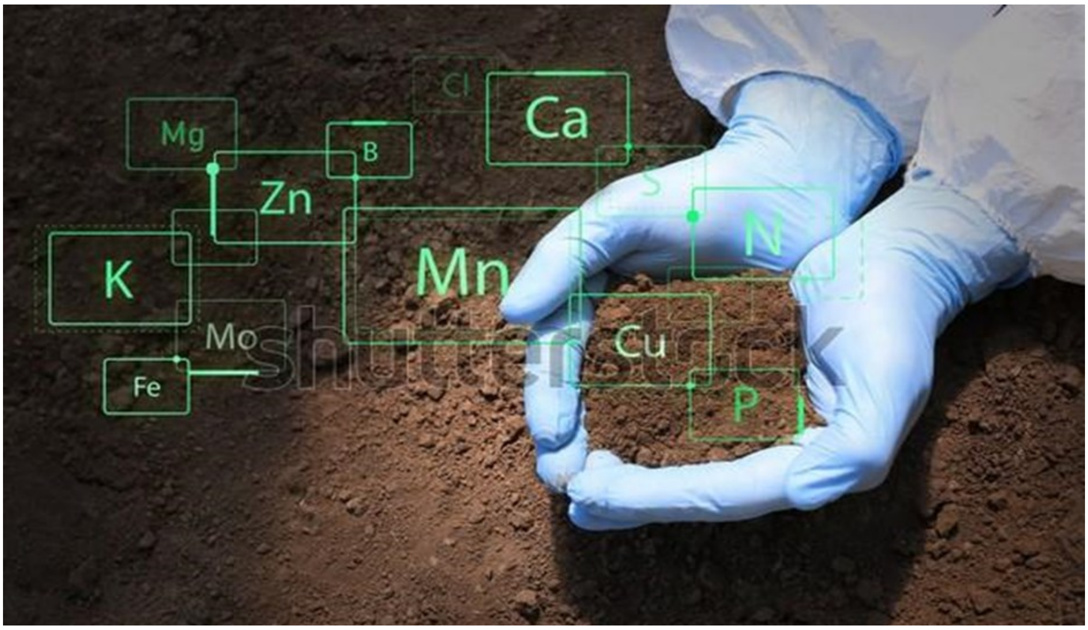
RSC INTEREST GROUP
ENVIRONMENTAL CHEMISTRY

July 2022

Environmental Chemistry Group

Bulletin



Articles. **Jo Wybrow** and **Tao Lyu** discuss micropollutants in wetlands. **Laura Thain** and **Joanne Kwan** describe the impact of a changing climate on land contamination. **Alice Marshall** uses single-cell mass spectrometry to profile xenobiotics in flora.

Environmental Briefs. **Sofia Iogna Prat De Medina-Rosales** discusses the amelioration of nitrate-contaminated ground and surface water. **Sarah Kemp** explains the role of synthetic textiles in microplastic pollution. **Kerry Sims** outlines the UK's Prioritisation and Early Warning System for emerging chemical contaminants.

Outreach. We report two outreach events and new initiatives to engage the next generation with the environmental sciences.

Upcoming meetings. We have three meetings organised for this September: a webinar on the circular economy (September 7th), the **2022 ECG Distinguished Guest Lecture and Symposium**, 'Electronics in the Environment' (September 9th), and a meeting on the 'Analysis of Complex Environmental Matrices' (September 16th).

Also in this issue. **David Owen** reflects on his career in chemistry post retirement. **Valerio Ferracci** reviews the RSC textbook *Atmospheric Chemistry* and we explain the RSC route for obtaining the professional qualifications Chartered Scientist, Chartered Chemist, and Chartered Environmentalist.

Contents

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ECG *Bulletin*

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The *ECG* Interview: David Owen

Formerly founder and managing director of TreatChem Ltd, David Owen is a retiree with a strong interest in environmental chemistry, and especially industrial wastewater systems. David still holds an interest in the company as a majority shareholder.

What inspired you to become a scientist? I have always been interested in science, ever since childhood. I had a very good teacher in secondary school, and I seemed to have an aptitude for it. The education system, at that time, encouraged competitive learning, which I took to.

