Source reduction of personal care products in the urban water cycle of Paris conurbation

Régis Moilleron **& Adèle Bressy**

Context

STARTING POINT

Darbre Ph. *et al.* (2004)
Potential link with breast cancer

MEDIATISATION

Envoyé Spécial (2005)
Whistle-blowers

PRACTICE CHANGES

Consumers
Industrials

FIRST STUDIES…

Geara-Matta (2012)
Flow and sources of parabens… : comparison between Paris and Beirut

1

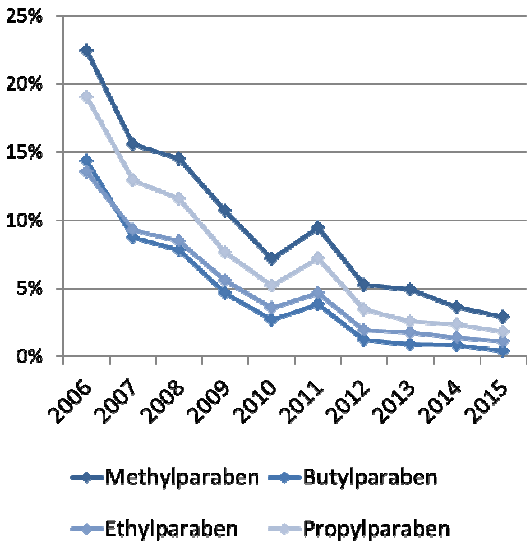
Context

STARTING POINT

MEDIATISATION

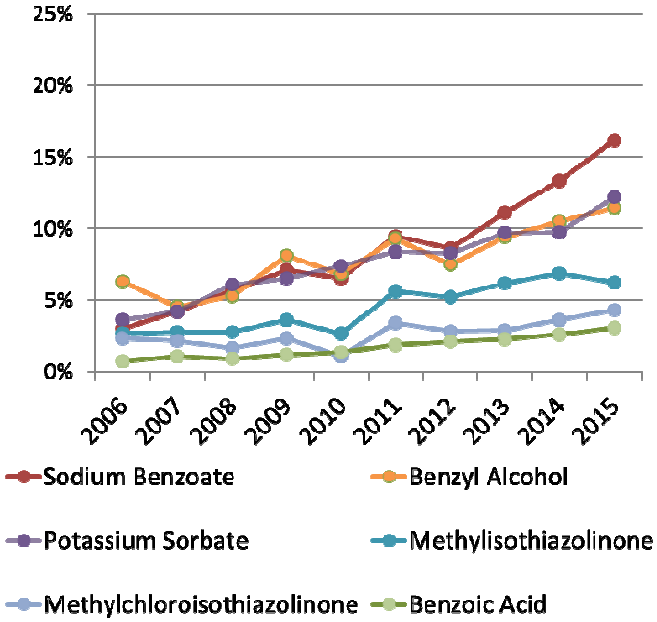
PRACTICE CHANGES

FIRST STUDIES…



2

Context



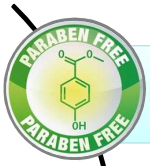
3

Cosmet'eau

- **Personal care products:** a pretext to study risks associated with micropollutants and source control solutions
- Two issues
  - Environmental impact
    - Effluent monitoring, ecotoxicological impacts of the different types of cosmetic product
  - Health impact through:
    - Alert (scientific origin)
    - The responses (from industrials)
    - Perception of risk by consumers of cosmetic products (surveys) and urban managers
- **Multidisciplinary approach to the strategies** of actors likely to interact with micropollutants, in particular risk anticipation (health and environment)
- Possibility of **prevention at source** of the impact of micropollutants on the environment (and on health)
  - Acting on products consumed and consumption practices,
  - Preventive policy partly promoted by local and regional authorities

4

Aims



To determine the impact of PCP use on the quality of urban effluents

To study the transfer from their release into greywater up to the receiving media

To assess the concentrations observed in the receiving environment

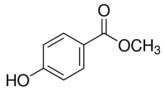
To evaluate the impact of the Paris conurbation

5

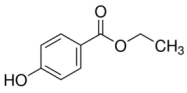
What Molecules?

