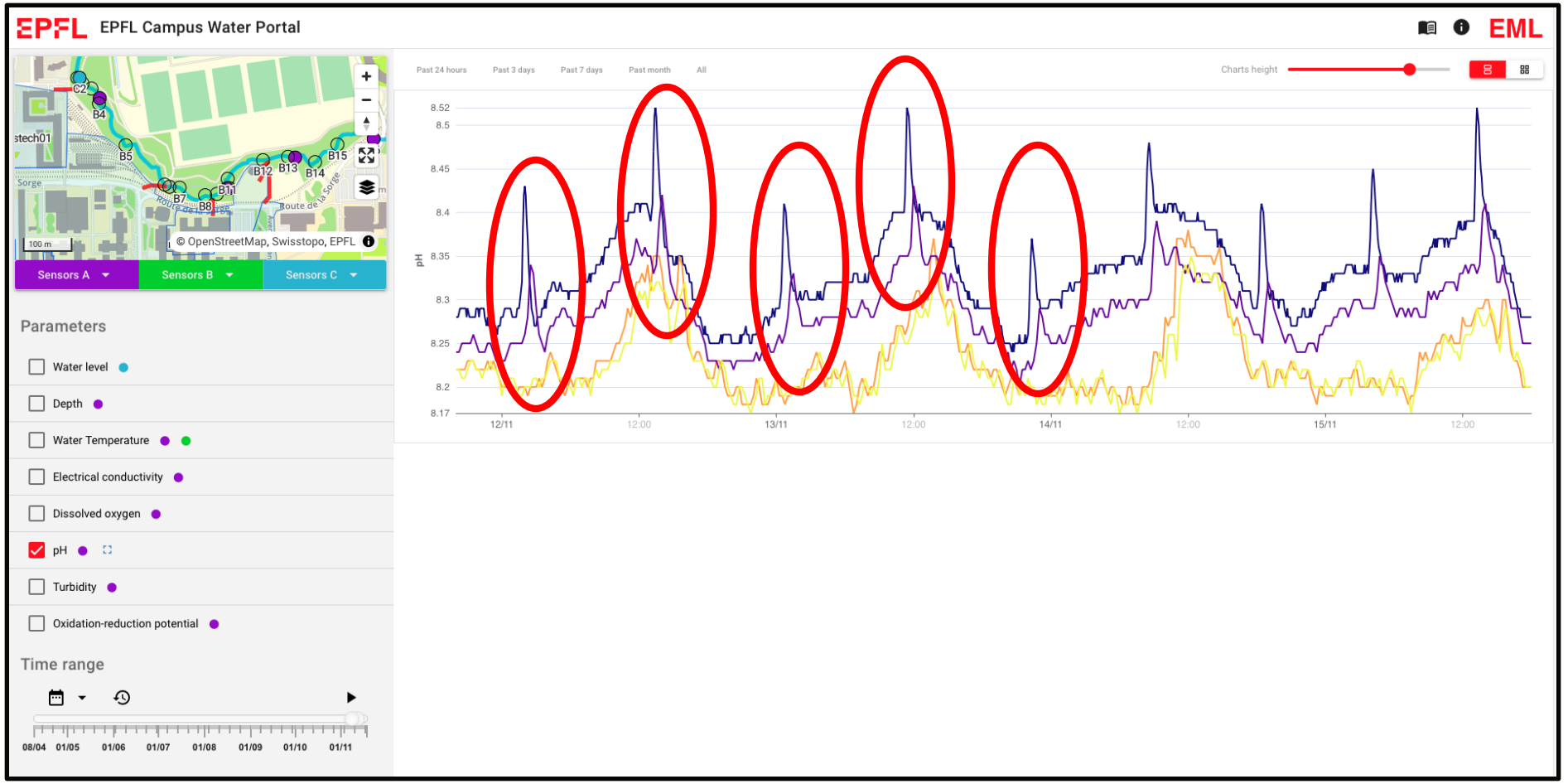
Results Sensors

- pH peaks of around 0.1 pH units since 1 November
- Intervals between peaks of 12 hours, then 8 hours and now 3 hours
- Where do these peaks come from?



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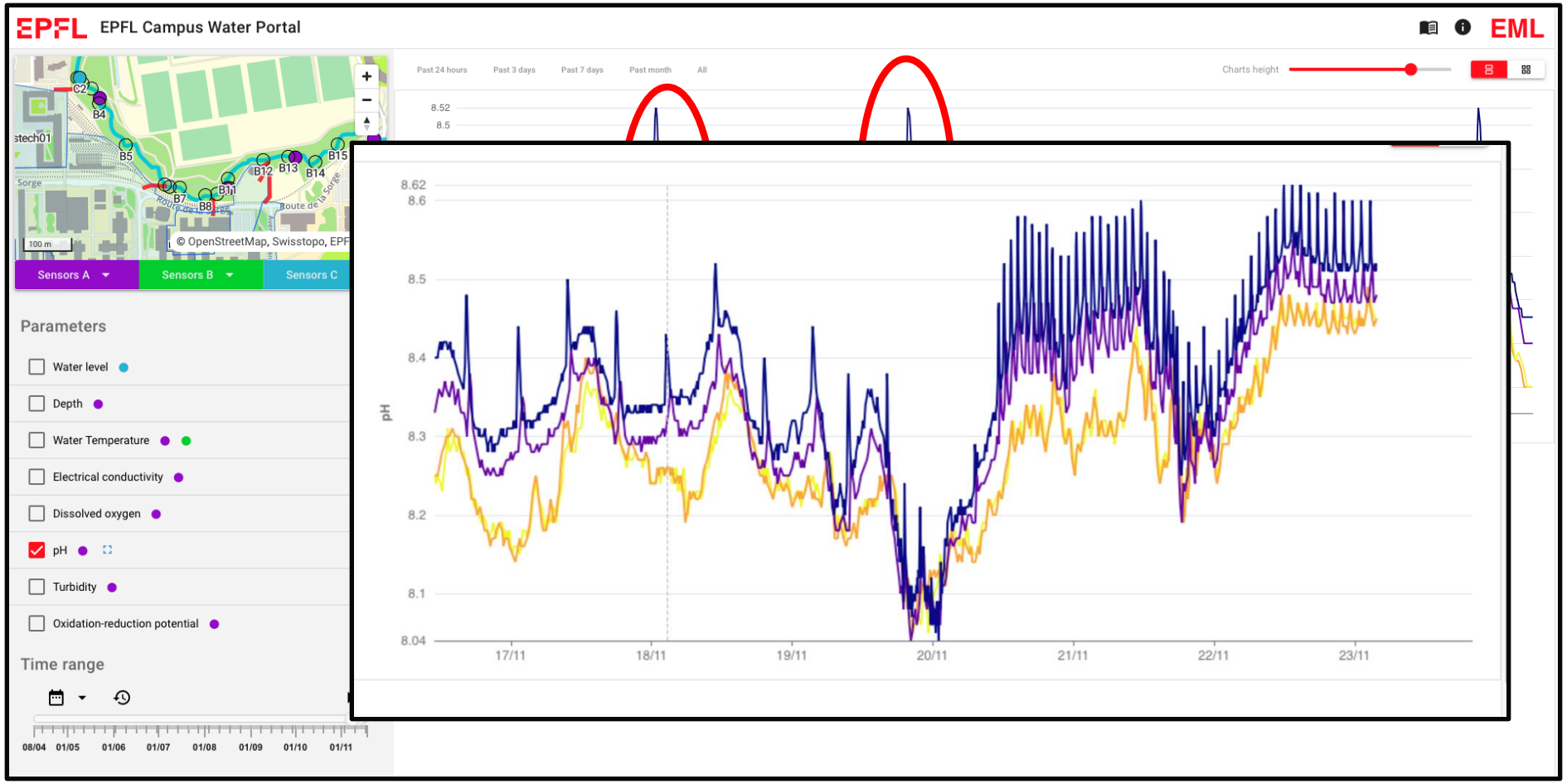
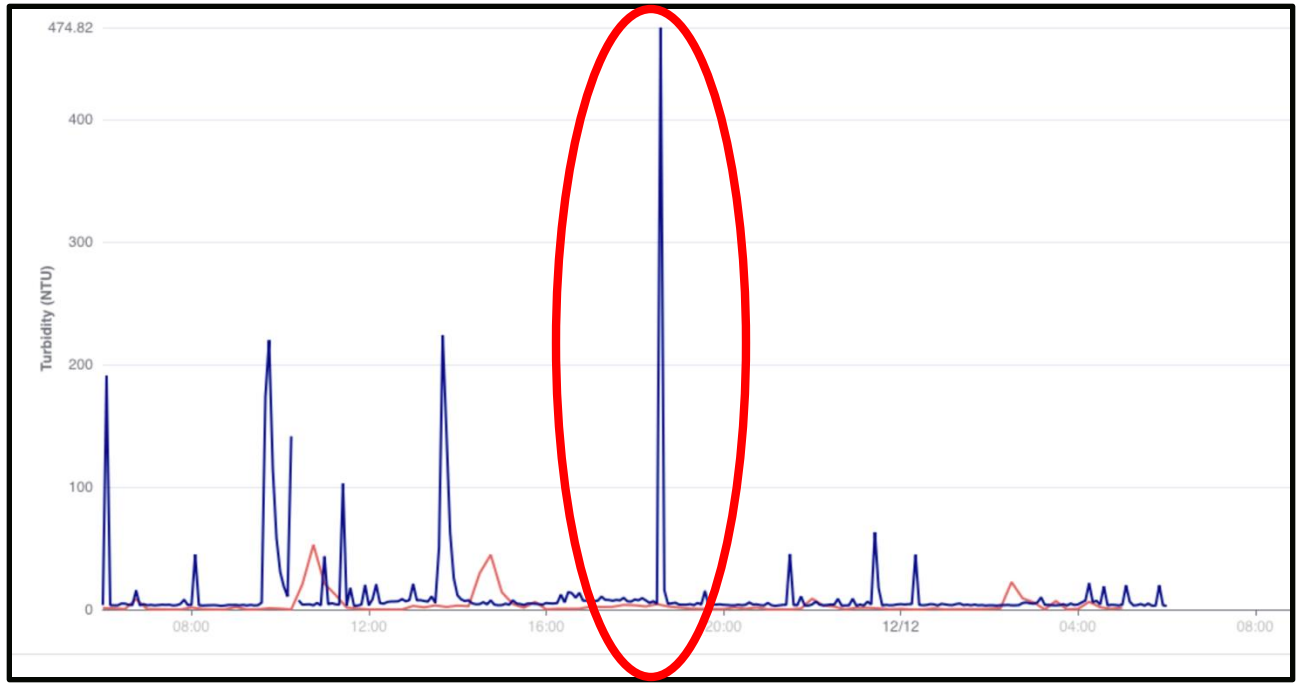


