Combined sewer overflow quality and EU Water Framework Directive

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1. Introduction

The Community strategy against pollution of surface water control policy was set out by the European Water Framework Directive 2000/60/EC which lays down new procedures for the identification of substances and development of control measures. After the decision n° 2455/2001/EC of the European Parliament and of the Council of 20 November 2001 setting out the first list of 33 substances or groups of substances that have been prioritized for action at community level, the Commission adopted on 17 July 2006 a Directive setting environmental quality standards for the priority substances which Member States must achieve by 2015, to ensure a «good chemical surface water status". Prior to achieve this objective by identifying possible reduction measures, an accurate knowledge on these substances at the different stages of the urban water cycle is required. Though some studies were launched to identify the occurrence and the significance of priority pollutants (PPs) in wastewaters (Rule et al., 2006ab; Palmquist and Hanaeus, 2005), no study focused on the quality of wet weather flows and combined sewer overflows (CSOs) within combined sewers, more especially for a heavily urbanized area such as Paris (France). Due to the lack of available information on the PP levels within combined sewers during wet periods, the OPUR research program (Observatory of Urban Pollutants in Paris, France) launched this study. Its objectives are i) to assess the priority pollutant concentrations, ii) to compare these concentrations to those observed in wastewater and runoff, and finally iii) to compare the measured concentrations to the Environmental Quality Standards (EQS).

2. Materials and methods

The most important CSO outfall of the Paris conurbation (Clichy outfall) was equipped with two automatic samplers to collect CSOs discharging into the Seine River. A total of 4 events were studied. Based on the conductivity measurement (about 1 000 µS.cm^{-1} for raw

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wastewater and 100-150 µS.cm^{-1} for runoff), the proportion of runoff ranges between 68 and 95 % in the 4 CSO discharges. For each sample, a total of 88 compounds including 7 metals (Cd, Cr, Cu, Hg, Ni, Pb and Zn) and 81 organic compounds or class of compounds (organotins, chlorobenzenes, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), pesticides, alkylphenols, phthalates, etc.) were investigated, as well as the ordinary wastewater quality parameters (total solids, organic matter, nitrogen, etc.). Except for the metals, halogenated volatile organic compounds (HVOCs) and BTEX (benzene, toluene, ethylbenzene and xylenes), which were analyzed on the total fraction, the dissolved and particulate fractions were separately assessed for each compound. Analyses were performed by the IPL-Bretagne laboratory, certified by the French Ministry of Environment (under European accreditation).

Table 1 : CSO discharge characteristics

Date (discharge number)	12/07/2010 (1)	14/07/2010 (2)	08/09/2010 (3)	24/09/2010 (4)
Height of rain (mm)	28	43	6.5	14.3
Volume discharged (m^3)	426 400	1 000 200	38 000	279 000
Conductivity (µS.cm^{-1})*	284	201	380	260
Proportion of runoff (%)	77-87	86-95	68-77	74-86
TSS (mg.l^{-1})**	260	170	700	150

*** Estimations done on the basis of two hypotheses, i.e. runoff conductivity equal to 100 or 150 µS.cm^{-1}, ** TSS = total suspended solids*

3. Results and discussions

This article examines the occurrence of each family of PPs and the significance of their concentrations within CSOs during wet periods. Briefly, of the 88 analyzed compounds, and depending on the CSO discharge considered, between 38 and 44 pollutants (between 15 and 19 priority pollutants) were observed. Interestingly, lower the proportion of runoff, higher the number of pollutants detected. Besides, 44 PPs were observed for the CSO discharge 3 against 38 for the discharge 2. During high rainy periods, the presence of COVs, some pesticides and decabromodiphenylether was observed.

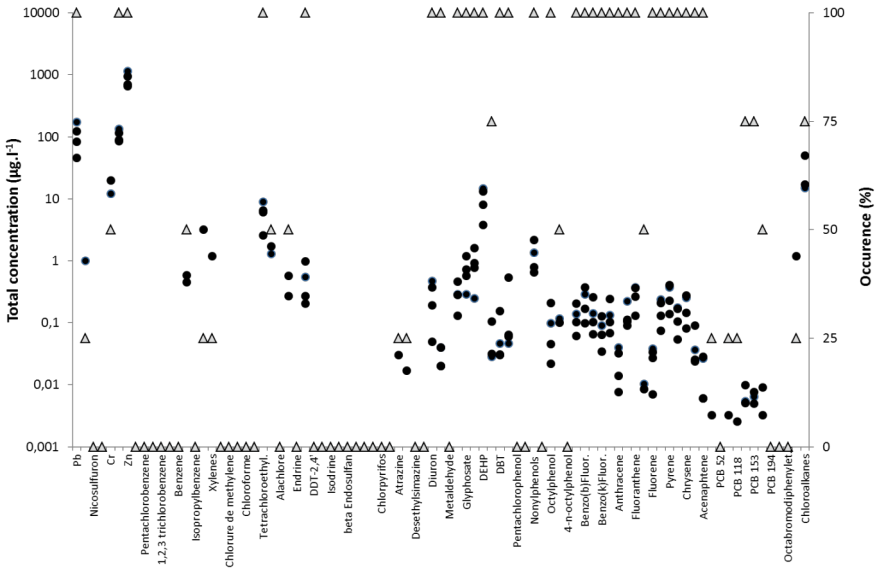

Figure 1 : Total concentrations (µg.l^{-1}) in CSO discharges (black circles), as well as frequency of detection (grey triangles)

The total concentrations measured in CSOs, as well as the frequency of detection or occurrence (in %) are reported in Figure 1 for all pollutants detected. As expected, most metals (Cu, Pb, Zn) were present in all samples, reflecting their ubiquitous nature. Chlorobenzenes, most of the pesticides (15-18 of the 24 monitored) were exclusively below the limit of quantification (varying from 0.01 to 0.06 µg.l^{-1}), while the majority of the other organic pollutants (organotins, VOCs, PAHs, etc.) were found in the µg.l^{-1} range.

