

# Long term monitoring of the Parisian conurbation: trends and perspectives

**Gauthier Bernier-Turpin**<sup>1, 2\*</sup>, Thomas Thiebault<sup>2</sup>, Julien Le Roux<sup>1</sup>, Fabrice Alliot<sup>2</sup>, Emmanuelle Mebold<sup>3</sup>, Sabrina Guérin<sup>4</sup> & Régis Moilleron<sup>1</sup>

<sup>1</sup>Leesu - Univ Paris Est Creteil, Ecole des Ponts, Creteil, F-94010, France

<sup>2</sup>METIS, Sorbonne Université, CNRS, EPHE, PSL University, UMR 7619, F-75005 Paris, France

<sup>3</sup>OSU-EFLUVE, PRAMMICS platform, UPEC, CNRS, F-94010 Créteil, France

<sup>4</sup>SIAAP, Innovation Department, FR-92700 Colombes, France

\*Corresponding author email: [gauthier.bernier-turpin@u-pec.fr](mailto:gauthier.bernier-turpin@u-pec.fr)

# Context : wastewater-based-epidemiology (WBE)

**2001** : Wastewater is the reflect of exposure/consumption of a population within a determined WWTP catchment

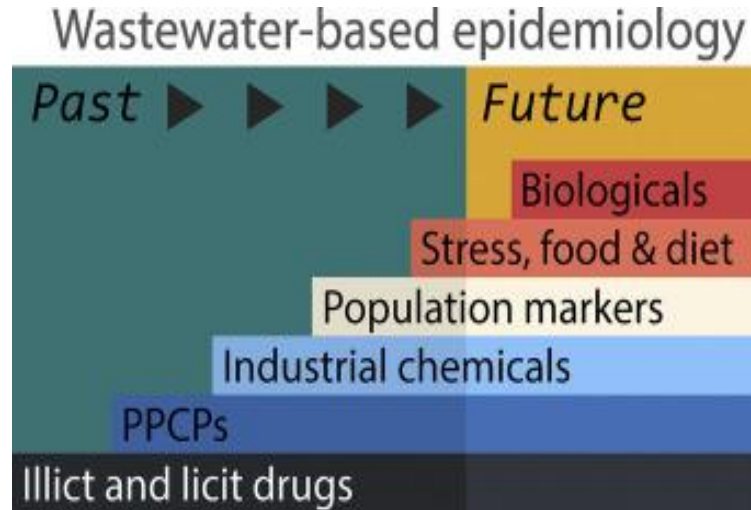
## Chapter 20

### Illicit Drugs in Municipal Sewage

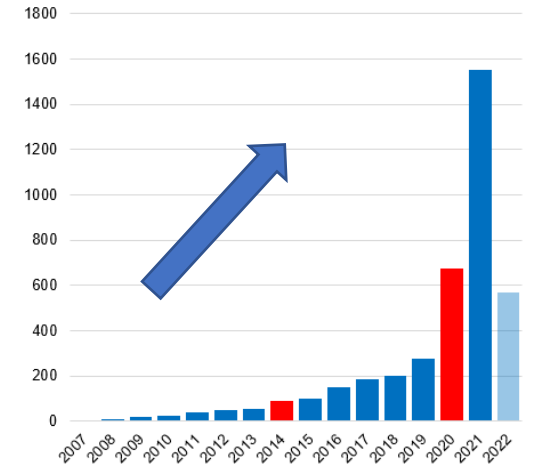
Proposed New Nonintrusive Tool to Heighten Public Awareness of Societal Use of Illicit-Abused Drugs and Their Potential for Ecological Consequences

Christian G. Daughton

*Daughton et al., 2001, ACS Symp. series*



*Choi et al., 2018, TrAC*



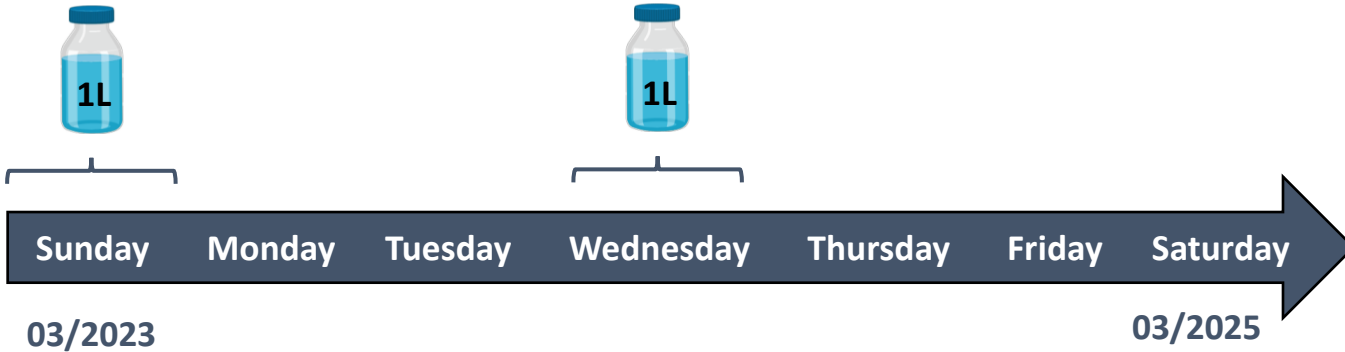
**2008** : first complete WBE study based on drug consumption in Italy (Zuccatto)

**Since 2010** : expansion to broader topics (PPCP's dietary intake...)

**2020** : Covid-19 pandemic monitoring using wastewater → growing interest

# Sampling site (urban observatory)

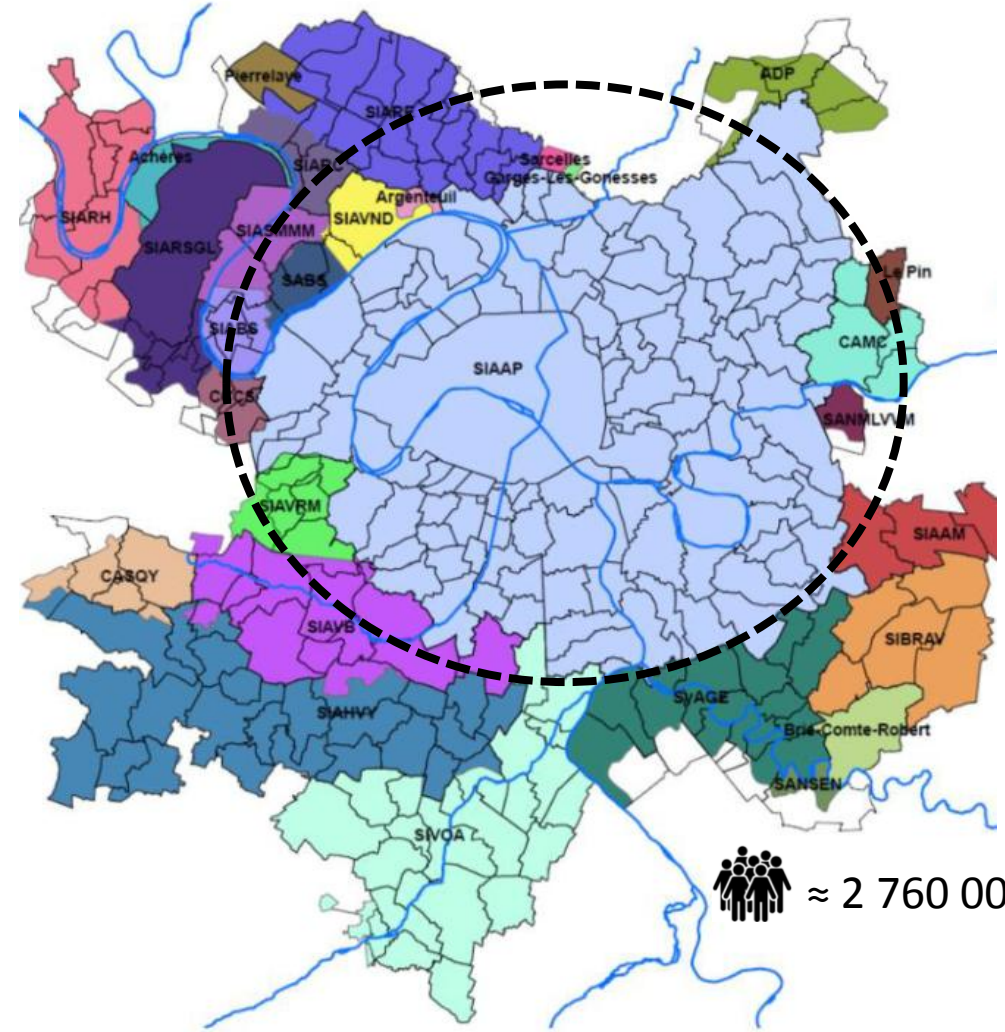
- Influent wastewater (IWW) gathered from the Parisian conurbation
- Monitoring planned for 2 years (from march 2023 to march 2025)
- Combined sewer network (domestic + rain water)



- **Targets** : licit and illicit drugs, PPCP's, dietary intake markers ( $\approx 60$ )...

