Combining science and legislation to protect the surface water sources of our drinking water

A call for concerted action

Introduction

During the last decade science has found new ways to identify and categorize substances that cause problems for drinking water production, especially from surface water, as they are persistent, mobile and toxic (PMT) or very persistent and very mobile (vPvM) (Neumann et al., 2019; Arp & Hale, 2019). As a result of their physical-chemical properties, these substances are difficult to remove in the current drinking water purification systems and therefore might end up in drinking water in higher concentrations than acceptable (Reemtsma et al., 2016; Albergamo et al., 2019; Schulze et al., 2019).

Minimization of the emission of these substances to the environment is therefore of paramount importance. The ambitions of the EU Water Framework Directive (WFD) and International Commission for Protection of the Rhine (ICPR) are high (Teodosiu, 2003), and for some macro-pollutants remarkable progress is made improving the quality of the water flowing in the river Rhine (Schulte-Wülwer-Leidig, 2018). However, the actual results on micro-pollutants are not always in line with these ambitions (Carvalho et al., 2019; Pronk et al., 2020; Wuijts et.al, 2017). Although efforts seem to be great, the goals are still not met. This paper provides a realistic and practical framework with the aim of protecting the sources of drinking water and achieving the objectives of the WFD for PMT and vPvM micropollutants, by combining existing ideas and legislation. It presents a way forward, providing a focus point for science, legislation, and the drinking water agenda the coming years, without pretending to be perfect or complete.

Additionally, we underscore the importance of complete and coherent Pollutant Release and Transfer Registers (PRTR) and present a short-cut on improving transparency on industrial emissions in a very practical way using the existing institutional routes of the ICPR and the International Meuse Commission (IMC).

(European) ambitions on water quality

On a European scale there are several ambitions to improve both ground and surface water quality in river basins. This is important for drinking water suppliers that depend on these sources. For the Dutch drinking water suppliers, located downstream in the basins of the rivers Meuse and Rhine, the most important ambitions are set by the WFD, and the (members of) the ICPR. European regulation providing tools to meet these ambitions are the Urban Waste Water Treatment Directive (UWWTD) and the Industrial Emissions Directive (IED), both aiming to protect the water environment from the adverse effects of discharges of urban and industrial waste water respectively.

The goal of the WFD is to ensure that the quality of surface water and groundwater in Europe meets high standards (good ecological status), at latest in the year 2027[1]. For drinking water, it is important that the objectives of Article 7.3 of the WFD are met. The aim of Article 7.3 is to achieve improvements in water quality and reduce the level of water treatment for drinking water production. The non-deterioration principle in the same WFD also underscores the basic idea that Member States must take measures to prevent the status of their water bodies from deteriorating.

During the 16th Rhine Ministerial Conference in January 2020 the ICPR adopted the "Rhine 2040" programme with ambitious targets for water quality. The program's objectives are to further improve water quality and to preserve the Rhine as a resource for drinking water production. Therefore, the discharge of micropollutants, e.g. residues of pharmaceuticals, contrast agents, industrial compounds and pesticides into the Rhine and its tributaries should be reduced by at least 30% by 2040.

Another important ambition is laid down in the EU's chemicals strategy for sustainability towards a toxic-free environment as presented in October 2020. The Strategy is the first step towards a zero pollution ambition for a toxic-free environment announced in the European Green Deal. This strategy aims to better protect citizens and the environment by banning the most harmful chemicals in consumer products, which includes plans to introduce endocrine disruptors, persistent, mobile, and toxic and very persistent and very mobile substances as categories of substances of very high concern (SVHC).

Combining the EU Chemicals strategy with the Water Framework Directive, the Industrial Emissions Directive (IED) and the Urban Wastewater Treatment Directive (UWWTD), provides in theory an adequate framework of relevant environmental legislation to improve the quality of the European waters.

Improvement on water quality plateaus

During the 70s, 80s and 90s of the last century the water quality in the Rhine river basin improved enormously (Schulte-Wülwer-Leidig, 2018). This was the result of early European water legislation for rivers and lakes used for drinking water abstraction in 1975 (Council Directive 75/440/EEC), which culminated in 1980 in set-

1 The original goal was to achieve good ecological status by 2015, with the possibility of two extension periods of six years.