Data transfer issues

- Data transfer from the sensors to the DB
- 1: Different sensors
  - In-Situ: first sent to a website then data recovered from it
  - Ijinus: data transferred directly via FTPs
  - Ruskin: manual download
- 2: EPFL firewall
- 3: Data format (pluviometer not same as rest)

Outlier or missing data issues

- Some sensors are more sensitive, such as turbidity
- **There are 2 reasons for this**:
- 1: Development of ‘mud bands’
- 2: Presence of macrovertebrates on the sensors
- Missing data during calibration / maintenance / sensors sent back to factory / battery issues



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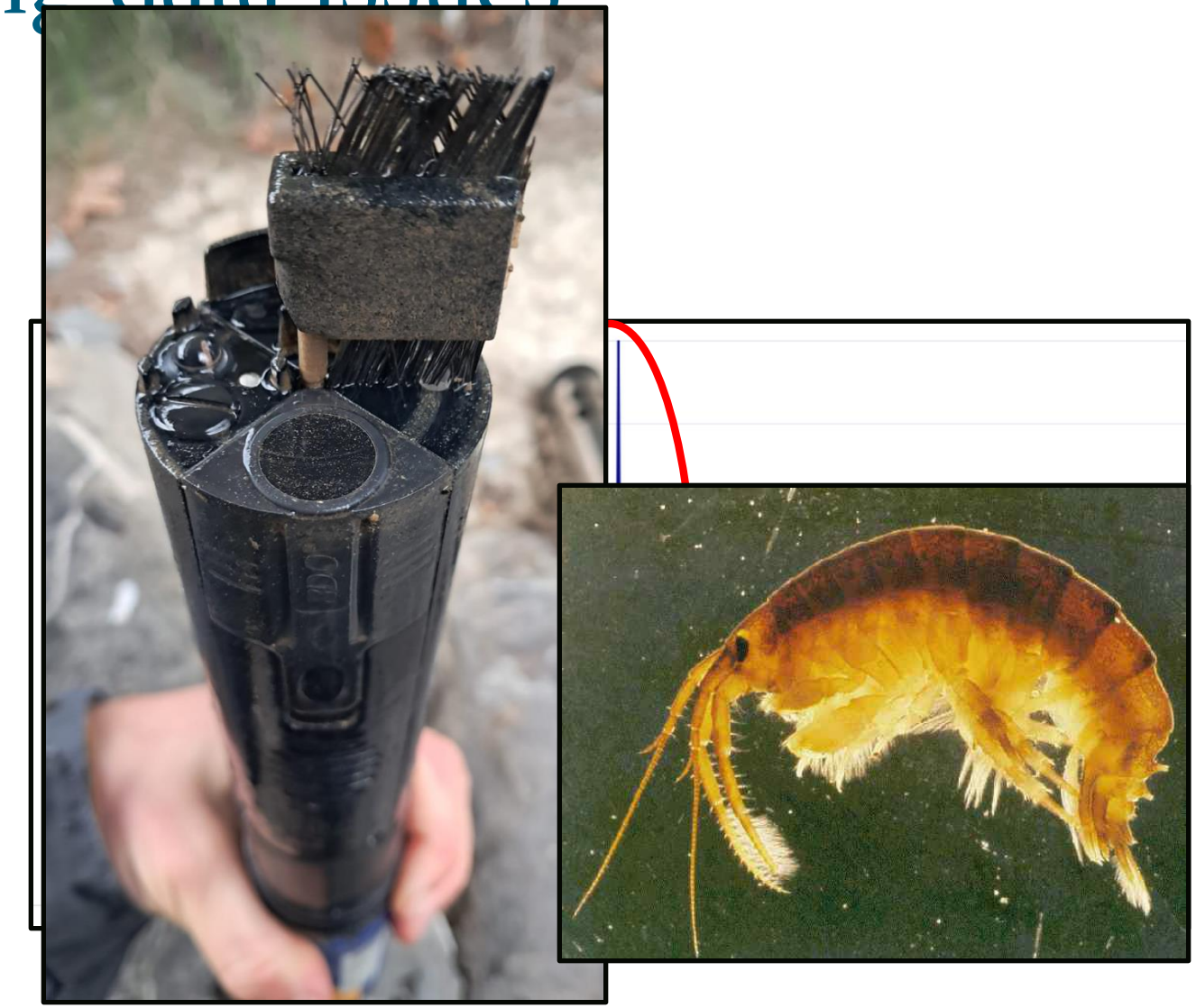