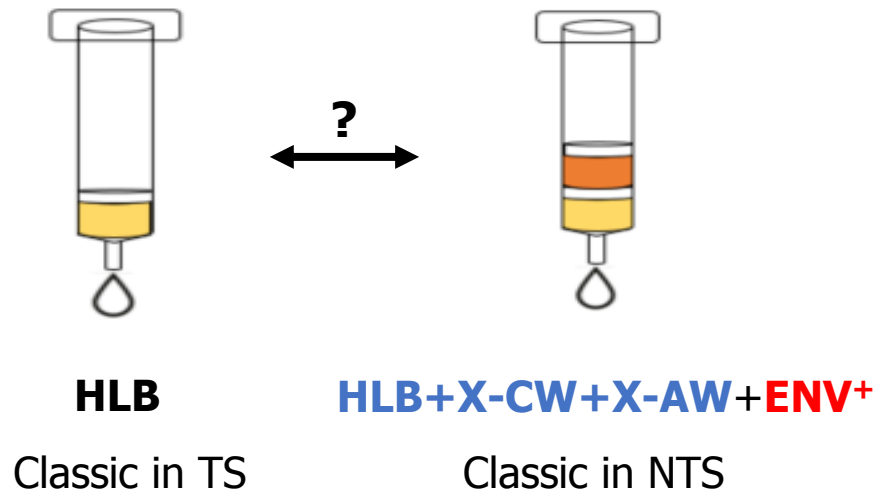


- Addition of **non-target** screening (NTS) using HRMS

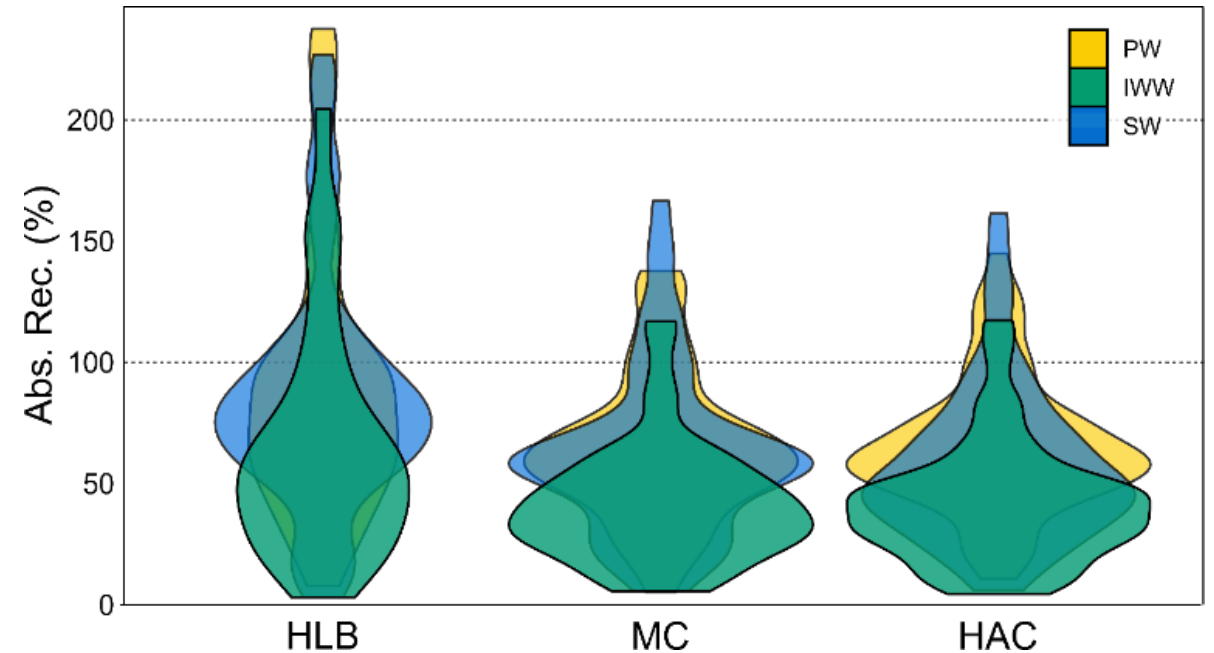


**Analytical procedure** : SPE followed by LC-MS/MS injection for analysis of targeted compounds and HRMS screening :

Selection of suitable SPE protocol : **1) recovery of target compounds**



Addition of ion-exchange materials reduces low recoveries for charged hydrophilic compounds

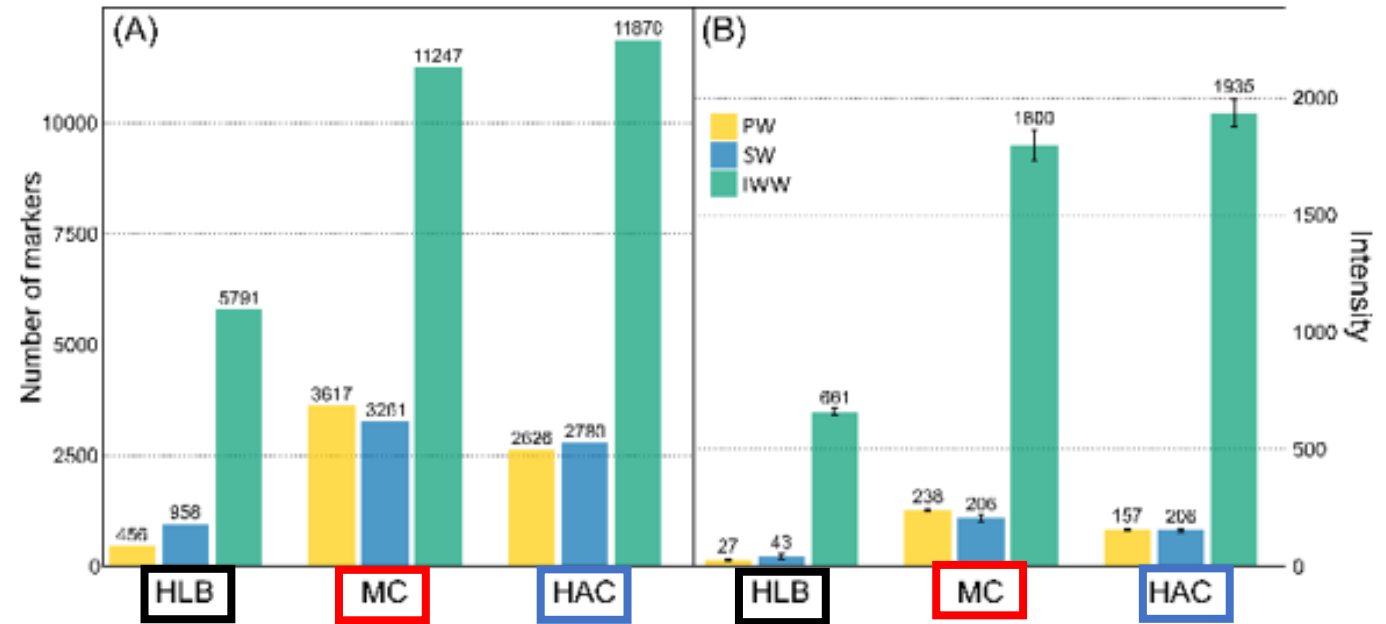
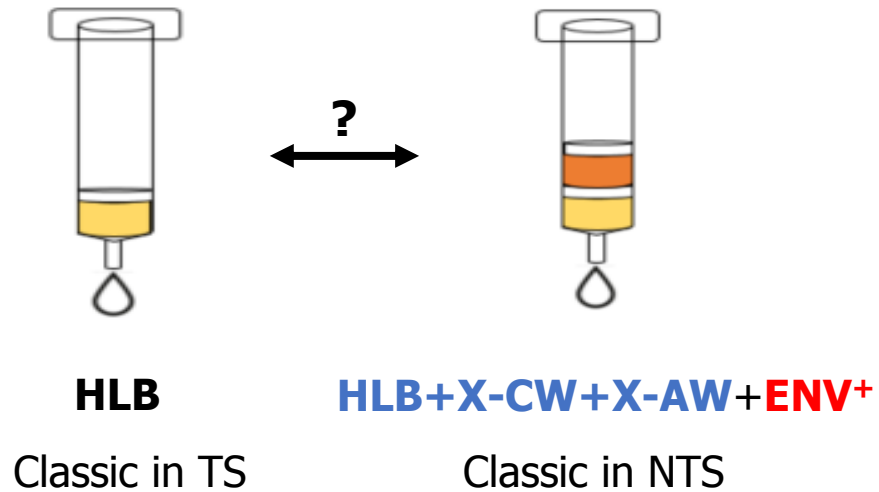


