PAN Germany
Pestizid Aktions-Netzwerk e.V.

Pharmaceutical Pollutants in Water and the Revision of the EU Groundwater Directive

Background Paper

A healthy world for all.

Contents

This project was supported by:

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit

Umwelt Bundes Amt
Für Mensch und Umwelt

Responsibility for the content of this publication lies with the authors.
The supporting institutions accept no responsibility for the correctness, accuracy or completeness of the information, or for the observance of the private rights of third parties. The views and opinions expressed herein do not necessarily reflect those of the supporting institutions.

Acknowledgements: We thank our funders for their support.

Impressum: © Pestizid Aktions-Netzwerk (PAN) e. V., Nernstweg 32, 22765 Hamburg, Phone +49 (0)40 - 399 19 10 - 0
info@pan-germany.org, www.pan-germany.org, Hamburg, April 2013
Text: Christian Schweer and Susan Haffmans; translation and editing of the English version: Paula Bradish; layout: grafik:sommer; printed on recycled paper; Cover photo: ©Juri Samsonov, www.fotolia.com

Significance of human and veterinary pharmaceutical pollutants in groundwater

A survey of numerous older and more recent scientific publications shows that residues from pharmaceuticals are increasingly found in the environment, including groundwater.

A workshop report published by the European Environmental Agency (EEA) in 2010 states that the status of environmental risks posed by pharmaceuticals "looks worse" than a decade earlier.[1] Widely recognized OECD tests show that 95% of the pharmaceuticals studied are not readily biodegradable.[2] Of the human pharmaceuticals examined, 15% are persistent in surface water.[3] About 50% of the veterinary pharmaceuticals studies are persistent in soil.[4] A large number of pharmaceutical substances and metabolites can be found in wastewater and surface water throughout Europe.[5] Standard long-term tests conducted with fish, daphnia, and algae as test organisms revealed effects at pharmaceutical concentrations of less than 1 mg/l.[6] At least one study describes changes in aquatic organisms at much lower concentrations of less than 0.001 mg/l.[7] Other research has demonstrated that the toxicity of substance mixtures is at times substantially higher than the sum of the toxicity of each individual component.[8] In the case of antibiotic mixtures, for example, total toxicity was as much as five times higher than the sum of the toxicity of the individual components.[9] Aquatic organisms are thus especially threatened by the effects of multiple pharmaceutical pollutants. Data analyses from 2008 describe a relatively stable market for pharmaceutical substances in Europe, with slight increases in the amounts sold.[10] Increases are documented for products that contain fluorine, which are quite persistent in the environment.[11] Due to the rising average age of the population in Europe, per capita consumption of pharmaceuticals is expected to rise.[12]

From the perspective of the EEA, more monitoring data is needed, especially on antibiotics, antiparasitics, hormones, analgesics, and psychotrophic drugs in water bodies and in sediments.[13] This should also include monitoring of groundwater after the relevant substances have placed on the market.[14] Furthermore, environmental quality standards should also be defined.[15] Special attention should be paid to those substances that are expected to effect the environment and are released in large quantities.[16] This is true, for example, for so-called PBT substances, which are classified as persistent, bioaccumulative and toxic.[17]

Pharmaceutical residues and their metabolites have been demonstrated to be present in groundwater at least since the early 1990s.[18] Although the concentrations of these substances observed in bodies of water have generally been below the levels permitted in food to protect human health, there is no proof so far that these levels do not harm aquatic organisms.[19] There is a significant lack of knowledge about the environmental paths and effects of pharmaceuticals. As late as 2008, there were only very few studies on pharmaceutical residues in groundwater and on whether and to what extent detrimental effects could be observed,[20] although it has become possible to identify an increasing number of substances, thanks to improved analytical methods[21]. But for many of the approximately 2900 pharmaceutical substances on the market in Germany, such methods are still lacking[22].

Pharmaceutical residues and their metabolites have been demonstrated to be present in groundwater since the early 1990s, at the latest. To date there is no proof that these residues do not harm aquatic organisms.

Although there is still a need for further research, our general understanding of the ecotoxicity of pharmaceuticals has improved in recent years.[23] Over time, a growing number of pharmaceutical substances, such as clofibric acid or carbamazepine, iopromide and diatrizoic acid (a persistent radiocontrast agent) have been found in relatively high concentrations in riverine groundwater.[24] Drugs for human use enter surface and groundwater via wastewater and the sewage system and wastewater treatment facilities; veterinary pharmaceuticals enter the environment for the most part when liquid manure from intensive livestock farming is used on agricultural land and then enters runoff water.[25] Pharmaceuticals also found their way into environmental via use of sewage sludge, inadequately secured dumps, and leakage in the wastewater systems.[26] About 30.000 tonnes of human pharmaceuticals are administered annually in Germany.[27] Of these, 131 substances with an annual sales volume of 5 tonnes are potentially relevant with respect to their environmental effects. The total consumption of these substances amounted to more than 7000 tonnes in 2009[28]. Most of the substances found in environmental water are components of pharmaceuticals authorised for sale before the obligatory environmental risk assessment was in place and therefore have not been tested for their environmental impact and substances which are disposed of via household waste collection[29]. Concentrations of these substances of more than 0.1 mg/l have been observed in groundwater close to the land surface that interacts with surface water.[30] These concentrations are alarming, since according to the European Medicines Agency, potential risks for the environment occur at values above 0.01 mg/l.[31] In Germany, the Bund-Länder-Arbeitsgemeinschaft für Chemikaliensicherheit (BLAC) commissioned a national study on the occurrence of pharmaceuticals in environmental water in 2000/2001 (39 of 2900 substances were selected for the study)[32,33] The results show that these substances can be identified at numerous test sites in groundwater that interacts with surface water and wastewater groundwater.[34] These results were described for a broad spectrum of pharmaceuticals.[35]

