Sources and fate of perfluorinated compounds in the aqueous environment and in drinking water of a highly urbanized and industrialized area in Italy

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HIGHLIGHTS

• Monitoring occurrence and fate of perfluorinated compounds in the aqueous environment.
• Industrial wastes are the main source of contamination in a highly industrialized urban area.
• Perfluorinated substances were not removed in sewage treatment plants.
• Surface water contamination was increasing from north to south in the Lambro river basin.
• Ground and drinking water were also contaminated in industrial areas.

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ABSTRACT

Perfluorinated substances are listed among emerging contaminants because they are globally distributed, environmentally persistent, bioaccumulative and potentially harmful. In a three-year monitoring campaign (2010–2013) we investigated the occurrence, sources and fate of nine perfluoroalkylcarboxylic acids and three perfluoroalkysulfonic acids, in the most industrialized region of Italy. Composite samples were collected in influents and effluents of wastewater treatment plants (WWTPs), in the main rivers flowing through the basin, and in raw groundwater and finished drinking water. Samples were analyzed by liquid chromatography tandem mass spectrometry. Perfluorinated substances were not removed in WWTPs and those receiving industrial wastes discharged up to 50 times the loads of WWTPs receiving municipal wastes. The mass balance of the emissions in the River Lambro basin showed continuously increasing contamination from north to south and differences in the composition of homologues in the west and east sides of the basin. Ground and drinking water were contaminated in industrial areas, but these substances were removed well in Milan. Contamination from industrial sources was prevalent over urban sources, contributing to 90% of the loads measured at the closure of the basin. The River Lambro was confirmed as one of the main sources of contamination in the Po River.

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1. Introduction

In the last decade concern about perfluoroalkyl substances (PFAS) has rapidly risen in the scientific community because of their worldwide distribution in different environmental compartments [1–4]. Their chemical and thermal stability and their unique water- and fat-repellent properties have made it possible to put a wide range of industrial and consumer products containing PFAS on the market in the last six decades (e.g. for surface treatment of textiles and paper, building paints, cosmetics, insecticide formulations, firefighting foams, and the production of fluoropolymers) [5–7]. PFAS include thousands of chemicals but environmental studies have mainly concentrated on perfluorooalkylacids (PFAA) such as perfluoroalkylsulfonic acids (PFSA) and perfluoroalkylcarboxylic acids (PFCA). PFSA and PFCA are low-molecular-weight surfactants in which all the carbons are bonded to fluorine atoms, and consist of homologous series of molecules that differ in carbon chain length.

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