Combined sewer overflow quality and EU Water Framework Directive

J Gasperi, M Cladière, V Rocher and R Moilleron

Observatory of Urban Pollutants in Paris (France)

The Future of Urban Water: Solutions for Liveable and Resilient Cities
SWITCH Scientific Meeting, France, 2011 January
Environmental topic

- European Water Framework Directive 2000/60/EC
- WFD + daughter Directives → 41 Priority Pollutants (PPs)
- Environmental Quality Standards → to achieve "good ecological and chemical surface water status" in 2015
- Combined sewer overflows (CSOs) → sources of PPs ???

Questions:

- Quality of CSOs ???
- Occurrence of PPs
- Conc of PPs
- CSO contribution to the urban pollutant loads ??
- Assessment of PPs in CSOs
- CSO reduction and "good water status"?
Site and sampling campaigns

The Seine river basin

Paris: combined sewer network
Numerous CSO outfalls

At the scale of Paris

\[ V_{CSO} = 50 - 100 \times 10^6 \text{ m}^3 \cdot \text{y}^{-1} \]

Clichy CSO outfall
Site and sampling campaigns

➢ The Clichy CSO outfall

$V_{CSO} \times 10^3 \text{ m}^3$

Decrease of CSO volume

1985 - 2008 discharges per year

$2 - 55 \times 10^6 \text{ m}^3$
Site and sampling campaigns

- 2 automatic samplers respectively equipped for organic pollutants and metals
- 4 rain events sampled (From July to Sept.)

<table>
<thead>
<tr>
<th>Date</th>
<th>Vol ($10^3$ m$^3$)</th>
<th>Runoff (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/07/10</td>
<td>426</td>
<td>77-87</td>
</tr>
<tr>
<td>14/07/10</td>
<td>1 000</td>
<td>86-95</td>
</tr>
<tr>
<td>08/09/10</td>
<td>38</td>
<td>68-77</td>
</tr>
<tr>
<td>24/09/10</td>
<td>279</td>
<td>74-89</td>
</tr>
</tbody>
</table>

Summer storm
14/07/10
H = 35 mm

Volume discharged (m$^3$/5min)
Priority pollutants monitored

- 88 substances including 41 WFD PPs
- Analyses carried out by a Lab certified by Ministry of Envir.
- Analyses on total or dissolved and particulate phases

<table>
<thead>
<tr>
<th>Famille</th>
<th>WFD</th>
<th>Additional Sub.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkylphenols</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>BTEX</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Chloroalkanes</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Chlorobenzenes</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Chlorophenols</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>VOC</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>PAH</td>
<td>8</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Metals</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Organotin</td>
<td>3</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>PBDE</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>PCB</td>
<td>-</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Pesticides</td>
<td>12</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>Phthalates</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>41</td>
<td>47</td>
<td>88</td>
</tr>
</tbody>
</table>
50 pollutants detected
22 PPs
Including 11 PHS

Clichy 1
Clichy 2
Clichy 3
Clichy 4

Pollutant detected

Runoff proportion (triangle)

PP contamination of CSOs

CSOs (n = 4, 88 subst.)

50 pollutants detected
22 PPs
Including 11 PHS

5 Metals
16 PAHs
3 Alkylphenols
1 Phtalate
9 Pesticides
5 VOCs
6 PCBs
5 Others

Copper
Mercury
Zinc
Lead
Chrome
Benzo(a)pyrene
Benzo(b+k)fluor
Benzo(ghi)perylene
Indeno(cd)pyrene
Anthracene
Naphthalene
Fluoranthene
Acenaphthylene
Fluorene
Phenanthrene
Pyrene
Benzo(a)anthr
Chrysene
Dibenzo(ah)anthr
Acenaphtene
6 PCBs

DEHP
Aldrine
Dieldrine
Atrazine
Desethylatrazine
Duron
Isoproturon
Aminotriazole
Glyphosate
AMPA
Toluene
Ethylbenzene
Tetrachloroethylene
Trichloroethylene
Xylenes
Nonylphenols
Octylphenol
Butylphenol
Organotins (3)
DecaBDE
Chloroalkanes
PP contamination of CSOs

CSOs (n = 4, 88 subst.)