Laboratory instruments

ICP-MS : heavy metals

Orbitrap : organic compound

Laboratory instruments

ICP-MS : heavy metals

Sources:

Orbitrap : organic compound

Types of organic compounds:

- Pharmaceutical products
- Cosmetics
- Drugs
- Plant protection products
- Insect repellent
- Tire residues
- PFAs
- Food additives
- …

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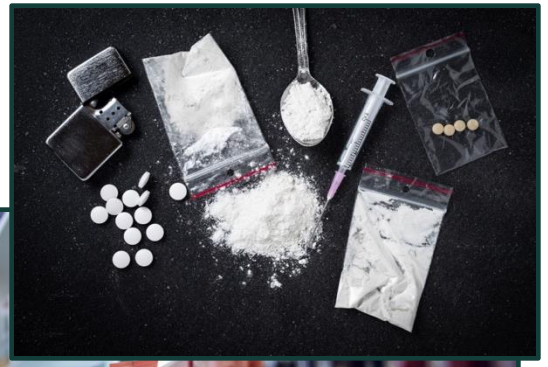

FRC cosmétiques

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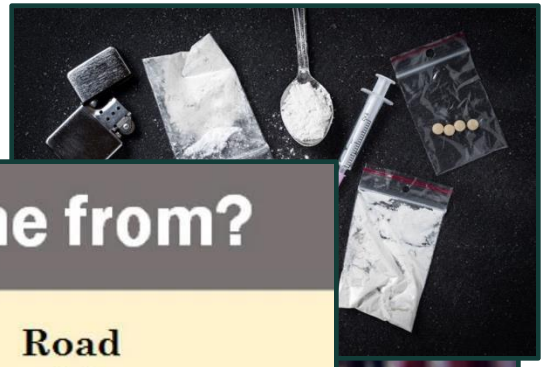

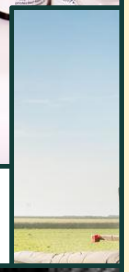

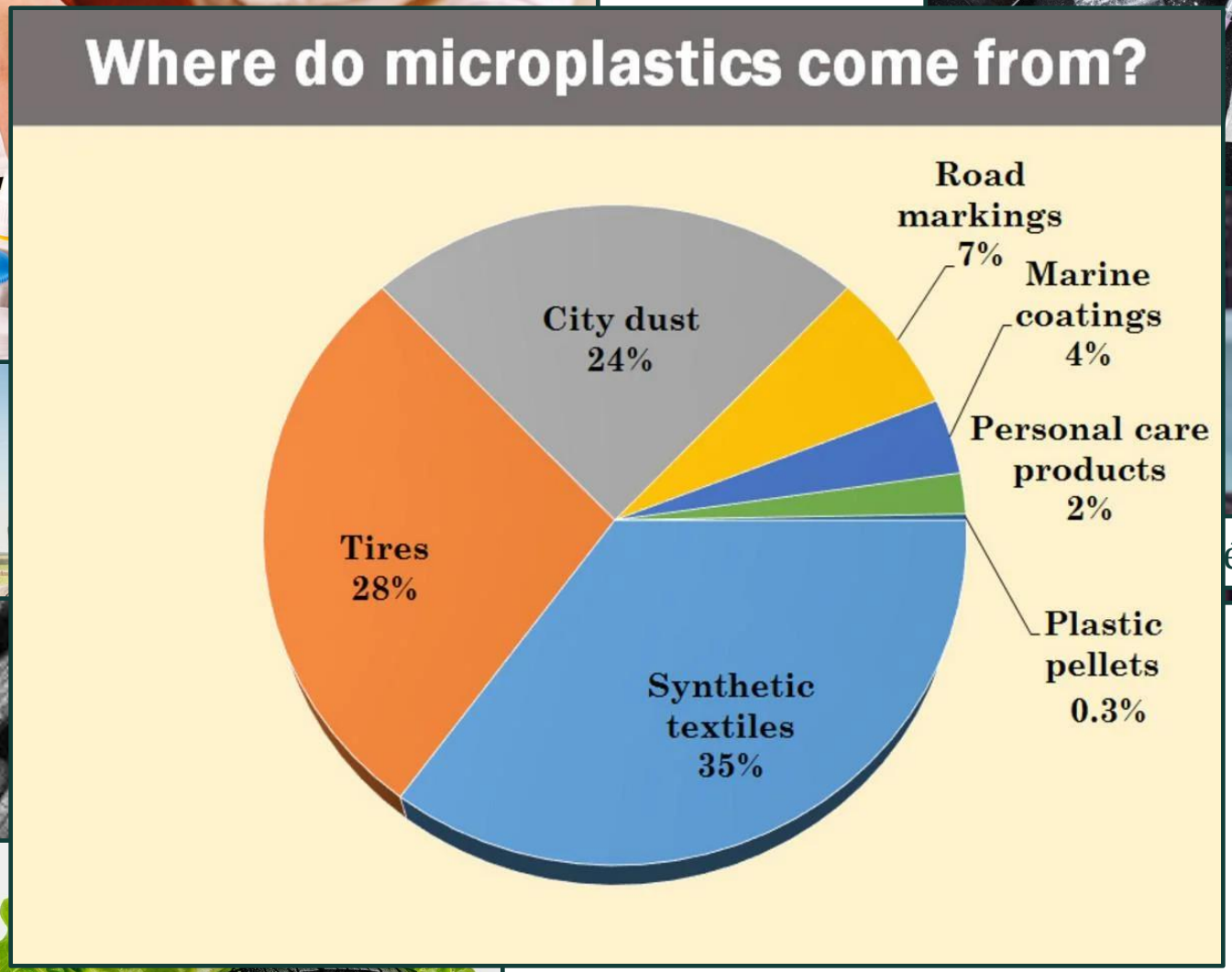

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Results laboratory analysis: Heavy metals

- Water samples from run-off and the river were analysed (heavy metals).

