German Environment Agency

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Scientific opinion paper

Recommendations for deriving EU minimum quality requirements for water reuse

As part of its plans for a more circular economy (COM(2015) 614) the European Commission (COM) is currently developing tools to foster safe and efficient water reuse. Within this context the Commission has identified agricultural irrigation and aquifer recharge with treated urban waste water as defined under the Urban Wastewater Treatment Directive (UWWTD) as beneficial measures to address water scarcity. In order to prevent potential risks related to these practices, the Commission seeks to establish minimum quality requirements for agricultural irrigation and groundwater irrigation with reclaimed water[1] . The Joint Research Centre (JRC) has been commissioned to develop a technical report that will serve as the basis for a legislative proposal.

The German Environment Agency (Umweltbundesamt, UBA) welcomes the Commission's objective to ensure that water reuse is safe to human health and the environment. However, the quality requirements presented in JRC's last draft (version 3.2, December 2016[2]) are not stringent enough to prevent the potential risks arising from excessive nutrients, microbial and chemical contaminants in soils, groundwater, drinking water and food crops. The suggested standards only reflect the least stringent requirements currently in place in Member States or international guidelines.

In this scientific opinion paper the German Environment Agency expresses its recommendations for the development of EU minimum quality requirements for water reuse for agricultural irrigation and aquifer recharge. More ambitious quality standards that complement the current EU legislation and are in line with the precautionary principle are needed to protect human health and the environment in a sustainable way.

[1] European Commission: Water Reuse - An Action Plan within the circular economy. http://ec.europa.eu/environment/water/reuse-actions.htm

[2] JRC (2016) Development of minimum quality requirements for water reuse in agricultural irrigation and aquifer recharge. Draft V.3.2, December 2016 https://circabc.europa.eu/d/d/workspace/SpacesStore/c5fd3128-b5d9-4151-aab6-4657f5a19776/JRC%20%20min%20qual%20req%20v.3.2%20December%202016%20corr.pdf

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Our core recommendations are as follows:

Establish quality requirements for water reuse as a guidance document

We recommend to establish quality requirements for water reuse as a guidance document instead of a binding legal instrument. This guidance document should recommend ambitious common threshold values for relevant parameters, identify additional parameters for which standards are needed for site-specific monitoring (i.e. where risk assessment indicates that they might occur) and provide a common approach on how to derive quality standards for those as well as for contaminants of emerging concern.

Member States should keep their flexibility to refrain from practicing reuse or to set more stringent standards. A binding legal instrument would not be appropriate to implement the ideas drafted by the JRC (version 3.2, December 2016), since most of its proposals are site specific.
While for water-scarce countries water reuse can be a beneficial option, for countries with sufficient water availability there is no necessity to implement water reuse. Water efficiency measures and good water demand management are the key to prevent water scarcity. Where these measures can be implemented, the potential risks and resulting costs of energy and infrastructure for reuse are likely disproportionate in comparison to its potential benefits, especially in countries with high water availability. For Germany an analysis on current and forecasted irrigation demands and water availability has shown that there is no overall need for water reuse[3].

Reflect the existing EU legislation

The quality requirements for water reuse should comply with and reflect the substantial EU legislation that already exists for site specific protection of surface water and ground water[4]. The following principles, resulting quality standards and threshold values need to be more clearly reflected.

- The principle of non-deterioration for groundwater and surface water bodies as prescribed by Article 4 of the Water Framework Directive (WFD)

[3] Wolfgang Seis, B. Lesjean, S. Maassen, D. Balla, R. Hochstrat, B. Düppenbecker (2016): Rahmenbedingungen für die umweltgerechte Nutzung von behandeltem Abwasser zur landwirtschaftlichen Bewässerung. UBA-Texte 34/2016. https://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_34_2016_rahmenbedingungen_fuer_die_umweltgerechte_nutzung_von_behandeltem_abwasser_0.pdf

[4] Water Framework Directive (2000/60/EC - WFD), Groundwater Directive (2006/118/EC, amended by directive 2014/80/EU - GWD), Environmental Quality Standards Directive (2008/105/EC, amended by Directive 2013/39/EU - EQSD), Urban Wastewater Treatment Directive (91/271/EEC - UWWTD), Nitrates Directive (91/676/EEC)

- The EU-wide groundwater quality standards and national threshold values listed in Annex I and II of the Groundwater Directive (GWD)
- The WFD prohibition for direct discharge of pollutants listed in Annex VIII of the WFD into groundwater (Article 11.3(j) of the WFD and Article 6 of the GWD). This includes substances with carcinogenic or mutagenic properties, those affecting reproduction or endocrine-related functions as well as persistent and bioaccumulative organic toxic substances. We do not share the interpretation in the current JRC draft which indicates a possible exemption to this rule for water reuse.

