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Contaminants of Emerging Concern

Trend dossier by and for professionals in Accessibility, Safety and Liveability

De Lichtkogel, issued by Rijkswaterstaat (RWS, a government agency within the Dutch Ministry of Infrastructure and Water Management), offers a platform for engaging in dialogue with partners on new trends and developments in our environment and the consequences for our organisation(s).

Definition of Contaminants of Emerging Concern (CECs):
Substances in water, soil and air whose concentrations in and degree of harm for the environment are not yet known, and for which no standards or guidance values have yet been determined. This edition refers only to CECs in water.

Foreword

On 30 August 2011 fourteen friends swam across the Hellespont in Turkey. Their motivation to do the three-kilometre crossing was to support their friend Weert-Jan Weerts who was suffering from ALS. ALS is a fatal muscle disease, with patients living for an average of three years after diagnosis. And there is still no cure. The swim was such a success that the friends started dreaming big: a swimming event in the Amsterdam canals to raise funds to fight this killer disease. The first-ever Amsterdam City Swim took place in September 2012. After six successful editions, attracting 3,000 participants and raising more than €12 million for the charitable cause, we as the Board unfortunately had to cancel last year's event. Due to torrential rainfall after a prolonged period of drought, the quality of water had become unsuitable for swimming. That was a tough decision to make, but it also brought everyone even closer together, and the latest edition took place this September.

Last year's forced cancellation also brought home to us the importance of good water quality. Clean water is essential for our swimmers, but also for all other inhabitants of Amsterdam and the Netherlands. Fortunately, together with the municipality of Amsterdam, the Amstel, Gooi en Vecht Water Board, Waternet and many other parties, we are able to closely monitor the quality of our water.

New medicines and clean water are indispensable for our health. So we are obviously keen to have both. But now water detectives (pp 10-13) tell us that the development of new medicines also leads to new chemicals entering the surface water, which can pose a threat to life in the water. So that's a new challenge we need to tackle! Let's continue raising funds for research into medicines against diseases like ALS. With the aid of donors and sponsors we can finance research that may ultimately lead to a definitive solution for the disease. But let's also work shoulder to shoulder to keep our water clean. And find ever-better ways to prevent these 'Contaminants of Emerging Concern' from reaching our beautiful water.

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Chair of Amsterdam City Swim

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Interview

By Ingrid Zeegers

Globally, the production of chemicals is increasing at an alarming rate. There appears to be high demand for them, but sooner or later they will all end up in the environment. According to Annemarie van Wezel, professor and director of the Institute for Biodiversity and Ecosystem Dynamics (IBED) at the University of Amsterdam, it is time to get a grip on the avalanche of substances that is raging across our planet. Technology is ready for it. But is it sufficient?

Addicted to chemistry

Professor Annemarie van Wezel is investigating the effects of human-induced use of chemicals and new technologies on human and ecological health. She argues that the subject of 'Contaminants of Emerging Concern (CECs)' is very relevant at the moment. "We are using more and more chemicals. For example, we are witnessing a rapid growth in the number of substances that are allowed on the market. This concerns substances in industry, pesticides, biocides and veterinary and human medicines. At the same time, methods of analysis for detecting these contaminants have evolved, which enables us to measure substances at very low concentrations. This leads to new questions. What impact do all these newly identified substances have on our health and the ecosystem? And what can we do about it?"

Why are we asking ourselves these questions right now?

"Due to new social objectives, such as development of the circular economy, these questions are now much more urgent than before. After all, this is where not only the raw materials circulate, but also all the chemicals that they contain. All kinds of contaminants circulate with them and accumulate. What does this mean? Research into substances in the environment is not new. But the technical possibilities for research are greater than before, and information about environmental consequences and the intrinsic toxicity is increasingly more available. Additionally, CECs are attracting more public attention and interest, due to recent incidents involving GenX and pyrazole, for example. Due to the latter, river water could not be used to produce drinking water for a long time. Media coverage of micro-plastics also serves to increase attention. Implementation of the European REACH regulation represents a significant milestone. REACH stands for Registration, Evaluation, Authorisation and Restriction of Chemicals. This regulation is a

"We are using more and more chemical substances"

significant historical milestone in the field of CECs and applies to all countries within the European Union. It improves the registration of contaminants. In short, we now know more about what we are actually using and that's why we are also more aware of the problem."

What kind of scientific research is currently being conducted?

"The scientific research is focused on contaminants in water, soil and groundwater. CECs appear to occur everywhere, because water and soil are closely interrelated, especially in the Netherlands. Firstly, the research focuses on technologies for measuring contaminants. An important new development in analytical chemistry is high-resolution mass spectrometry, a technology for identifying molecules based on the masses of various segments of the molecule under investigation. This allows us to detect many more substances at once. Furthermore, the research focuses on effect-oriented monitoring: measuring the possible negative effects of substances on humans, animals and the environment. The research also focuses on the sources of emissions and the impact of contaminants in the environment. Ultimately, all produced substances will be released back into the environment sooner or later. What happens then, where do those substances remain and what new degradation products are formed? How can contaminants be removed, using purification technology for example? And what is the impact of chemical substances on people and the environment? Finally, more and more attention is being paid to research into the front end of the substance chain. After all, why do we actually use so many chemicals, and aren't there less harmful or non-chemical alternatives?"

> "CECs appear to occur everywhere, because water and soil are closely interrelated"

How is CEC policy structured?

"The aforementioned European REACH Regulation plays a pivotal role in the policy. Thanks to REACH, we are at the global forefront. It is nice to see that this regulation seems to be becoming a sort of standard in other parts of the world as well. Producers who wish to launch their products on the European market must comply with REACH. But there is still work to be done. The European and Dutch contaminants policy is structured by sector. There is a policy for substances in the care sector and the pharmaceutical industry, for the agricultural sector/pesticides, for industrial substances and for biocides. All these policies are spread across several European authorities and they all have different safety requirements. It is difficult to oversee. There is no coherence between the different types of legislation; we have a fragmented substance-by-substance policy."

What measures are needed to address the problem?

"A more co-ordinated European policy with greater focus on non-degradable contaminants and an obligation to develop non-chemical solutions as well, instead of constantly developing new chemicals. Another important point is the prevention of regrettable substitution, which means that one harmful substance is banned, but simultaneously replaced by another similar substance. One example is GenX, a replacement for the banned substance PFOA. Furthermore, we could invest more in green and circular chemistry, with the focus on the development of less toxic and more biodegradable substances. The problem of CECs must be brought to the attention of substance developers. We will also pay more attention to this in student training. Finally, I see many developments such as the use of precision technology in agriculture and the care sector. The outlined promise of personalised medicine can lead to significant emissions reductions. But ultimately, it will also be necessary to invest more in better purification technology."

What can water authorities do specifically with regard to CECs?

"Water authorities are involved in granting permits, which is an important means of dealing with CECs. It is important that permit issuers are well informed about existing legal frameworks, especially the contents of REACH. This enables them to ask more targeted questions when a permit application is submitted. Water authorities are also concerned with technology. From a technical point of view, it is possible to treat wastewater - a significant source of CECs in the environment - in a very comprehensive way. There is much talk about this in the Netherlands, but little experimentation with it.

> "At the end of the day, it's all about our own behaviour"

Our neighbouring countries are already a step ahead. In Switzerland, for example, additional purification technologies are being installed at sewage treatment plants. This costs a Swiss citizen 8 euros a year. From a technical point of view, much can be done, it is very affordable, and it provides much cleaner water."

Why isn't this also happening in the Netherlands?

"One of the causes is the fundamental question of how much should be invested in solutions at the end of the chain. The question is also whether we should not reduce our dependence on chemicals. And if we do need all these substances, should we not invest in more biodegradable substances, or in less toxic contaminants? Personally, I find it naïve to think only in terms of prevention. After all, we can see that society's demand for chemicals continues to grow. In practice, therefore, a combination of measures will be needed."

Are you optimistic about the future?

"Absolutely, because there's a lot we can do. At the end of the day, it's all about our own behaviour. We need to better understand why we as a society are addicted to chemical substances, and terrified of them at the same time. Research into this social imbalance seems very interesting to me." ❮

Annemarie van Wezel

Annemarie van Wezel is Professor of Environmental Ecology and Director of the Institute for Biodiversity and Ecosystem Dynamics (IBED) at the University of Amsterdam since 1 January 2019. In her research she brings chemistry, toxicology and environmental policy together. She previously worked as principal scientist for chemical water quality at KWR.