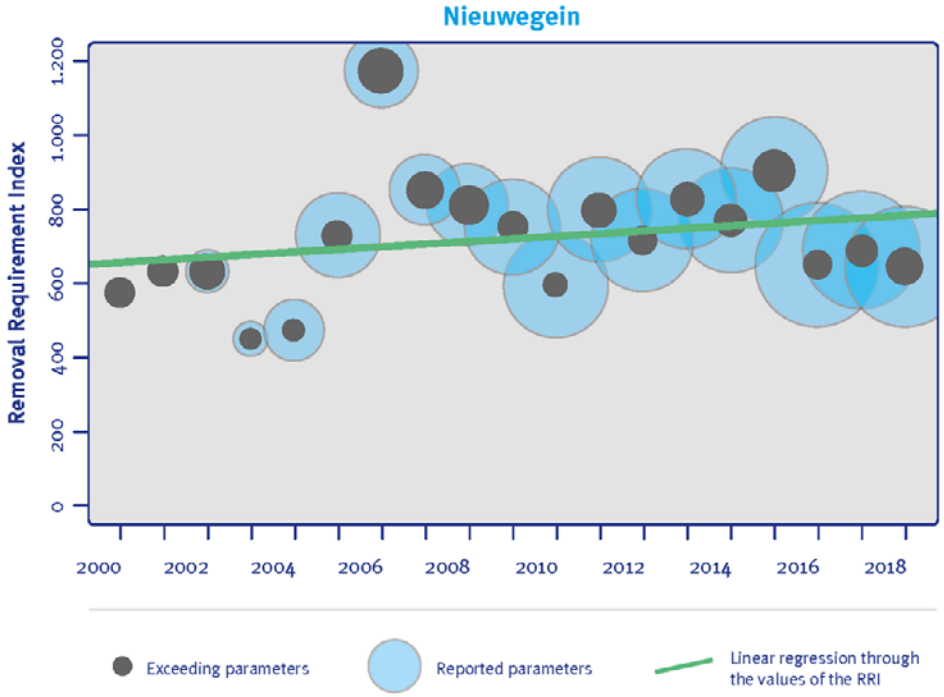

Figure 1: *Removal Requirement Index for source water along the river Rhine at Nieuwegein in the period 2000 to 2018. The size of the blue spheres indicates the number of measured substances that are in the Dutch drinking water Decree DWB (2018) in that year. The size of the black cores indicates the number of substances exceeding DWB values in that year. The height of the blue spheres with black core, along the y-axis, is the height of the removal requirement. This value is the sum of all removal requirements (RR) for individual substances that exceed the DWB value in that year. The solid (green) line is a linear regression through the values of the RR index.*

ting binding quality targets for our drinking water (Council Directive 80/778/EEC, as revised by Council Directive 98/83/EC). Also, directives were introduced aimed at setting quality objectives for fishing waters, shellfish waters, bathing waters and groundwaters. Its main emission control element was the Dangerous Substances Directive.

A second phase of water regulation was the adoption of the Urban Wastewater Treatment Directive (Council Directive 91/271/EEC), providing for secondary (biological) wastewater treatment (and even more stringent treatment where necessary)and the Directive for Integrated Pollution and Prevention Control (IPPC, Council Directive 96/61/EC), adopted in 1996, addressing pollution from large industrial installations, later transformed into the IED.

In December 2000, the European Water Framework Directive (WFD, Directive 2000/60/EC) was adopted, with a visionary water management model for the whole river basin - the natural geographical and hydrological unit - instead of following administrative and/or political boundaries (European Parliament and Council, 22 December 2000). Unfortunately, this WFD did not provide the big steps forward as seen from the earlier legislation. Although the ambitions for 2027 are still unchanged, the last progress reports of the WFD do not look very promising. It is very unlikely that we will meet the high water quality standards that we set ourselves more than 20 years ago (Carvalho et al., 2019; Wuijts et.al, 2017).

