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Topics

Anthropogenic Trace Pollutants in the Water Cycle

Pharmaceuticals

May 2008

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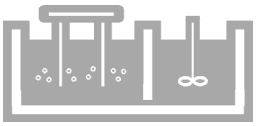

Anthropogenic Trace Pollutants in the Water Cycle

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The German Association for Water, Wastewater and Waste (DWA) is intensively involved with the development of reliable and sustainable water management. Being a politically and economically independent organisation it operates specifically in the areas of water management, wastewater, waste and soil protection.

In Europe the DWA is the association in this field with the greatest number of members and, due to its specialist competence, it holds a special position with regard to standardisation, professional training and information of the public. The members, approximately 14,000 represent specialists and managers from municipalities, universities, consulting engineers, authorities and businesses.

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Foreword

This issue of DWA Topics has been elaborated by the DWA Working Group KA-8.1 "Anthropogenic Trace Pollutants in the Water Cycle" and Committee III "Basic Research" of the Waterchemical Society. The DWA-Working Group would like to thank DWA and DVGW members for numerous valuable comments and critical remarks.

This issue of DWA Topics primarily addresses representatives from politics and administration as well as from public utilities, but also producers, consumers and users of products, which contain anthropogenic trace pollutants. Generally, anthropogenic trace pollutants include organic compounds such as pharmaceuticals, personal care products, perfluorinated compounds, pesticides or biocides, which can be detected in wastewater, groundwater, surface waters or drinking water in ranges of µg/L to ng/L.

Using pharmaceuticals as an example, this issue of DWA-Topics discusses the current pollution load and explores the complex problem of anthropogenic trace pollutants, ecotoxicological and human-toxicological risks as well as possible consequences for water supply and wastewater disposal. An interdisciplinary approach was used to look at the problem from the point of view of human-toxicology, ecotoxicology, environmental and water chemistry as well as wastewater treatment and drinking water supply. The objective of this publication is to present risk potentials, to recommend possible activities at various levels and to point out loopholes in national and European law.

An easy standard solution for the avoidance and/or removal of anthropogenic pollutants from the urban water cycle does not exist. Politicians/administration, producers, users, consumers as well as public utilities must cooperate in the future, in order to minimize risks, which may result from the pollution of surface waters, groundwaters and drinking waters.

After an introduction to the problem (Chapter 1), Chapter 2 exemplarily describes pollution caused by selected pharmaceuticals in various environmental matrices such as wastewater, flowing water bodies and drinking water. Chapter 3 discusses deficits of the German Drinking Water ordinance in regard to anthropogenic trace pollutants and recommends solutions for these deficits. Measures to reduce discharge of pharmaceuticals are discussed in Chapter 4. In Chapter 5, new legal regulations for assessing ecotoxicological risks of pharmaceuticals are introduced. Chapters 6 and 7 describe processes for the elimination of pharmaceutical residues and other trace pollutants during wastewater and drinking water treatment. Afterwards in Chapter 8, the occurrence of anthropogenic trace pollutants in drinking water is discussed in regard to legal regulations and aesthetic aspects. Chapter 9 gives scientific background and regulatory aspects for an assessment from the point of view of ecotoxicology. Examples of international water reuse projects can be found in Chapter 10. Finally, Chapter 11 presents problems of closed urban water cycles using the example of the city of Berlin, while Chapter 12 describes agricultural water reuse in Braunschweig, Germany. Based on the information given in the previous chapters, Chapter 13 shows current demand for further research.

It is not the objective of this DWA Topics to give a complete survey of literature existing on the topic of trace pollutants in the water cycle. Wherever necessary, suggestions for further readings are given.

Authors

This issue of DWA Topics was elaborated by the DWA-Working Group KA-8.1 "Anthropogenic Trace pollutants in the Water Cycle" within the DWA-Committee KA-8 "Processes for advanced wastewater treatment after biological treatment". The DWA-Working Group KA-8.1 has the same members as the Committee III "Basic Research" of the Waterchemical Society – a Division of the German Chemical Society.

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Argumentation and Summarizing Discussion

Intention of this Issue of DWA-Topics

This issue of DWA-Topics shows possible risk potentials, possible actions and the demand for research in order to be able to avoid discharge of anthropogenic trace pollutants to the aquatic environment. Also it describes loopholes in national and European laws, such as the European Water Framework Directive. The focus is on human pharmaceuticals in place of the large variety of trace pollutants.

Various precautionary measures are recommended to avoid risks for humans and animals. If these measures are realized, pollution of the water cycle from wastewater to drinking water will be reduced. Suggested measures cover pollutant reduction at the source up to wastewater treatment processes and drinking water production.

Below, the following questions will be discussed and answered as far as possible:

- Are there any risks for humans and animals due to anthropogenic trace pollutants in the urban water cycle?
- Do regulations of the European Water Framework Directive, the European Groundwater Directive and the Drinking Water Ordinance suffice to protect mankind and environment from anthropogenic pollutants?
- Which measures can possibly be taken at discharge sources, in wastewater treatment and drinking water production?

Concluding Discussion and Requirements for Politics, Science and Associations

Are there any risks for humans and animals due to anthropogenic trace pollutants in the urban water cycle?

In regard to current risk assessment criteria, none of the substances detected in water (groundwaters, drinking waters) posed a health risk for humans. However, data availability is more than unsatisfactory, since a complete health risk assessment of pharmaceuticals and their degradation products found in the water cycle is only possible in very few cases. Prioritization of substances, which need to be assessed completely, seems inevitable on the basis of exposure data and effects.

From the point of view of human toxicology, so far four toxicologically relevant effect groups have been identified, the presence of which is always undesired in regard to health: (a) substances with hormone effect potential, (b) substances with genotoxic effects (e. g. cytostatics), (c) substances with immunotoxic effects and (d) substances with antiinfective effects (e. g. antibiotics).

As long as data supply is incomplete, the so-called health based precautionary value (HPV) for non-genotoxic substances developed by the Federal Environmental Agency in Germany (UBA) is used for non-assessable or only partially assessable substances present in drinking water. This concept regards a concentration of non-genotoxic or hardly genotoxic substances below the HPV_1 of 0.1 µg/L as safe in regard to health at life-long exposure. For highly genotoxic substances, only values below the HPV_2 of 0.01 µg/L can be accepted due to their high toxicological relevance. Only if values are permanently below both these precautionary values, a sufficient safety margin to strictly toxicologically derived values can be expected for a complete assessment at a later point.

From the point of view of ecotoxicology, so far investigation of the water cycle is limited to the assessment of individual chemical substances and does include substance mixtures only in rare cases. It also hardly considers the occurrence of microbial contaminants, which of course can also influence ecosystems. These facts must be evaluated taking into regard their pathogenicity and the development of multi-resistances against antibiotics.