Cosmet'eau

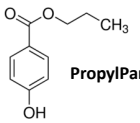
Preservatives and biocides



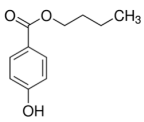
MethylParaben (MeP)



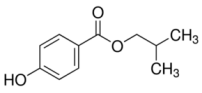
EthylParaben (EtP)



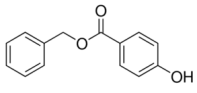
PropylParaben (PrP)



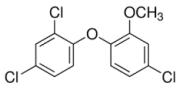
ButylParaben (BuP)



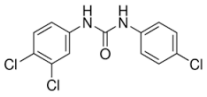
isoButylParabene (IsoBuP)



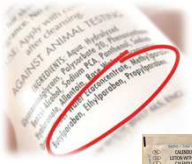
BenzylParaben (BzP)



Triclosan (TCS)



Triclocarban (TCC)



Aqua, glycerin, glucose, calendula officinalis extract, potassium sorbate, sodium benzoate, phenoxyethanol, methylparaben, butylparaben, ethylparaben, propylparaben, isobutylparaben

Used in:

- pharmaceuticals
- foodstuffs
- personal care products…

LCMS²

6

Part I
Housing scale: Greywater study

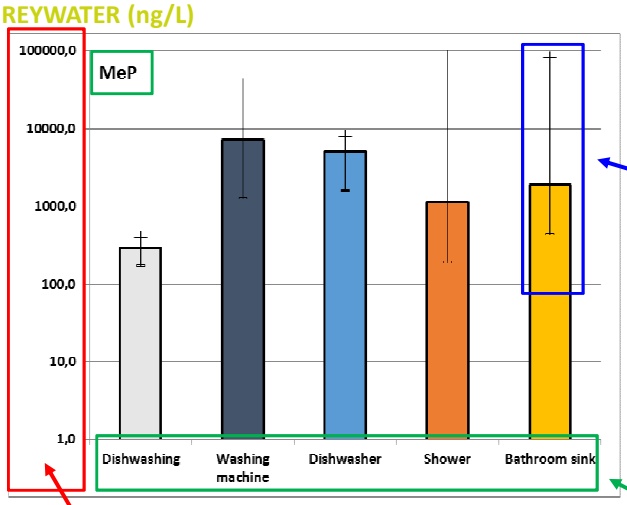
To determine the origin of domestic wastewater contamination for source reduction purposes

ICPP

LEESU
laboratoire eau environnement systèmes urbains

Greywater contamination - results

GREYWATER (ng/L)



whisker plot

d90

d50

d10

n=5 n=11 n=6 n=19 n=5

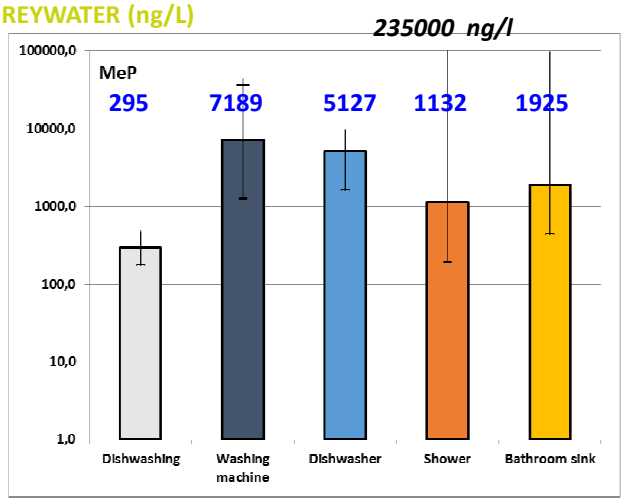
Logarithmic scale

Sample type or Compounds

8

Greywater contamination - results

GREYWATER (ng/L)



n=5 n=11 n=6 n=19 n=5

1. Ubiquitous contamination for every greywater

2. Intra-greywater variability highlighted

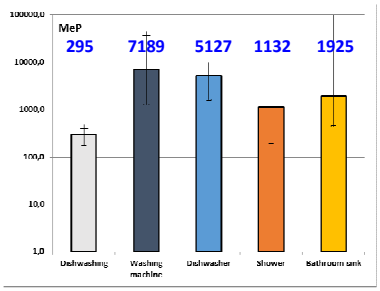
3. MeP (> TCS) > PrP = EtP ➔ formulation of cosmetics