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Water detectives measure things differently

By René Didde

How can you measure substances of an unknown composition? By smartly monitoring water samples for its toxic effects, and subsequently unveiling the precise composition of the substance using hypersensitive equipment. Waternet and KWR reveal how their harmonious cooperation is bearing fruit.

Worldwide, more than 100 million organic chemical substances have been registered, excluding the often dozens of decomposition products of each of those substances. The toxicity of around 30 percent of the decomposition products is estimated as being greater, in fact, than of their original parent products. Hundreds of contaminants have been well to fairly well investigated. Their acute and chronic effects on organisms in the water are broadly known, and measurement protocols are in place for their detection and analysis. Moreover, legal standards and threshold values assumed to be safe have been laid down, that determine in micrograms per litre of water the concentrations at which no harmful effects occur.

New approach

However, there is little or no understanding of the remaining hundreds of thousands of substances. They may also include hazardous contaminants. It is an impossible task to detect and analyse these substances using conventional measuring methods, explained Ron van der Oost, toxicologist at Waternet in Amsterdam. To still be able to assess the possible harm caused by these new substances, he has been working on a new approach since 2010. At locations where he suspects effects, he suspends a sort of plastic fish in the water. “After some time we retrieve the contaminants from this ‘fish’, concentrate the water and then apply it to bacteria, algae and water fleas.” In addition to these ‘in-vivo’ tests, he also applies the water sample to cell cultures, to measure more specific effects.

Traffic light model

In this way Van der Oost maps out the potential effects on organisms. On behalf of Waternet and the knowledge centre STOWA, he has developed a traffic light model, known as SIMONI – an anagram for Smart Integrated MONItoring. He has also developed a scale that indicates the risks that refer to chronic toxicity – the poison level following long-term or repeated exposure. “If the SIMONI risk indicator (SRI) is greater than 1, there is an increased risk, and the red lamp lights up. Between 0.5 and 1, the orange light flashes, to show ‘risk, but acceptable’. The green lamp lights up at below 0.5, representing a low risk.” His system is recognised as a fast and relatively cheap screening method for chronic toxicity. “It gives us a first impression of the toxicity if biological tests show effects. At that point we are not yet sure whether it relates to one or more substances, and have no idea at all which contaminants cause those effects.”

> “We examine how relevant the risks are, and try to identify the contaminants”

Further investigation

To date, the SIMONI traffic light switches to red in around 10 percent of all cases. “That is when we subject the water sample to further investigation. In a test based on zebrafish embryos, we examine how relevant the risks are, and try to identify the contaminants causing the effect using chemical analysis.” This is the point at which Annemieke Kolkman enters the scene. “It’s brilliant, isn’t it,” commented the senior researcher analytical chemistry and team leader of the chemical laboratory KWR in Nieuwegein, referring to the brand-new mass spectrometer. This device is able to measure extremely precisely the weight of organic substances that flow out of the column of a liquid chromatograph in peaks. “Based on the precise mass of the substance, we can then determine the composition of the molecule. That tells us how much carbon, nitrogen, hydrogen and other atoms make up the molecules.”

Detectives

That already tells us a great deal, but the substance in question is still concealed in a spectrum of sometimes a thousand substances with that same specific composition. “Pyrazole is a positive story,” continued Kolkman. “It is a tiny substance with a relatively low weight, so the possibilities are limited. So we identified it quite quickly. However, the higher the weight the greater the range of possibilities. In those cases, just like real life detectives, we have

to go in search of the further chemical fingerprints of the substance. What helps is that the mass spectrometer fragments the substance in question into separate chunks. They reveal the general pattern and a fingerprint of the molecule. We then puzzle away in our database until we have identified the most probable substance – or at least the family to which it belongs." Sticking to the detective metaphor, the scene of the crime and the moment of occurrence can be useful. Researchers in the southern Netherlands for example are aware that waste that ends up in the sewer system or surface water is often related to the production of synthetic drugs like XTC. "We have a licence to keep samples of XTC for analysis. That helps us speed up the identification of the contaminants from the mass spectrometer." Kolkman referred to this investigative process as datamining. For that reason, more and more programmers and ICT specialists are joining the team at KWR, who with their detective skills are more easily able to find their way through the colossal data files.

Non-target screening

Devices for both chemical and ICT analysis are constantly becoming faster, more sensitive and more precise. Kolkman continued, "Methods like these for identifying unknown substances are known as non-target screening, and have only been in existence for about ten years. KWR is not the only organisation to use these methods; more and more laboratories at drinking water companies and routine laboratories are doing the same." The standard non-target screening uses classic chromatography. The disadvantage, however, is that the very polar contaminants – those that easily dissolve in water and as a result are more difficult to identify – are not revealed. "Melamine and the perfluorinated compound trifluoro-methanesulfonic acid are two of the extremely polar contaminants we recently identified using the new non-target screening including the mass spectrometer," explained Kolkman with obvious satisfaction.

Ambition

Kolkman and Van der Oost's ambition is to deploy their successful combination of different disciplines to chart out the problem of Contaminants of Emerging Concern (CECs). To start with, Van der Oost's traffic light model identifies the most high-risk samples, at which point Kolkman sets to work identifying the substance or group of substances. One recent success of this new toxicological and chemical method was the discovery of pyrazole pollution in the river Maas (Meuse) in Limburg. Van der Oost is proud that the SIMONI model has been included in the Water Quality knowledge stimulation programme of the Ministry of Infra-structure and Water Management, as a means of measuring effluent from sewage water purification plants. "Where the monitoring identifies potential risks, we hope to be able to take targeted measures to improve water quality." ❮

Ron van der Oost

Ron van der Oost studied chemical technology at Delft University of Technology and molecular toxicology at VU Amsterdam. He worked at the Central Environmental Laboratory of the Municipality of Amsterdam, and obtained his PhD at VU Amsterdam on biomarkers in fish. He is currently employed at Waternet as a toxicologist.

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Annemieke Kolkman

Annemieke Kolkman studied pharmacy at Utrecht University and obtained her PhD on the analysis of proteins in yeast. Following previous employment at the RIVM and the Wilhemina Children's Hospital, she has been employed at KWR since 2010 as senior researcher in the field of analytical chemistry. She is also team leader of the chemical laboratory.

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On a Rijkswaterstaat measuring vessel

By René Didde

On this sun-drenched spring day, a fisherman on an island in the tributary of the Maas river is staring at his float. Next to the bank at Eijsden is a forty year-old measuring vessel operated by Rijkswaterstaat. "The water is relatively clear, although it appears green because of the algae, and there is also lots of plastic," pointed out Henk Zemmelink, senior consultant at the Rijkswaterstaat lab. The measuring vessel is packed with equipment that precisely monitors the quantity of substances that travel past on their way from Belgium.

The alarm level in the river Maas was exceeded 24 times just last year. "In response, one of the things we do is notify the Limburg Water company, so that they can close two water extraction basins, further downstream," explained Zemmelink. On one occasion the wrongdoer was cadmium, while on other occasions the problem was tributyl ether and benzotriazole. Most notably, half of all cases are marked 'unknown'. "With the exception of the around 120 calibrated contaminants, we have no idea what we are dealing with. All we have is the retention time – the moment at which we see the substances on the chromatograph, when they have exceeded the concentration level of 3 or 10 micrograms per litre."

Core business

Zemmelink took us on a tour of the four laboratory chambers. Once water from the river Maas is pumped into the vessel via a pipeline, it is divided across different analysis devices. They measure polar, apolar and volatile contaminants, radioactivity and toxicity, for example on wriggling water fleas and green algae. The identification of unknown substances is not really the core business of Rijkswaterstaat. "Our main role is to warn drinking water companies in time. However, if an unknown substance with a particular retention time recurs regularly, or its concentration rises, then we notify the Expert Group Alarm Levels, which is made up of Rijkswaterstaat and the drinking water companies."

Continuous chemical maps

The decision is then sometimes taken to further analyse the unknown contaminants. That takes place at Rijkswaterstaat's main laboratory in Lelystad, in collaboration with the laboratories of the drinking water companies or KWR. "We also issue notice of substances that score just below the alarm levels," continued Zemmelink. At some point in the future, the old measuring vessel in Eijsden, and its counter-part in Lobith where the Rhine is monitored, will be replaced by a station that contains even more accurate analysis equipment. "We then expect to be able to produce continuous chemical maps of the river water, which will help us monitor the quality of the water even better." ❮

Henk Zemmelink

Henk Zemmelink obtained a PhD in marine biology before acquiring significant practical experience with measuring systems. He has now been employed as senior laboratory consultant at Rijkswaterstaat for nine years.