As previously observed by Gasperi *et al*. (2008), DEHP represents the main plasticizer used in household materials exhibits concentration up to 10 µg.l^{-1}. For pesticides, diuron, isoproturon, aminotriazole, glyphosate and aminomethyl phosphonic acid (AMPA) were frequently observed, generally with concentrations lying in the 0.2 – 1.2 µg.l^{-1} range. Globally, the high concentrations of glyphosate and AMPA dominating the pesticide patterns clearly reflect the urban runoff impact. For the first time, chloroalkanes were observed in dissolved phase with concentrations ranging from < 3 µg.l^{-1} to 50 µg.l^{-1}.

For PAHs, the $\sum_{16}$ PAH was comprised between 0.9 and 2.8 µg.l^{-1}. The main compounds contributing to total load were fluoranthene and pyrene, indicating the presence of pyrolytic origins since pyrolytic inputs are characterized by the abundance of high molecular weight compounds. Additionally to the 88 PPs monitored, some compounds, mainly herbicides or fungicides (carbendazime, dichlorophenyl-uree, boscalide, myclobutanil, propiconazole, dimétachlore, nicosulfuron, sulcotrione) were also occasionally detected in CSOs. Their concentrations can reach 0.2 µg.l^{-1}. A full comparison with levels observed in wastewater and runoff will be soon established.

Figure 2 compares the concentrations observed in CSOs and the Annual Average Concentration and the maximum allowable concentration - Environmental Quality Standards (AAC- EQS and MAC-EQS, respectively), as defined by the European Parliament.

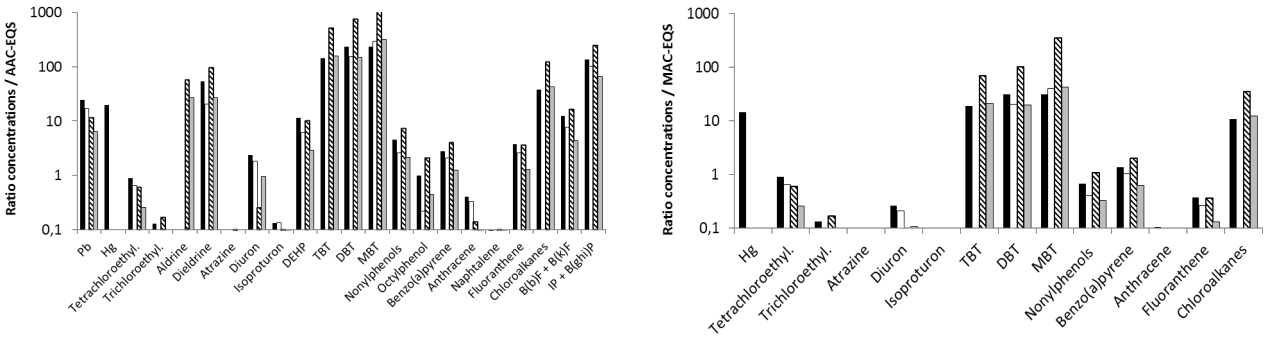

Figure 2: Ratios between concentrations in CSOs (discharges 1 – 4, from left to right) and AAC-EQS or MAC-EQS

For the 22 pollutants for which the comparison between concentrations and AAC-EQS is possible, 6 pollutants (tetrachloroethylene, trichloroethylene, isoproturon, octylphenol, anthracene and naphthalene) exhibit CSO concentrations lower than AAC-EQS. On contrary, 8 compounds or groups of compounds (dieldrine, DEHP, organotins – TBT, DBT and MBT, chloroalkanes, benzo(b and k)fluoranthene - B(b)F + B(k)F, indeno(cd)pyrene and benzo(ghi)preylene - IP + B(ghi)P) indicated concentrations 10 fold higher than the defined standards. For some compounds, exceedances of the MAC-EQS were also observed and are of particular concern for organotin compounds (MBT, DBT and TNT) and chloroalkanes. The high ratios observed for these substances between CSO concentrations and AAC-EQS, and to a greater extent between CSO concentration and MAC-EQS, could attest that CSOs can play for the considered substances an important role to the contamination of receiving waters.

4. Conclusions

This survey constitutes one of the first studies in Europe to report data for a variety of priority substances in CSOs. A large range of PPs in CSO was observed, and most of them present concentrations in the $\mu g.l^{-1}$ range, or even up to 10 $\mu g.l^{-1}$. These results are of critical importance since the data generated for a predetermined number of hazardous substances may be used in the future to identify PPs of potential significance and to elaborate strategies for new monitoring programmes for both CSOs and receiving waters.

References

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