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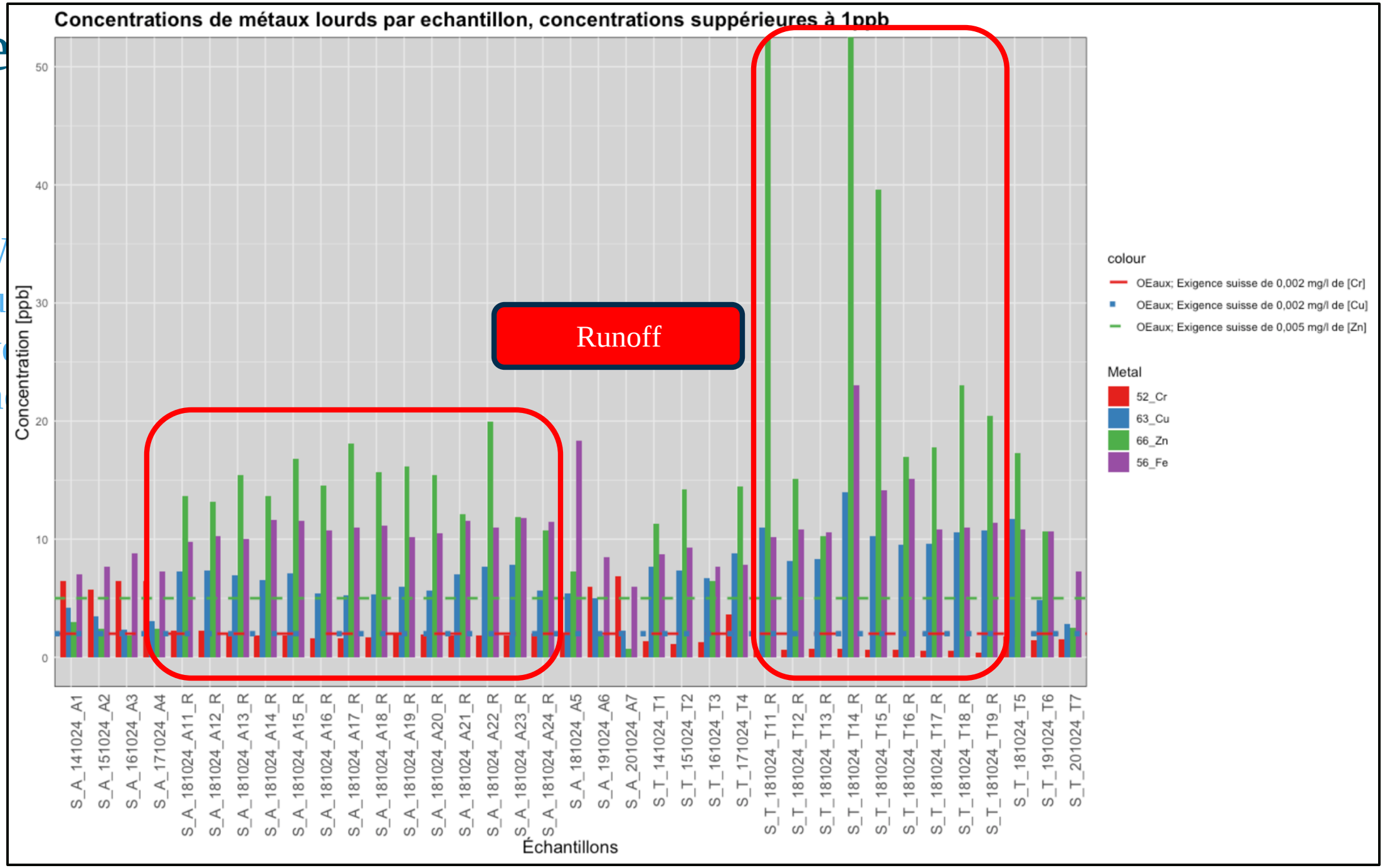
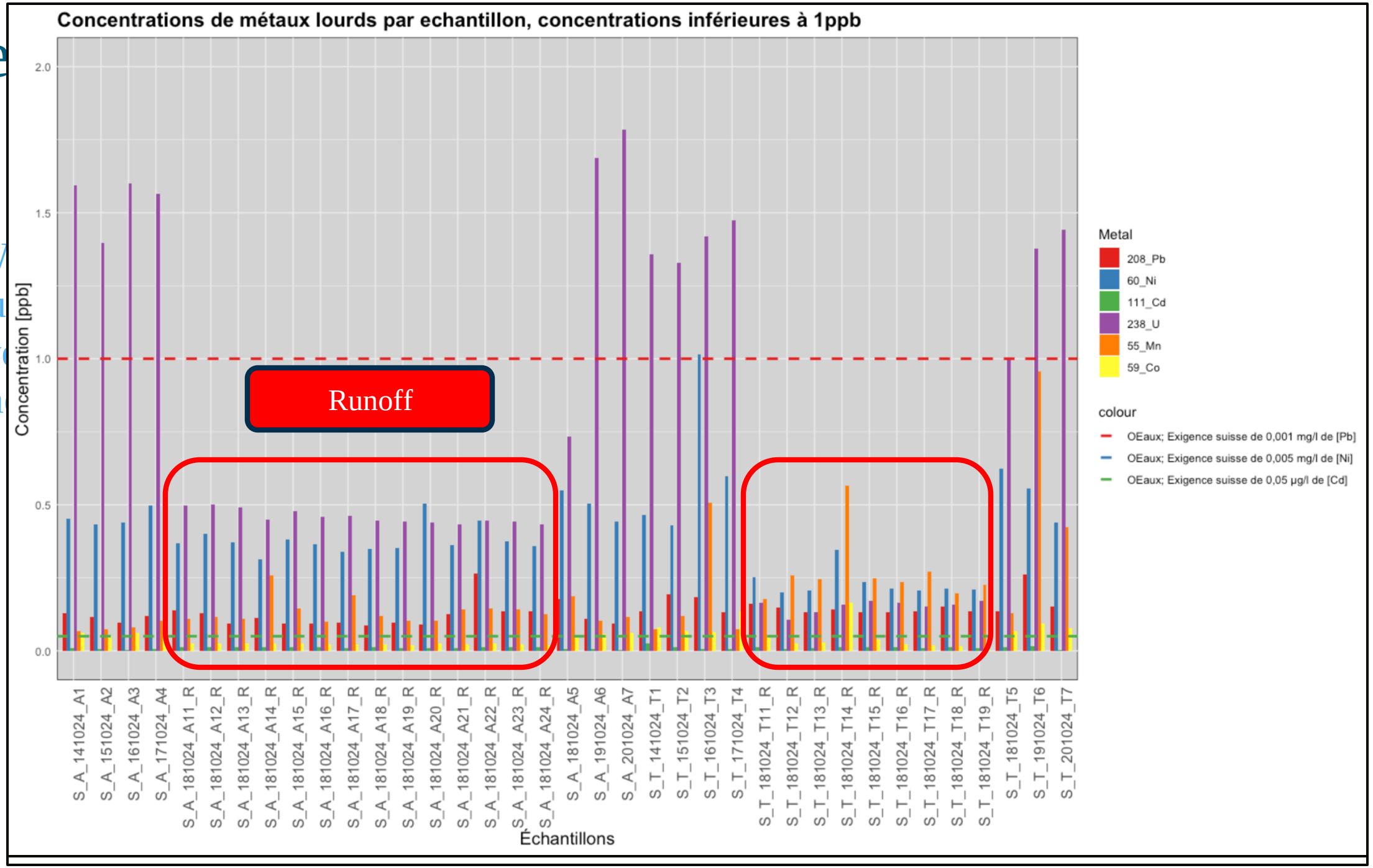
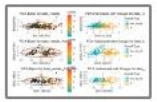

Concentrations de métaux lourds par echantillon, concentrations suppérieures à 1ppb
Concentration [ppb]
0
10
20
30
40
50
Runoff
S_A_141024_A1
S_A_151024_A2
S_A_161024_A3
S_A_171024_A4
S_A_181024_A11_R
S_A_181024_A12_R
S_A_181024_A13_R
S_A_181024_A14_R
S_A_181024_A15_R
S_A_181024_A16_R
S_A_181024_A17_R
S_A_181024_A18_R
S_A_181024_A19_R
S_A_181024_A20_R
S_A_181024_A21_R
S_A_181024_A22_R
S_A_181024_A23_R
S_A_181024_A24_R
S_A_181024_A5
S_A_191024_A6
S_A_201024_A7
S_T_141024_T1
S_T_151024_T2
S_T_161024_T3
S_T_171024_T4
S_T_181024_T11_R
S_T_181024_T12_R
S_T_181024_T13_R
S_T_181024_T14_R
S_T_181024_T15_R
S_T_181024_T16_R
S_T_181024_T17_R
S_T_181024_T18_R
S_T_181024_T19_R
S_T_181024_T5
S_T_191024_T6
S_T_201024_T7
Échantillons
colour
OEaux; Exigence suisse de 0,002 mg/l de [Cr]
OEaux; Exigence suisse de 0,002 mg/l de [Cu]
OEaux; Exigence suisse de 0,005 mg/l de [Zn]
Metal
52_Cr
63_Cu
66_Zn
56_Fe

