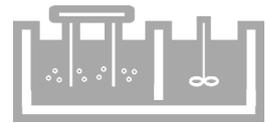


Anthropogenic Trace Pollutants in the Water Cycle

Pharmaceuticals

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Anthropogenic Trace Pollutants in the Water Cycle

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 $\mu\text{g/L}$ 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.

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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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Contents

Foreword	3
Authors	4
List of Figures	7
List of Tables	8
Argumentation and Summarizing Discussion	9
Intention of this Issue of DWA-Topics	9
Concluding Discussion and Requirements for Politics, Science and Associations	9
1 Introduction	13
1.1 Sanitary Engineering and Wastewater Reuse	13
1.2 Pathways of Pharmaceuticals to the Environment.....	15
References	16
2 Contamination Situation in Regard to Pharmaceuticals	17
2.1 Introduction	17
2.2 Treated Wastewater and Flowing Water Bodies	17
2.3 Groundwater and Drinking Water	19
2.4 Other Environmental Matrices	20
2.5 Pathogenic Microorganisms as Carriers of Antibiotic Resistances	20
References	22
3 Evaluation of Surface Water Contamination within the Enforcement of the European Water Framework Directive (WFD)	25
4 Strategies for Preventing Discharge of Pharmaceuticals into Water Bodies	27
4.1 Introduction of an Ecolabel	28
4.2 Treatment of Highly Polluted Waste Streams and Source Separation	29
4.3 Example: Iodinated X-Ray Contrast Media.....	30
4.4 Conclusion	31
References	32
5 Considering Environmental Fate and Effects of Pharmaceuticals During Market Approval	33
5.1 Environmental Risk Assessment for Individual Substances	33
5.2 Examples	34
5.3 Outlook	38
References	38
6 Removal Mechanisms in Mechanical-Biological Wastewater Treatment Plants and Possible Advanced Treatment Procedures	40
6.1 Introduction	40
6.2 Sorption	41
6.3 Biological Degradation	42
6.4 Advanced Measures for Municipal Wastewater Treatment.....	44
6.5 Conclusion	47
References	48

Anthropogenic Trace Pollutants in the Water Cycle

7	Requirements for Drinking Water Treatment	49
7.1	Introduction	49
7.2	Processes for Drinking Water Treatment.....	50
7.3	Removal Efficiency of Selected Treatment Processes in Regard to Pharmaceuticals	50
7.4	Examples of Process Combinations for Drinking Water Treatment of Surface Waters with a Wastewater Influence	57
7.5	Discussion and Outlook	58
	References	58
8	Evaluation of Pollution of Drinking Water with Mobile Organic (and Inorganic) Contaminants in View of Drinking Water Hygiene and Aesthetics	61
8.1	Evaluation of Drinking Water Hygiene	61
8.2	Aesthetic Evaluation – How Much Recycling Can be Handled, How Much Is Obligatory?	62
	References	63
9	Human Toxicity of Pharmaceuticals/Combined Effects in the Aquatic Environment	64
9.1	Introduction	64
9.2	Substances of Special Interest for Public Health	64
9.3	Toxicological Data and Their Interpretation	65
9.4	Kinetic Data	66
9.5	Regulatory Aspects	66
9.6	Health Risk Assessment	66
9.7	Precautionary Principle, Prioritization (HPV, TTC)	67
9.8	Combination Toxicology: Definition and Problems	68
9.9	Conclusion	68
	References	69
10	Wastewater Reuse	70
10.1	Introduction	70
10.2	International Examples.....	71
	References	74
11	Sources and Collectors of Anthropogenic Pollutants in the Berlin Water Cycle	75
	References	78
12	Water Reuse in Braunschweig	79
	References	81
13	Demand for Research and Measures	82
	Glossary	83
	Abbreviations and Symbols (not part of the German version).....	85