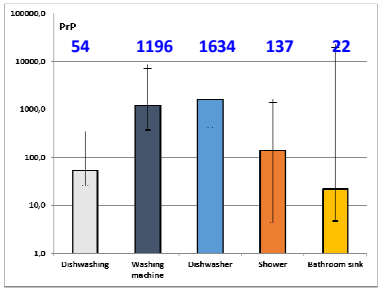
9

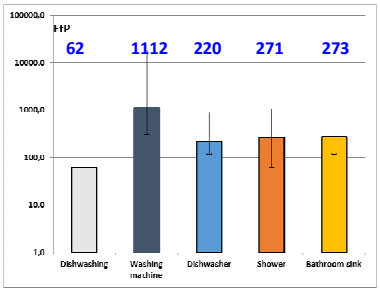
Greywater contamination - results

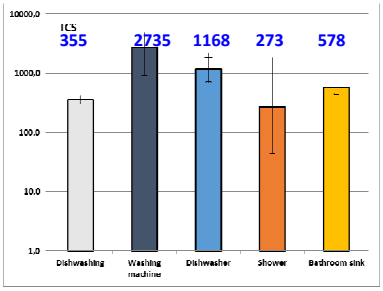
Cosmet'eau

GREYWATER (ng/L)









10

Greywater contamination - conclusion

Cosmet'eau

Findings

- Contamination of all greywater waters by parabens, TCS and TCC
  - No unique source… ➔ ***questioning of information available to the consumers (INCI regulation)***
- **MeP, EtP & PrP predominate**
  - Consistent with the uses associated with these preservatives… ***in personal care products***
- **Significant concentration variability**: from < LOQ up to 2 mg/L (shower) for parabens and from 36 ng/L up to 20 µg/L (shower) forTCS
  - Nature of products used
  - User habits ➔ ***need to acquire more data ?***
- Major contribution of **shower and washing machine** (loads)

  ➔ ***What are the product origins?***

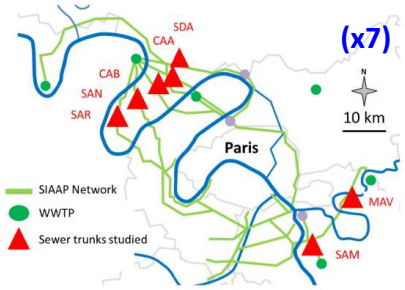
11

Part II
Urban watershed scale: Wastewater study

Selected activities

(x2) (x2) (x1)

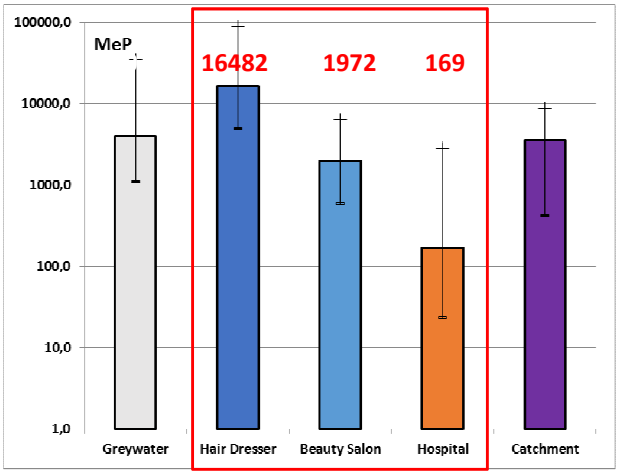
Main sewer trunks



Wastewater - results

Cosmet'eau

Wastewater (ng/L)



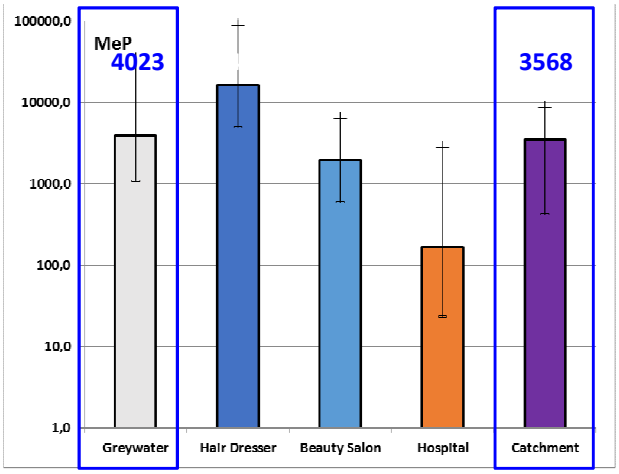
1. Industrial effluents (more or less) contaminated…

13

Wastewater - results

Cosmet'eau

Wastewater (ng/L)