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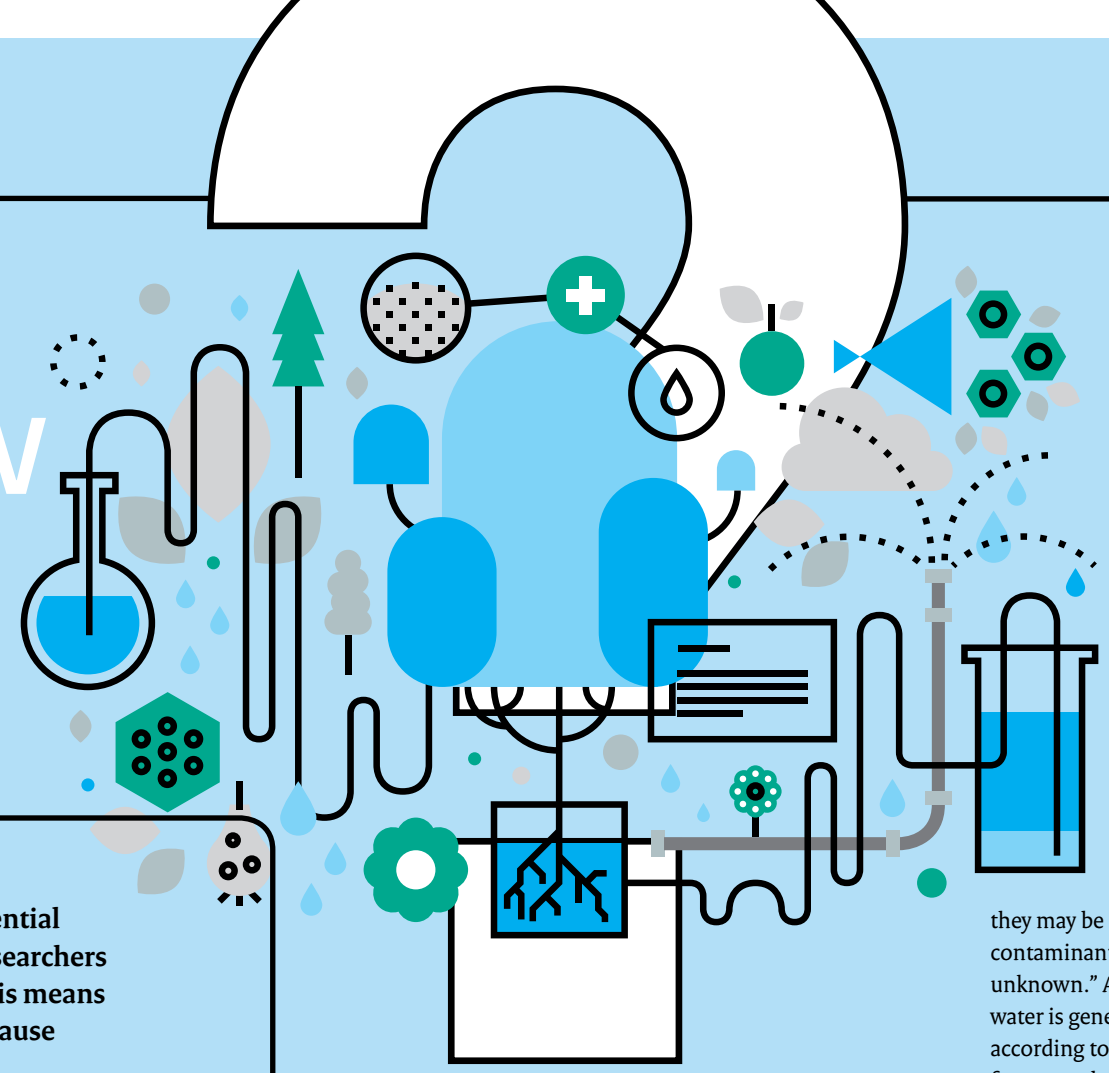
WHAT DO CITIZENS KNOW AND WHAT CAN THEY DO?

By René Didde



The general public is not exactly well-informed about the potential hazards of Contaminants of Emerging Concern (CECs), and researchers and policy makers alike are still getting to grips with the subject. This means that civic communication requires a degree of care and caution, because "Chemicals carry a stigma".

In his capacity as educator at the Centre for Nature and Environment Education for Maastricht and environs (CNME), Peter Alblas goes out on field trips several times a week with groups of students, members of various football clubs, and employees from companies or local authorities. He also supervises collections of flood waste left behind by the receding waters of the river Maas (Meuse) near his home town, Maastricht. In his opinion most people know little about the background of environmental problems. "The result is that public awareness levels remain low", he says. "When we are clearing the plastic waste caught high up in the trees and shrubs along the banks of the Maas, people will ask us 'Did all that rubbish get blown in there by the wind?' or 'Did all that high water disappear into the river bed?'"

Vague concept

A new concept such as the term 'CECs' will hardly have registered in the public mind, is also the opinion of Tom Jansen, who is researching his PhD on communicating uncertain risks at RIVM and the Amsterdam UMC. "The whole concept of 'CECs' is pretty vague, and different people will give you different definitions of it", Jansen says. "Communication efforts must take into account that the general public may have differing ideas and opinions about concepts such as 'risks' and 'CECs'. Your communications will need to be adapted accordingly. Expert statements such as 'potentially carcinogenic' for example could make people think something is bound to give you cancer when there isn't any scientific evidence that the material is in any way carcinogenic."

Health risks

Jansen's PhD research involves investigating what the general public thinks about the presence in food of chemicals which science has not yet proved free of health risks. According to Jansen the problem is that in many cases even scientists aren't certain about the health risks involved. "Information about the nature of the substance may be lacking, its toxicity may be unclear, exposure data may not be available, or we may simply know next to nothing about its potential effects." This lack of certainty also plays a role where CECs are concerned. The preliminary conclusions of Jansen's research suggest that people may be more sensitive to the idea that water contains certain chemicals than they are to the health risks involved. "Chemicals carry a stigma", he says. "If people expect water, and drinking water in particular, to be safe, they may be less likely to accept the presence of contaminants for which the health risks are still unknown." A compounding factor is that Dutch water is generally perceived to be of high quality, according to Jansen. "When you arrive back home from your holiday destination where the drinking water is often heavily chlorinated, it's nice to be able to say 'Lovely, we can safely drink water straight from the tap again'."

Offer an alternative

How best to communicate the uncertain risks of CECs? "Begin by making things easy to understand", Alblas says. "I always try to take the personal route. In the case of CECs for example, I would establish a link with the medication granny takes on a daily basis. You know, the ones from the little box marked Mon/Tue/Wed. These drugs are necessary to keep granny alive for as long as possible, but parts of them pass through her system and into the sewers, with most of them ending up in river water. Some of these drugs could be harmful to small aquatic wildlife, which in turn could be detrimental to fish. In short, start small, use expressive examples, lay down the

full chain in easily understandable terms, and don't hesitate to touch on global problems." Alblas adds that you also need to offer people alternatives. "Otherwise you create apathy. For example, manufacturers have a legal obligation to add fire retardants to television sets and carpets, and there is nothing consumers can do about it. On the other hand, take a dog's flea collar. That contains neonicotinoids, which are well known to contribute to bee mortality. I said to my wife: 'Let's try an experiment and skip the flea collar for the next three months.' That's where things get tricky. On the one hand we are against neonicotinoids, but on the other hand we don't want the dog scratching itself all day long." The problem according to Alblas lies in the 'chemical illiteracy' of the general public. "Most people consider oddly named substances to be 'chemical' and therefore stuff that should be avoided by the industry."

> "Begin by making things easy to understand"

Care and caution

Above all, Jansen urges care and caution in communications about uncertain health risks. "You need to realise what you are communicating", he explains. "Does your terminology come across to your target audience in the same way that it does to you? Is your message concrete and does it leave little room for interpretation? Does it match the language of the target audience? These are important things to check. If we know that a certain substance causes hormonal imbalance in water snails while it remains unclear what its effects are on humans, it is better not to say: 'Certain effects on water snails have been established'. The alternative would be: 'We are currently investigating whether the substance could have an effect on humans'."

Jansen is sceptical about the awareness of the general public regarding its own role in these matters. "Of course you can explain to people that superfluous medication should not simply be flushed away. However, there is little to be done against medication excreted by a patient ending up in the sewer. That is not to say that people shouldn't be aware of this, even if they do trust the authorities to guarantee the safety of their drinking water." ❮

Peter Alblas

After a short period at Wageningen Agricultural University, Peter Alblas graduated from the Teacher Training College in Nijmegen. A former teacher, he has worked for ARK Nature Development and currently works in the field of education and urban ecology at the Centre for Nature and Environment Education for Maastricht and environs (CNME).