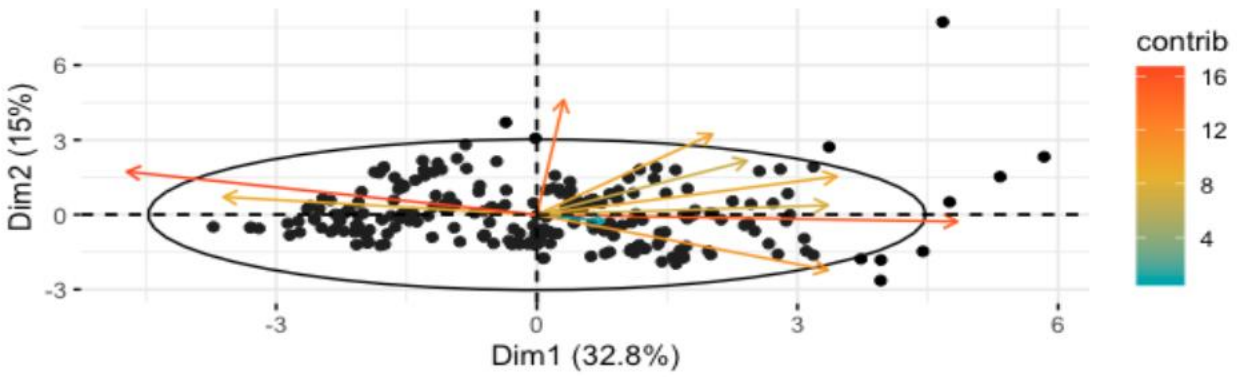
Re

- W
ru
w
m

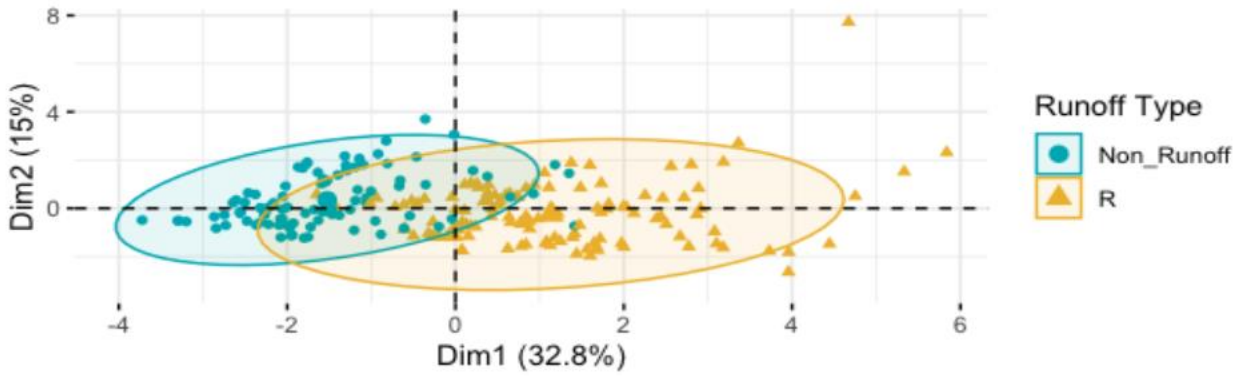

Concentrations de métaux lourds par echantillon, concentrations inférieures à 1ppb
Concentration [ppb]
2.0
1.5
1.0
0.5
0.0
Runoff
Échantillons
S_A_141024_A1
S_A_151024_A2
S_A_161024_A3
S_A_171024_A4
S_A_181024_A11_R
S_A_181024_A12_R
S_A_181024_A13_R
S_A_181024_A14_R
S_A_181024_A15_R
S_A_181024_A16_R
S_A_181024_A17_R
S_A_181024_A18_R
S_A_181024_A19_R
S_A_181024_A20_R
S_A_181024_A21_R
S_A_181024_A22_R
S_A_181024_A23_R
S_A_181024_A24_R
S_A_181024_A5
S_A_191024_A6
S_A_201024_A7
S_T_141024_T1
S_T_151024_T2
S_T_161024_T3
S_T_171024_T4
S_T_181024_T11_R
S_T_181024_T12_R
S_T_181024_T13_R
S_T_181024_T14_R
S_T_181024_T15_R
S_T_181024_T16_R
S_T_181024_T17_R
S_T_181024_T18_R
S_T_181024_T19_R
S_T_181024_T5
S_T_191024_T6
S_T_201024_T7
Metal
208_Pb
60_Ni
111_Cd
238_U
55_Mn
59_Co
colour
OEaux; Exigence suisse de 0,001 mg/l de [Pb]
OEaux; Exigence suisse de 0,005 mg/l de [Ni]
OEaux; Exigence suisse de 0,05 µg/l de [Cd]



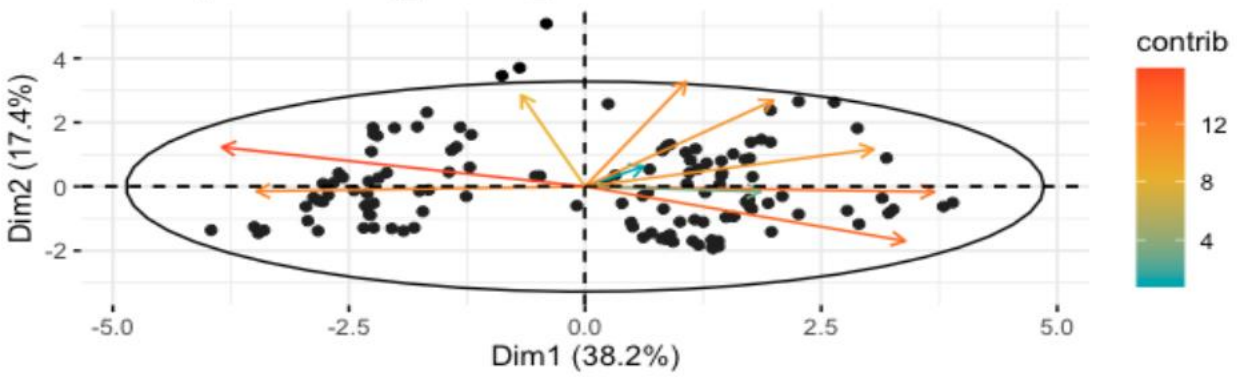
PCA Biplot for data_metals



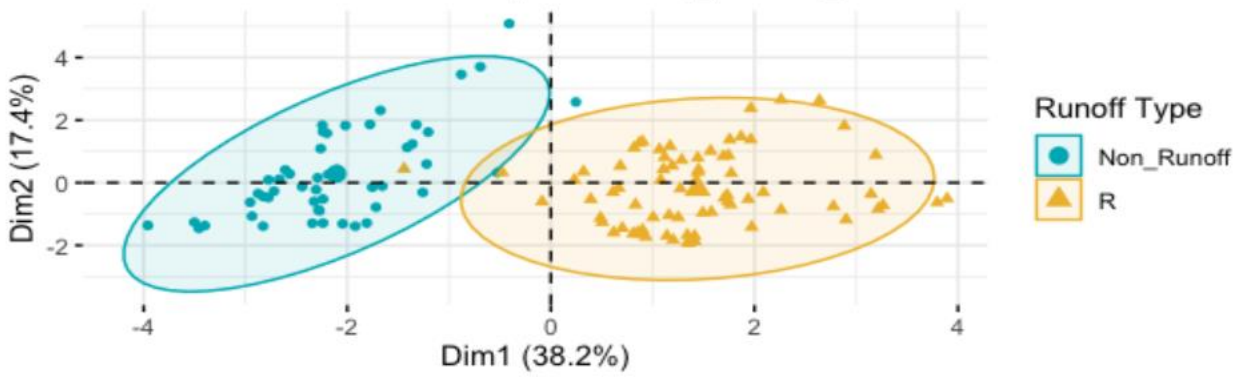
PCA Individuals with Groups for data_metals