About 30.000 tonnes of human pharmaceuticals are administered annually in Germany. Of these, 131 with an annual sales volume of 5 tonnes per anum are potentially relevant with respect to their environmental effects. The total consumption of these substances amounted to more than 7000 tonnes in 2008.

A study of the relevant literature commissioned by Germany's Federal Environment Agency (referred to here as UBA study) showed: 55 active pharmaceutical substances were identified in groundwater samples from Germany and 15 active substances in samples from other European countries (positive identification).[36] For 20 substances, the highest concentrations measured were between 0.1 and 1 mg/l in groundwater; for 13 other substances, the highest values were more than 1 mg/l.[37] A maximum value found for carbamazepine (an anticonvulsant) was more than 3 mg/l.[38] On the basis of concentrations found in water bodies during monitoring, scientists assume that substances such as carbamazepine and diclofenac, which have already been found in groundwater, have a ecotoxicological impact potential (MEC[39] max/PNEC[40] > 1). This means that the environmental concentrations observed have adverse effects on local ecosystems. In this work, researchers studied solely the adverse effects on organisms in surface water. Possible negative consequences for groundwater ecosystems were not addressed. Carbamazepine and diclofenac and 24 other pharmaceutical substances must be treated as high-priority hazards, according to the authors of the UBA study, because they are especially

problematic, based on the ecotoxicological evidence.[41] The researchers who conducted the UBA study propose the introduction of an efficient monitoring system for surface and groundwater, in order to achieve a more comprehensive survey of the pollution situation, as a basis for implementing appropriate measures[42] In their opinion, veterinary pharmaceuticals classified as tetracyclines and sulphonamides are relevant for the proposed monitoring.[43] Furthermore, they recommend selecting the substances to be observed and the appropriate monitoring points based on use patterns and the probability of exposition, so that, for example, samples would be taken where with intensive agricultural use or intensive livestock farming or where surface water is known to be polluted.[44]

For surface and groundwater, researchers propose introduction of an efficient monitoring system to achieve a more comprehensive survey of the pollution situation and implement appropriate measures. In their opinion, veterinary pharmaceuticals classified as tetracyclines and sulphonamides are relevant for the proposed monitoring.

The effects of pharmaceutical residues on groundwater fauna is another issue that calls for further study. In Germany, ongoing research in the realm of ground water as a habitat focuses on defining criteria for assessing the state of groundwater ecosystems. This work has lead to a preliminary proposal for defining ecological groundwater reference states[45]. Switzerland has recently begun implementing systematic monitoring of groundwater habitats.[46] Available information from the studies conducted in Switzerland and Germany do not yet support an evidence-based answer to the question of whether pharmaceutical residues have effects on groundwater ecosystems. It is possible that these substances and their metabolites adversely affect fauna, especially in view of the special nature of groundwater ecosystems. The majority of the more than 2000 groundwater species discovered so far in Europe are microscopically small organisms that mostly live near the water surface. Some of these species have longer life spans than similar species in surface water and can be found in only one or in a small number of groundwater bodies.[47] At least one study from Italy has already confirmed that pharmaceutical residues have negative effects on groundwater organisms.[48]

The effects of pharmaceutical residues on groundwater fauna calls for further study, since it is possible that pharmaceutical substances can adversely affect the fauna of groundwater ecosystems.

Protection of groundwater in regulations on pharmaceuticals

Authorisation of pharmaceuticals is to a large extent subject to EU legislation. EU law also grants members states legislative power in some areas, in order to supplement or specify regulations pertinent to groundwater protection. However, these options have hardly been utilized to date. The basis for EU legislation with respect to veterinary and human pharmaceuticals differ; this has lead to more or less large gaps in regulations that are relevant for both EU and national pharmaceutical authorisation procedures.