*Bernier-Turpin et al., submitted*

# Methodology

**Analytical procedure** : SPE followed by LC-MS/MS injection for analysis of targeted compounds and HRMS screening :

Selection of suitable SPE protocol : **2) HRMS potential**



*Bernier-Turpin et al., submitted*

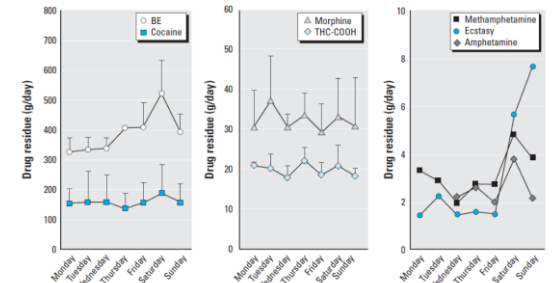
Higher number of features and intensity with multi-layered cartridge

→ favourable conditions for HRMS

# Objectives

Deploy a long-term observatory for global health prediction within the Parisian conurbation through wastewater analysis

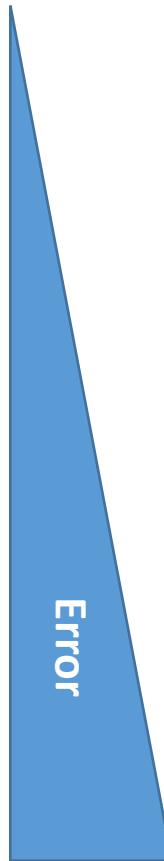
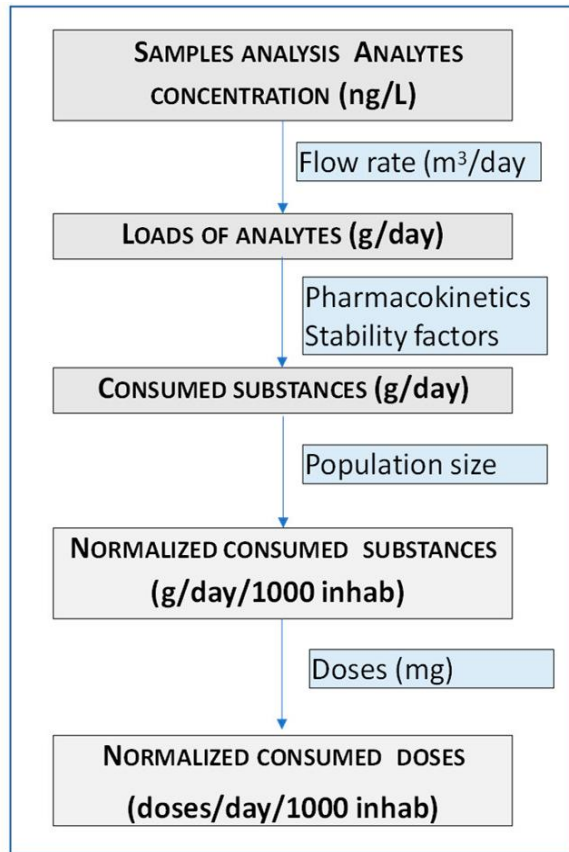
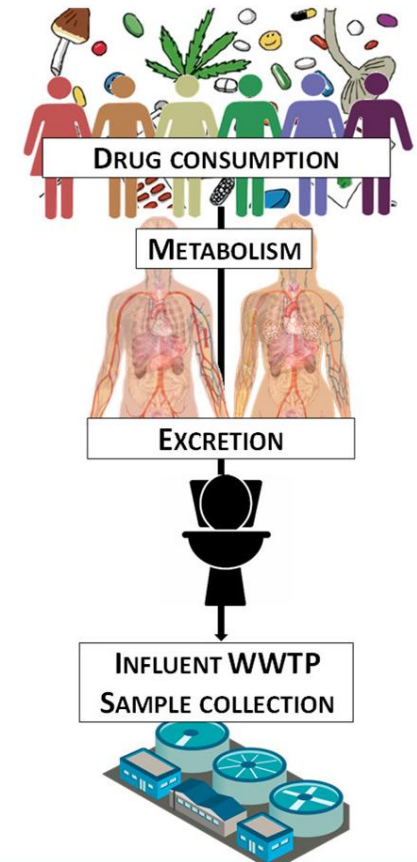
- Compare local trend to existing pattern observed elsewhere on common WBE targets
- Explore the variability of some recently proposed WBE markers
- Explain recorded trends by confronting acquired data to external factors



*Zuccatto et al., 2008, Env. Hea. Persp*



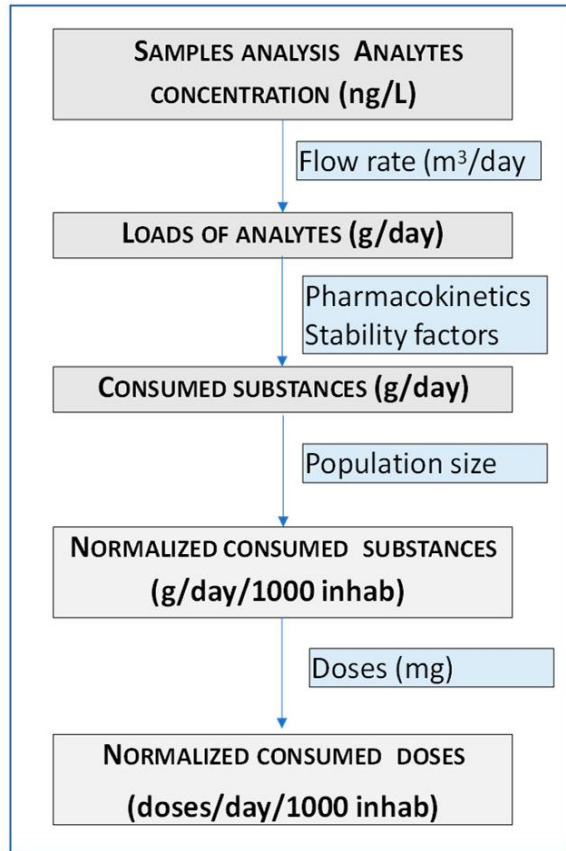
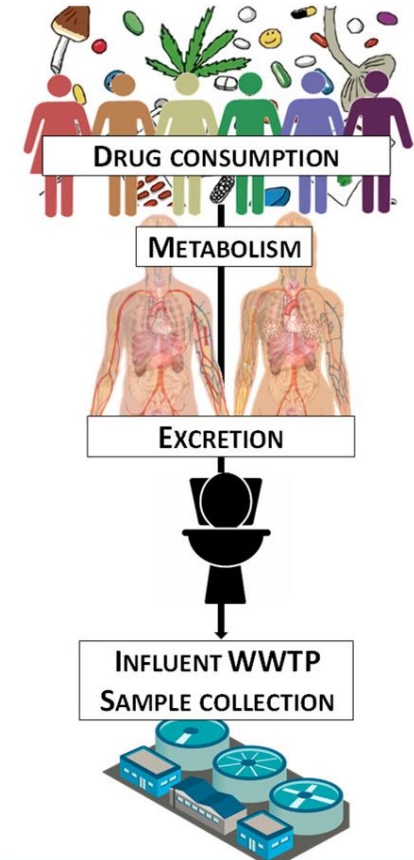
# Workflow