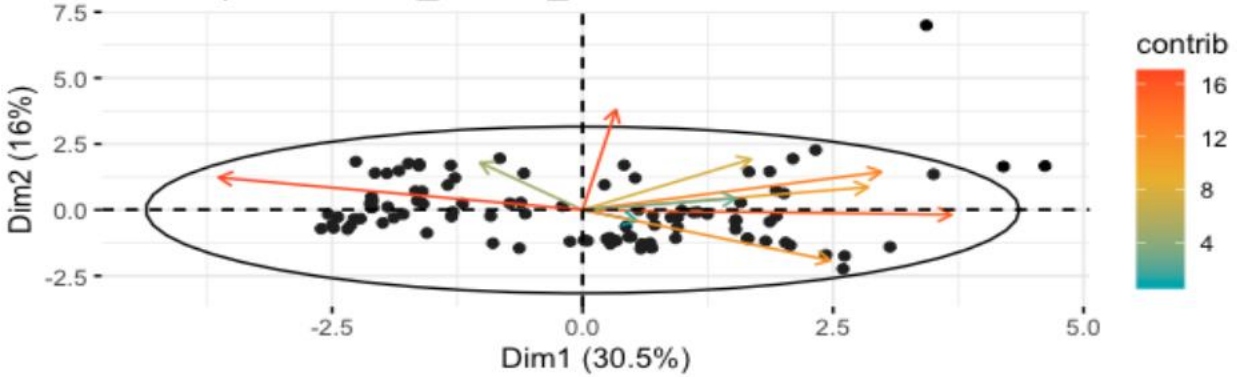
PCA Biplot for data_metals_Amont



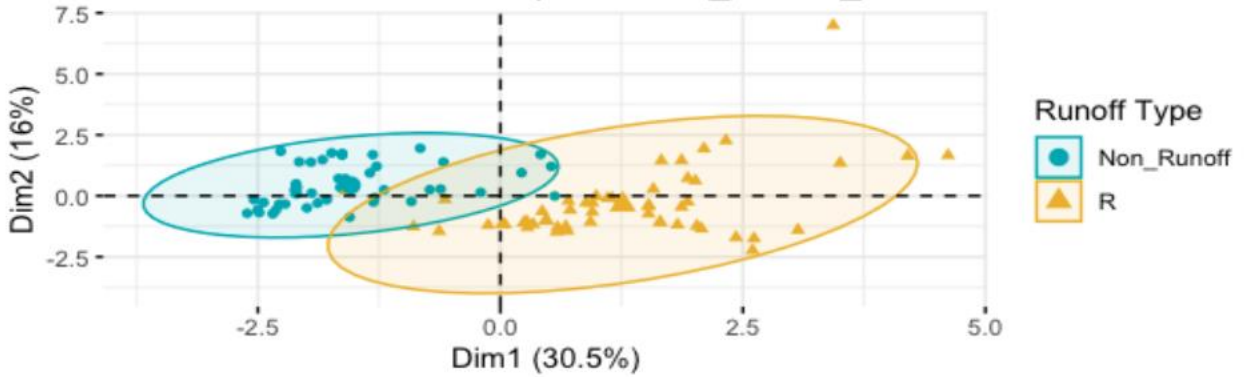
PCA Individuals with Groups for data_metals_Amont



PCA Biplot for data_metals_Triaudes



PCA Individuals with Groups for data_metals_Triaudes



Results laboratory analysis:

- Examples of compounds found in the river, in the outlet or in both

	A	B	C	D	E	F	G
1	Concentration in water (ng/L)	Aniline	1,3 diphenylguanidine (DPG)	6PPD-Quinone	Hexamethoxymethylmelamine (HMMM)	1,3 dicyclohexylurea (DCU)	IPPD-quinone
2	R1S08	198,1	8680,6	4,3	69,4	664,4	<LOQ
3	R2S08	571,4	2837,0	62,1	1397,7	317,6	<LOQ
4	R11S08	1276,5	3677,7	205,9	4330.6	547,3	12,8
5	C1S08	52,4	298,9	3,2		20,3	<LOQ
6	C2S08	588,5	2427,9	74,5		253,0	<LOQ
7	C11S08	1108,7	3165,0	161,7		432,3	8,4
8	X1S08	41,2	683,8	3,1		16,6	<LOQ
9	X11S08	199,4	802,6	23.2		53,8	<LOQ
10							
11	**Infos à confirmer:**						
12	**R (échantillons amont d'un drain)**						
13	**C (échantillons aval d'un drain)**						
14	**X (échantillon du drain)**						
15							
16	**Echantillons 1 et 2 en période sèche et 11 en période de crue**						
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29			**Données de concentrations dans d'autres drains du canton en période de pluie (collab DGE Vaud)**				
30							

6-PPDQ has a LC50 for coho salmon juvenils at 0.095 µg/L → 95 ng/L

Washington State Department of Ecology

Concentration (ng/L)	Aniline	DPG	6-PPDQ	HMMM	DCU
P_V_3 (Venoge)	9968	19529	1276	13544	4954
P_V_2 (Venoge)	12273	10990	854	17985	4954
MPlast A (Talent)	4709	24501	849	4037	922
MPlast B (Talent)	3785	15591	612	4172	942
Tolochenaz_1 (Boiron)	3749	14040	707	8146	1634
Tolochenaz_2 (Boiron)	3195	9467	736	2472	1014
Tolochenaz_3 (Boiron)	1934	5714	520	1322	594
Ballens (Boiron)	308	809	81	364	69
Cheseaux (La Mèbre)	3532	18589	782	5014	777
Pigeon (Le Grenet)	2505	5024	360	2615	615
rond_point (Le_Grenet)	606	2249	129	655	115
Lac_de_Bret	2771	3730	475	2127	666
Tolochenaz_prlvt_inst (Boiron)	4322	17972	829	7722	789
Tolochenaz_prlvt (Boiron)	9982	24756	1002	9201	1514
Promenthouse_prlvt_inst_RD	n.d	n.d	n.d	n.d	n.d
Promenthouse_prlvt_RD	2084	5731	381	6337	603
Promenthouse_prlvt_RG	5011	15834	730	8995	1751