Implement a systematic and comprehensive risk management system

Quality requirements should build on a preventive, risk-based approach that analyses possible hazards and identifies efficient measures from source to exposure within the case-specific conditions of the planned water reuse scheme. Providing guidance for the risk assessment and risk management of aquifer recharge and agricultural irrigation with reclaimed water should be at the core of the document, not only referencing other international guidelines.

We recommend to adopt a systematic approach similar to the Water Safety Planning and Sanitation Safety Planning developed by WHO. The WHO approach allows to analyse which hazards are likely to occur in the specific system, assess their risks, identify measures to control the hazards and establish monitoring criteria to observe whether the controls to reduce, prevent or eliminate potential hazards are operating as intended.

The risk based management approach should be in accordance with a common tolerable risk level that is harmonised with the standards defined in other relevant EU-legislation.

For efficient and reliable risk reduction multiple barriers at different points in the whole system, consisting of the catchment, the wastewater treatment, storage, the distribution system and the agricultural practice should be in place.

Follow a precautionary approach

Environmental protection needs to be in line with a precautionary approach to ensure the sustainable protection of soil and groundwater.

- We welcome to consider all freshwater aquifers as potential resources for drinking water, i.e. set thresholds for microbial and physio-chemical standards for irrigation and aquifer recharge stringent enough to enable the aquifers' use for drinking water abstraction in the present and future. Special attention needs to be given to drinking water relevant contaminants.

- Concepts should not rely on the natural attenuation capacity of soils. Soil capacities are highly variable depending on different site-specific factors and are not static. The continuous uptake of contaminants, flushing, a change in climatic conditions or water tables may alter the soils' capacity to retain contaminants. Water quality requirements should not be reduced on the basis of generally assumed soil removal capacities, but should rather be determined on the basis of site-specific assessments of retention capacities.
- For aquifer recharge reclaimed water should comply with the GWD's quality standard for nitrate (50 mg/l)[5] before infiltration (total nitrogen < 11 mg/l) . For agricultural irrigation, nutrients in reclaimed water need to be included in the overall nutrient balance.

Include monitoring of viruses and protozoa to ensure health protection

In order to ensure human health protection we recommend to add requirements for viruses and protozoa. When disinfection or filtration processes are used to improve the water quality intended for reuse, indicators for protozoan parasites (e.g. Clostridium perfringens spores) or viruses (e.g. somatic coliphages or F-specific coliphages) respectively, have to be considered in addition to E. coli. This is necessary to validate the effectiveness of the treatment processes.

E. coli is not sufficient as an indicator for safe water reuse as its persistence (especially when disinfection processes are involved) and possible accumulation in soils and vegetables is limited. The highest risk for human health derives from pathogens that are able to survive for a longer time period and can cause diseases at low doses. This is the case for some parasites (Giardia, Cryptosporidium) or viruses (e.g. rota-, norovirus).

Protozoa or viruses are also a major threat to public health in water reuse via groundwater recharge. As the reduction of viruses through soil-passage significantly depends on local conditions, water quality requirements need to be stringent enough so that there is no risk of groundwater contamination resulting from either aquifer recharge by surface spreading or from irrigation.

In addition to pathogen removal, quality requirements should also encourage the removal of antibiotic resistances. At this point there are still uncertainties regarding their potential impact, fate and behaviour in environmental matrices.

[5] Seis et al. (2016): Rahmenbedingungen für die umweltgerechte Nutzung von behandeltem Abwasser zur landwirtschaftlichen Bewässerung. UBA-Texte 34/2016.

Ensure soil protection

We suggest maximum tolerable soil concentrations for various toxic chemicals and regular soil monitoring to ensure that there is no significant accumulation of contaminants in the soil in order to prevent risks for soil ecology, groundwater and humans as final consumers of agricultural products and drinking water.

Soils have a significant function to filter and buffer contaminants and thereby protect groundwater. It is crucial to sustain these functions of the soil to prevent a breakthrough of accumulated pollutants into the groundwater or an accumulation in crops. This includes the prevention of shifts in redox conditions (e.g. through nitrate) caused by aquifer recharge, as these might mobilise naturally occurring toxic substances such as uranium.

Threshold values for physico-chemical parameters such as salts, heavy metals and nutrients should not only be established for irrigation but also for aquifer recharge to ensure soil and groundwater protection.

We also recommend further research and analysis regarding the potential accumulation of plastic in the environment. Current studies show that especially microplastics are not fully retained by waste water treatment. The risks arising from microplastics in soils are not yet fully understood.

No aquifer recharge by direct injection

Aquifer recharge by direct injection of treated urban waste water should only be considered if there is proof that no other options are available. As recharge without a soil passage poses significantly higher risks of contamination the reclaimed water has to be treated additionally by more advanced technologies such as activated carbon, nanofiltration or reverse osmosis. The prohibition of direct discharge of pollutants is prescribed by the existing EU legislation as stated above.