Human pharmaceuticals

Directive 2001/83/EC (Community Code Relating to Medicinal Products for Human Use) as well as the acts that supplement or revise this directive (Directives 2004/27/Ec, 2009/53/EC, 2010/84/EU, 2011/62/EU; Regulations 1901/2006 and 1394/2007) currently provide for the authorisation of human pharmaceuticals in Germany and the other EU member states.[49] According to Article 2 of the consolidated version of the community code for human pharmaceuticals, these provisions apply in principle only to pharmaceuticals that have yet to be brought onto the market.[50] „Older" pharmaceuticals such as diclofenac or carbamazepine that were authorised to be placed on the market before these rules entered into force are not subject to them[51]. Article 8 stipulated that environmental hazards are to be indicated together with submission of an application for authorisation. However, this rule regarding environmental risk assessment was not in fact implemented until 2006, when an assessment concept that applied throughout the EU was enacted.[52] This concept foresees an in-depth environmental risk assessment (phase II) whenever the predicted environmental concentration = PEC of a specific pharmaceutical substance exceeds 0.01 mg/l in surface water. Among other things, such an assessment must determine whether groundwater can be contaminated. One serious deficit in this regulation that must be emphasized is the fact that environmental risks that have been identified are not taken into consideration in the decisive second phase of the authorisation process (see Article1 (28a)), because these risks are not part of the cost-benefit analysis according to Article 26. The consequence is that authorisation of a human pharmaceutical product cannot be denied for reasons related to environmental protection, including those pertaining to protection of water bodies, even if the risk assessment shows that the designated use of a particular pharmaceutical will lead to substantial damage to the environment. In such cases, placing such problematic substances on the market and their use can be allowed only under certain conditions, in order to limit the risks involved. Article 8 of the Community Code stipulates, for example, that special provisions can be defined. Applicants can also be required, on the basis of these legal provisions and those outlined in Annex I 1.6, to introduce risk management and monitoring systems. Article 54 also provides that special precautions for disposing of these pharmaceuticals must be stated on the product labelling. A further problem is the fact that, according to Article 24, authorised pharmaceuticals are subject to review only once, namely, five years after they have first been authorised. Once this review of the cost-benefit relation for a particular pharmaceutical has resulted in a positive decision, the substance is authorised permanently. Subsequent limits for such products are only possible if – within the context of routine pharmacovigilance to monitor side effects of products that have already been authorised – evidence is detected that makes limits necessary.

Although environmental water and individual environmental compartments and organisms (e.g. groundwater, fish, algae, daphnia) play a special role in the guidelines for environmental risk assessment, the Community Code lacks obligatory and detailed rules on water protection or references to water legislation. As a result, the effectiveness of standards pertaining to water protection remains vague; moreover, the Code leaves a large scope for decision-making up to the discretion of the relevant authorities. Not only legal experts have confirmed that these rules are ineffective[53]. The actual practice of authorisation shows that environmental protection measures are generally limited to requiring manufacturers to include precautionary information in the patient information leaflet for certain products.[54] Whether product users implement these measures is not monitored, since such monitoring activities are precluded due to the wide dissemination of these medicinal products.

Authorisation of a pharmaceutical for human use cannot be denied for environmental protection reasons, including protection of water bodies, even if risk assessment shows that the environment will be seriously damaged as a result of the intended product use. At best, specific limitations can be prescribed with respect to bringing the product onto the market and use of problematic substances, in order to reduce risks.

Veterinary pharmaceuticals

The Community Code Relating to Veterinary Medicinal Products (2001/82/EG), which has been revised and supplement in recent years with the enactment of Directives 2004/28/EG and 2009/53/EG and Regulation 596/2009/EG covers the bringing onto the market of veterinary pharmaceuticals by EU member states. Among the products for which these rules do not apply are medicated feedingstuffs.[55] Authorisation procedures for veterinary pharmaceuticals include environmental risk assessment; depending on the results, precautionary measures may be required (see Annex 1, Title1 und 2 of the consolidated version of the Community Code).[56] As in the case of standards for human pharmaceuticals, a two-phase process for assessing environmental risks also applies to veterinary pharmaceuticals; however, in contrast to human pharmaceuticals, veterinary drugs can be denied authorisation on the basis of their environmental effects. If a potential environmental exposition is identified in the first phase of the assessments conducted according to the guidelines,[57] for example, when the predicted environmental concentration (PEC) exceeds 100 mg/kg of soil, or the PEC introduced into water bodies exceeds 1 mg/l, the applicant must assess the possible ecological hazards, including hazards for aquatic organisms in surface and groundwater, in the second phase. If necessary, this should include further study of the effects of the pharmaceutical in water and aquatic systems. Article 1 (19) stipulates that environmental risks must be taken into account in analysis of the cost-benefit relation. Whether benefits outweigh risks – in other words, whether the ration is determined to be positive – is, according to Article 30 a decisive criterion for authorisation of a specific pharmaceutical. Moreover, Article 33 stipulates that a member state can reject an assessment report if a significant environmental hazard is identified. The commission has defined specific guidelines for such cases. Article 40 provides for suspension of authorisation and use of a pharmaceutical by a member state. Article 67 requires prescriptions in order to protect the environment, and Article 12 stipulates that applicants must install monitoring and, when necessary, risk management systems.

In contrast to medicinal products for human use, veterinary pharmaceuticals can be denied authorisation because of its environmental effects.

Whereas specific – albeit incomplete – water protection standards are included in the guidelines on environmental impact assessment, concrete or more comprehensive standards of groundwater law are lacking in the Community Code. Consequently, it is not clear whether groundwater protection can be effectively guaranteed and implemented. From the perspective of precautionary protection of the environment and water, furthermore, the fact that current rules on authorisation of veterinary pharmaceuticals are only valid for newly authorised products but not for those first authorised before 1992, or for generics authorised for sale before 2005 must be criticized.[58] As already criticized for human pharmaceuticals, review of the authorisation of veterinary medicines according to article 28 is only required once, five years after the original authorisation; if this review is positive, authorisation is grant without any further time limit. Here again, if pharmacovigilance procedures reveal negative effects, authorisation must be reviewed. However, the current monitoring regime is inadequate for regularly supplying information on the environmental effects of the substances in question.[59] Thus, there is currently no routine, systematic monitoring of the environmental effects of veterinary pharmaceuticals that have already been authorised. To date, environmental aspects played no role in the ongoing review of veterinary pharmaceutical law. PAN Germany is thus actively promoting increased attention to environmental protection, including water protection, in the relevant legal act. It is expected that the EU Commission will present a draft law to the public in the second quarter of 2013.[60]

