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Emerging pollutants in the environment: A challenge for water resource management

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Abstract

A significant number of emerging pollutants (EPs) resulting from point and diffuse pollution is present in the aquatic environment. These are chemicals that are not commonly monitored but have the potential to enter the environment and cause adverse ecological and human health effects. According to the NORMAN network, at least 700 substances categorized into 20 classes, have been identified in the European aquatic environment. In light of their potential impact action is urgently required.

In this study, we present a concept that shows the current state of art and challenges for monitoring programs, fate and risk assessment tools and requirements for policies with respect to emerging pollutants as a base for sustainable water resource management.

Currently, methods for sampling and analysis are not harmonized, being typically focused on certain EP classes. For a number of known highly hazardous EPs detection limits are too high to allow proper risk assessment. For other EPs such as microplastics method development is in its infancy. Advanced ultra-sensitive instrumental techniques should be used for quantitative determination of prioritized EPs in water, suspended matter, soil and biota. Data on EPs' and their metabolites' properties that determine their fate in the environment are often not available. National surveys on water quality often use different parameters for water quality assessment and often do not include EPs. A harmonized monitoring of surface and groundwater is not yet achieved and urgently required. Specific component integrated into models assessing the fate of EPs in a multi compartment environmental approach are missing and must be developed.

The main goal of risk assessment is the overall protection of ecological communities in the aquatic environment and human health. New methods for assessing the cumulative risks from combined exposures to several stressors, including mixtures of EPs in a multi-scale approach are required.

A combination of regulations and management measures with respect to use/emissions of EPs into the environment, as well as to their occurrence in the environment are fundamental to reach an efficient water resource management.

Keywords: Emerging pollutants; Water resource management; Monitoring; Risk assessment; Water policies

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1. Introduction

Water pollution is a severe worldwide problem that urgently requires concepts for monitoring and implementation plans deriving solutions. Every day, 2 Mio t sewage, industrial and agricultural waste are discharged into the world's water (UN WWAP, 2003), equivalent of the weight of the entire human population. The UN estimates that the amount of wastewater produced annually is about 1500 km^3, six times more water than exists in all the rivers of the world (UN WWAP, 2003). Lack of adequate sanitation causes water resources contamination worldwide, making it one of the most significant causes of water pollution. Worldwide, 2.5 billion people live without proper sanitation (UNICEF, 2009). In some regions of the world, more than 50% of native freshwater fish species are at risk of extinction, and this is also the case for nearly one-third of the world's amphibians (Vié, Hilton-Taylor, & Stuart, 2009).

Over 70% of the people who lack sanitation, or 1.8 billion people, live in Asia. In China, which has a rapidly growing economy water is a scarce resource as just 8% of the world's fresh water has to meet the needs of 22% of the world's population. However, 33% of industrial waste water, and 70% of household sewage is untreated and directly released into rivers and lakes, while 80% of China's cities have no sewage treatment facilities and water supplies in 90% of the cites are contaminated. Environmental degradation costs China nearly 9% of its annual gross domestic product (http://factsanddetails.com/china/cat10/sub66/item391.html).

Nowadays, more than 700 emerging pollutants, their metabolites and transformation products, are listed as present in the European aquatic environment (www.norman-network.net). Emerging pollutants (EPs) are defined as synthetic or naturally occurring chemicals that are not commonly monitored in the environment but which have the potential to enter the environment and cause known or suspected adverse ecological and (or) human health effects. In some cases, release of emerging pollutants to the environment has likely occurred for a long time, but may not have been recognized until new detection methods were developed. In other cases, synthesis of new chemicals or changes in use and disposal of existing chemicals can create new sources of emerging pollutants (http://www.norman-network.net). EPs are currently not included in (inter)national routine monitoring programmes and their fate, behavior and ecotoxicological effects are often not well understood. They can be released from point pollution sources, e.g. waste water treatment plants from urban or industrial areas, or from diffuse sources through atmospheric deposition or from crop and animal production (Fig. 1). EPs are categorized into more than 20 classes related to their origin (http://www.norman-network.net). The prominent classes are: pharmaceuticals (urban, stock farming), pesticides (agriculture), disinfection by-products (urban, industry), wood preservation and industrial chemicals (industry). In light of the potential impact of these substances on aquatic life and human health, the lack of knowledge regarding their behavior in the environment and the deficiency in analytical and sampling techniques, action is urgently required at multiple levels.

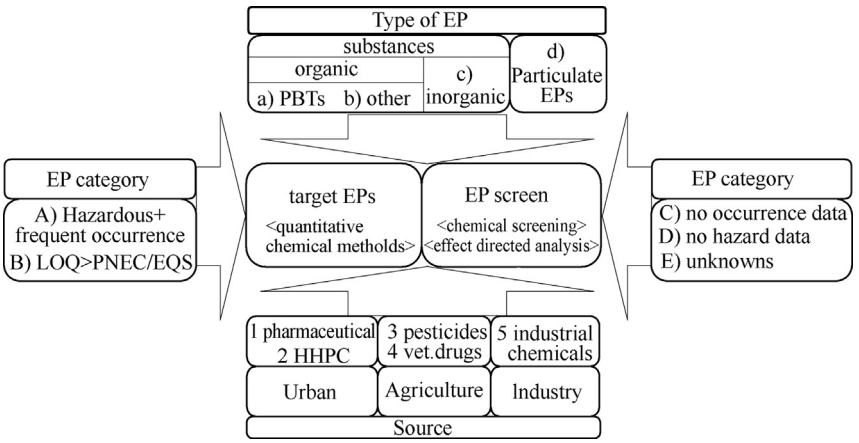

Fig. 1. Types of EPs from different origins that can be monitored by targeted and screening approaches.
(PBT = persistent bioaccumulative and toxic, LOQ = limit of quantification, PNEC = predicted no-effect concentration, EQS = environmental quality standard, HHPC = household & personal care products).