1. Industrial effluents (more or less) contaminated…

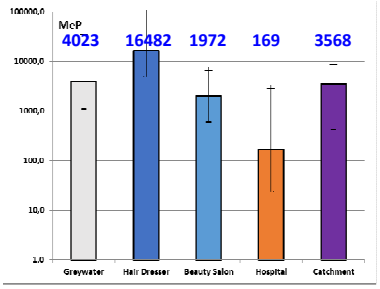
2. Wastewater levels similar to greywater ones

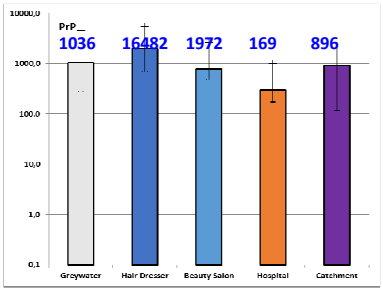
14

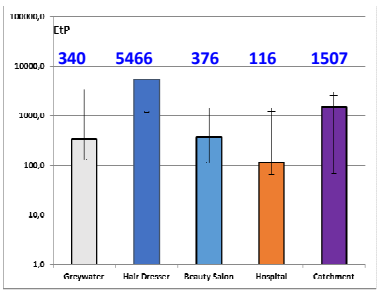
Wastewater - results

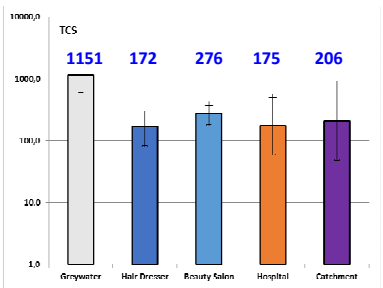
Cosmet'eau

Synoptic (ng/L)







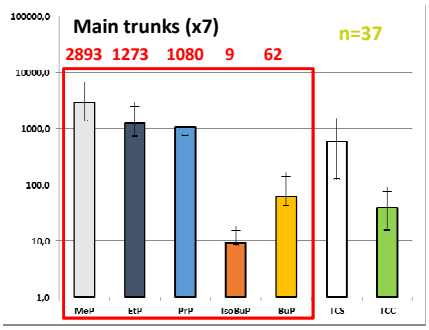


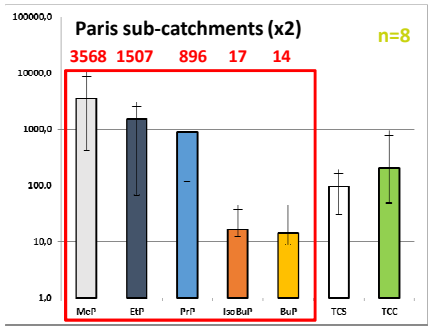
15

Main sewer trunks of Paris conurbation - results

Cosmeteau

Comparison between main sewer trunks and sub-catchments of Paris (ng/L)





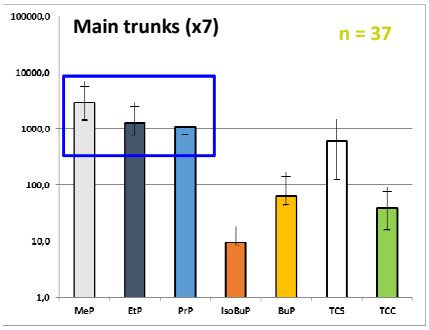
1. **Same profiles for parabens**

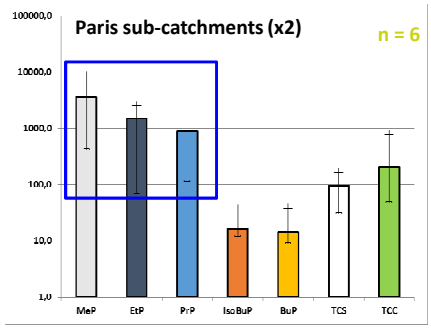
16

Main sewer trunks of Paris conurbation - results

Cosmeteau

Comparison between main sewer trunks and sub-catchments of Paris (ng/L)