PAN Germany has prepared a brochure on "Veterinary medicinal products and protection of the environment" that informs readers about current EU laws and about the aims of the ongoing revision process. It describes deficits from the perspective of precautionary environmental protection and makes recommendations for enhancing provisions for protecting the environment in laws on veterinary medicines. The brochure can be downloaded at www.pan-germany.org/download/tierarzneimittel/tierarznei-EN-130207-web.pdf

EU authorisation of pharmaceuticals

EU Regulation 726/2004 on the centralized (EU-wide) authorisation of human and veterinary pharmaceuticals permits member states to enforce the suspension of use of previously authorised products to ensure protection of the environment in urgent cases.[61] However, there is a lack of clear specifications that ensure that the authorities will indeed take action to protect water bodies. Existing rules do not guarantee that the use of specific pharmaceuticals can be permanently prohibited or the authorisation rescinded throughout the EU for environmental reasons. Moreover, decisions about possible limits for environmental reasons, including water protection, can be taken only by the EU Commission.

Review of laws on pharmaceuticals

In 2010 the EU Commission was called upon by the European Parliament and the European Council to prepare a report on the environmental effects of pharmaceuticals, following recognition that residues from these substances in water and soil posed environmental problems.[62] The Commission has yet to present their report (as of 26 April 2013), which was to be compiled in cooperation with the European Environment Agency and the European Medicines Agency and with member states, who were to provide relevant monitoring data. In this context, the Commission was also charged with an evaluation of whether EU pharmaceutical law and other relevant laws required revision.

Current provisions in water protection regulation aimed at limiting pharmaceutical pollution

Since the year 2000, Directive 2000/60/EG establishing a framework for Community action in the field of water policy, or Water Framework Directive (WFD) as it is usually referred to, defines goals and steps for protecting ground and surface water in the EU.[63] This directive is also relevant for limiting and avoiding pharmaceutical residues in groundwater. Although the WFD and the Groundwater Directive (the so-called WFD Daughter Directive) do not explicitly deal with pharmaceuticals, the provisions of these directives consider substances that endanger water. However, implementation of these provisions is to date inadequate.

Article 1 of the WFD states that its aim is to "ensure the progressive reduction of pollution of groundwater". Article 4 identifies the goal of preventing further deterioration of the status of groundwater and states that good water quality should be achieved by 2015. Member states can, however, be exempted from achieving these goals. The WFD also states that measures must be taken to "reverse any significant and sustained upward trend in the concentration of any pollutant. According to Annex II paragraph 2 WFD, groundwater pollution was to have been described, in a first phase, by 2004; based on this survey, bodies of water that are at risk were to be identified. Subsequently, threshold values and quality standards for relevant pollutants were to be defined. Article 8 and Annex V stipulate that the relevant bodies of water were to be monitored, beginning in late 2006. The aim here was to determine if changes in the concentrations of these pollutants can be observed and the threshold values were met as a result of the measures implemented to protect aquatic environments. These measures were to be introduced in the form of programs and management plans. In keeping with Article 11 and Article 13 of the WFD, which were to be drafted by the member states by 2009 and revised every six years. According to Article17 WFD, the standards for assessing the state of groundwater for reducing and avoiding pollution of groundwater on the basis of EU norms were to be developed further.

The Groundwater Directive, which was revised in 2006 (Directive 2006/118/EG)[64] includes in part the provisions called for in Article 17 of the WFD. Of relevance here is consideration of groundwater ecosystems (see principle 20) and the demands addressed according to Article 6 to the member states, including measures to be introduced against hormone-disruptive substances, CMR and PBT substances to prevent them from being introduced into bodies of water. These therefore also apply to pharmaceuticals. Environmental quality norms for the entire EU, which must be established according to Annex I, have to date only been defined for nitrate, biocides,

The European Water Framework Directive aims to progressively reduce groundwater pollution. Thus far, however, environmental quality norms have only been set for nitrate, biocides, and pesticides, but not for pharmaceuticals.

and pesticides, but not for pharmaceuticals. Annex II states that threshold values are also to be defined for pollutants in bodies or groups of bodies of groundwater by member states in keeping with certain procedures the concentration of a particular pollutant means that the good status of a groundwater body cannot be achieved without additional measures. In establishing the threshold value, the aim of not impairing the groundwater function must be taken into account. Furthermore, interactions between groundwater-linked aquatic and associated terrestrial ecosystems must be considered. Annex II also includes a minimum list of pollutants for which establishment of threshold values must be considered. This list, too, does not yet include pharmaceuticals. Annex II also stipulates that management plans must state how many groundwater bodies are at risk by which pollutants and which threshold values apply. According to Article 10, the EU Commission was to have reviewed by 16 January 2013 whether Annexes I and II required possible revisions and present legislative proposals for such revision to the Council of Europe and the European Parliament.

In summary, implementation of the WFD has lead, at best, to preliminary steps toward taking into account pharmaceutical pollutants in bodies of water.