A similar conclusion can be drawn on the water quality of the river Rhine when we look from the perspective of the drinking water suppliers. The Dutch association of river water suppliers RIWA-Rijn published a report in 2020 which illustrated that the effort to purify drinking water from river water did not decrease in between 2000 and 2018 (Pronk et al., 2020). In this study the Removal Requirement Index (RRI) for source water at the five locations along the river Rhine was calculated in the period 2000 to 2018. The Removal Requirement Index is the difference between the measured river water quality and the requirements from the Dutch drinking water regulations. **Figure 1** provides the results of the river water intake at Nieuwegein, which is the main source for the drinking water of Amsterdam. The Removal Requirement Index at this intake rose instead of dropped in 19 years. Which is at odds with the non-deterioration ambitions of the WFD, and the goal of the WFD article 7.3, to reduce the required level of drinking water treatment.

Recent insights and developments identifying relevant parameters

In 2017 the German Umweltbundesamt (UBA) has come up with a coherent vision based on the idea to prevent emissions into the environment of substances, registered under the EU's Registration, Evaluation, Authorization, and restriction of Chemicals (REACH), which have the intrinsic properties that indicate a hazard to the sources of our drinking water (Neumann, 2019). These properties are persistency, mobility, and toxicity (PMT) as well as being very persistent and very mobile (vPvM). UBA proposed criteria and an assessment procedure that can be used to identify these substances. The aim is to classify these substances as "substances of very high concern" (SVHC), and to minimize environmental emissions of PMT/vPvM substances by encouraging registrants to implement strict risk reduction measures. This will eventually avoid undue contamination of the sources of our drinking water and will protect these valuable resources for future generations. This idea is gradually getting accepted by regulatory agencies and can be recognized in the recently presented EU Chemical Strategy, as part of the EU's zero pollution ambition, which is a key commitment of the European Green Deal (European Commission, 2020).

Unlike the WFD, the positively distinguishing part of this concept is that it identifies problems beforehand at the source of the

problem and prevents pollution. Within the WFD regulations there is a system of watch-lists and lists with priority substances that can identify problem causing substances after they have entered the environment. Which is putting the proverbial cart before the horse. The current problems with PFAS and similar substances proves again that the precautionary principle should prevail. Prevention is always better than the cure and should be the preferred option.
The proposed approach in which a PMT/vPvM substances are classified as SVHC also offers clues for other European environmental directives aiming to protect the water environment, like the IED and UWWTD.

Developments improving licensing of industrial discharges

The need for improved procedures for contaminants before they enter the aquatic environment became apparent in the Netherlands in 2015 and 2017. As a result of some seriously problematic issues with emerging substances like pyrazole, PFOA and GenX threatening our drinking water supply (RIWA-Maas, 2016, Gebbink et al., 2017, Gebbink & van Leeuwen, 2020), the system of licensing industrial discharges in the Netherlands was elegantly revised in 2019 by adding a drinking water test to the existing regulatory guidelines of the "discharge-test" guidelines, that are used by the authorities in their permitting procedures. **Figure 2** illustrates the idea of the discharge-test.
The most important revision is that the potential impact of industrial discharges on the water quality of the river at the location of the direct intake of a drinking water supply company, or indirect, at the location of a riverbank infiltration site (where the production wells are directly along the river), is added as an important criterium for licensing and the amount of effort that an industry or Industrial wastewater treatment should make to prevent emissions.