*Pico & Barcelo, 2021, ACS Omega*

# Workflow

Exemple for a widely used compound : Acetaminophen (Paracetamol)



Flow rate (m<sup>3</sup>/day) ≈ 50-150 µg/L

*Flow rate (m<sup>3</sup>) ≈ 750 000*

LOADS OF ANALYTES (g/day) ≈ 30-200 000 g/day (excreted)

Pharmacokinetics  
Stability factors

*C.F. : 1.8 (55% excretion)*

CONSUMED SUBSTANCES (g/day) ≈ 50-350 000 g/day (consumed)

Population size

*Population ≈ 2 700 000*

NORMALIZED CONSUMED SUBSTANCES (g/day/1000 inhab) ≈ 20-150 g/day per 1000 inhabitants

Doses (mg)

*DDD = 3 g*

NORMALIZED CONSUMED DOSES (doses/day/1000 inhab) ≈ 5-50 DDD/day per 1000 inhabitants

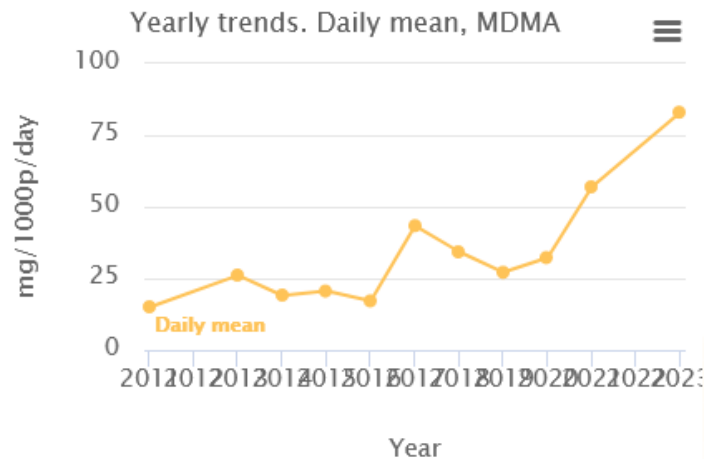
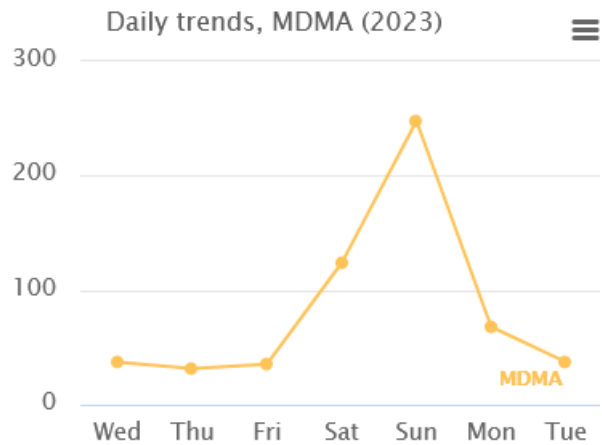
National prevalence (based on sales data) : ≈ 5%

Pico & Barcelo, 2021, ACS Omega



# From a local perspective...

Monitoring of MDMA : a known case of short temporal pattern



Source : EMCDDA, SCORE network

## Previous data (same sampling site) :

Weekday : **35,4** mg/day per 1000 inhabitants

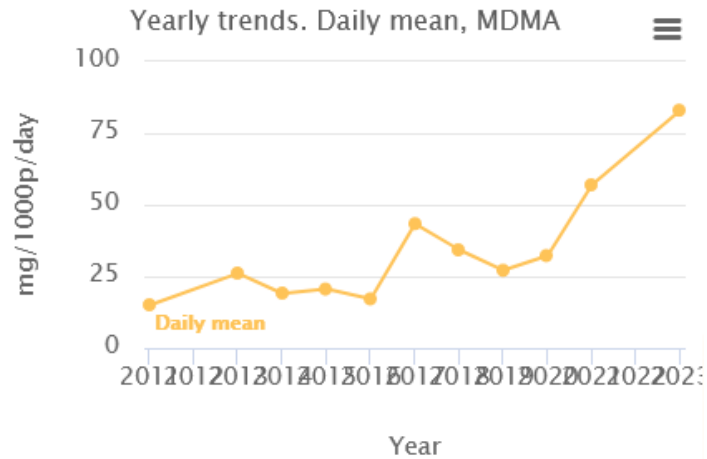
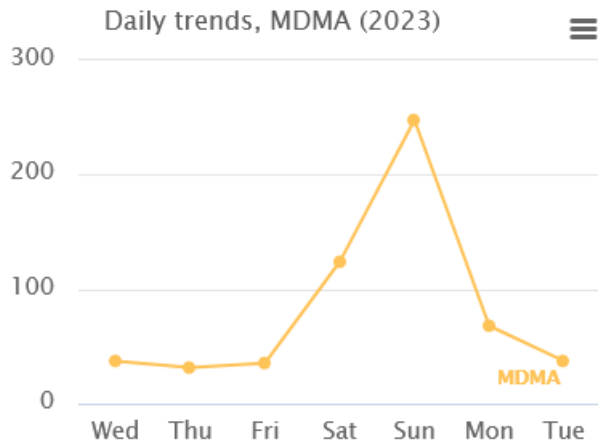
Weekend : **118,8** mg/day per 1000 inhabitants (But **247,8** on Sunday)

→ **Recreational pattern** (raise during week-end days)

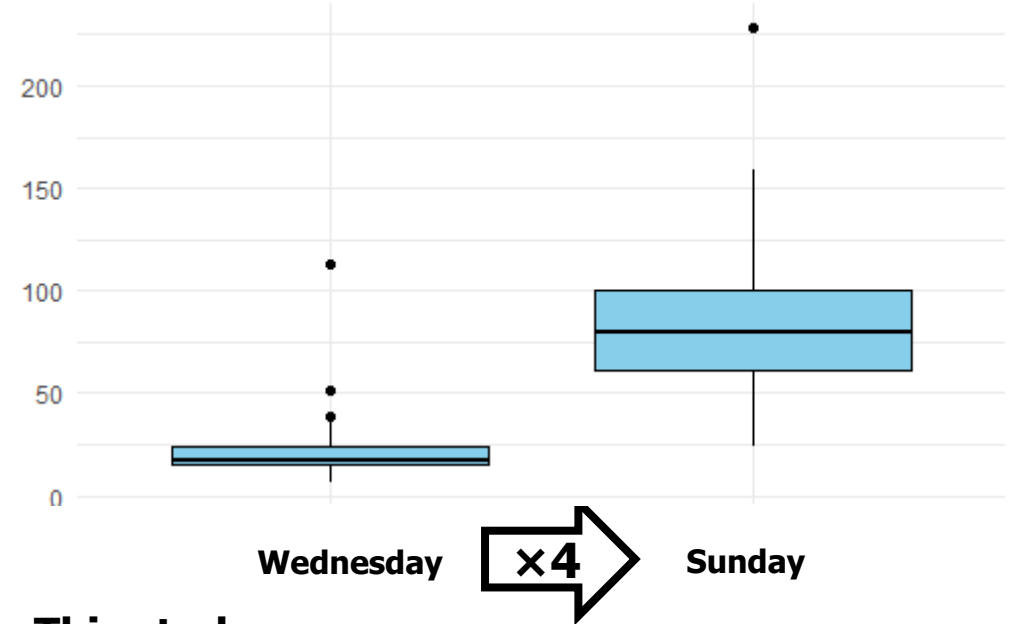
→ Continuous trend to increasement over years (**× 5 since 2011**)

# From a local perspective...

Monitoring of MDMA : a known case of short temporal pattern



Source : EMCDDA, SCORE network



**This study :**

Weekday : **22** mg/day per 1000 inhabitants  
 Weekend : **84** mg/day per 1000 inhabitants

→ Same pattern, underestimation ?