On the European level, the directive on priority substances is now being revised. This is also a WFD daughter directive. Based on the current status of consultations, it appears that there will be support for a common EU strategy to address pharmaceutical pollutants in water and that precise timescales will be formulated for implementation of appropriate measures.[65] At least three substances (diclofenac, 17 alpha ethinyl estradiol, and 17 beta estradiol) are explicitly earmarked for study within the framework of EU-wide water monitoring in the years ahead to determine if they should be listed as priority substances.[66] Whether and when threshold values will apply to this selection of human and veterinary pharmaceutical substances and appropriate water protection measures will be implemented for more pharmaceutical substances is, at present, uncertain. In any event, these decisions only apply to surface water bodies and thus offer at best indirect protection for groundwater.[67]

In Germany, there are first national[68] and regional measures that address pharmaceutical pollutants (e.g. monitoring programmes in Hessia,[69] North Rhine-Westfalia,[70] and by the International Commission for the Protection of the Rhine[71]). Attempts to introduce national threshold values for bodies of water for certain substances such as carbamazepine, diclofenac, or sulfamethoxazole, which have been proposed by the German Federal Ministry for the Environment to at least protect surface water bodies, have not been successful to date.[72]

Revision of the Groundwater Directive: Provisions on pharmaceuticals in the current version

Review of Annexes I and II of the Groundwater Directive by the EU Commission was to have been completed by January 2013, according to relevant EU decisions, but completion of this task, including a hearing on the issues, will probably not occur until the second half of 2013.[73] Within the context of the Common Implementation Strategy (CIS) of the EU member states, Working Group 2 C has produced a technical report published in early 2012, which presents recommendations for revising Annexes I and II of the Groundwater Directive[74]. The report is based on (preliminary) outcomes of an EU study on assessing climate change and land-use impacts on groundwater (GENESIS), on results from a survey of EU member states and stakeholders, and on other contributions made to a workshop.

The survey showed, on the one hand, that there are significant delays in implementing the measures set out in the Water Framework and Groundwater Directives. Data for 45% of the groundwater bodies are still insufficient to conduct a satisfactory risk assessment. Where evaluation has been completed, a large number of groundwater-threatening pollutants have been identified. So far, 26 member states have identified a total of 158 relevant pollutants or indicators and established threshold values for them. The document does not indicate whether pharmaceutical residues have been taken into account. With respect to the pollutants identified, more than 30% of the groundwater bodies will not meet the quality norms (compliance with threshold values) by 2015. Differences in applying the quality norms are apparent from country to country (e.g. comparison of the threshold value with the mean value or with the maximum value of pollutant concentrations observed in groundwater). **On the basis of the survey results, which revealed that a significant majority of the respondents did not identify a need for revision of Annexes I and II, the recommendations in EU report include the following:**

- ► No new pollutants should be added to Annexes I and II
- ► No change to the current “minimum list of pollutants“
- ► Clarification of the exact application of the threshold values from Annex I (maximum or mean values),
- ► requirement to consider Directive 2008/105/EC (priority substances) when setting threshold values for groundwater bodies (in Annex II (Part B))

PAN Germany holds that this report and its recommendations must be subject to critical scrutiny with respect to pharmaceutical pollutants for the following reasons:

- Although various environmental authorities and scientific studies have determined the polluting effect of pharmaceuticals, the report does not address this issue. Indeed, the report even recommends that "no new pollutants should be added to Annexes I and II". There are also no suggestions for additional environmental quality norms.
- With respect to dealing with pharmaceutical pollutants, no recommendations have been made, although results from the monitoring programmes and proposals from various environmental authorities indicate a need.
- The survey offers only limited insights into the standpoints of representatives of the business sector, society, and policy making. Only respondents to the survey classified themselves as NGOs, and these represent the interests of users (mining industry). An additional representative of economic interests (plant protection) took part in the consultations. The document does not clearly indicate whether the European Environmental Agency, the Scientific Committee on Health and Environmental Risks, and environmental NGOs were able to participate in the survey or the discussion of the draft report. According to information from the EU Commission, a public hearing will take place in the course of further work on revising the Groundwater Directive. As yet it is not known whether environmental NGOs will be given an opportunity to make a qualified contribution to these discussions. Article 10 of the Groundwater Directive states that the recommendations of European environmental organisations are to be considered in the review of Annexes I and II. Despite the ongoing lack of a risk assessment for the majority of groundwater bodies, the report does not formulate appropriate consequences, recommending, for example, further clarification of EU standards, implementation of a action plan, or implementation of sanctions.
- Recent research and the resulting insights relevant to the protection of groundwater ecosystems were apparently not taken into consideration in drafting the report.

Conclusions and recommendations for action

Existing legal standards on water and groundwater are currently not being implemented with all due consistency with respect to pharmaceutical pollutants in water bodies. To date only rudimentary measures aimed at protecting groundwater from adverse pharmaceutical pollutants are in place; these preliminary measures must be implemented and supplemented. In the course of revising the Groundwater Directive, the options provided by water policy laws should be utilized to initiate further legislative action that ensures legally binding provisions that address the issues of pharmaceutical pollutants in groundwater and that more effectively and systematically identify and reduce the spread of pharmaceutical substances and their effects in groundwater ecosystems in European groundwater.