50 pollutants detected
22 PPs
Including 11 PHS

Concentrations below LOQ
Low-level metals (Ni and Cd)
Chlorobenzenes (< 0.03 µg.l⁻¹)
Penta & octa-BDE (< 0.03 µg.l⁻¹)
Banned pesticides (< 0.03 µg.l⁻¹)
(HCH, triazines, lindane, etc.)
PP contamination of CSOs

- Metals
- VOCs
- Pest
- PAHs
- PCBs
- Others

Most of organic PPs
Conc < 1 µg.l⁻¹
High concentrations especially for Zn, Cu and Pb

Impact of street and roof runoff (80% roofs equipped with metallic materials)
PP contamination of CSOs

**Herbicides also detected in Parisian wastewater and runoff**

- Municipal use (road or railway maintenance)
- And private use

**Conc (µg.l⁻¹) / Circle**

Herbicides:
- AMPA > Glyphosate > Aminotriazole
  - AMPA: 0.2-1.6
  - Glyphosate: 0.3-1.2
  - Aminotriazole: 0.1-0.5

**Occurrence (%) / Triangle**

**5 Metals**
**5 VOCs**
**9 Pest.**
**16 PAHs**
**6 PCBs**
**7 others**
PP contamination of CSOs

HMW PAHs > LMW PAHs

[PAHs]_{CSO} > [PAHs]_{WW or runoff}

Pyrolytic sources

In-sewer contribution

Combined sewer

5 Metals
5 VOCs
9 Pest.
16 PAHs
6 PCBs
7 others
DEHP and nonylphenol are present. Results expected since high levels are reported in wastewater.

DEHP ➔ Main plasticizer used in household materials and products.

NP ➔ surfactants, detergents.

BPA also measured by Cladière M. (2010 – PhD Thesis) 0.9 – 2.0 µg.l⁻¹
PP contamination of CSOs

High concentrations of organotins
29 – 530 ng.L⁻¹

Main active ingredients in biocides +
Application as polyvinyl chloride stabilizers

MBT > DBT > TBT

Conc (µg.l⁻¹) / Circle

Occurrence (%) / Triangle

5 Metals  5 VOCs  9 Pest.  16 PAHs  6 PCBs  7 others
CSO concentrations and EQS

Average annual concentration
CSO/AAC-EQS

Maximal allowable concentration
CSO/MAC-EQS

PPs in CSOs could pose a risk of exceedance

... may pose a risk

.... do not pose a risk

> 10
Tributyltin
PAHs
Chloroalk.
Pb & Hg

> 1
DEHP
Nonylphenol
Fluo, B(a)P

< 1
Atrazine,
diuron
isoproturon
Anth, Napht
CSO concentrations and EQS

Average annual concentration
CSO/AAC-EQS

Maximal allowable concentration
CSO/MAC-EQS

- Tributyltin
- PAHs
- Chloroalk.
- Pb & Hg

- DEHP
- Nonylphenol
- Fluo, B(a)P

- Atrazine, diuron
- isoproturon
- Anth, Napht

- Tributyltin

- PAHs
- diuron

> 10

> 1
Conclusions

- Large broad of PP detected in CSOs
  - CSOs (n = 4, 88 subst.)
  - 50 pollutants detected
  - 22 PPs
  - Including 11 PHS

- CSO and EU WFD
  - Concentrations > MAC-EQS for organotins, PAHs
  - For the first time, chloroalkanes reported at high levels
  - What role can be played by the CSO reduction to achieve the “good water status”?

Parabens / Triclosan (PhD Geara)
Nonyphenol / BPA (PhD Cladière)
Organic matter / metals (PhD Matar)
CSOs and WFD ???

What role can be played by the CSO reduction to achieve “good water status”?

Atmosph. Inputs

Runoff inputs

WWTPs

Combined sewer

Separate sewer

Few data

Flows x10^3 m^3.y^-1

1 000

300 - 500

250

Conc Gasperi (2010)

This study

Zgheib (2009)

Seine River

Flows : 17 000 x 10^6 m^3.y^-1

Concentrations from literature
Thank you for your attention

http://anthony.atkielski.pagesperso-orange.fr/SeineNightLarge.jpg