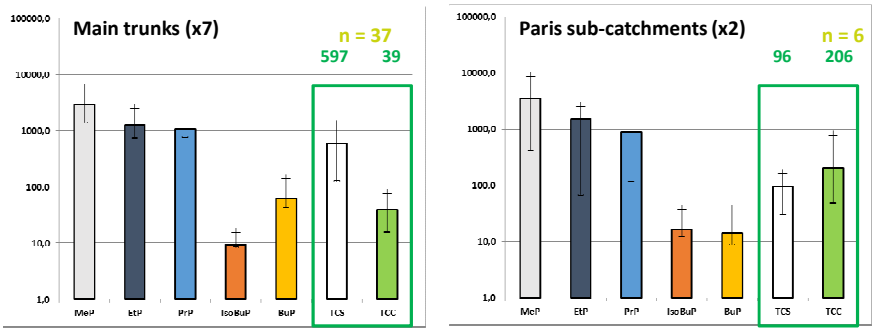
1. **Same profiles for parabens**
2. **When the scale increases, the variability decreases**

17

Main sewer trunks of Paris conurbation - results

Cosmet'eau

Comparison between main sewer trunks and sub-catchments of Paris (ng/L)



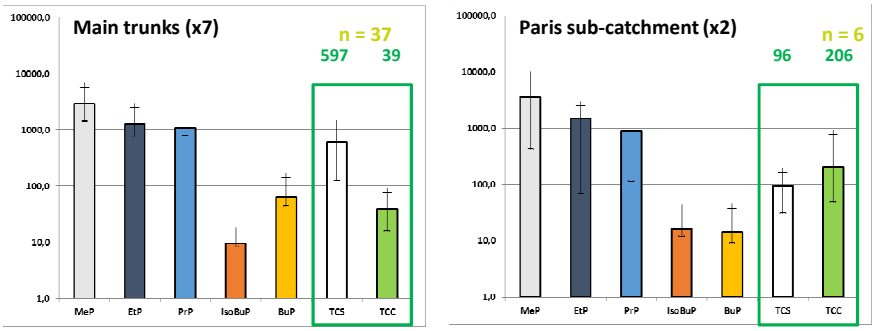
1. **Same profiles for parabens**
2. **When the scale increases, the variability decreases**
3. **Surprising behaviour of triclosan and triclocarban…**

18

Main sewer trunks of Paris conurbation - results

Cosmet'eau

Comparison between main sewer trunks and sub-catchments of Paris (ng/L)



1. **Same profiles for parabens**
2. **When the scale increases, the variability decreases**
3. **Surprising behaviour of triclosan and triclocarban…**

➔ **Substantial flows reach WWTPs: what about the receiving environment?**

19

Urban watershed scale: Wastewater study

Findings

- Ubiquitous **wastewater contamination** by parabens, TCS and TCC
  - Domestic and industrial origins

  ➔ ***Relative contributions to identify levers for action?***
- **MeP, EtP & PrP predominate**
  - Consistent with the uses associated with these preservatives… ***in personal care products***
- **Significant variability of concentrations**
  - Within a given sector of activity but also between different sectors

  ➔ ***What about the composition of the products used?***
- **Smoothing of observed levels when scale increases**
  - Concentrations close to those in greywater
- Transfer from emission sources to WWTP

  ➔ ***Fate at the different stages of WWTP? In fine impact on the environment?***

20

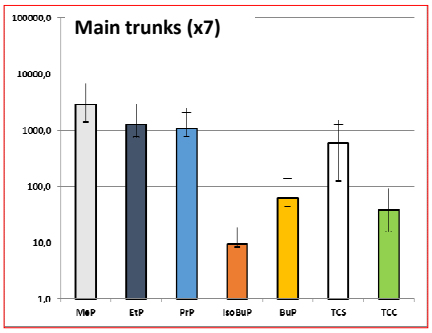
Part III
Surface Water Contamination

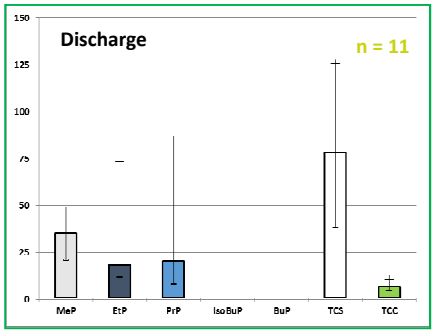
Determine the levels of impregnation of the Seine River

WWTP discharge

Cosmeteau

Discharge vs main trunks (ng/L)





Trunks (ng/L)	
MeP :	2893
EtP :	1273
PrP :	1080
IsoBuP :	9
BuP :	62
TCS :	597
TCC :	39