How did you come to specialise in science for the environment? After graduating from the University of Birmingham with a Ph.D. in organo-fluorine chemistry, I decided that a laboratory career was not for me. After a spell working in the commercial department of British Steel, I was tempted by an advert in the local paper to join a major American water treatment company. I was instantly hooked by their keen attitude and problem-solving culture. They taught me much about industrial water treatment, and I became fascinated by the need to understand the technologies required to solve the problems when new legislation demanded better results.

Could you describe your current job? I am a retiree, but I keep getting involved by referral. I maintain my activity as a consultant, usually by looking at the big picture (where the company technologists get bogged down in detail). I still have things on my books from Ireland and the United States, although Covid had a major impact on activity for the last two years. I also keep an eye on what is happening in my own limited company.

What advice would you give to anyone considering a career in the environmental sciences? The field is enormous, so choose your area carefully. There are many routes into academia and industry. Always choose an aspect of the environment sciences and/or environmental regulation, which interests you and which matches your academic and practical skills. Be seen by your supervisors as a good learner.

What are some of the challenges facing the environmental chemistry community? Complexity is probably the main issue. Every time, as an expert, you feel you are getting to grips with a problem, remember that good communication is essential to win over support for apparently 'simple' new ideas. The average person in the street has a very low boredom threshold when confronted with jargon-laden 'tech-speak'.

What is the most rewarding aspect of your career so far? People. The smile on the face of a satisfied customer who had a nightmare problem sorted to their satisfaction.

If you weren't a scientist, what would you do? I would have to do something completely different such as a yachtsman. However, that would require me to learn a lot more about ocean racing.

And what do you do when you are not working? As a retiree, I revel in being a member of the ECG and several other RSC Interest Groups. But most of all, I really enjoy going away in this country, to new areas and take short breaks, staying in a cottage, with my wife and dog.

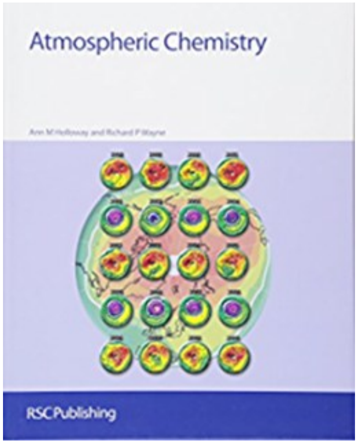
Book Review

Atmospheric chemistry

Valerio Ferracci (Cranfield University, v.ferracci@cranfield.ac.uk)

This textbook provides a key to understanding the chemistry behind major atmospheric environmental issues, from stratospheric ozone depletion to poor air quality.

The first two chapters provide a general description of the composition and physical structure of the Earth's atmosphere, from its temperature and pressure vertical profiles to how electromagnetic radiation (both incoming from the sun and emitted by the Earth itself) interacts with the atmosphere. In particular, the authors provide a very clear account of the radiative transfer model used to calculate the surface temperature of the Earth, and of the greenhouse effect. In Chapters 3, 5, and 6, before diving into a more detailed overview of the chemical reactions occurring in the atmosphere (from Chapter 8 onwards), the reader is introduced to a number of key concepts in atmospheric science, including sources and sinks of trace gases, the photochemistry of ozone, chemical families, and biogeochemical cycles of elements. Ozone, in particular, is a "recurring character" in this book, which reflects its central role in driving much (if not all) of atmospheric chemistry.



Chapter 7 (on the history and evolution of the Earth's atmosphere) is interesting and well written. The authors explain clearly the various types of feedbacks regulating the Earth's atmosphere, and the compelling idea that some trace gases (*e.g.* CO_2, DMS) act as "thermostatic controls" for the temperature of our planet. The section on the theories on the evolution of molecular oxygen in the atmosphere was fascinating. Accompanied by details on fossil and mineral evidence, it also addresses the question of the role of oxygen and the protection afforded by the ozone layer from solar UV radiation (therefore, ultimately, of atmospheric photochemistry) in the emergence of life on land after its first appearance in waters. This piqued my interest and inspired me to look further into current studies and theories.