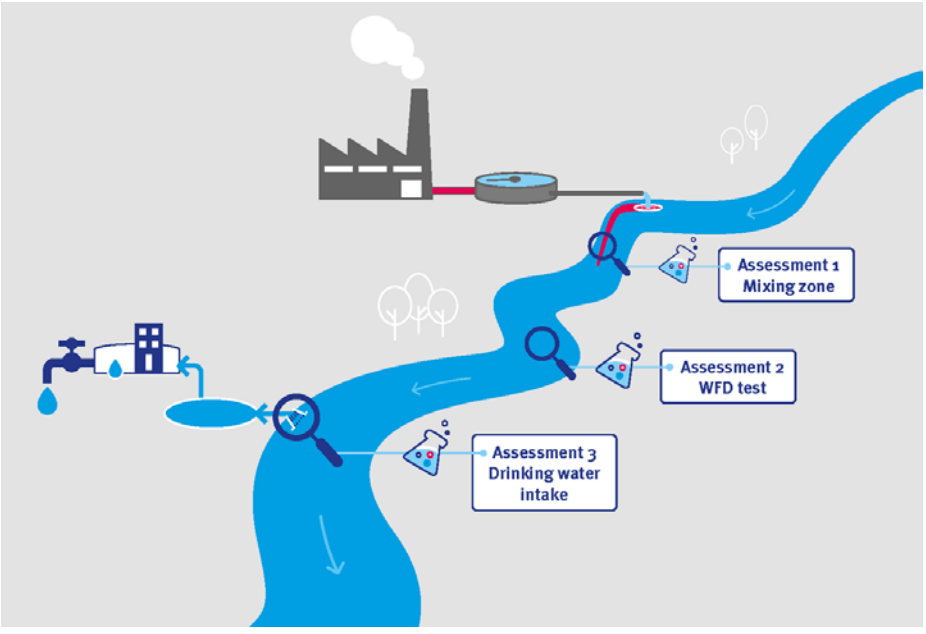

Figure 2: *the principles of the discharge-test*

To guarantee adequate safeguarding of water quality, the following two principal rules are applied when assessing a discharge permit application:

- The first specifies that at the very minimum the 'best available technique' (BAT) is applied. For a range of economic sectors water emission abatement techniques are outlined in European reference documents (the BAT reference document or BREF and BAT conclusions), as well as Dutch Information documents about BAT. Should these documents be unforthcoming, the competent authority must make its own independent assessment regarding the best available techniques for the requested discharge. The General Assessment Methodology (GAM) is used to assess the detrimental aquatic impact of substances. The detrimental aquatic impact of substances then determines which (combination of) techniques must be applied as BAT.
- Following BAT application, the second principal approach entails assessment of the remaining discharge on its effect on surface water quality. The 'discharge test' tool has been developed for this in the Netherlands, such as outlined in the Discharge Test Handbook. If the discharge test cannot be met, additional pollution abatement (BAT+) is required prior to endorsing the discharge.

The discharge test consists of 3 important steps:

1. Assessment of the effects of the discharge in close vicinity of the discharge (mixing zone test), in which the acute, not completely diluted, impact of the discharge is weighted.
2. Assessment of effects of the discharge at WFD water body level, in which the consequences of the discharge for the water body is calculated and matched with the of Environmental Quality Standards (EQS), based on yearly average flow conditions.
3. Assessment of effects of the discharge at the nearest drinking water intake point, based on 90-percentile low flow conditions. The concentration at the drinking water intake point may not exceed the drinking water intake standards. If no (provisional) drinking water standards are available, the concentration at the drinking water intake point may not exceed a value of 1 µg/l.

This elegant approach is in line with EU regulations and protects the drinking water intake against PMT/vPvM substances, by describing additional pollution abatement (BAT+). The identification of these substances within REACH as Substance of Very High Concern (SVHC) helps the watershed- or river-authorities in the licensing process as required based on the IED and UWWTD. The approach also provides the opportunity to allow acceptable and a minimum of unavoidable discharges for industries and (for example) concentrate of drinking water production reverse osmoses installations.

The need for improved transparency on (industrial) emissions

Next to an adequate system of labelling problematic substances and the use this information in the permitting process of industrial emissions, transparency is needed on the location, amount, and chemical composition of these emissions. Ideally this should be centralized per watershed, easily accessible and standardized. This will help drinking water utilities to ask upstream industries to adapt their process when their monitoring methods[2] detect a signal (feature/peak) of an emerging compound, known or unknown. In most cases these discharges are unintentional and the result of process disruptions or unknown by-products of their process. In the majority of cases a telephone-call or e-mail would prevent further harm, but unfortunately a quick identification of the source is not always possible. A transparent system with emission sources will help.