Significant decrease of concentrations

- **Efficiency** of treatment processes…

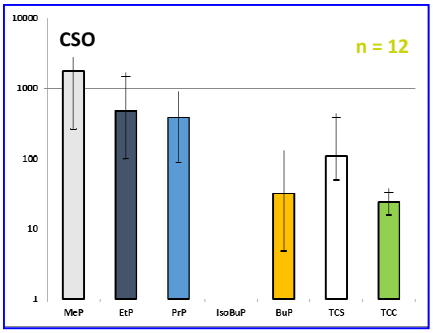
Discharge (ng/L)	
MeP :	35
EtP :	19
PrP :	21
IsoBuP :	< LQ
BuP :	< LQ
TCS :	78
TCC :	7

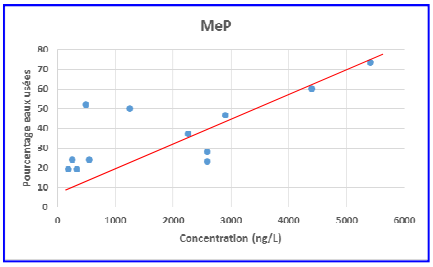
22

Combied Sewer Overflows (CSOs)

Cosmeteau

CSOs (ng/L)





CSO levels in between sewer trunks and discharge

DO (ng/l)	
MeP :	1757
EtP :	476
PrP :	381
IsoBuP :	< LQ
BuP :	32
TCS :	109
TCC :	24

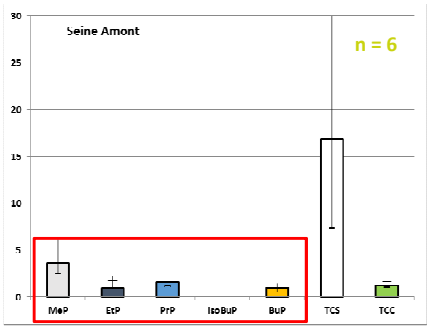
High temporal variability

- Largely related to the intensity of the discharge…
- and *therefore the volume of wastewater mixed to runoff.*

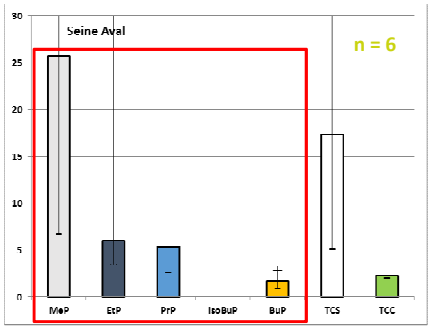
23

Surface water contamination

UPSTREAM (ng/L)



DOWNSTREAM (ng/L)

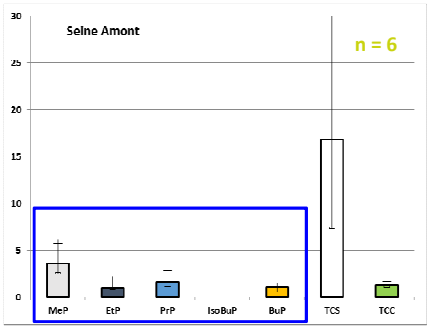


1. **Increase in concentrations from upstream to downstream of the Paris conurbation... for parabens**

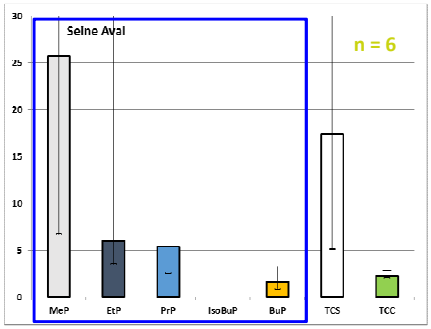
24

Surface water contamination

UPSTREAM (ng/L)



DOWNSTREAM (ng/L)

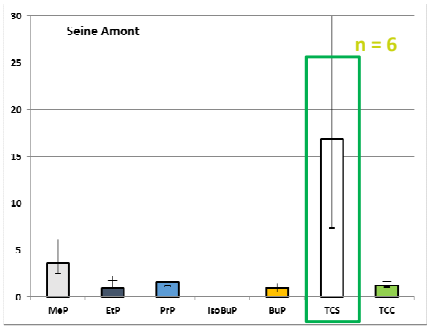


1. **Increase in concentrations from upstream to downstream of the Paris conurbation... for parabens**
2. **Along with spatial variability → *to be linked to contamination sources***