More generally, some of the structure of the book may appear confusing when read front-to-back. Chapter 10, covering the chemistry of the upper layers of the atmosphere (mesosphere and thermosphere), is very interesting as the focus has traditionally been on the lower parts of the atmosphere (troposphere and stratosphere). However, its position following these chapters (8 and 9 respectively) feels out of place, especially as the "narrative" threaded through those chapters builds towards the discussion in Chapter 11 on the adverse influence of humankind on the atmosphere.

Some of the illustrations in the book could be improved on, especially those elucidating concepts the reader might not necessarily be familiar with, such as the lapse rate (how temperature changes with altitude), and the various subtleties between adiabatic, dry and saturated lapse rates. As many atmospheric scientists can attest, this is not the most intuitive concept to explain to students, so including more details in the diagrams would provide invaluable visual help (*e.g.* showing what happens to an air parcel rising through the troposphere against one in the stratosphere).

Understandably, much progress has been made in atmospheric chemistry since the publication of this book in 2010. I was expecting some topics to be absent or already outdated, but I was pleasantly surprised. One notable example is the chemistry of Criegee intermediates, which generated an intense wave of research only a few years after the publication of this book.

One of the authors already produced a very influential book on this very subject (Richard Wayne's *Chemistry of Atmospheres*, now in its third edition), with which some readers may be familiar. As the authors explain in the introduction, *Atmospheric Chemistry* is designed as an entry-level textbook rather than a reference book. I agree with the authors, and would recommend this book as an excellent introduction to the field.

Reference

Ann M. Holloway and Richard P. Wayne, *Atmospheric Chemistry*, Royal Society of Chemistry, Cambridge, 2010
ISBN: 9781847558077

Meeting report

Three outreach updates

Rowena Fletcher-Wood (University of Oxford, rowena.fletcher-wood@admin.ox.ac.uk)

In the spring and summer of 2022, the ECG participated in two outdoor science festivals. We report on these two festivals and on initiatives to engage the next generation with the environmental sciences.

Dorchester Science Festival

On Monday 2nd May, the ECG ran an outreach activity table at the **Dorchester Science Festival**, a small local festival (https://dorchesterfestival.com) with a science afternoon on the bank holiday Monday. With the luck of sunshine and the stunning venue of Dorchester Abbey, it was an extremely well-organised entirely volunteer-led event.

Dorchester Science Festival raises money for **Daybreak**, a charity that provides activities and support for people living with dementia. Besides the ECG, it featured a **Bright Sparks** science show, the **UK Atomic Energy Authority**, bell ringing, and a vicar walking on custard.

Our outreach table: From left to right: ECG Bulletins; river water testing; ocean acidification; hunting for microplastics.

Hunting for microplastics using a magnifying lens on a phone camera.

During the day, we saw ~100 quality interactions with the stall. Three activities were on offer, including our dry ice ocean acidification demo, where we use colour changes, alongside effervescence and clouds, to illustrate how CO_2 is changing our oceans – rapidly. An outline of this activity may be found in the **July 2019 *Bulletin***, p. 22 (*1*). A stunning visual demonstration, it is always popular, and children enjoy touching the "steam" coming off the top.

For those who wished to get hands on, we also ran our hunting for microplastics (**July 2018 *Bulletin*** p. 22 (*2*)) and testing river water to distinguish Oxford and Peak District samples. Framed as detective challenges, these are engaging table-end practicals.

Investing in the future of science: A UK environmental science engagement

A **Natural Environment Research Council**-funded study has identified UK institutions (mainly universities) which participate in outreach projects to engage school-aged children with the environmental sciences (*3*). A **Royal Society of Chemistry** initiative has focused on children's involvement with environmental sciences online during the Covid-19 pandemic (*4*). Some of the outreach projects which emerged from these two studies were tested in the Oxfordshire science festival reported below.

Findings from the primary study showed that most providers of environmental science outreach operated locally, visiting a small number of schools a few times a year, and aimed to expand to wider geographies and larger numbers of students in future. Funding was highlighted as a barrier to achieving this. Most projects were practical and in person, operating during school time: very little was online.

The additional study is assessing the changes in environmental science outreach activities during lockdowns and afterwards. Following a survey of providers, researchers are identifying the rapid adaptations that took this hands-on science off the field and onto the web. Of particular interest is whether expanding geography and numbers of pupils remain key aims, or whether targets shifted along with social changes. A greater move to online engagement has already been demonstrated, as well as changes to where and when activities take place.