**Previous data (same sampling site) :**

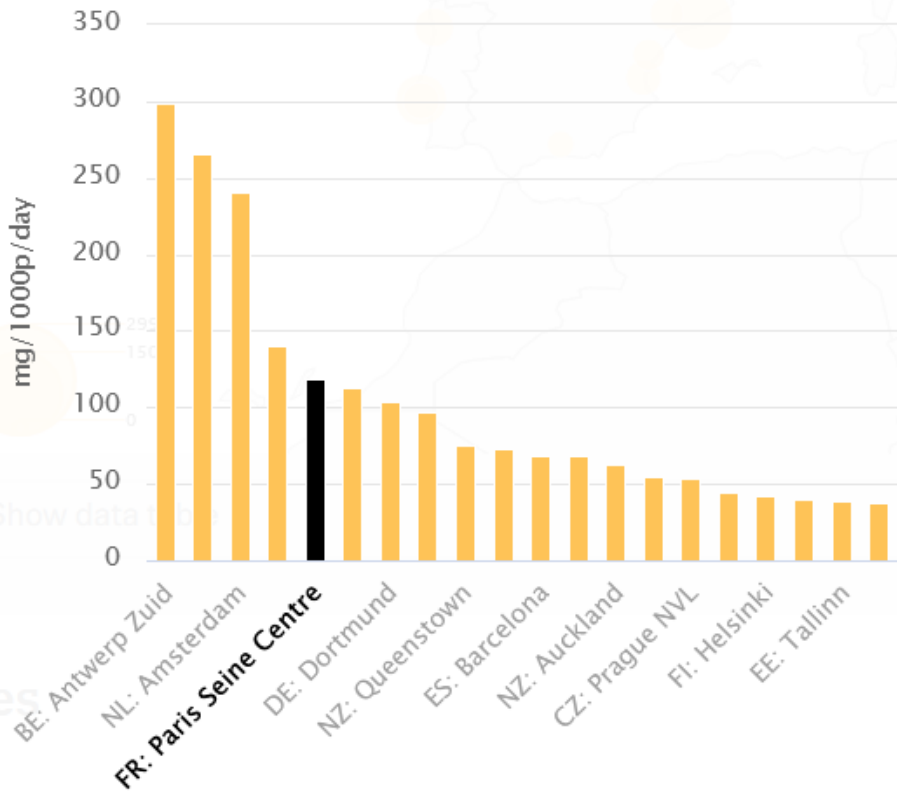
Weekday : **35,4** mg/day per 1000 inhabitants  
 Weekend : **118,8** mg/day per 1000 inhabitants (But **247,8** on Sunday)

→ **Recreational pattern** (raise during week-end days)  
 → Continuous trend to increasement over years (**x 5 since 2011**)

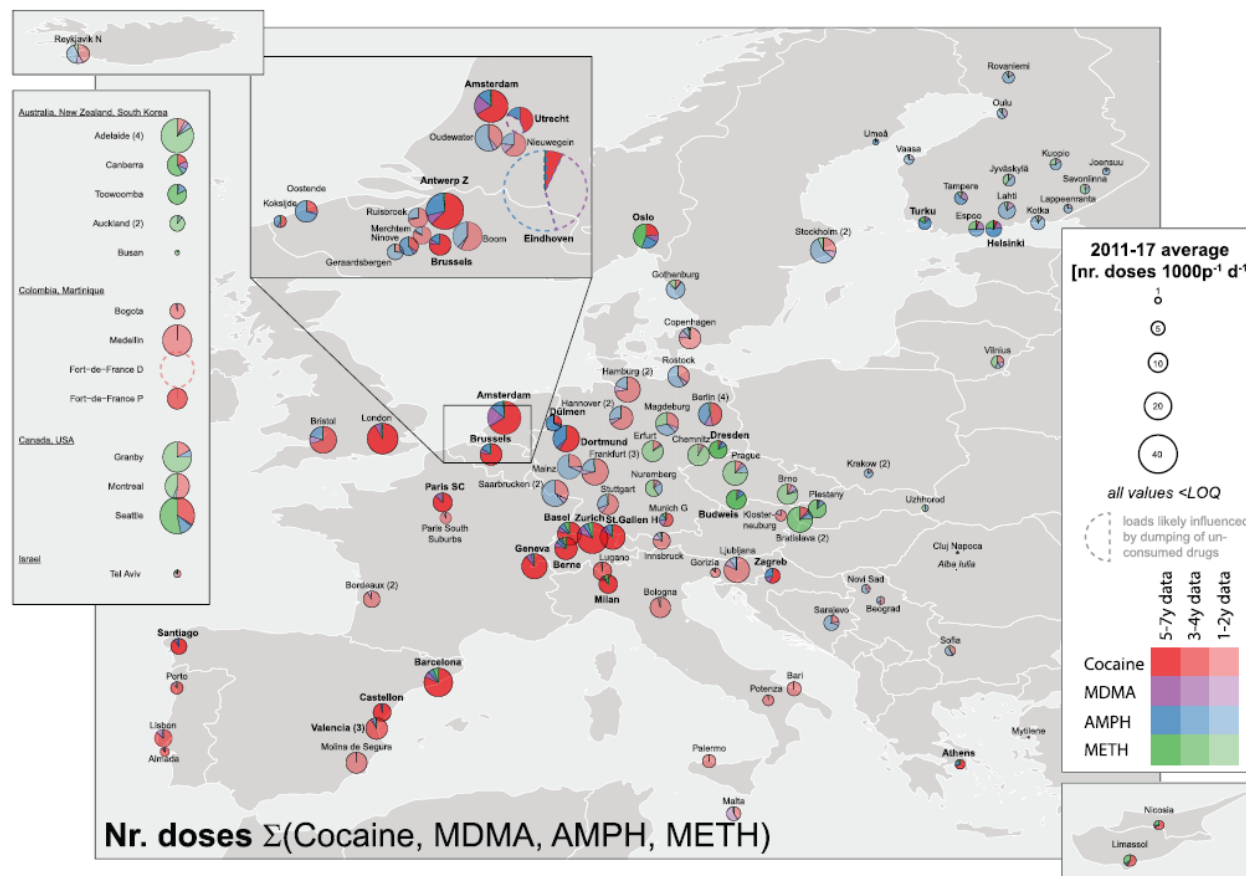
# ... to global trend

## Possibility of inter-city comparison : the SCORE network

Top 20 cities in Europe. Weekend mean, MDMA (2023)



Source : EMCDDA, SCORE network



→ Geographical impact on drugs consumption habits (Eastern/Western)