Monitor and regulate contaminants of emerging concern (CECs)

Regulated chemical contaminants need to be monitored in order to avoid any exceedances of environmental quality standards. We highly recommend selecting additional contaminants of emerging concern (CECs) for the monitoring of a reuse scheme.
For CECs that are not regulated, preventive threshold values according to (eco)-toxicological assessments need to be derived. The pragmatic health-based parametric value approach (in German: GOW; Gesundheitlicher

Orientierungswert[6]) can be taken as reference on how to preliminarily assess new substances.

We further encourage the establishment of environmental quality standards for CECs and related monitoring requirements. As regulatory requirements must be based on best available science, the European Commission should promote and support further research in this field.

CECs are not completely eliminated by conventional waste water treatment processes and can thus accumulate in the soil or percolate to the groundwater as a result of water reuse. Substances of high concern include especially those which are persistent, bioaccumulative, and toxic (pbt), persistent, mobile and toxic (pmt), very persistent and very bioaccumulative as well as substances affecting endocrine-related functions.

There is scientific evidence (e.g. from two sites in Germany) that irrigation with reclaimed water can result in groundwater pollution with pharmaceuticals that are not adsorbed or degraded during the soil passage (such as carbamazepine and sulfamethoxazole)[7][8]. Also, accumulation of micropollutants and metabolites in crops grown with reclaimed water has been demonstrated.

Advanced water treatment is needed to obtain suitable water quality

Advanced water treatment is necessary to reduce microbial contaminants, nutrients as well as contaminants of emerging concern. We recommend to provide further guidance on suitable processes and their specific performance. For the elimination of CECs activated carbon or ozone can be applied. Options for the disinfection of treated wastewater include UV radiation, ozonation, and micro- and ultrafiltration. Due to the formation

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[6] Health related guide values for drinking-water since 1993 as guidance to assess presence of new analytes in drinking-water. International Journal of Hygiene and Environmental Health, Volume 217, Issues 2–3, March 2014, Pages 117-132. http://www.sciencedirect.com/science/article/pii/S1438463913000758/pdfft?md5=16aa6965bd4436585f76ef5b2899b1ca&pid=1-s2.0-S1438463913000758-main.pdf
List of substances assessed on the basis of health related indication value (May 2016) https://www.umweltbundesamt.de/sites/default/files/medien/374/dokumente/20160520_liste_der_nach_gow_bewerteten_stoffe_0.pdf

[7] Final report of POSEIDON (2004): Assessment of Technologies for the Removal of pharmaceuticals and Personal Care Products in Sewage and Drinking Water Facilities to Improve the Indirect Potable Water Reuse. http://undine.bafg.de/servlet/is/2888/Final-Report-POSEIDON-May20060af7.pdf?command=downloadContent&filename=Final-Report-POSEIDON-May2006.pdf

[8] Thomas A. Ternes, M. Bonerz, N. Herrmann, B. Teiser, H. Rasmus Andersen (2007): Irrigation of treated wastewater in Braunschweig, Germany: An option to remove pharmaceuticals and musk fragrances, Chemosphere, Volume 66, Issue 5, January 2007, Pages 894-904, ISSN 0045-6535, https://doi.org/10.1016/j.chemosphere.2006.06.035

of toxic disinfection by-products, disinfection with chlorine cannot be recommended.

Treatment as prescribed by the UWWTD is clearly not sufficient for safe reuse. In Germany tertiary treatment falls short to meet hygienic requirements for irrigation as defined in DIN 19650.

Conclusion

Water reuse can be a beneficial measure in countries or regions that experience water stress or scarcity. However, in Member States without water stress the risks, additional costs, energy and infrastructure requirements for practicing water reuse for irrigation and aquifer recharge are likely to be disproportionate. Therefore, any European instrument on this issue should leave flexibility to the Member States to refrain from practicing water reuse at all or to set more stringent standards.

We recommend a non-binding guidance document that complements the existing EU legislation, follows the precautionary principle and establishes a common approach to risk management. It should appropriately address all risks along exposure pathways and possible risk-reduction measures in the entire system in order to ensure that reuse is safe for the environment and human health. In addition to the quality requirements outlined in the last draft presented by JRC (version 3.2, December 2016) we recommend to include pathogens (particularly to represent persistent and highly infectious viruses and parasites) and organic chemicals (e.g. industrial chemicals, contaminants of emerging concern, disinfection by-products). We also recommend to give further consideration to the issue of spreading antibiotic resistances as well as to soil protection for the protection of the environment, drinking water sources and human health as well as the consumers in other EU Member States that import agricultural products produced with reclaimed water. Safe reuse requires advanced treatment of urban waste water beyond the requirements of the UWWTD.