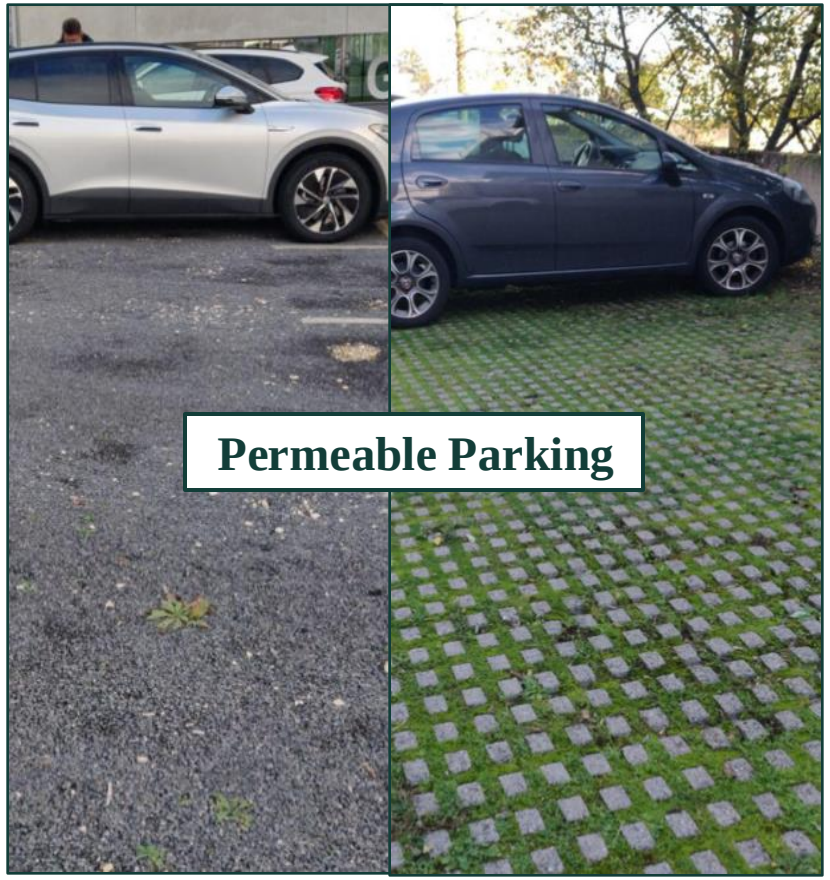
EPFL Campus Water Portal

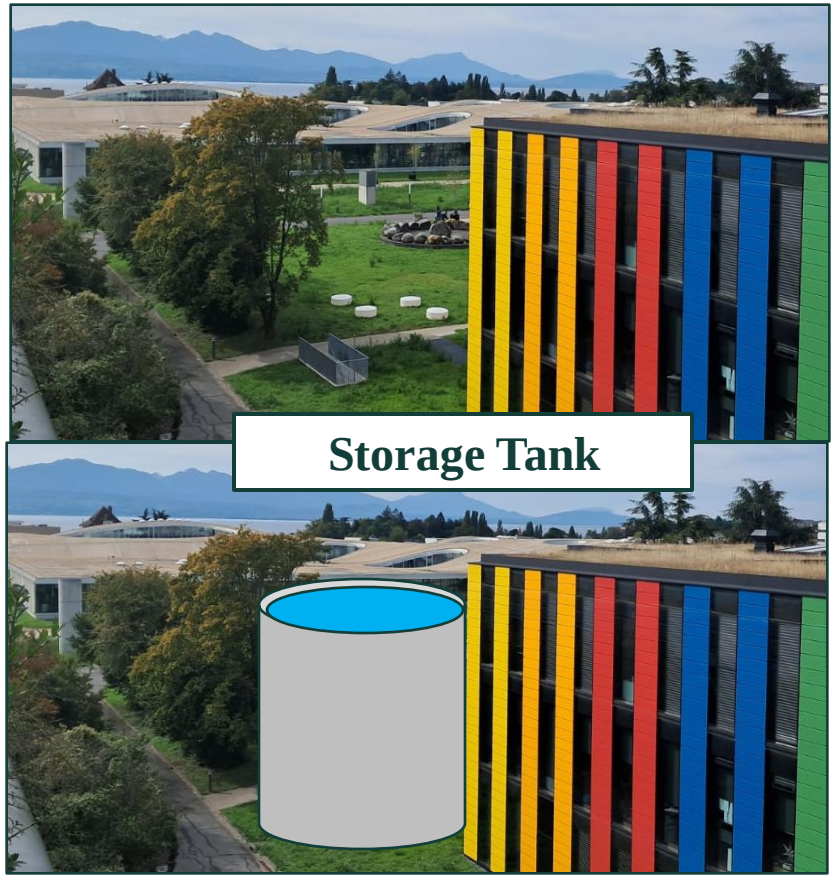
- Soon available on the website of the Environmental Microbiology Laboratory (EML)
- Open to all (Canton gave permission)
- Daily update of the data
- Scenario testing to design «sponge city» type of infrastructure to decrease runoff
- Link: https://water-portal-dev.epfl.ch

EPFL Campus Water Portal

- Not fully finished
- If you are interested in this data, please contact me at the following address
- dan.andersson@epfl.ch