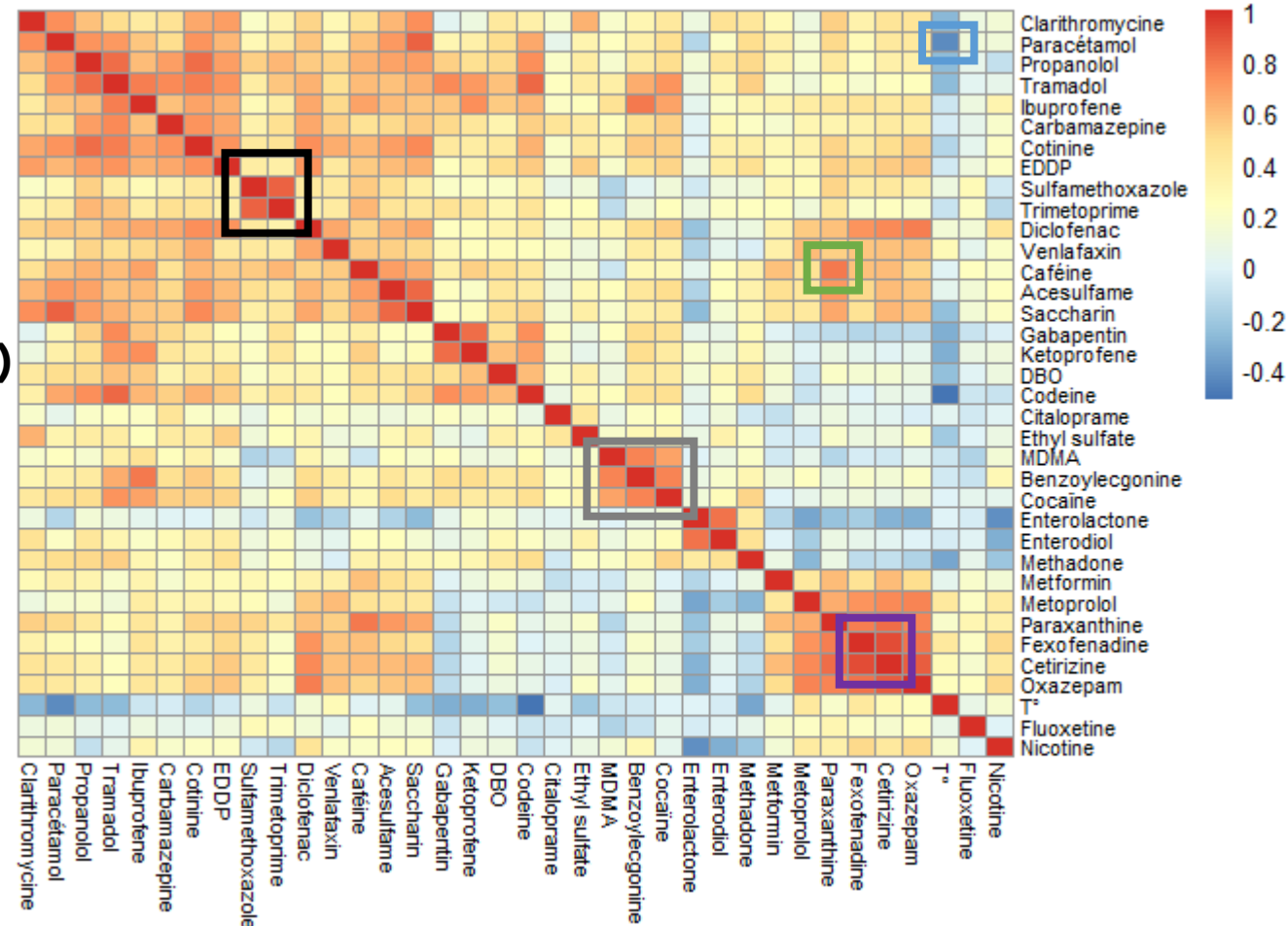
# Data processing

## How to deal with obtained data ?

Some lead already exist based on previous work :

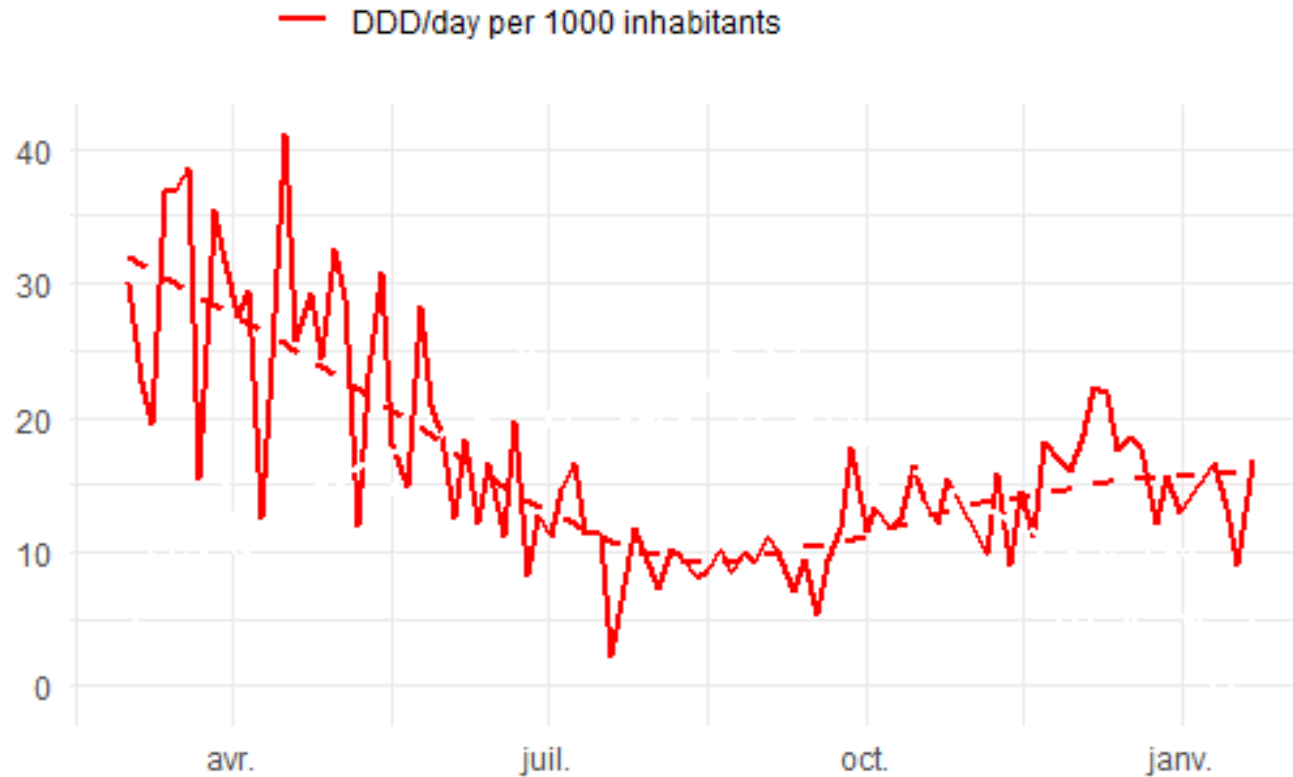
- **Co-medication (ex : Sulfamethoxazole/Trimethoprim)**
- **Parent/Metabolite (ex : Caffeine/Paraxanthine)**
- **Therapeutic class (ex : Fexofenadine/Cetirizine)**
- **Temporal pattern (ex : Cocaine/MDMA)**