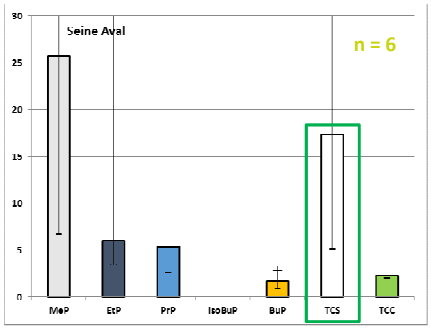
25

Surface water contamination

UPSTREAM (ng/L)



DOWNSTREAM (ng/L)

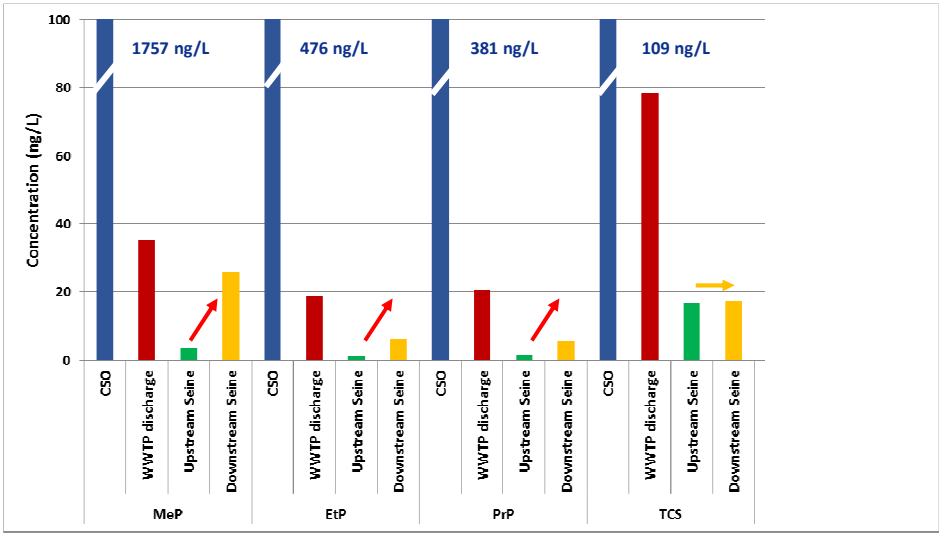


1. **Increase in concentrations from upstream to downstream of the Paris conurbation… for parabens**
2. **Along with spatial variability ➔ *to be linked to contamination sources***
3. **Less net increase for triclosan…**

26

Surface water contamination

Evolution of the contamination of the Seine River from upstream to downstream



27

Surface water contamination

Findings

- High WWTP removal efficiency…
- However WWTP discharges contaminate the receiving environment
  - ➔ *Need to refine treatments (by promoting tertiary treatment)*
- **CSOs**: significant source of contamination
  - ➔ *Keep on limiting untreated discharges for major events*
- **Impact of the Paris conurbation** on the Seine River quality
  - Increase of the concentrations from upstream to downstream

28

Conclusion

Discharge into the environment

Receiving waters

Impact of Paris Conurbation

WWTP

Removal Efficiency

Fate in sewer network

Wastewater

Ubiquitous Water Contamination in Urban Areas

Greywater

Significant concentration variability

Zedek (2016)

Dynamics of emerging pollutants (parabens, triclosan and triclocarban) in the grey waters-receiving environment continuum