Outputs of this study included a suite of online resources to support teachers and parents teaching environmental chemistry at home. Based on in-person activities discussed in **ECG *Bulletin* July 2020** (*5*), Minecraft activities from *Science Hunters* provides a series of construction-themed challenges. In my capacity as an independent science communicator, I also prepared several activity sheets for Early Years (under 5 years) to Key Stage 5 (16-18 years). These activities include making bee balls (see p. 14), designing plastics for reuse, investigating plastic types according to floatation in water, and analysing solar energy data. The full list may be found on the study website (*4*).

ATOM Festival of Science and Technology

On Friday 3rd June, the ECG ran an outreach activity table at the Abingdon-on-Thames **ATOM Science and Technology Festival** (https://www.atomfestival.org.uk/) a three-week science festival that aims to unite partner schools and build local science capital. Activities were held in a tent in a field; the weather proved good and the event, which also included food stalls and sellers, was well attended.

This Oxfordshire festival saw many of the same science providers as the **Dorchester Science Festival**, with additional appearances including from **Nuffield Department of Medicine**, University of Oxford, and various local schools. Chemistry was taught using virtual reality, and younger children were able to immerse themselves inside a giant bubble.

At the ECG table, however, our usual activities were conspicuously absent: we took the opportunity to try out some of the new activities developed in the *Investing in the future of science: UK environmental science engagement* study. Although **Filter Funnel Engineering** made an appearance (**ECG *Bulletin* January 2021** (*6*)), new

Our outreach table: *From left to right: Bee balls; Float or sink; Bulletins; Filter funnel engineering.*

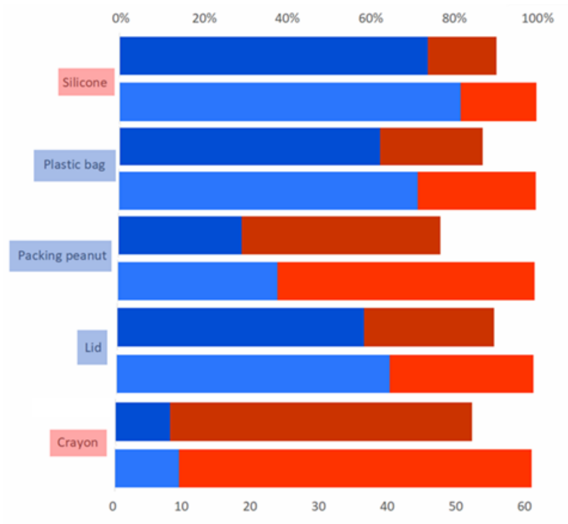
activities included **Bee balls** – making wildflower, soil and clay balls to seed bee-friendly wild flowers and boost biodiversity (see p. 14) – and **Float or sink?** a guessing game where participants look at five types of plastic and post a coloured paper vote into a box before testing the materials to see if they were correct.

Around 50 votes were collected for each plastic in **Float or sink?**, indicating ~50 family engagements (in the most part, only the children voted, or each family as a whole) across the four-hour festival (estimated 200 people in all). Results from the vote were collated afterwards. Most people guessed correctly that the crayon would sink (red) and plastic bag float (blue), even when told that the plastic bag would be filled with water and submerged – it was the material being tested here, not the shape. However, silicone proved misleading, with >80% of voters suspecting it would float – when in fact it sinks. The plastic bottle lid was the most difficult to decide item and, excitingly, when sunk in the Kilner jar tank, rose only very slowly to the surface, providing an atmosphere of suspense.

This pilot outreach adventure has clearly demonstrated that the **Float or sink?** game was the most popular activity, allowing more or less hands-on involvement, depending on what the participants preferred (and avoiding mess, which put some people off making bee balls!), and incorporating evaluation into the stall intrinsically. It extended the natural dwell time for non-committal visitors, and opened the possibility for discussion on what happens to plastic waste once it enters the environment, and how its chemistry affects whether we can see it or not. A further extension activity would be to provide an adjacent saltwater tank to test how ocean salinity impacts floatation.