Examination of work so far on reviewing the Groundwater Directive and in this context especially the review of Annexes I and II reveals deficits with respect to procedures and content. For example, so far there are no signs that measures are being considered that are relevant to groundwater ecosystems. Available reports from the EU do not show whether environmental organisations were involved in consultations on the revision of criteria for assessing the good chemical state of groundwater. There have been delays in implementing key groundwater protection measures.

Although the deadline set in EU law for reviewing Annexes I and II of the Groundwater Directive has expired, the Commission has not yet present its conclusions (as of 26 April 2013). Digital information sources provided by the EU Commission's General Directorate for the Environment indicate that these conclusions will be available in the second half of 2013, at the earliest.[75]

On the backdrop of the current state of European waters and in order to enhance protection of bodies of water from negative effects due to pharmaceutical pollutants, PAN recommends that the following steps be undertaken in revising the Water Framework Directive and Groundwater Directive.

Recommendations for a revised version of the Groundwater Directive and for enhanced protection of bodies of water against human and veterinary pharmaceutical pollutants

- **Systematic identification of pharmaceutical pollutants by means of the monitoring programmes of the Water Framework Directive (WFD)**
  Systematic identification and transparent publication of monitoring data, especially on antibiotics, antiparasitics, hormones, analgesics, and psychotropic drugs in water bodies, sediments, and soils is an important prerequisite for compiling a comprehensive survey of the probability and the extent of groundwater pollution with pharmaceuticals. The review of the status of water pollution begun under the provisions of the Water Framework Directive in 2013 provides an opportunity for implementing these steps. Moreover, these activities should be coordinated with the EU Commission's task of studying the environmental effects of pharmaceutical pollution, which has not yet begun. The strategy to also reduce the influx of pharmaceuticals, which will probably be called for as part of the current revision of the Directive on Priority Substances, should be used to collect further data on this basis. In the course of implementing these measures, relevant pharmaceu-

tical substances should be included in the groundwater monitoring programmes already being conducted throughout Europe as additional monitoring parameters. The development of improved monitoring systems and of suitable monitoring point networks should also be ensured. Furthermore, additional criteria for comprehensive ecotoxicological identification and prevention of pharmaceutical pollution in groundwater should be introduced. To this end, Annex II of the Groundwater Directive must be adapted.

- **Definition of threshold values for pharmaceutical residues in water bodies**
  Threshold values or environmental quality norms valid throughout the EU must be set for human and veterinary pharmaceutical residues in bodies of water. These can be added to Annexes I and II of the Groundwater Directive. Special attention should be paid to substances that are released into the environment in large quantities and to those expected to have environmental effects, in particular substances classified as persistent, bioaccumulative, and toxic, so-called PBT substances.
- **Close gaps in knowledge on the environmental behaviour of pharmaceuticals**
  An important step is the establishment of methods for identifying pharmaceutical substances now on the market in the environment, so that residues can be located. Further knowledge about the effects of pharmaceutical residues and mixtures of different substances on groundwater ecosystems must be generated, for example by funding appropriate research.
- **Measures to minimize pharmaceutical pollution in water**
  In developing concepts for minimizing pharmaceutical pollution and implementing suitable measures, a high degree of coherence between the various areas of legislation (legislation on human and veterinary pharmaceuticals, water, animal husbandry, etc.) is essential. The spectrum of possible measures is large and ranges from activities to promote animal health, to collection systems for unused pharmaceuticals, to the development and promotion of pharmaceuticals that are water-safe.
- **Enhancement of water protection in legislation on human and veterinary pharmaceuticals**
  Besides enhanced provisions on pharmaceutical residues in water legislation, laws on human and veterinary pharmaceuticals must contribute to improving water protection. The current revision of EU law on veterinary pharmaceuticals offers an opportunity to create more coherence between the different areas and thus promote water protection. The aim should be to introduce relevant provisions that serve water protection in European Community law and in the subordinate standards for authorising, using, and monitoring (pharmacovigilance) pharmaceutical substances. In this context, measures must be introduced that ensure the environmental sustainability of previously authorised medicinal products, similar to the obligatory review programme established to examine biocides within a fixed timescale. PAN Germany published background information and recommendations on environmental issues related to veterinary pharmaceuticals in late 2012[76].