29

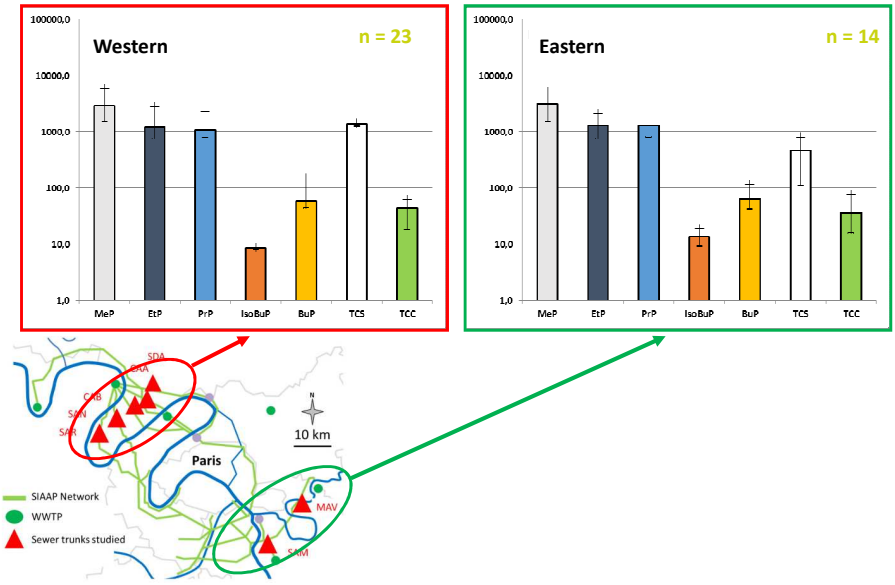
30th November – 1st December 2017

INSA Lyon, France

Colombian - French Conference on Urban Water Systems

Main sewer trunks of Paris conurbation - results

Comparison between « western » and « eastern » trunks (ng/L)

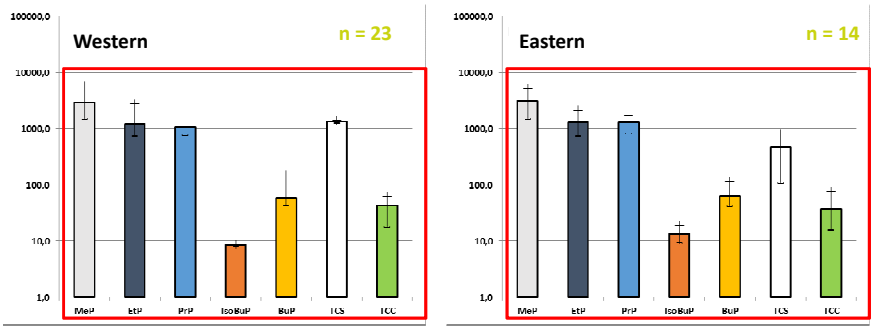


31

Main sewer trunks of Paris conurbation - results

Cosmeteau

Comparison between « western » and « eastern » trunks (ng/L)



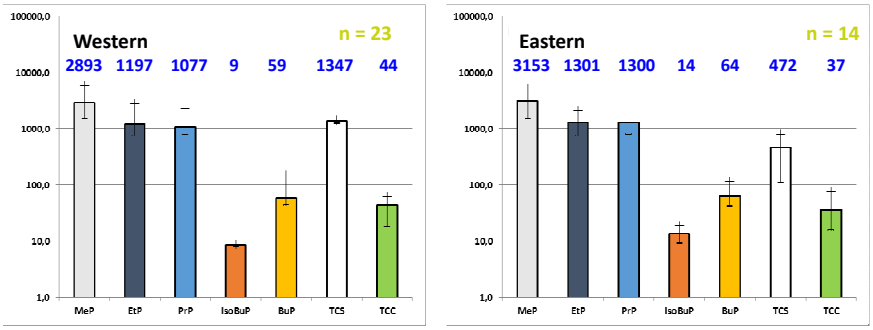
1. **(very) similar profiles…**

32

Main sewer trunks of Paris conurbation - results

Cosmeteau

Comparison between « western » and « eastern » trunks (ng/L)



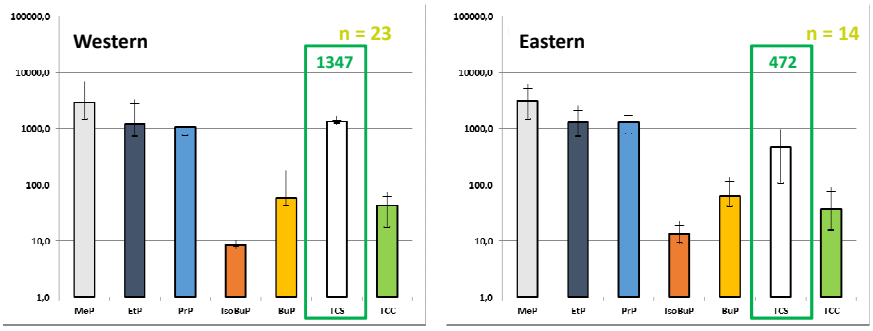
1. **(very) similar profiles…**
2. **Same concentration levels…**

33

Main sewer trunks of Paris conurbation - results

Cosmet'eau

Comparison between « western » and « eastern » trunks (ng/L)



1. (very) similar profiles…
2. Same concentration levels…
3. Except for TCS

34