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Tom Jansen

Tom Jansen studied Conflict, Risk and Safety Psychology at Twente University. In 2014 he started researching his PhD at the Amsterdam UMC and RIVM on communication of uncertain environment-related health risks. His research continues.

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Business portrait

TRACKING TRACES AT CHEMELOT

By Ingrid Zeegers

» Apply for a new water permit and become an expert on contaminants of emerging concern (CECs) in one fell swoop. That is what happened to the team of Hans Geijselaers and Denise Bakker. They work for the Sitech technical support company, which is responsible for wastewater management at the Chemelot industrial site.

Chemelot is a 800-hectare industrial site in the south of the Netherlands, home to over 150 different businesses. The name is of course a reference to legendary Camelot, seat of King Arthur from where the Quest for the Holy Grail was launched. Sitech is on a quest of its own, searching for CECs that might become a problem for drinking water companies and elsewhere. The driving force behind the quest is an increasingly stringent government policy, as embodied in the application process for a new water permit.

Production process

The wastewater produced by the Chemelot industrial site contains some eight hundred different chemicals. Understanding where these all come from means knowing what goes on at the site, at least in general terms. Hans Geijselaers, manager of the Sitech water management business unit, explains: "Chemelot has 54 chemical plants running production, and basically they come in two flavours: plants with production processes based on ammonia, and petrochemical plants. For example, natural gas comes in, and is turned into ammonia. This then becomes the raw material for products such as melamine, fertiliser and acrylonitrile. We also have a large flow of naphtha, which gets processed into raw materials for a number of synthetics, such as polypropylene and polyethylene. In addition to all this, a large R&D Campus is under development, and we have sustainability plans."

Waste materials

Geijselaers explains that the various production processes produce a number of waste materials, including metals, salts, nitrogen compounds and organic materials. "These waste materials can end up in the process water. In some cases the wastewater is treated at the plant to remove a specific problem chemical. The remainder is conveyed through a 290-kilometre sewer system to a central biological treatment system, known as the integrated wastewater treatment plant (IAZI). Having passed through the central treatment plant, the resulting process water flow — the effluent — is discharged into a branch of the river Ur, which empties into the river Maas (Meuse). That is why we need a water permit."

Accepting the unknown

That is also the point at which CECs become an issue. Denise Bakker, head of the Sitech permit handling department, explains that the old permit system was

based on standards for group parameters. “That is no longer sufficient. These days, each of the 54 plants needs to specify in much more detail which separate substances they are discharging into the sewer system. It all adds up to some seven hundred substances. Quite a job for a water permit. It all becomes even more complicated when you realise that the river Maas also brings in substances from elsewhere into our country — and into the Chemelot process water.” Geijselaers adds: “It is very important for us to know which substances enter the Maas in France and Belgium. As the Maas is a rain-fed river, there is also a big difference between summer and winter conditions, with the dilution levels of discharged substances depending on the amount of rainfall.” Another unknown factor is the extent to which substances get broken down on their way to the treatment plant. This might cause unknown substances — known as metabolites — to be formed. Bakker: “This introduces a degree of uncertainty. Part of this uncertainty we will simply have to accept. In order to reduce the risks, we monitor and assess the substances that are known, following statutory processes. On top of that, we further minimise the risks by using additional analysis techniques.”

Effluent to drinking water

The discharge situation at Chemelot is unusual in that further downstream the Maas water is used to prepare drinking water. Consequently, the river water needs to meet the strict intake standards for drinking water preparation. The discharge from Chemelot needs to take this into account. This means that the effluent from the Chemelot outlet has always been subject to very stringent monitoring. Even so, drinking water plants increasingly find that they have to suspend the intake of water from the Maas. In 2017 this happened on 59 occasions. Only a few of these were due to a substance originating from Chemelot, by the way. In order to gain a grip on all the unknown new contaminants, the authorities are continuously developing additional policies, to be filled in by individual companies, including Chemelot.

How? Geijselaers: “In order to gain more insight into CECs, Sitech has invested in new analysis methods and technology, one of which is a mussel monitoring scheme. Today, this enables us to detect or measure many more individual substances in the effluent. Bear in mind that we are dealing with very low concentrations: we are talking about a few micrograms per litre or less.”

Emerging substance detected — what next?

Measuring new substances also raises new questions, according to Geijselaers. “Detecting a new substance is one matter, but finding out its identity — which substance causes which new peak — requires additional detective work. We have started building a database holding information about all the different substances. This also involves assessing to what extent a substance should be avoided, after which a standard can be defined. My team of specialists — together with the technologists of the plants —

> “It all adds up to some seven hundred substances”

are working on the assessment of our measurements, and we are putting together a fingerprint for each plant.” So what comes next? Bakker: “Well, the checklist is as follows: Is the substance known? Did the substance come from Chemelot? Should the substance be avoided in surface water? If so, we will take immediate action to reduce or halt the discharge.”

Selective action

Bakker and Geijselaers both realise that in order to be in control, additional insight needs to be gained into what exactly is being discharged. “We are also facing new issues due to climate change”, Geijselaers says. “The question is what will be needed to cope with reduced water levels without losing sight of our industrial interests. The fact is that new businesses coming to Chemelot often get a shock when they see the cost of wastewater treatment.” Finally, where do we go from here with regard to CECs? “We take sustainability very seriously”, Bakker says. “Our aim is to minimise our environmental impact. The trick lies in picking out the substances that most affect the environment, and then to focus water treatment on those.” ❮

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Public opinion and transparency surrounding GenX

By Chris Aalberts

The discovery of GenX in the drinking water in Dordrecht caused enormous public unrest. In Helmond, people reacted calmly to the news that the substance had been found in the surface water. Jonne van Bochove (Municipality of Dordrecht) and Sander Schaepman (Municipality of Helmond) recall the events.

"A nuanced account will never prevail over emotion"

In 2012, Chemours started using GenX in its production process to replace perfluorooctanoic acid (PFOA), a potentially carcinogenic substance. However, doubts were also quickly expressed about GenX itself. Jonne van Bochove of the municipality of Dordrecht: "We don't know precisely how dangerous the substance is. We are learning more all the time."

In 2016, minute quantities of GenX were found in drinking water. Although the concentration of the substance was well below the limit value prescribed by the National Institute for Public Health and the Environment (RIVM), the discovery did increase public concerns in Dordrecht and the surrounding region. Van Bochove: "Even though similar limit values apply for all consumer products, there are still people in Dordrecht today who will not drink water from the tap because of GenX."

What is the role of the municipality?
"Chemours is licensed by the province of Zuid-Holland; the municipality has an advisory role. In that context, we act in concert with the municipalities of Sliedrecht and Papendrecht. We are in the same effect region and have the same objective: we do not want these contaminants to enter the environment. At the same time, we seek to connect with others because you need partners if you are to achieve anything. And the key to achieving results often lies at provincial, national or European level. We also address Chemours itself about its social responsibility. There is more to that than securing a permit. Chemours recently announced that it wants

to reduce emissions of GenX by 99%. It did so partly as a result of the pressure from all of these parties and from public opinion."

How do the residents feel about the role of the municipality?
"There are many issues over which the municipality has no say, but naturally the well-being of our residents is our responsibility. We are accountable for it. There is just one government as far as the residents are concerned. From the outset we made it clear that we didn't know everything, but what we did know we would share. The municipality and the other relevant authorities commissioned a number of studies. We also organised public meetings together with the municipal health service, the water companies and the province. Furthermore, we have had a section devoted to topic on our website for years and actively report on the latest developments to the public. We have found that holding meetings is the most effective mechanism for addressing the concerns of residents. But it is always difficult to reach everyone and to ascertain how widespread the concerns really are."

> "The trick is to close the gap between reason and emotion"

What role do the media play?
"The media performed an important role with their revelations. But it is also noticeable that they sometimes have little interest in subtleties. The government's nuanced account is then often drowned out."

Is there anything the municipality can do to counter that?
"Our view is that there is no place for these contaminants in the environment. We are also making progress in achieving that goal. But this is an ongoing issue. It started with emissions and their impact on health, but now we are talking about concerns relating to soil pollution, drinking water and vegetables grown in allotments. With each new development, there is a new peak in attention for the subject. And that feeds the feeling that the situation is becoming steadily worse. But we are simply learning more about the consequences and effects of emissions of these contaminants. The publicity is therefore something we simply have to learn to live with."