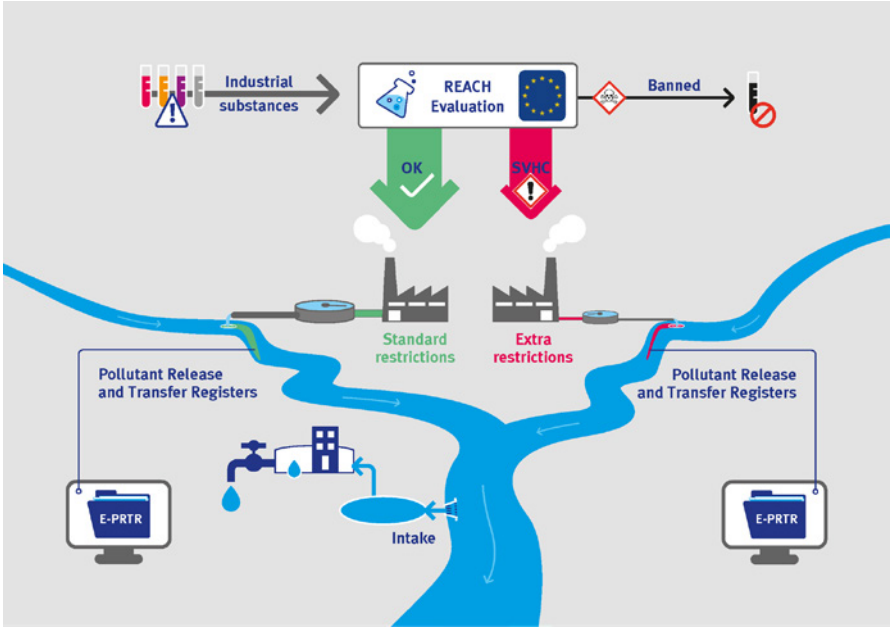

Figure 3: *Visualisation of the total concept with 1) identification of PMT/vMvP substances within REACH, 2) Licensing process with restrictions on SVHC substances and 3) registration in PRTR system*

This need is recognized and regulated in article 8 and 9 of the Revised Drinking Water Directive (EU) 2020/2184 of 16 December 2020, in which member states shall ensure the identification of hazards and possible pollution sources affecting the bodies of water used for the abstraction of water intended for human consumption, using Risk Analysis, followed by Risk Management. Similar goals are described in the 1992 Helsinki Convention on the Protection and Use of Transboundary Watercourses and International Lakes (ECE Water Convention), which aims to prevent, control, and reduce transboundary pollution (Wouters & Vinogradov, 2003). Luckily, this transparent system of emissions is the intention of the Aarhus convention (1998) and the Kyiv Protocol (2003). The Aarhus Convention describes the rights citizens and civil society organisations have, to receive environmental information that is held by public authorities. The objective of the legally binding Kyiv Protocol is to enhance public access to information through the establishment of coherent, nationwide Pollutant Release and Transfer Registers (PRTRs). PRTRs are inventories of pollution from industrial sites and other sources. The Protocol places indirect obligations on private enterprises to report annually to their national governments on their releases and transfers of pollutants. "E-PRTR", is the EU system for collecting and disseminating information about environmental releases and transfers of hazardous substances from industrial and other facilities.

One would expect that, with gradual integration of EU and national legislation, this system would be functional after almost 20 years. Unfortunately, it is not yet fully operational within the EU, although it is signed and ratified by all member states and the EU. Pistocchi et al (2019) states that the information currently available shows limited quality, completeness, and homogeneity.

Overall, we conclude that on EU level, the components of the high-quality regulatory and registration machinery are available, but the machine still has to be put together, and requires finetuning for optimal performance.

A tempting perspective to protect the quality of sources for drinking water

The list of instruments and operating mechanism that we need is:

- A fully operational and complete system within REACH, in which all relevant substances that can potentially harm drinking water sources are identified as SVHC;
- This SVHC label should be used by the licensing authorities in the EU to minimize the emissions of these specific substances to a level that is below the level that poses problems for the ecological or human use of these waters. This minimization should apply to both indirect discharges into wastewater systems (UWWTD) and direct discharges to surface waters (IED);
- An easily accessible, complete registration system for industrial (and other) emissions in the framework of the European Pollutant Release and Transfer Registers (E-PRTR), including emissions of SVHC substances.

