Chapter 3
A Review of Emerging Contaminants in Water:
Classification, Sources, and Potential Risks

Alexandros I. Stefanakis
University of Brighton, UK

Julie A. Becker
University of the Sciences, USA

ABSTRACT

Contaminants of emerging concern or, simply, emerging contaminants represent a newly discovered group of chemicals present in surface and groundwater. It was only the improvements in analytical instrumentation that allowed for the detection of these contaminants even at trace levels. The continuous detection of new chemicals with time raises questions concerning their source pathways, their fate, transport, transformations and impact on aquatic environments. The scope of this chapter is to present an overview of the contaminants classified as "emerging", their sources and introduction pathways to the environment and the related risks to human health and aquatic life.

INTRODUCTION

Current practice and experience dictates that investments in detection, prevention, control and elimination strategies of environmental pollution by chemical pollutants will continue to rise. However, given the huge number of pollutants occurring in the environment due to the combined effects of both natural processes and human activities, it seems that the range of currently regulated chemical pollutants represents only a small fraction of the total chemical pollution. To this, the gradual detection and identification of new emerging pollutants further increases the long list of chemical pollutants. It is then unavoidable that national and international lists of regulated chemicals will ignore the majority of other chemicals occurrence based on the assumption that the chemicals considered by the regulatory processes are the most significant and that they possess the greatest risk to the environment, human health and the economy. However, questions will still remain concerning the right (or not) selection of

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the most dangerous chemical pollutants. Additionally, developments of the last 10-15 years imply that there is a large chemical universe still unidentified that will be possibly determined in the near future.

Contaminants of emerging concern or emerging contaminants (ECs) represent relatively newly discovered groups of unregulated contaminants which occur in surface and groundwater, such as pharmaceuticals and personal care compounds, and generally include compounds used in everyday life and various industrial additives. Most of these pollutants were previously (e.g., 15-20 years ago) unknown or simply unrecognized or unidentified and have recently emerged as contaminants associated with potential environmental risks. Their fate in water/wastewater treatment plants, in engineered systems and generally in the environment still remains relatively unknown. At the same time, potential impact and risks to human health, wildlife, aquatic life and ecosystems is another important topic of great interest which needs further investigation. These pollutants are usually bioactive and bioaccumulative and can have a widespread occurrence and persistence. The vast majority of ECs is currently not regulated which means that a continuous monitoring and reporting of their possible presence in water supplies and effluent discharges is required. Today, it is clear that an integrated research and approach to these contaminant groups should be multidisciplinary, involving disciplines such as chemistry, biology and engineering.

Background

ECs are not necessarily newly created chemicals. It could be stated that term refers to three general categories. The first category includes compounds which are recently introduced into the environment (e.g., industrial additives). The second category consists of compounds that might have been present in the environment in the past for many years, but it is only during the last years that their presence was detected and their significance started to attract interest (e.g., pharmaceuticals). The third category includes compounds that are known for a longer time but their potential negative impact on humans and the environment was only recently realized (e.g., hormones). The main problem with ECs is that available data for most of these contaminants are scarce and relatively limited and respective detecting methods and instrumentation either do not yet exist or are at the early development stage. This is why only with the gradual progress in analytical detecting and measuring techniques became possible the detection of these micro-contaminants in the environment. In other words, for many ECs it is not yet clarified the level of risk they represent for the environment and human health, while the techniques to monitor them and the effective technologies to further mitigate contamination are still in development. Only advances in analytical chemistry and instrumentation, as well as in engineering, made it possible to identify ECs in the environment. Analytical capabilities have significantly improved during the last two decades from parts per thousand to parts per trillion (ppt) or even parts per quadrillion (ppq) in some cases, which allowed for the detection and investigation of these contaminants in environmental samples.

The goal of this chapter is to present an overview of these newly discovered contaminant groups, mainly of the organic chemicals detected in surface and groundwaters. The chapter includes their classification, sources and related environmental and human risks, along with a brief analysis of the current legislative status in Europe.