How is the municipality of Dordrecht handling it?
"The trick is to close the gap between reason and emotion. The municipality and the drinking water company can say that the concentrations of GenX are very small, but the facts are hard to get across if members of the public have the feeling that their drinking water used to be clean but now it isn't. There are some who think our only concern is to keep people calm, but that is not our intention. A little more nuance would be very welcome, although I am aware by now that nuance will never prevail over emotion. We want to be transparent, to tell it as it is. Anyone who wants to know what is going on must be able to rely on our information and come to us with any questions they have. We will not pretend that things are better than they are, but also not portray them as worse than they actually are. We will continue to pursue that course. We also want this case to lead to structural improvements in the policy and the licensing system relating to contaminants. Fortunately, the national government and the EU are already doing more to address the challenges."

Jonne van Bochove
Jonne van Bochove was a communications adviser with the Drechtsteden Service Centre from 2008. Since 2009 he has held the same position for the municipality of Dordrecht, where he has been information officer and senior communications adviser for the last few years. Van Bochove has been intensively involved with the Dupont/Chemours portfolio for years.
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"Everyone could see that we were being transparent"

The municipality of Helmond was also confronted with the GenX issue. As Sander Schaepman explains, at the end of 2017 the water board found very high concentrations of GenX in the surface water. "My first question was: what in heaven's name is GenX? What will happen if I drink a glass of GenX-water? Almost everyone felt this uncertainty. It was a totally new situation for us all."

Fortunately, the water board had an idea of where the GenX came from, says Schaepman. "The source was Custom Powders. We instructed the company to stop using GenX immediately. That was a risk, but public health was our priority. Custom Powders was also shocked and cooperated with complete transparency."

What happened then?
"We now know that the levels at the time were not harmful, but that was not clear then. There are various standards, but the question is which one should apply. What should we do? Should we close a lake where people swim? Should we close allotment gardens? Is it safe for people to eat the vegetables they grow there? At the same time, everyone has already ingested PFOA. It is always a question of the concentration. The standards prescribed by the RIVM and the municipal health service are decisive."

How did you address the situation?
"The key to my job is remaining calm. We therefore immediately formed a crisis team. That provides clarity, because you know that everyone involved will be meeting at ten o'clock every Thursday morning: the water boards, the ministry, the environmental department and the municipal health service, and sometimes also the Netherlands Food and Consumer Product Safety Authority. At these meetings the team discusses latest news: what measurements have been performed, what changes have occurred and how can the discrepancies be explained? We constantly analysed various scenarios. With this structure you avoid poor communication. In my experience, this procedure allows everyone to provide the best possible input. The right people have to be around the table to ensure that the entire process is properly coordinated. But that does not mean that the practical experts take the lead. I like to say that civil servants fix punctures, while administrators consider whether having a flat tire is not a good time to think about whether we need a scooter. My job is to bridge the worlds of the bureaucrat and the politician. Civil servants sometimes underestimate the political significance of a specific measure, for example."

What might be underestimated?
"We followed the recommendation of the RIVM and chose not to close De Berkendonk, a lake for swimming. Why should we reach a different decision? The risk is that the moment you close off a lake with red tape there will be newspaper headlines saying 'Poison in De Berkendonk'. But the process is entirely different if you place a sign saying 'Swimming is at your own risk'. You try to avoid public panic. That is entirely different to covering something up. We have always been proactive and have immediately communicated what was happening. There was no risk and scarcely any commotion." ❮

Sander Schaepman
Sander Schaepman is the head of security and compliance for the municipality of Helmond. Since 2008 he has run his own security firm. He had previously worked with the police for 25 years. He headed the crisis team in Helmond following the discharge of GenX by Custom Powders.
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Case 2

Time for a new compass: **drinkable rivers**

By Li An Phoa

Last summer, I spent sixty days walking the length of the river Maas (Meuse), a total of 1,061 kilometres from its source in France to the North Sea. Along the way, I carried out a study of the quality of the water in the Maas with local people and spoke to children, entrepreneurs, administrators, journalists, teachers and directors about my campaign for a new social compass: drinkable rivers.

Rivers are the resultant of an entire watershed. They constitute part of the small fraction of fresh water available on Earth - water that is crucial for all life. Just think about it: we were once able to drink the water in our rivers but in just a few generations we have poisoned them.

Economic growth

Fourteen years ago, I spent a month canoeing on the Rupert River in Canada. At the time, the water along the entire length of the river, from the source to the sea, was drinkable. Then, under the guise of economic development, a silver mine was opened on the Rupert. Less than three years later, the tears rolled down my cheeks as I held the hand of an indigenous woman whose family had been living on the river for centuries. In no time, the mercury used to mine silver had poisoned the river, the fish and the indigenous population. With a single intervention, on the basis of a compass geared to economic growth, the water was no longer drinkable and the quality of life in the Rupert River basin was destroyed.

Time for a reset!

The social compass in the Netherlands is also set incorrectly. Our compass – guided by economic growth like in Canada – promotes the development of countless Contaminants of Emerging Concern (CECs). More than 50,000(!) substances seep into our environment every day, some of them ending up in our drinking water. For example, at least 140,000 kilos of medicine residues (not even including metformin, a treatment for diabetes) are found in the river Maas every year.

> "Together we can make our rivers drinkable again"

These substances are known as externalities – side effects of a compass geared to economic growth. Today, no one can ignore these side effects any longer as 15 million people depend on the Maas for drinking-water. Climate destabilisation is a reality and the time for tackling side effects has passed. It is time to reset our compass.

Drinkable Rivers

The Rhine authorities know the importance of setting the compass correctly. Following the environmental disaster in Basel in 1986 – a fire at a chemical factory which released toxic chemicals into the river and caused the deaths of masses of fish – the authorities adopted the Rhine Action Programme in which they formulated the target of restoring salmon to the Rhine by 2000. The programme has been a success! I therefore propose that we now set our compass to drinkable rivers. Every inhabitant of this planet – whether they live in a mangrove forest or a desert – is part of a watershed and would benefit from drinkable rivers. The same applies for the salmon, the otter and the willow tree, whose pollen also sustains the wild bee. Drinkable rivers represent more than just clean water, because rivers can only be drinkable if the entire watershed is healthy and in balance. Drinkable rivers are therefore an indicator of the health of a habitat. I would therefore like our social compass to be guided by the following question: "Does this behaviour, this measure or this innovation contribute to drinkable rivers?"

Step by step

Together we can make our rivers drinkable again. Step by step, in the same way I walked the length of the river Maas. In association with network organisations such as the Mayors for a Drinkable Maas, we are pursuing a four-step plan that should culminate in drinkable rivers. Step one: *experience your river*. By making rivers accessible for walking, fishing or swimming, we will re-establish a relationship with them. Step two: *love your river*. With experience, love will grow. Step three: *care for your river*. Step four: *drinkable rivers*. A river that is drinkable for all life on earth. ❮

Li An Phoa

Li An Phoa is a graduate in business administration, philosophy and whole system ecology. She teaches at various universities, including Nyenrode Business University, linking ecology with economics and combining outdoor lectures with walking. In the last few years, Phoa has walked more than 15,000 kilometres on five continents. In 2017, Phoa gave a TEDx talk on the topic of drinkable rivers. In 2018, she was ranked number 19 in the Sustainable Top 100 compiled by the Dutch newspaper Trouw.

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Public authorities want to get a grip on Contaminants of Emerging Concern

By Ingrid Zeegers

Gaze at the heavens and you will constantly discover new stars. It's the same with Contaminants of Emerging Concern (CECs). The more you measure, the more you find. This brings with it the risk of choice overload: how to decide which of these contaminants you should focus on to preserve a healthy environment? That is the issue that is being addressed by the administrative accelerator platform for CECs.

There is nothing new about efforts to combat pollution (including water pollution). In 1873, for example, the Assembly of Medical Inspectors of Public Health (*Vergadering van geneeskundig inspecteurs van de volksgezondheid*) already warned against the implications of water pollution in this country. Their warning led to the publication of a legislative proposal designed to improve the situation. But it was only in 1970, after almost a hundred years of political manoeuvring, that the Pollution of Surface Waters Act entered into force. The political process advances more rapidly today. As it must, in light of the explosive pace of technological development in society. Even as industrial product developers are still working on an entirely new generation of substances by merging nanotechnology, biotechnology and information science, the authorities are already drawing up a campaign plan. The question they are addressing: How should we address the risks associated with new, unknown CECs in this day and age? A discussion with Liz van Duin, head of the Water, Soil and Marine Directorate at the Ministry of Infrastructure and Water Management, and Theo van de Gazelle, Chief Engineer and Director of Rijkswaterstaat Sea and Delta.