This integrated concept is visualized in **Figure 3**.

Not the solution for everything

As stated, this concept is not perfect and not complete, as it lacks solutions for unknown emerging compounds, agricultural emissions like pesticides, non-industrial emissions from Urban Waste Water Treatment Plants (such as pharmaceuticals and personal care products) and emissions below thresholds of the REACH regulation etc. But it is a realistic step into the right direction, and provides a focus point for science, legislation and drinking water agenda the coming years.

2 Be it targeted analysis, non-target or suspect screening.

The way forward: next steps

In order to prevent pollution at the source, protect drinking water sources, meet the ambitions of the European River Memorandum Coalition (ERM Coalition)[3] and fulfil the ambitions of the WFD, the described existing instruments and operating mechanism should be combined and made operational. In concrete terms, the next steps should be taken by the EU and its member states:

1. EU: Identify PMT and vPvM substances as SVHC in REACH, as is the ambition of the EU's Chemicals Strategy for Sustainability - Towards a Toxic-Free Environment[4];
2. Member States: Use the SVHC label in the regional/national licensing process to minimize the emission of these substances as much as possible with the most stringent emission thresholds, in order to meet the acceptable ecological and human quality standards. Strict licensing should apply to both indirect discharges into wastewater systems (UWWTD) and direct discharges to open water (IED).
3. This approach for minimizing industrial discharges of PMT and vPvM substances into wastewater systems should be considered within the current revision of the Urban Waste Water Treatment Directive.
4. Consider a catchment area that is a source of a drinking water intake as a "vulnerable area" and include an assessment at the intake for drinking water (river water or riverbank filtrate), when assessing industrial emissions. The presented Dutch system of the General Assessment Methodology (GAM) can be used as an example.
5. The suggestions for improved methodology for licensing and assessment should be considered within the scope of the current evaluation and revision of the Industrial Emissions Directive (IED) that addresses pollution from large industrial installations in 2021.
6. EU/Member States/Industry: Optimize the current E-PRTR towards an easily accessible, complete registration system for industrial (and other) emissions with at least the discharge of the SVHC substances. The attention under the EU Green Deal for the improved implementation by the EU of the Aarhus Convention on the access to information, public participation in decision-making and access to justice in environmental matters might provide an impetus for a more strict and complete implementation of the E-PRTR.
7. EU/Member States of the Rhine River Basin: As an option preventing discussions on confidentiality and the protection of legitimate economic interests, the optimization of E-PRTR could start with a pilot of an easily accessible, complete registration system for emissions more than 300 kg per year (>300 kg/a) per watershed under the (confidential) umbrella of the ICPR, as was proposed by RIWA-Rijn (De Jonge, 2020).
8. EU/Member states: use the review and revision of the Industrial Emissions Directive (IED) and the Urban Waste Water Treatment Directive (UWWTD) to align these directives with the ideas presented here.

These actions will give substance to article 191.2 of the treaty on the Functioning of the European Union (TFEU) that states that "Union policy on the environment (...) shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay". We are convinced that these steps will reduce the vast majority of the current quality issues for drinking water sources, and that these steps help to achieve the targets of the WFD and ICPR. A dedicated and focussed effort of the EU organization, (inter)national institutes (UBA/RIVM), regulators and NGO's like the ERM Coalition and EUREAU, could do this within one term of the European Committee (5 years).

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3 Around 170 water suppliers representing the water protection and drinking water interests of 188 million people in the catchment areas of the rivers Rhine and Ruhr, Danube, Elbe, Meuse and Scheldt in 18 riparian states: Germany, Austria, Belgium, Bosnia-Herzegovina, France, Croatia, Liechtenstein, Luxembourg, the Netherlands, Montenegro, Romania, Serbia, Slovakia, Slovenia, Switzerland, Czech Republic, Bulgaria and Hungary.

4 https://ec.europa.eu/environment/pdf/chemicals/2020/10/Strategy.pdf

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