Preface

The perspective on contamination of aqueous environment by anthropogenic trace pollutants has experienced a remarkable change in the past ten to fifteen years. Traditionally hydrophobic persistent organic pollutants (POP) that may accumulate in sediments and enrich along food chains were studied extensively. Meanwhile the awareness developed that also polar contaminants may pose a significant problem to water quality, especially if they are not well degradable.

This growing awareness of polar pollutants has several reasons, of which only a few may be mentioned here.

• studying the occurrence of polar pollutants requires that these contaminants are analytically accessible. It was only in the second half of the 1990s that the effective coupling of liquid chromatography to mass spectrometry by electrospray ionization offered a highly sensitive approach to determine polar pollutants from water (see Chapter 1). This progress in analytical chemistry was a prerequisite to direct more attention towards such polar pollutants and to study them in more detail.

• Also in the 1990s it was shown, that trace organic pollutants present in municipal wastewater effluents may have severe sub-lethal effects to aquatic biota. It was shown that xeno-estrogens may interfere with the hormone cycle of wildlife at trace level.

• Globally an increasing water demand calls for an increasing portion of indirect potable reuse of treated municipal wastewater. However, such a partial closure of water cycles at local and regional scale urges to consider new criteria for contaminant evaluation. Especially polar and persistent pollutants can be problematic as they may travel along a water cycle from wastewater to raw waters used for drinking water production. The past ten years have seen increasing evidence that such compounds are present.

The Partially Closed Water Cycle

One example of a partially closed water cycle is displayed in Figure 1. In such a cycle a polar and persistent component that is neither removed by sorption nor by
biodegradation could pass all barriers such as wastewater treatment or underground passage and would, then, appear in raw waters used for drinking water production. Polar pollutants may originate from consumer products used in household, pesticides applied in agriculture or chemicals used in industry. Surface runoff may also contribute. The occurrence of trace pollutants in raw waters requires an ever increasing technical effort in drinking water production.

Of the various components of such a water cycle (Fig. 1) the municipal wastewater treatment plants are, certainly, best investigated. Meanwhile, an impressive body of literature is available concerning the occurrence and removal of polar trace pollutants from municipal wastewater by biological treatment. Other processes such as the transport of pesticides applied in agriculture to groundwater are also comparatively well studied. The occurrence of polar pollutants in other compartments of this cycle, however, and their removal in or passage through other barriers than wastewater treatment or soil are less thoroughly investigated. Even less so has the occurrence and behaviour of polar pollutants in all components of a partially closed water cycle been studied systematically.

Therefore this book aims at bringing together results obtained in various studies concerning all compartments and barriers of a (hypothetic) partially closed water cycle.

**The Polar Pollutants**

As this book focuses on the water cycle the selection of contaminant classes that are covered is, among others, based on *polarity*. The authors agreed to select an upper limit of the octanol/water partition coefficient (log $K_{ow}$) of 3 for inclusion into this book. Therefore, the reader may miss certain contaminant classes that he became familiar with in the past years, like endocrine disruptors. Certainly, these compounds would be an issue in a more general book on ‘contaminants in water’ but, due to the comparatively high log $K_{ow}$ values of many of these compounds, they are not relevant as ‘contaminants in the water cycle’.

The *production volume* is another relevant criterion as a high production volume chemical, even with an almost complete removal in wastewater treatment, could still lead to significant amounts being discharged into surface water. For this rea-
son a number of high production volume chemicals are included in this book. The first to mention are surfactants which are used almost everywhere (Chapter 9). The occurrence of poorly degradable surfactants in surface waters and groundwaters made this class of compounds the first, for which a minimum extent of biodegradability was required by regulations in Western Europe and the United States in the early 1960s. Other important groups of polar high production volume chemicals that are covered in this book are herbicides (Chapter 6), complexing agents (Chapter 7) and amines (Chapter 8).

Also compounds used and released in substantially less amount can be problematic, if their use profile requires a certain level of stability. Pharmaceuticals are an example for this and the occurrence of such compounds in wastewater discharges and surface waters has received significant attention within the last years. Several chapters of this book deal with this ‘dark side’ of the so beneficial development in pharmaceuticals (Chapters 2–5).

Finally, polar pollutants may even be generated in wastewater treatment or drinking water production as it is the case for disinfection byproducts (Chapter 10).

With improved analytical capabilities (Chapter 1) that allow to detect nanogram per litre concentrations of trace pollutants positive findings in virtually all aquatic compartments are almost inevitable. Thus, the need for proper knowledge how the occurrence of low concentrations of polar pollutants has to be evaluated is becoming more urgent. Chapter 11 deals with such aspects of ecotoxicology. A combined evaluation of physico-chemical and ecotoxicological properties of high production volume chemicals is necessary to avoid contamination and to reduce the risk related with the use of chemicals. This is the basis of the chemicals management (REACH) in the European Union (Chapter 12).

Also in the European Union the Water Framework Directive (WFD) has bundled many different regulations concerning the protection of freshwater resources. While the WFD has strengthened biological quality criteria for waters and water bodies, there is growing concern with respect to chemical quality criteria. Inter alia chemicals that may not be harmful to human health or the quality of aquatic ecosystems are not considered pollutants. Thus, the WFD may hamper rather than foster the protection of the water cycle from anthropogenic compounds that are polar and persistent and that may spread in aquatic environment.

We would be pleased if this book contributes to increasing the knowledge on and the awareness of the relevancy of polar pollutants for the quality of waters, not at least those being used as drinking waters.

We are grateful to all the authors that shared this view on polar pollutants and contributed with their expertise, time and effort in preparing the different chapters of this book.

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