Administrative accelerator platforms

The quality of water has improved greatly over the years, Van Duin says, but it still does not meet all the targets. "The ministry has therefore decided to join forces with other public authorities and establish administrative accelerator platforms to provide a further impulse to efforts to meet the challenges in the field of water quality." There are three accelerator platforms: one for agriculture (manure and pesticides), another for CECs and medicine residues, and a broad-based overarching platform. Van Duin: "The platforms include representatives from business, civil-society organisations and public authorities. Their task is to jointly explore the problems with a view to reaching a consensus on solutions for them. The approach accelerates the process of generating measures to improve water quality that go beyond rules and regulations."

Different categories

Thousands of new substances are manufactured every year, Van Duin explains. "Substances fall into a variety of categories. There are substances we do not want and for which we have to find alternatives – these are known as substances of very high concern. There are also harmful substances that society wants, but the residues of which must be prevented from getting into the water. One such substance is GenX, one of whose uses is to make clothing waterproof. Then there are harmful substances that we need, but not in the water, such as medicines. This classification means that we need different assessment frameworks and different types of measures. And our aim is to conclude administrative agreements on them."

Structural approach

Theo van de Gazelle represents Rijkswaterstaat in the administrative accelerator platform for CECs and medicine residues and in the overarching platform. He agrees that the platform for CECs and medicine residues is still in its infancy. "We have just started compiling a joint inventory of the problems." But life goes on and a form of approach to dealing with CECs has already been developed through practical experience.

> "We look beyond rules and regulations"

"This is a consequence of the growing frequency of incidents in recent years, for example with GenX and pyrazole. Some of these incidents created serious issues for drink water companies, causing them to halt the intake of river water. Public authorities, companies and research institutes resolved those problems together." Van Duin adds: "As soon as a new substance of concern is found, the National Institute for Public Health and the Environment (RIVM) determines how harmful it is and formulates a standard for it. This system appears to work well, so we want to make it generally applicable and use it as the default procedure for other CECs."

Pilot project with permits

What specific role do the water managers play in relation to CECs? Van de Gazelle: “Waste water discharge permits are an important instrument for the managers in dealing with CECs. Rijkswaterstaat, for example, has issued eight hundred waste water discharge permits. We are currently reviewing seventy of them to evaluate what we can do in relation to CECs and whether the permits need to be updated.” For example, we have found that the permits were granted on the basis of information about a company’s production processes rather than the current knowledge about CECs. Van de Gazelle: “Meanwhile companies are better able to measure and detect new substances in the water whose existence was previously unknown. In short: it’s a matter of progressive insight.”

A tighter focus

Rijkswaterstaat expects to know the results of this pilot project in the course of 2019. More important, however, is what is done with the findings. Van de Gazelle: “How will we then roll out the knowledge we have gained to Rijkswaterstaat’s roughly 730 other permits? That will be another enormous challenge, especially in terms of manpower.” In that context, he feels that big data could provide new pointers. Smart algorithms could help in finding connections in large volumes of measurements, for example. “But the accelerator platform will first have to find a way of condensing thousands of unknown substances into a list of ten contaminants of genuine concern. In other words, it is all about creating focus.” What next for the accelerator platforms? Van Duin is adamant: The platforms are only temporary, but the community of practice will continue. The work goes on.” ❮

Safe handling of hazardous substances in the physical environment

There is public concern about the effects of hazardous substances on the health and safety of humans and the biodiversity of ecosystems. The worries arise from the fact that although the concentrations of many contaminants in the environment are declining, the number of substances is increasing and new applications of substances could potentially create new risks. These concerns are reinforced by incidents, changing demands with regard to the quality of water and uncertainty about the negative impact of the accumulation of contaminants in the environment. These concerns are also becoming more pressing in light of the transition to a circular economy. The Council for the Environment and Infrastructure (Rli) is therefore writing an advisory report on the regulatory system governing contaminants, products and the environment for the Minister of Infrastructure and Water Management. The report is due to be published in February 2020.
For more information, visit www.rli.nl/werk-in-uitvoering/veilig-omgaan-met-gevaarlijke-stoffen-in-de-leefomgeving.

Liz van Duin

Liz van Duin is head of the Water, Soil and Marine Directorate at the Ministry of Infrastructure and Water Management. She was previously Director of Network Development at Rijkswaterstaat Sea and Delta and at Rijkswaterstaat Noord-Holland.

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Theo van de Gazelle

Theo van de Gazelle is Chief Engineer and Director of Rijkswaterstaat Sea and Delta, as well as portfolio holder for water quality and ecology for Rijkswaterstaat as a whole. He is a former deputy director-general of Rijkswaterstaat.

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Column

How to buy a carton of milk?

Clean water. Naturally, it’s something we all want. But we also want to be certain that the responsible organisations are carefully monitoring the quality of the water. Fortunately, we are living in a world with an abundance of data. A world in which those organisations can measure practically anything, easily and in real time, and are therefore able to provide the public with maximum transparency about the safeguards for water quality. After all, transparency is the best remedy for gaining (or regaining) the trust of the articulate citizen, is it not? Well... no.

A persistent misunderstanding is that we trust something because we know a lot about it. In fact, the opposite often applies, since if you already know (almost) everything, there is no longer any need for trust. Trust is believing in something without knowing whether it is true. It is actually making a leap in the dark. Take the example of buying a carton of milk. When you buy it, you check the sell-by date, but do not investigate how the farm guarantees the quality of its product or how the inspectorate safeguards that quality. That is practically impossible to do. You have no choice but to blindly rely on the quality controls.

We should therefore use transparency with restraint, if only because too much transparency can be bad for us. It has been shown that the human brain is quickly mistrustful of too much transparency. This is an important lesson in today’s digital world, when detailed data can be provided to the public without any difficulty. The fact that it is possible does not mean it is sensible.

In his book ‘A human’s guide to machine intelligence’, Kartik Hosanagar explains not only why we have to be careful about providing too much transparency in relation to data and algorithms, but also that this is totally explicable in light of human nature. When we make a new acquaintance, we want to learn more about the person before we trust them. But if that person is too obviously trying to be transparent, we quickly become suspicious. Our brain then wonders what this person is trying so hard to prove.

Transparency sometimes does more harm than good. The challenge is to find the sweet spot: not too much, but not too little. How? The metaphorical carton of milk points in the right direction: provide the consumer with straightforward information like the sell-by date, but only explain the complicated details of quality control to experts. For a layperson, the details only create mistrust. ❮

Nart Wielaard

Nart Wielaard works at the intersection of society, technology and business. As a writer, public speaker and consultant, he distils complex subjects into convincing narratives. He is the author of a number of books, including ‘Wij zijn Big Data’ and ‘Vertrouwen in de slimme samenleving’.

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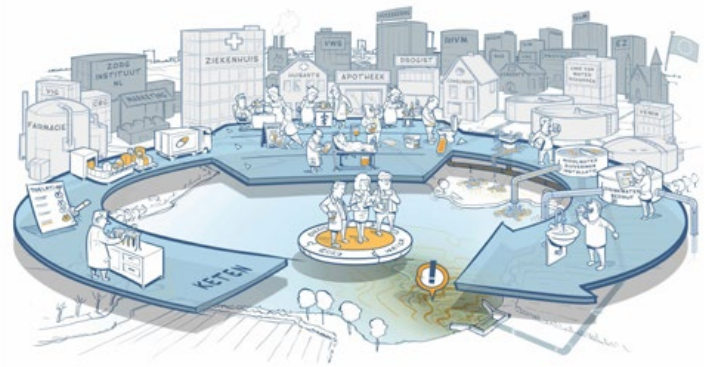
Case 3

Medicine residues in the Maas

Concentrations of medicine residues and other organic micro-pollutants in the surface water of the Maas (Meuse) basin are increasing. Water partners in the Dutch part of this area want to do something about this. Their motto: The Maas can and must be cleaner!



By Maarten Nederlof and Henk Ketelaars

We all take a paracetamol once in a while when we're sick or have a headache. These medicines are only partially used and broken down in our bodies; their residues end up in sewage water via our urine and faeces. The water board purifies sewage water in such a way that it can be discharged into surface water in line with the standards. A proportion of the medicine residue is removed. There are currently no standards for medicine residues in treated sewage.

Surface water

The unremoved medicine residues then end up in surface water where they are diluted heavily with rainwater, which means that the concentrations are so low that these contaminants are considered to be 'organic micro-pollutants'. Despite the low concentrations, they may have an effect on the aquatic environment. In the case of a number of medicine residues, such as diclofenac, the Predicted No Effect Concentration (PNEC - the concentration at which there is no effect on aquatic organisms) in surface water is exceeded. Ultimately, a large proportion of the water ends up directly or indirectly in our (major) rivers.