Literature

1 European Environment Agency (2010): Pharmaceuticals in the environment. Technical report No 1/2010, p. 4, www.eea.europa.eu/publications/pharmaceuticals-in-the-environment-result-of-an-eea-workshop/at_download/file.
2 Ibid., p. 18.
3 Ibid.
4 Ibid.
5 Ibid., p. 8.
6 Ibid., p. 18.
7 Ibid., p. 16 (for example, by ethinyl estradiol in fish).
8 Ibid., p. 5.
9 Ibid., pp. 5, 33 (for antibiotics).
10 Ibid., p. 12.
11 Ibid., p. 8.
12 Ibid., p. 4.
13 Ibid., p. 5.
14 Ibid., p. 11.
15 Ibid., p. 10.
16 Ibid., p. 5.
17 Ibid., p. 18.
18 Umweltbundesamt (2011): Arzneimittelrückstände in der Umwelt. p. 54 www.umweltdaten.de/publikationen/fpdf-l/4180.pdf.
19 Umweltbundesamt (last modified 31 May 2012): Chemikalienpolitik und Schadstoffe, REACH. Arzneimittel. www.umweltbundesamt.de/chemikalien/arzneimittel/index.htm.
20 Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (2008):Grundwasser in Deutschland. p. 41. www.umweltdaten.de/publikationen/fpdf-l/3642.pdf.
21 Eisenstadt, Leah (2005): Drugs in the waters. In: Triplezone. www.bu.edu/sjmag/scimag2005/features/drugsinwater.htm.
22 Schulte-Oehlmann U, Oehlmann J, Püttmann W (2007): Humanpharmakawirkstoffe in der Umwelt: Einträge, Vorkommen und der Versuch einer Bestandsaufnahme. UWSF – Z Umweltchem Ökotox 19 (3) 168–179. p. 172 www.start-project.de/downloads/UWSF_Schulte_Oehlmann_et_al_0807.pdf.
23 EEA (2010) a.a.O., p. 4.
24 Gießen, Hannelore (2011): Arzneimittelrückstände. Wie belastet ist unser Wasser? In: Pharmazeutische Zeitung online (Nr. 49/2011). www.pharmazeutische-zeitung.de/index.php?id=40244&type=0,
25 Umweltbundesamt (last modified 31 May 2012): Chemikalienpolitik und Schadstoffe, REACH. Arzneimittel. www.umweltbundesamt.de/chemikalien/arzneimittel/index.htm,
26 Schulte-Oehlmann U et al., pp. 174-176,
27 Ibid., p. 169.
28 Bergmann A., Fohrmann R., Weber F.-A. (2011): Zusammenstellung von Monitoringdaten zu Umweltkonzentrationen von Arzneimitteln. Umweltbundesamt Texte 66,.p. 23 www.umweltdaten.de/publikationen/fpdf-l/4188.pdf
29 Schulte-Oehlmann U et al., p.169.
30 Ibid.
31 European Medicines Agency (2006): Committee for Medicinal Products for Human Use (CHMP). Guideline on the environmental risk assessment of medicinal products for human use. pp. 1ff. www.ema.europa.eu/docs/en_GB/document_library/Scientific_guideline/2009/10/WC500003978.pdf.
32 Ibid.p.171 (secondary source).
33 Bund/ Länder-Arbeitsgemeinschaft für Chemikaliensicherheit (24 March 2010): AG Arzneimittel in der Umwelt. www.blac.de/servlet/is/Entry.2255.Display/.
34 Ibid.
35 Schulte-Oehlmann U et al., p.171 (secondary source)
36 Bergmann A., Fohrmann R., Weber F.-A. (2011): Zusammenstellung von Monitoringdaten zu Umweltkonzentrationen von Arzneimitteln. Umweltbundesamt Texte 66. p. 23 www.umweltdaten.de/publikationen/fpdf-l/4188.pdf
37 Bergmann A., Fohrmann R., Weber F.-A. (2011), p. 25
38 Bergmann A., Fohrmann R., Weber F.-A. (2011), p. 24
39 MEC is the abbreviation for measured environmental concentration.
40 PNEC is the abbreviation for predicted no-effect concentration.
41 Bergmann A., Fohrmann R., Weber F.-A. (2011), p. 43ff.
42 Bergmann A., Fohrmann R., Weber F.-A. (2011), p. 48ff.
43 Bergmann A., Fohrmann R., Weber F.-A. (2011), p. 50.
44 Ibid.
45 European Commission – CORDIS (29.10.2012): Healthy groundwater ecosystems essential for clean groundwater. www.cordis.europa.eu/fetch?CALLER=EN_NEWS&ACTION=D&RCN=35187
46 UBA (last modified 30 August 2011): Wasser, Trinkwasser und Gewässerschutz. Lebensraum Grundwasser. Text und Vorträge. www.umweltbundesamt.de/wasser/themen/grundwasser/lebensraum-gw.html.
47 BUND (2007): Hintergrund Grundwasser. Guter Zustand bis 2015! p.5f www.bund.net/fileadmin/bundnet/publikationen/wasser/20070300_wasser_grundwasser_hintergrund.pdf.
48 Grenni, Paola (2011): Effects of pesticides and pharmaceuticals on soil and water bacterial communities. p. 200, www.boa.unimib.it/bitstream/10281/19697/3/Phd_unimib_716451.pdf.
49 Europäische Union: Europa. Zusammenfassungen der EU–Gesetzgebung. Gemeinschaftskodex für Humanarzneimittel. www.europa.eu/legislation_summaries/internal_market/single_market_for_goods/pharmaceutical_and_cosmetic_products/l21230_de.html.
50 Consolidated version of the Directive 2001/83/EG in the EU website, www.eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32001L0083:EN:NOT
51 Gießen, H. (2011): Arzneimittelrückstände. Wie belastet ist unser Wasser? In: Pharmazeutische Zeitung online (Nr. 49/2011). www.pharmazeutische-zeitung.de/index.php?id=40244&type=0.
52 European Medicines Agency (2006): Committee for Medicinal Products for Human Use (CHMP). Guideline on the environmental risk assessment of medicinal products for human use. p. 1ff. www.ema.europa.eu/docs/en_GB/document_library/Scientific_guideline/2009/10/WC500003978.pdf.
