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Importance of domestic releases in urban sewer networks: case of alkylphenols, phthalates and parabens in the Paris agglomeration

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Abstract

In order to protect the aquatic environment, minimizing the introduction of hazardous substances seems to be an interesting complement to the implementation of new water-treatment technologies. Some European and French regulations (Directive 2000/60/EC, directive 2003/53/CE, French decree of 2015 July 21st) encourage the development of action plans contributing to the reduction of emissions of pollutants by limiting the flows arriving at wastewater treatment plants (WWTP). A lever of action that seems natural to communities is the control of emissions from industries and agriculture in the watersheds under consideration. This paper focuses on another source of contribution to pollutant flows that is not necessarily taken into account: domestic wastewater. In the case of the Paris conurbation, heavily urbanized and poorly industrialized, the aim of our work was to compare the contamination of domestic wastewater with that of industrial wastewater for three families of micropollutants: alkylphenols, phthalates and parabens that are toxics for aquatic environments and classified as endocrine-disrupting compounds (Oehlmann *et al.* 2009; Haman *et al.* 2015). Then, we tried to identify ways to reduce the contamination of domestic wastewater. First the origin of the contamination was investigated through greywater and finally the impact of regulation and/or changing of practices on the contamination of wastewater were assessed.

Industrial vs. domestic fluxes at the Paris conurbation scale

Alkylphenols (NP: nonylphenols, OP: octylphenols), phthalates (DEP: diethylphthalate, DnBP: di-n-butylphthalate, BBP: butylbenzylphthalate, DEHP: di-(2-ethylhexyl)phthalate) and parabens (MeP: methylparaben, EtP: ethylparaben, PrP: propylparaben) were measured in industrial wastewater, domestic wastewater and in the influent of Parisian WWTP mixing both domestic and industrial wastewater. Figure 1 summarizes the levels of contamination measured for domestic water (measured at the head of the watershed), industrial water and water entering the WWTP. For all substances, domestic water is systematically more contaminated than industrial water. The calculated flows highlighted that the industrial contribution represents less than 3% of the incoming flow in WWTP for the studied substances. This low contribution from industry can be explained by the nature of the Ile-de-France watershed. Indeed, the Paris region is a highly urbanized but poorly industrialized watershed. The effort granted by the industries would therefore reduce by 3% the contributions to the sewer network. What levers of action to imagine for other sources, namely domestic sources? To answer this question, greywater and the impact of the changes in consumer practices and the impact of the regulation concerning substances were investigated.

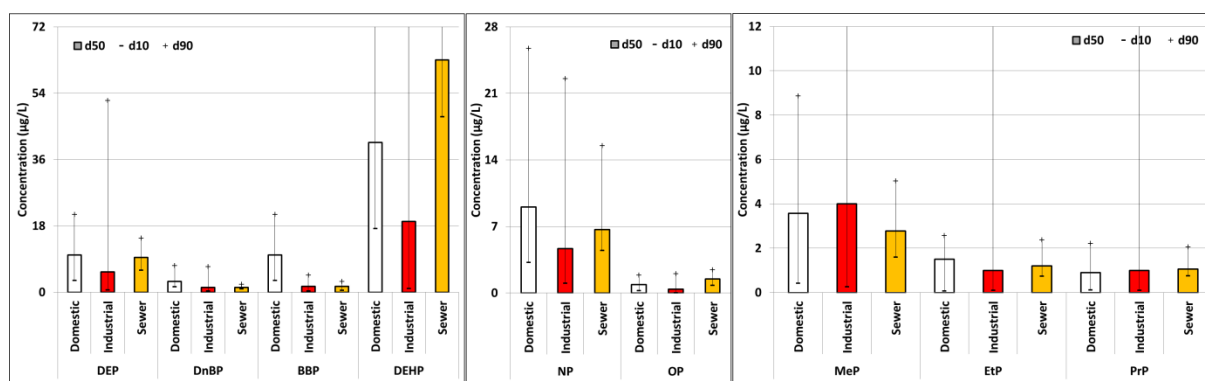


Figure 1: Concentrations (µg/L) in domestic wastewater, industrial wastewater and in influent of WWTP

Greywater, the major source of alkylphenols, phthalates and parabens in domestic wastewater

Domestic wastewater consists of greywater (80% by volume of water) and sewage (20% by volume of water). In the idea of finding levers of action for a reduction at the source of micropollutants, the study of greywater was prioritized because they are more important in water flow and it seems easier to modify our practices concerning them. We were therefore interested in the flows emitted by five different types of greywater: shower, washbasin, manual dishwashing, dishwasher and washing machine. Shower and washing machine effluents were the main contributor to the wastewater

contamination. This study highlighted that the daily use of different products for domestic activities explained the levels observed in wastewater. Moreover, the concentration variability could be explained by different habits of consuming.