Drinking water

Effluent from the water board Waterschap Aa en Maas, and other water boards in the Maas catchment area, is discharged into the Maas where almost 3 million people living downstream depend on this river as a source of drinking water. Just before the confluence of the Maas and the Nieuwe Merwede rivers, the water company Evides collects water from the Maas to produce drinking water. This water must

Contaminants in focus

Metformin and diclofenac are examples of contaminants found in relatively high concentrations in surface water. Metformin is a medicine used to treat diabetes and diclofenac is the most commonly used painkiller in the Netherlands.

Every year, Dutch pharmacists dispense 150 million doses of 2 grams of metformin. This amounts to 300,000 kilos if all of them are used, and it is estimated that 51,000 kilos of it are released into the sewage system and 5,300 kilos into surface water. On average, pharmacies dispense diclofenac 2 million times a year to approximately 1.2 million users. Furthermore, diclofenac is freely available under various brand names from supermarkets and medicine stores.

Concentrations in µg/l	Diclofenac	Metformine
Sewage	0,33-0,59*	64-100*
Treated water	0,19-0,40*	0,4-1,7*
Surface water, upstream of treatment plant	0,013-0,076*	0,25-0,68*
Downstream	0,06-0,22	0,30-1,04
Maas	0,04 (max)	<0,5 ; 0,83 (max)
Evides drinking water	<0,01	0,3 (max)

*Purification data from Aa en Maas, averaged over 12 samples during a 1 year period.

Table 1: Average and maximum concentrations of medicine residues in the Maas basin. (Data from Waterschap Aa en Maas and Evides water company)

comply with the strict requirements of the Drinking Water Decree. A large proportion of the medicine residues are removed through storage in large reservoirs and drinking water treatment. Ultimately, we only find traces of these contaminants in drinking water. The concentrations are so low - nanograms per litre - that it has no impact on health whatsoever. Nevertheless, the water companies believe that these contaminants do not belong in drinking water.

> "Only by working together can we make the Maas and its watershed cleaner"

Unique co-operation

The Maas is the wastepipe of the Netherlands, Belgium and part of Germany, but it is also used as a source to supply water for agriculture and for the production of drinking water. In order to safeguard water for this use in the long term, it is necessary to reduce the concentrations of medicine residues and other organic micro-pollutants. If there were one agency in charge of the Maas, responsible for the drinking water supply, the sewage system and waste water treatment, how would it deal with it? With this idea in mind, we started a unique co-operation with all the water partners in the Dutch section of the Maas basin: Schone Maaswaterketen (Clean Maas Water Chain partnership). Participants are the water boards Brabantse Delta, De Dommel, Limburg, Rivierenland and Aa en Maas, the water companies WML, Brabant Water, Dunea and Evides, plus Rijkswaterstaat and the Ministry of Infrastructure and Water Management.

A clean river Maas

The Schone Maaswaterketen is working on, among other things, mapping the origin of substances and monitoring concentrations. We are also taking stock of the possibilities for reducing the level of medicine pollution in surface water. We are developing a joint

ambition to serve as many functions as possible. And finally, we are setting up an action programme with concerted measures to actually make the Maas cleaner. The ultimate ambition is to scale this up internationally as well, with a river Maas that is fit to drink from as a dream for the future.

Lower concentrations

In order to reduce the concentrations of medicine residues and other organic micro-pollutants, the partnership focuses on three 'layers'. First of all, municipal overflows with high concentrations of medicine residues, which take place in the vicinity of hospitals, for example, can be prevented. Furthermore, the water boards can extend some of the existing biological treatment plants with an additional step to remove medicine residues. Additionally, the water companies themselves must maintain their treatment processes in order to produce trustworthy drinking water. The second 'layer' focuses on abroad. Approximately half of the medicine residues enter our country via the Maas and its tributaries from Belgium and Germany. Measures taken in the Netherlands will therefore only be effective if water boards abroad also take their responsibility. This is being discussed in the international context of RIWA-Maas. The third 'layer' addresses the source. Ultimately, it is best if less medicine residue ends up in the sewage system. For example, by pharmacists collecting leftover medicines and by prescribing medicines more responsibly. A more educated use of medicines that can be bought at the chemist's, such as paracetamol, ibuprofen and diclofenac, can also result in a decrease.

Think along with us

Due to medicalisation and an ageing population, the number of people taking medicines will increase considerably in the coming years. The Dutch National Institute for Public Health and the Environment (RIVM) has calculated that by 2050 use of the top 50 medicines will be 37 percent higher than in 2007. Fortunately, at the same time, we also see a trend that more and more people want to live healthier lives. Medicine residues in water will therefore continue to demand our attention in the years ahead. We invite water partners, technologists, the healthcare sector, the government and consumers to think along with us. Because only by working together can we make the Maas and its watershed cleaner!

Maarten Nederlof

Maarten Nederlof works as a waste water policy advisor at Waterschap Aa en Maas. He is the creator of the waste water strategy, in which the water board has expressed the ambition to remove medicine residues from the waste water.

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Safe by Design

A totally different approach

By Amanda Verdonk

Safe by Design is all about thinking through the consequences of your design: does it contain any 'toxic materials' that could end up in the soil or surface water? This new principle aims to ensure that materials, products and processes are inherently safe. Within the chemical and maritime sectors, the first products inspired by this philosophy are already coming to the fore.

"Safe by Design is the magic word at the moment," says Dick Jung, Manager at the Directorate Environmental Safety and Risks of the Ministry of Infrastructure and Water Management (I&W). "The basic credo is: think through the consequences before embarking on a new product or process." All too often, researchers and product developers produce innovations in the laboratory, only for the company to run into regulatory issues when it starts bringing them onto the market. Jung: "We want to break through that process. It would be so much better if new things were safe and healthy from the outset. Then you don't have to worry retrospectively: Is this product safe? Is there any danger of it leaking or exploding?"

Shifting perceptions

Safe by Design has been embraced by the cabinet and now forms part of the I&W Conscious About Safety Programme. It fits in with the shifting perceptions on environmental policy. Jung: "Policy used to be all about environmental remediation or, to put it more bluntly, cleaning up the mess. Then the focus switched to controlling 'toxic materials' – chemicals that are harmful to people and the planet. Though that policy has been very successful and the risks of unacceptably high concentrations of hazardous materials are sometimes negligible, there are still all sorts of dangerous chemical materials in circulation, with all the attendant risks. What's more, people don't always feel safe. It's all very well saying that most problems are under control and below the set limits, but that is not necessarily the right answer for society. The challenge in this new stage of environmental policy is to prevent risks."

Simple solution

Pilot projects are already underway to explore and apply this new mode of operation. Such as at Novochem, a company that offers "chemically-tinted

"It would be so much better if new things were safe and healthy from the outset"

solutions for industry," says R&D Director Erik Bijpost. The company's products include protective coatings for fertiliser pellets. These coatings are 100% plant-based and therefore free of harmful substances. Farmers use these pellets to make their land more fertile, so materials from the coating obviously end up in the soil. But – much to Bijpost's disappointment - there is still no European legislation to ban toxin-containing coatings. "A middle ground has been found. But we prefer the cleanest way, and hope the customer does too."

"Down-to-earth common sense can take you a long way"

Safe by Design also often means: simpler. The laboratory chemists of Novochem have found certain combinations that also occur in nature and deliver just as good results as existing products. There was no need for a complicated high-tech solution. "The strength lies in keeping things simple and staying close to the basics. That increases the chance of success because the customer understands and accepts it faster. Down-to-earth common sense can take you a long way."

Great leap forwards

Novochem also delivers a coating for aluminium cans that is entirely solvent-free. Producers who struggle to meet emissions standards are particularly interested in this solution. The coating may be more expensive, but it also means one processing step less for can manufacturers, because they no longer have to remove solvents after applying the coatings. Novochem delivers its coatings to some of the biggest can manufacturers in Europe. "Chances are you have had our product in your hands lots of times," says Bijpost, who assures us that the industry sees the new method as a great leap forwards. "We are the innovators who are shaking things up and showing that different approaches work too."

Holy grail

Drawing on this conviction, the HISWA water sports association is also trying to show its members that a coating for pleasure boats can be Safe by Design. Ships are magnets for all sorts of organisms, such as algae, shellfish and barnacles. These accretions slow down the ship and lead to more fuel consumption. What's more, ships can also carry undesirable organisms – invasive exotics – to other regions.