53 Kern, K. (2011): Die Apotheke im Gewässer – Regulierungsmechanismen und Reformvorschläge für umweltgefährliche Arzneistoffe im Arzneimittel-, Wasser-, Chemikalien- und Agrarrecht, Zeitschrift für Umweltrecht (ZUR) 22 (1), 9 – 15. p. 1 ff.
54 Gießen, H. (2011).
55 Europäische Union: Europa. Zusammenfassungen der EU- Gesetzgebung. Gemeinschaftskodex für Tierarzneimittel. www.europa.eu/legislation_summaries/food_safety/animal_health/l21231_de.htm
56 Consolidated Version of Directive 2001/82/EC on the website of the European Union www.eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32001L0082:EN:NOT
57 European Agency for the Evaluation of Medicinal Products (2000): VICH Topic GL 6 (Ecotoxity Phase I). p. 1 ff www.ema.europa.eu/docs/en_GB/document_library/Scientific_guideline/2009/10/WC500004394.pdf; European Medicines Agency (2008): Committee for Medicinal Products for Veterinary Use (CVMP). Revised guideline on environmental impact assessment for veterinary medicinal products. S. 1 ff. www.ema.europa.eu/docs/en_GB/document_library/Scientific_guideline/2009/10/WC500004386.pdf
58 PAN Germany (2012): Tierarzneimittel und Umweltschutz. p. 10
59 Ibid., p. 9
60 PAN Germany (2012), p. 12.
61 See Art. 20 and 45 of Regulation (EC) 726/ 2004 www.eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:136:0001:0033:en:PDF
62 See Principle 6 of directive 2010/84/EU
63 Directive 2000/60/EG www.eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:327:0001:0072:EN:PDF
64 Directive 2006/118/EG www.eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:372:0019:0019:EN:PDF
65 Unpublished information from the EU Council from 18 April 2013 on the consultations on the revision of the Priority Substances Directive.
66 Ibid.
67 European Parliament (28 November 2012) Press release. Surface waters: new chemicals added to EU risk list. www.europarl.europa.eu/sides/getDoc.do?type=IM-PRESS&reference=20121126IPR56466&format=XML&language=EN.
68 In the context of implementing the LAWA and BLAC monitoring programmes in Germany, water bodies were also tested to determine pharmaceutical pollutants. UBA (2010): Wasserwirtschaft in Deutschland. Teil 1 Grundlagen. www.umweltdaten.de/publikationen/fpdf-l/3469.pdf; moreover, environmental quality norms were developed and applied for carbamazepine, diclofenac, and sulfamethoxazole as preliminary norms, as long as no other legislative decisions have been taken. UBA (2010): Wasserwirtschaft in Deutschland. Teil 2. Gewässergüte. p. 31 www.umweltdaten.de/publikationen/fpdf-l/3470.pdf.
69 Hessisches Landesamt für Umwelt und Geologie(2012): Arzneimittel, last modified 2 August 2012. www.hlug.de/index.php?id=7182&type=98.
70 Vietoris, Friederike (LANUV NRW, 2011): Arzneimittel-Monitoring nach WRRL und Umweltqualitätsziele. p. 11. www.umweltbundesamt.de/chemikalien/veranstaltungen/ws-monitoring-arzneimittel/3_praesentation_vietoris.pdf.
71 IKSR (2010): Evaluation report for medicinal products for human use. www.iksr.org/uploads/media/Report_Nr._182e.pdf
72 Vietoris, p. 6.
73 The EU Commission first plans to collect further information. European Commission (2013): Environment. Water. Groundwater. www.ec.europa.eu/environment/water/water-framework/groundwater/review.htm.
74 European Commission (2011): Common Implementation Strategy for the Water Framework Directive (2000/60/EC). Technical Report No. 7. Technical report on recommendations for the review of Annex I and II of the Groundwater Directive 2006/118/EC. Technical Report – 2011 – 057. www.circabc.europa.eu/sd/d/ff038417-8518-40c5-916d-e7471d378367/Technical_report_No7_recommendations_GWD_review_AnnexesI-II.pdf.
75 So will die EU-Kommission zunächst noch weitere Informationen sammeln. European Commission: Environment. Water. Groundwater. www.ec.europa.eu/environment/water/water-framework/groundwater/review.htm
76 Pestizid Aktions-Netzwerk (PAN) e. V. (2012): Veterinary medical products and protection of the environment. 16 pages. Hamburg 2012. Available online at: www.pan-germany.org/download/tierarzneimittel/tierarznei-EN-130207-web.pdf

PAN Germany
Pestizid Aktions-Netzwerk e.V.

Nernstweg 32, 22765 Hamburg
phone: +49 (0)40 - 399 19 10 - 0
info@pan-germany.org
www.pan-germany.org

We appreciate donations to
Pestizid Aktions-Netzwerk e.V. (PAN Germany)
GLS Gemeinschaftsbank eG, PO Box 10 08 29, 44708 Bochum
account 203 209 6800, bank code 430 609 67
IBAN DE91 4306 0967 2032 0968 00, BIC (SWIFT) GENODEM1GLS

PAN Germany is a charitable organisation which provides information on the adverse effects of pesticides and promotes environmentally friendly and socially just alternatives. We are part of the Pesticide Action Network International. Our work areas range from critical assessments of the pesticide industry to constructive interaction with policy-makers to practical services for farmers and consumers.

A healthy world for all. Protect humanity and the environment from pesticides. Promote alternatives