## Impact of external factors ?



# Environmental impact

**Hypothesis** : Loads of Paracetamol are linked to temperature

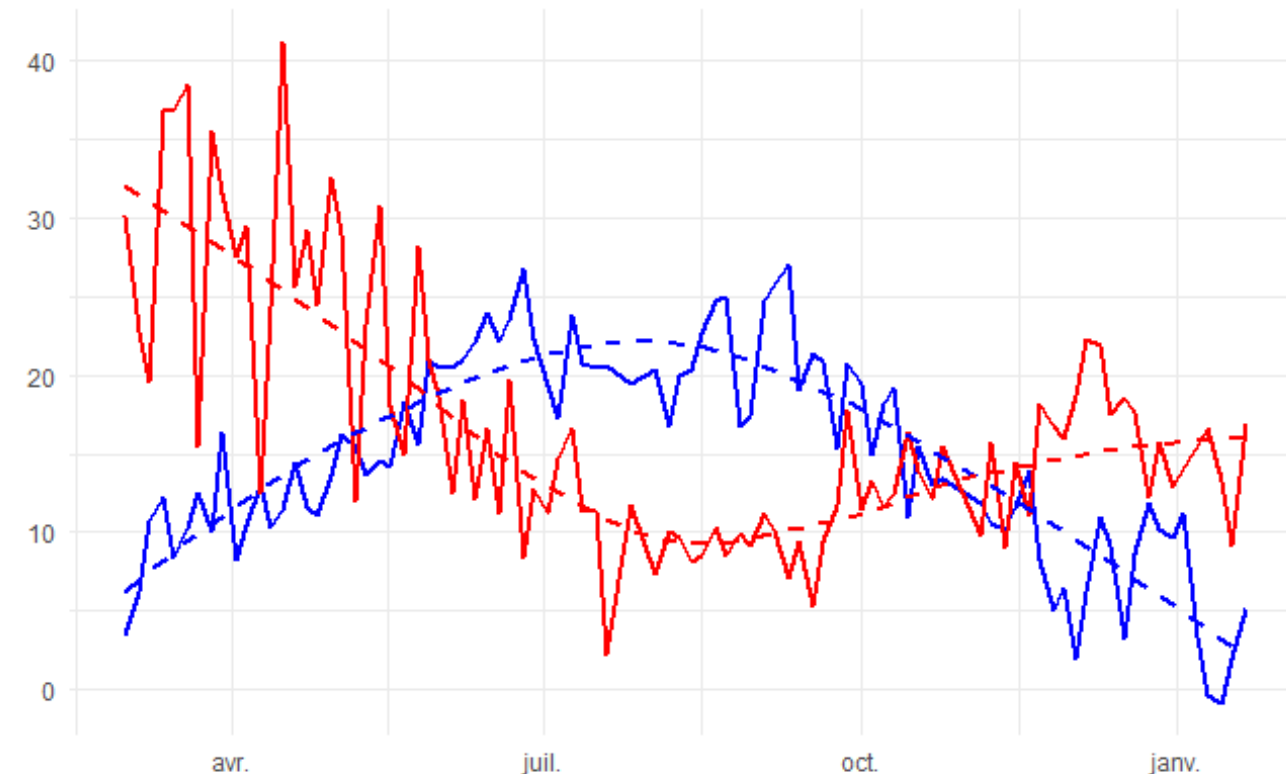


1) Plot **Paracetamol daily consumption** among time

# Environmental impact

**Hypothesis** : Loads of Paracetamol are linked to temperature

— DDD/day per 1000 inhabitants — Averaged temperature (T°C)



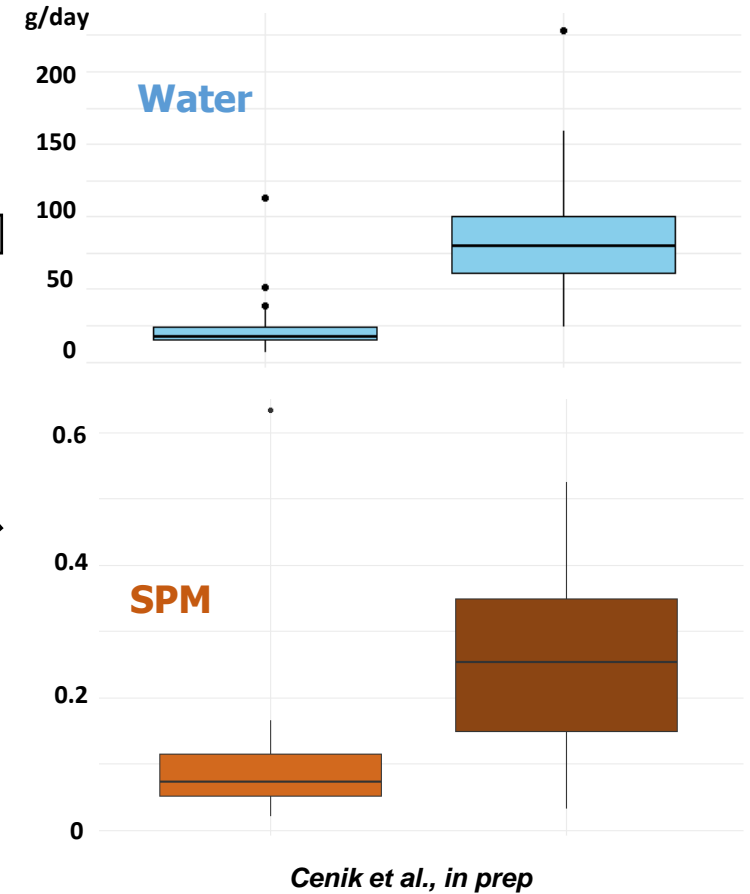
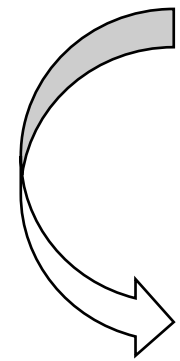
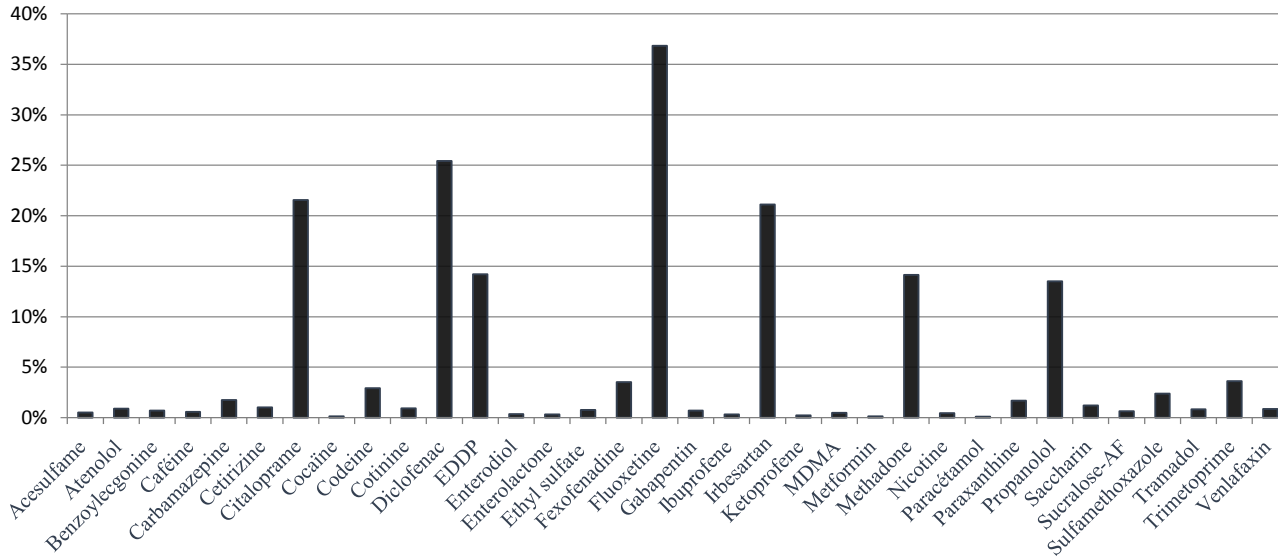
- 1) Plot **Paracetamol daily consumption** among time
  - 2) Compare with recorded **average temperature**
- Demonstration of a **long-term** (seasonal) **temporal pattern**
- Importance of external factors such as climatic conditions

# To go further...

WBE is based on analysis made on dissolved phase (usually predominant for polar compound such as WBE markers)

What about the particular phase ? → Analysis of suspended particular matter (SPM)

Mean contribution of SPM to total flux (%) (n=41)



- Low contribution for the majority of studied compound (< 5%) → **not for all**
- Dynamics of dissolved phase is reflecting on SPM

# Next...

High amount of data acquired since march 2023 (over 100 samples) → still processing

- Go further on the exploitation of results in regards to environmental factors (ex : air pollution) and temporal trends
- Year 2 as a confirmation of year 1 ?