"Shaking things up and showing there is another way"

Pleasure boats are particularly susceptible to these kinds of accretions because they lie berthed in the marina most of the time. Antifouling agents repel the accretions, but contain lots of biocides, such as copper or zinc. As time goes by, these biocides let loose and end up in the surface water. The amount of biocides in coatings has been sharply reduced in recent years. "But what you ultimately want is a biocide-free product, that is the holy grail," says Jeroen van den Heuvel, Head of the Members Service at HISWA.

Rat race

According to Van den Heuvel, the situation surrounding the various coatings in recent years is reminiscent of a rat race. "Certain substances were initially allowed and then banned, just like with doping in cycling. So the products are becoming cleaner, but there are also more and more alternatives on the market." As a matter of fact, if you opt for on-land boat storage or a boat wash service – a bit like a car wash – you don't need any coating at all. But in cases where coatings are still necessary, there are also better alternatives, such as extremely smooth and hard coatings with a repellent effect, silicon coatings or stickers. The transmission of ultrasonic sound waves around the hull can also prevent unwanted accretions of organisms. At the request of the Ministry of Infrastructure and Water Management, HISWA is carrying out a pilot with

"Ultimately, we need to get rid of all these harmful substances"

fifteen boats to test the various alternatives that are already available on the market. As far as Van den Heuvel is concerned they are all examples of Safe by Design. "A sticker or ultrasonic sound is obviously an entirely different design from the traditional pot of paint. It is not an improvement of an existing product, but a brand-new approach."

Foolproof

Jung notices that there is still a lot of debate about the subject: when is something really Safe by Design? "We, as the government, have no official stamp of approval to put on what we consider to be Safe by Design, but we do want to show that it is actively on our radar. As things stand, it is still mainly a concept that we want to see put into practice wherever possible; crucial too is the attitude of the people making the product. So we are still mainly engaged in building awareness and enthusiasm."

Ultimately, we must get rid of all these harmful contaminants, he thinks. "Wherever toxic substances occur, you need to do something sooner or later. So what could be better than leaving them out in the first place? That's foolproof too; there's no need for cautionary inserts or further worry." ❮

Erik Bijpost

Erik Bijpost graduated at the Chemistry Department of the University of Groningen. After completing his post-doc research, he joined Holland Novochem in Houten in 1998, where he held various positions before being appointed R&D Director of the Packaging Coatings Department six years ago.

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Jeroen van den Heuvel

Jeroen van den Heuvel was a maritime officer at the Nedlloyd shipping company before moving to the HISWA water sports association in 2000, where he is currently Head of the Members Service and Manager of the Trading Companies Department.

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Dick Jung

Dick Jung is Manager at the Safety & Risks Directorate of the Ministry of Infrastructure and Water Management. Together with his teams, he is promoting the safe transportation of hazardous contaminants and the development and roll-out of Safe by Design. Formerly, his responsibilities included the safety of biotechnology and chemical substances.

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The value of CECs in the circular economy

Thinking in reverse

By René Didde

If there is one sector that is thinking circular in a big way, it is the sewage water sector. Reclaiming materials from waste water, such as toilet paper, saves energy and costs, while also yielding new products. Can circular thinking also work for Contaminants of Emerging Concern (CECs)? Erik Pijlman, one of the directors of Cellvation, is not convinced.

"Every person in the Netherlands flushes about 10 kilos of toilet paper down the toilet every year. That adds up to about 180 thousand tons of paper that ends up in the sewer. Once it's pumped through to the water treatment plant, bacteria, combined with oxygen, break down the degradable part of the waste. But the toilet paper's more than they can handle. So this paper sinks into the sewage sludge together with other particles and spent bacteria. The water boards are obliged to dewater and burn the sludge, which is very expensive and unprofitable. At best, they can extract a bit of biogas by fermenting the sludge first."

Savings

"So capturing toilet paper before it reaches the water treatment plant saves a lot on costs. But that's not all: the sludge sedimentation process takes place in large tanks that take up a lot of space. If fewer particles are transported with the water, water managers can process more sewage with the same space. This leads to major savings on investments as well as scarce space for the construction of new sewage treatment facilities."

Toilet paper as wall insulation

"Using the fine-screen installations of one of our parent companies, CirTec, we reclaim cellulose, which is the valuable main component of toilet paper. This is third-hand cellulose. Virgin cellulose comes from the trees, second-hand cellulose is obtained from collecting and recycling used newspapers and cardboard boxes into, for instance, toilet paper.

Our third-hand cellulose is already used in infrastructure as an asphalt binder - because adding cellulose makes warm viscous asphalt easier to transport to the road construction site. This significantly improves the Environmental Cost Indicator value of asphalt. And that's very important for Rijkswaterstaat. It can also be used as insulation material in housebuilding. Examples are wall blankets and the fluffy material that is injected into cavity walls. We can also mix the fibres with plastic particles and use this mixture as a composite material to make frontage cladding, for instance. These initiatives are being undertaken together with developers, large construction companies and infrastructure contractors."

"Our third-hand cellulose is pure and readily available"

From cost item to revenue driver

"But the most interesting market for us is probably the chemical industry. These companies are eagerly looking for building blocks to make chemicals that are currently manufactured from oil. The quantities they work with are huge. Our third-hand cellulose is pure and readily available - because the most energy-intensive processing of cellulose has already been done by the paper industry. Which is a great help. And the best thing of all is that this cellulose has

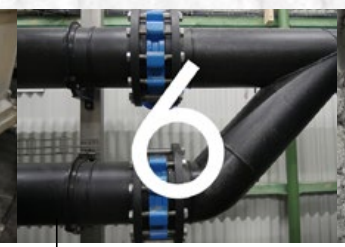
Through the Cellvation® process, cellulose is recovered from sewage water, transforming waste into a resource.

First, the easily settable solids like sand and grit are removed.

The water that flows from the grit removal passes through a cellulose washer, which takes out the hair and other organic contaminants.

The Salsnes filter then filters the cellulose out of the water.

The cellulose is further dewatered in the CellPress.



The sievings are hygienised to reach the EPA class A rating, ensuring that the product produced is clean and safe to use.

The larger chunks of cellulose are broken down to smaller parts. From there, the cellulose is turned into fluffy cellulose or compacted into pellets.

The result is Recell®: the recycled cellulose produced by the Cellvation® process.

a ‘positive price’: the chemical companies and road builders pay for it. Whereas until now, it had a ‘negative price’ for the water boards due to the high costs of processing paper sludge. At the moment, we work a lot with Nouryon, the former Akzo Nobel Specialty Chemicals which was hived off last year.”

Economic value

“As for whether new CECs can be extracted in a similar manner from the water for reuse, I have my doubts. Even if it were technologically possible, you still need a viable business case. For one thing, CECs are usually present in very low concentrations in the sewage water. Even more importantly, they are still merely a ballast in the water. Unlike our cellulose, they do not have an economic value at present. Who wants them and what can we do with them? That’s what I wonder.”

> “CECs are still a big unknown for the market and society at large”

Pizza box

“We obviously check the quality of the cellulose we reclaim from the toilet paper. Because the product we deliver must be safe. Pathogenic organisms, medicine residues and PAHs are still on the toilet paper, but after our processing the levels are below the detection limits of the measuring equipment and always under the statutory limits. So in terms of risk profiles, we are on the safe side. Moreover, it makes a big difference whether cellulose is reused in asphalt or finds its way back to the market in the form of a pizza box.”

Key

“I know that the water boards and RWS are keen to push circular thinking forwards. Their ambition is to transform the water treatment plant into a materials and energy factory, with an even stronger focus on sustainability and re-use. The water boards are already reclaiming phosphate in the form of struvite-based fertilizer. Alginate, a valuable polymer, and sand are also perceived to have good potential. To my mind, this is because these materials, like cellulose, do not incur high processing costs – and hence a negative price – while also having an economic value, i.e. a positive price. What’s more, they are finding increasing acceptance among businesses and consumers. There lies the key.”

Rewarding good initiatives

“CECs are still a big unknown for the market and society at large. Consumers know much less about CECs than, for instance, about free range eggs. At the moment, the water boards are mainly looking at ways of making CECs harmless through the use of ozone, active carbon and UV light. So the primary focus is on preventing contaminants from ending up in the river. But at the same time the government is not doing enough against CECs by rewarding good initiatives and punishing bad developments. If certain CECs are indeed found to be ‘very worrying’, the government can bring in regulations to encourage industry to manufacture products that are easier to degrade or contain less dangerous active ingredients.” ❮

Erik Pijlman

Erik Pijlman studied Building Engineering and Environmental and Infrastructure Planning at Groningen University of Applied Sciences and the University of Groningen. Pijlman is one of the Directors of Cellvation; a joint venture of KNN Cellulose and fine-screen supplier CirTec.

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