EPFL Campus Water Portal: Solutions to decease infiltration



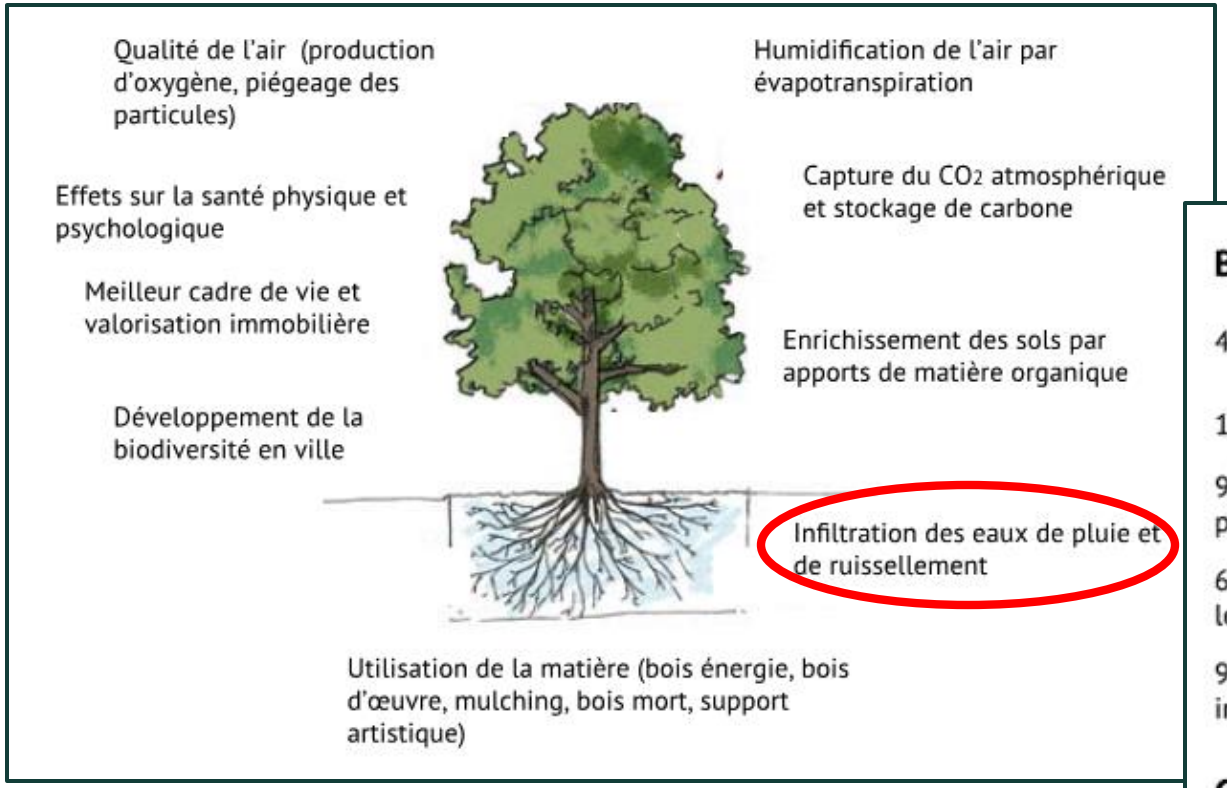


EPFL Campus Water Portal: Solutions to decease infiltration

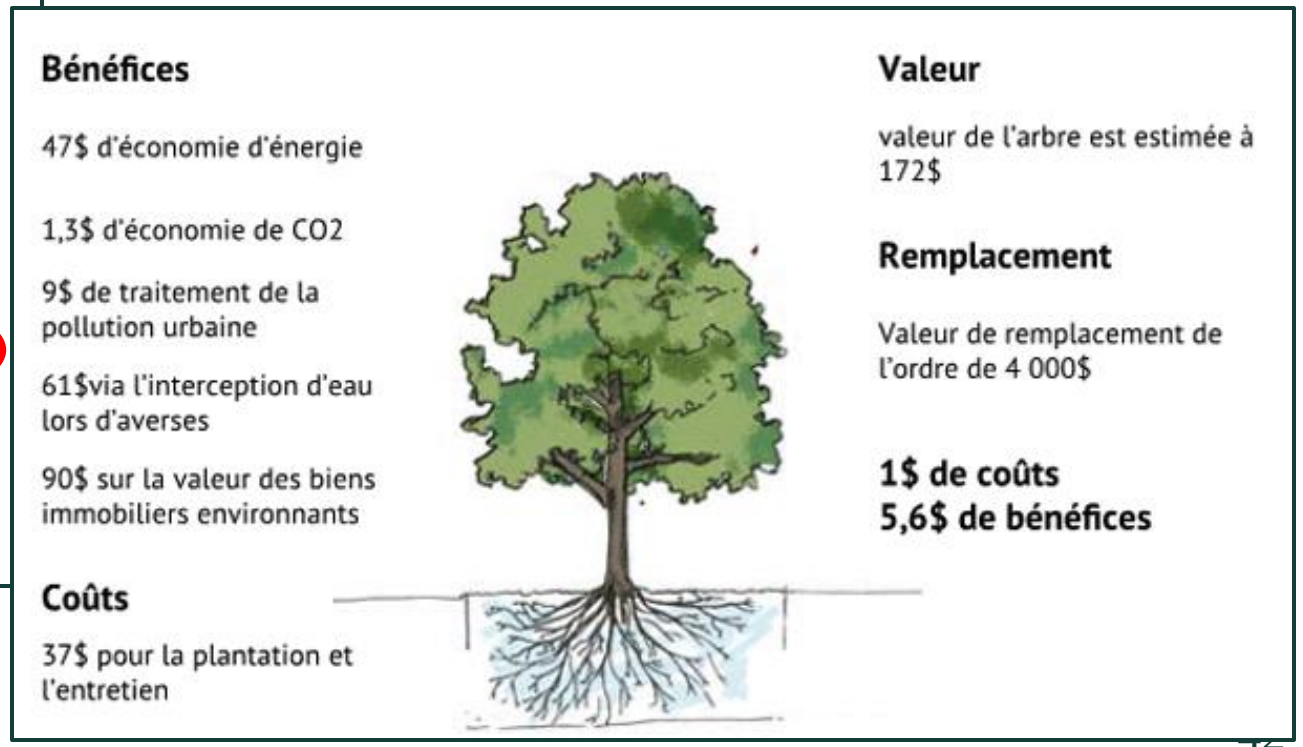
EPFL Campus Water Portal: Solutions to decease infiltration

EPFL Campus Water Portal: Solutions to decease infiltration

What are the benefits of having trees in cities?

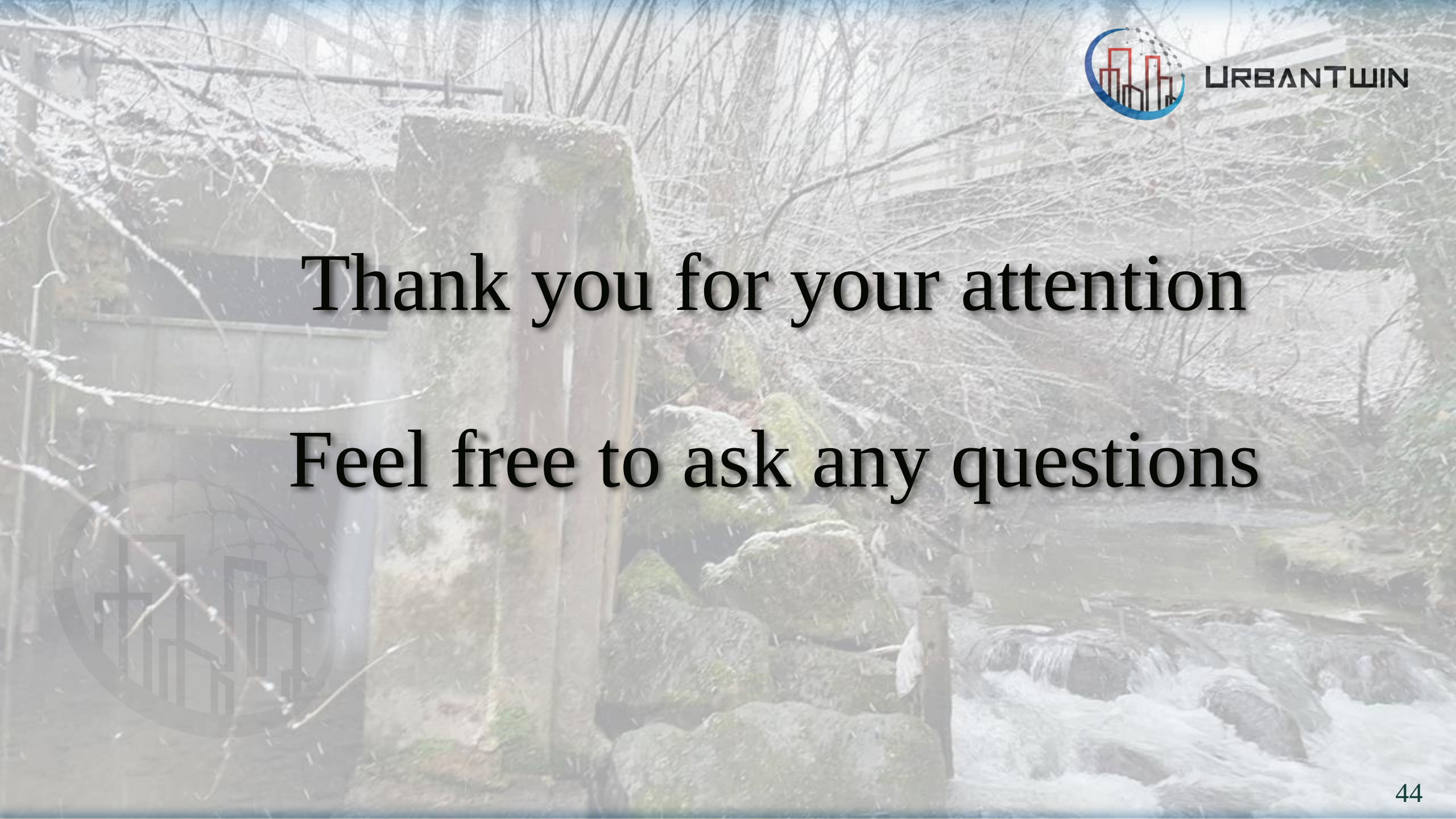


Study made by the City of New-York



Source: https://conseils.xpair.com/actualite_experts/arbre-en-ville-outil-territoires.htm

Negative aspects of the project: Unexpected stolen sensor issues



Thank you for your attention

Feel free to ask any questions