Evolution of concentration in wastewater following changing of industrial formulations

Concentrations of alkylphenols, phthalates and parabens were measured in the influent of the main WWTP of the Paris agglomeration in 2010 (Bergé *et al.* 2014; Gasperi *et al.* 2014). These concentrations represent the reference levels of the impregnation of urban wastewater for these micropollutants since they were the first studies providing information on these molecules. The same sampling points were again studied in 2015 and 2016. The evolution of the concentrations measured in Parisian wastewater between these two periods is showed in Figure 2. Since 2010, paraben concentrations have decreased by a factor of between 6 for MeP and 3.5 for EtP and PrP. For the alkylphenols, the NP concentrations are 5 times lower whereas those of the OP have been divided by 10; the levels recorded in 2015 are now very often close to the limit of quantification (0.17 µg/L). For phthalates, DnBP stands out, the concentrations in 2015 are higher than those of reference by a factor of 5 whereas for the other congeners the levels measured are approximately 5 times lower. Thus, for all the molecules, except for DnBP, the concentrations observed in 2015 are lower than the reference levels. This trend, which seems to be general, is however a reflection of very contrasting situations from one family to another. Parabens were almost withdrawn from personal care products following a sanitary alert (Darbre *et al.* 2004) and substituted by other preservatives. This latter withdrawal was the response of cosmetic manufacturers although no new regulations have been issued to ban them. Concerning alkylphenols and phthalates recent regulations limited their use in manufactured products (Regulation (EC) No 1907/2006, directive 2003/53/CE).

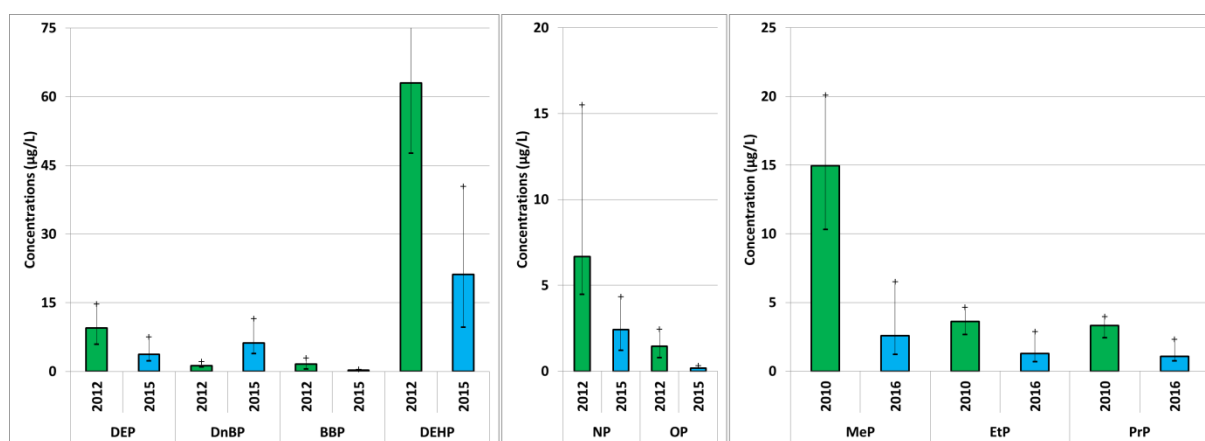


Figure 2: Temporal evolution of the concentrations (µg/L) in influent of WWTP following modifications of industrial formulations or regulation concerning phthalates, alkylphenols and parabens

Conclusion

This study focuses on the domestic origin of the contamination of wastewater. In the case of a heavily urbanized and scarcely industrialized conurbation, we highlighted that the contamination of domestic wastewater is predominant compared to industrial wastewater for three families of micropollutants: alkylphenols, phthalates and parabens. Then, the investigation of the quality of greywater allowed us to identify shower effluent and washing machine effluent as the main source of domestic wastewater contamination and so to identify ways to reduce it. Finally, the decrease of observed concentrations between 2010 and 2015 in the main trunks of the Paris conurbation, allowed us to understand the determinants (regulations and/or consuming practices) of these fluctuations in order to imagine levers for action by local authorities. The regulation of domestic activities seems to be central to promote a source reduction of micropollutants.

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Keywords: source reduction, domestic wastewater, industrial wastewater, levers of action, micropollutants