List of Figures

Figure 1.1:	Pollutants, which have been monitored for a long period of time and have already been regulated to a large extent	13
Figure 1.2:	Selection of emerging contaminants which have been detected in flowing water bodies in the last couple of years and have been gaining in importance	14
Figure 1.3:	Pathways of pharmaceuticals to environment and potable water	16
Figure 2.1:	Schematic presentation of drug metabolism	17
Figure 2.2:	Comparison of contamination of small streams located in Hessisches Ried/Germany and the large rivers Rhine and Main with selected	19
Figure 2.3:	Concentrations of four selected pharmaceuticals in exposed groundwaters	20
Figure 3.1:	Schematic presentation of risk assessment for water bodies according to the WFD	25
Figure 4.1:	Options for reducing discharge of pharmaceuticals at their source	28
Figure 4.2:	Decentralized wastewater treatment concept of the Hans Huber AG	30
Figure 5.1:	Simplified schematic presentation of the steps of an environmental risk assessment for declaration and registration of individual substances	34
Figure 5.2:	Schematic presentation of the steps of an environmental risk assessment according to EMEA (2006) for 17 α -ethinyl estradiol (EE2)	36
Figure 5.3:	Schematic presentation of the steps of an environmental risk assessment according to EMEA (2006) for carbamazepine (CBZ)	37
Figure 6.1:	Historical development of the activated sludge treatment	40
Figure 6.2:	Sorption constant and sorbed fraction of selected compounds in the influent as well as in primary and secondary sludge	42
Figure 6.3:	Biological degradation or transformation of a compound in dependency on sludge age (t_{DS}) of the activated sludge	43
Figure 6.4:	Substance flow and degradation of the contraceptive 17 α -ethinyl estradiol at the wastewater treatment plant at Wiesbaden, Germany in g per day.	44
Figure 6.5:	Oxidation of pharmaceuticals in biologically treated wastewater by treatment with ozone	46
Figure 7.1:	Water resources and frequently used treatment processes	50
Figure 7.2:	Break through behaviour of diatrizoat and iopromid during activated carbon filtration (F300) at waterworks	54
Figure 7.3:	Half-lives and reaction rate constants for the reaction of pharmaceuticals with ozone	55
Figure 7.4:	Retention of substances using membrane processes	56
Figure 7.5:	Removal of selected pharmaceuticals during treatment at a German waterworks	57
Figure 7.6:	Removal of ICM during surface water treatment O ₃ -dosage pre-ozonation: 1 mg/l; dosage main ozonation: 1.7 mg/l; spec. throughput of the activated carbon filters 30 to 72 m ³ /kg	57
Figure 10.1:	Water sources and water supply in Windhoek, Namibia	71
Figure 10.2:	Direct water reuse in Windhoek, Namibia	72
Figure 10.3:	Water Factory 21	72
Figure 10.4:	NEWater, Singapore	73
Figure 11.1:	Hydrogeological view of the city of Berlin	75
Figure 11.2:	Origin of raw water used for drinking water production in Berlin	76
Figure 11.3:	Technical parts of the water system of the Berliner Wasserbetriebe	76
Figure 11.4:	Water cycle in the urban area of Berlin	78
Figure 12.1:	Water Reuse concept of the city of Braunschweig	79

List of Tables

Table 2.1:	Concentration ranges of detected pharmaceuticals in German WWTP effluents	18
Table 2.2:	Concentration ranges of detected pharmaceuticals in German rivers and streams	18
Table 4.1:	Evaluation of removal efficiency of a pharmaceutical due to flocculation, ozonation and activated carbon filtration	29
Table 5.1:	Characteristics of selected pharmaceuticals.....	35
Table 5.2:	Predicted concentrations of two pharmaceuticals for human use (CBZ and EE2) in surface waters in Germany (PEC_{sw-G}), calculated according to equation 1, in which however $DOSE_{ai}$ has been replaced by defined daily dose values (DDD) of the WHO (2005); refined values of PEC_{sw-G} according to EMEA-guideline; comparison with measured concentrations (MEC_{sw-G}); compiled and evaluated according to LIEBIG et al. (2006)	35
Table 6.1:	Concentration and removal (in brackets) of pharmaceuticals (LOD: 0.050 $\mu\text{g/L}$) and estrone (LOD: 3 ng/L) in the wastewater treatment plant effluent of Braunschweig, Germany (DOC: 23.0 mg/L, pH 7.2) before/after ozonation (5, 10, 15 mg/L O_3)	45
Table 6.2:	Number of resistances detected in enterococci from the urban and rural influent of a WWTP and after dosing of 8 resp. 15 g ozone per m^3 WWTP effluent of biologically treated wastewater	46
Table 7.1:	Efficiency of bank filtration, flocculation and activated carbon filtration for the removal of pharmaceuticals.....	51
Table 7.2:	Efficiency of advanced treatment processes for the removal of pharmaceuticals	52
Table 9.1:	Ranking of the five most prescribed classes of pharmaceuticals with exemplary substances detected in the water cycle	64
Table 9.2:	Health risks of pharmaceutical residues in the water cycle and their epidemiological evidence.....	67
Table 10.1:	Types of wastewater reuse	70
Table 10.2:	Water reuse plants compilation from <www.vatechwabag.com>.....	71
Table 11.1:	Reduction (in %) of anthropogenic parameters at the surface water treatment plant Tegel, AAA acetylaminoantipyrine, FAA formylaminoantipyrine, AMDOPH 1-acetyl-1-methyl-2-dimethyl-oxamoyl-2-phenylhydrazide.....	77
Table 12.1:	Concentration ($\mu\text{g/L}$) of pharmaceuticals in the Braunschweig WWTP influent and effluent and in selected wells in the irrigation area. Median values of 4 sampling campaigns	81

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 HPV₁ of 0.1 µg/L as safe in regard to health at life-long exposure. For highly genotoxic substances, only values below the HPV₂ 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.