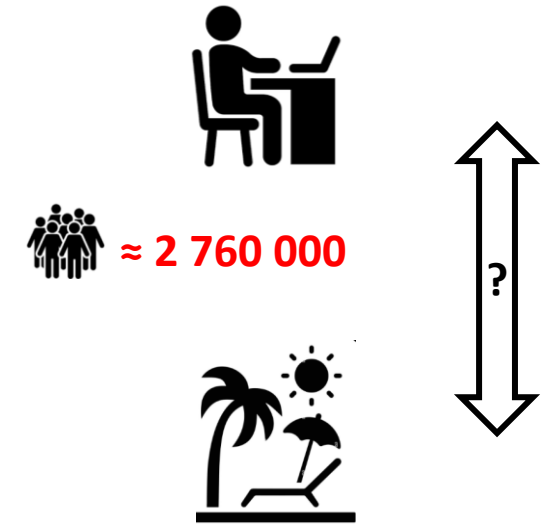
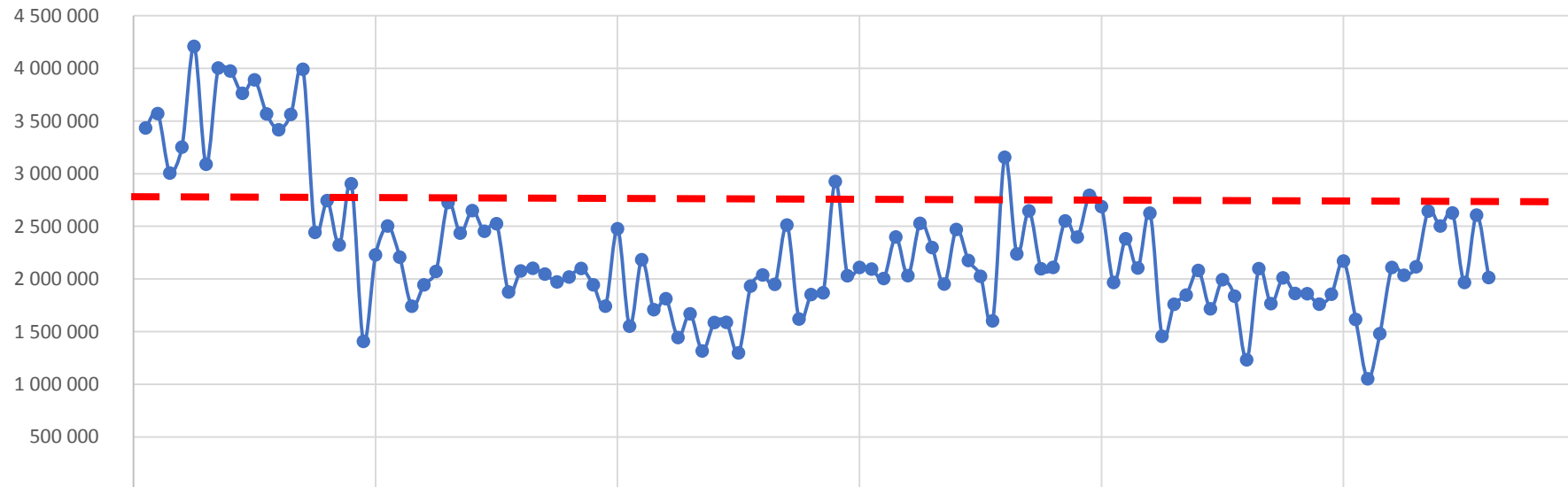




# Next...

- Estimation of « real-time » population to normalize flux

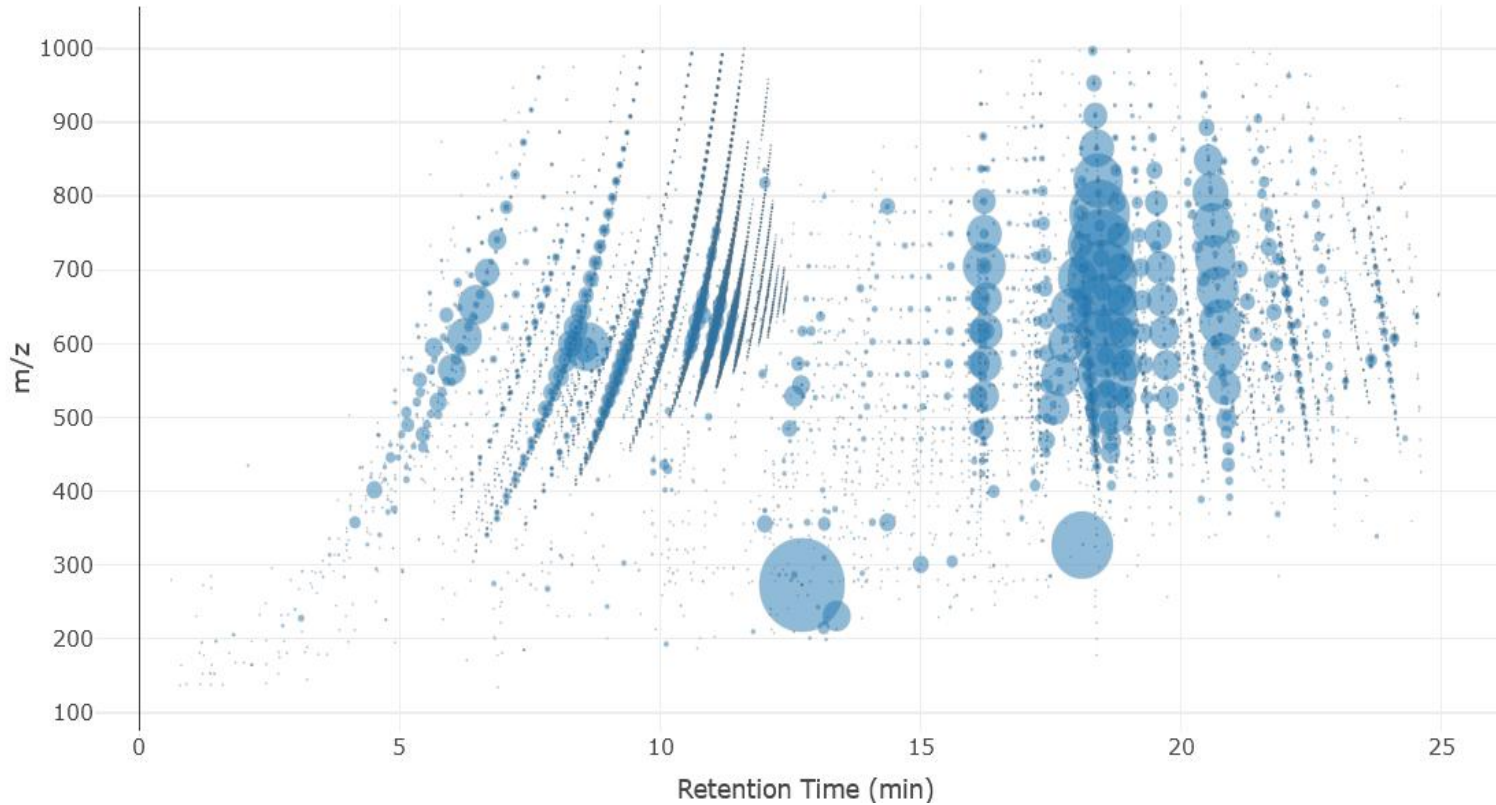
Estimation of population based on hydrochemical parameters (BOD, N, P)



Impact of population movement (work, vacations...) to real loads contributions ?

# Next...

- HRMS fingerprints to opened-up the range of targeted compounds ?



Over 20 000 HRMS features detected in one IWW sample



Observations Géochimiques des Trajectoires Urbaines



# Thank you for your attention !