Volunteer with us

Please email us if you would like to participate in a similar ECG outreach event in the future, or suggest one to us. We provide full training and are always interested in new exhibits and activities. If you want our help running outreach activities for your existing event or would like us to help source volunteers, please get in touch, providing details. Email rowena.fletcherwood@admin.ox.ac.uk to make enquiries.



Float or sink? *People voted blue (float) or red (sink) for each of the materials, before we tested them. Vote counts for the day are shown (top axis: percentage, lower axis: total numbers), with the true colours on the labels.*

References

1. Ocean Acidification **July 2019 *Bulletin***, p. 22.
2. Hunting for Microplastics **July 2018 *Bulletin*** p. 22.
3. Hobbs, L. and Stevens, C. (2022). Investing in the future of science: Assessing UK environmental science engagement with school-aged children. *Plants, People, Planet*, **4**(3), 232-242. https://doi.org/10.1002/ppp3.10250 Accessed 9th July 2022.
4. Investing in the future of science: UK environmental science engagement, accessed 5th June 2022, https://www.uwe.ac.uk/research/centres-and-groups/scu/projects/investing-in-the-future-of-science Accessed 9th July 2022.
5. Elements of Construction, **ECG *Bulletin* July 2020**, pp. 21-23.
6. Filter Funnel Engineering, **ECG *Bulletin* January 2021**, p. 21

You can watch all our activity videos and access 'How Tos' and activity sheets at https://www.envchemgroup.com/resources.html Accessed 9th July 2022.

Article

Constructed wetlands, micropollutants and climate change

Jo Wybrow (The Environment Agency, jo.wybrow@environment-agency.gov.uk)
Tao Lyu, Gabriela Dotro, Bruce Jefferson (Cranfield University, t.lyu@cranfield.ac.uk)

Integrated Constructed Wetlands (ICWs), also known as 'surface flow treatment wetlands', have been applied worldwide to treat wastewaters and, as a nature-based solution, deliver other environmental benefits. Through its Chemicals Programme, the UK Environment Agency identifies key evidence gaps, commissions research, and improves understanding of chemical and climate risks. Hence actions can be implemented to reduce environmental impacts. We recently commissioned a project to summarise and consolidate our knowledge on ICWs.

Treatment wetlands (TWs) are artificially created systems designed to optimise processes occurring in natural wetlands and are, therefore, considered an environmentally friendly and sustainable option for wastewater treatment. Integrated constructed wetlands (ICWs) are surface-flow TWs that look like natural, open-water wetlands and mainly remove nutrients, nitrogen and phosphorus (*1*). In response to increased awareness of micropollutants, ICWs qualify as a potential solution to treat micropollutants and other emerging contaminants (*e.g.* microplastics, antimicrobial resistance). However, climate change poses a threat to both natural and constructed wetlands. Altered hydrology and rising temperatures can change the wetland's biogeochemistry and function, thus compromising the performance of important services.

The Environment Agency commissioned this work to develop a concise literature review to summarise current evidence for treating sewage in ICWs beyond nutrient removal. The review covers 1) the removal of priority substances, for which environmental quality standards (EQS) exist, and other unregulated micropollutants; and 2) the interaction of climate change and ICW functions.

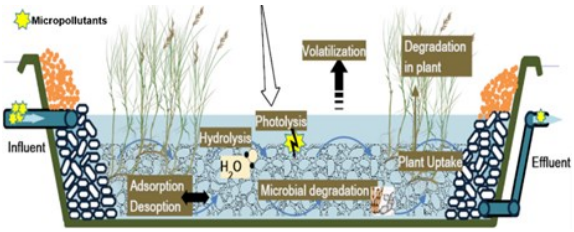


Figure 1. *General mechanisms for the removal of micro - pollutants in ICWs.*

Removal efficiencies of micropollutants in ICWs

Although micropollutants are found at trace concentrations (ng L^{-1} to µg L^{-1}) in aquatic environments, their continuous discharge through various sources may pose risks for humans and biota, aquatic and terrestrial life. ICWs are complex systems containing water, substrate, plants in most cases, and native microorganisms. ICWs support physical, chemical, and biological removal mechanisms (**Figure 1**). These include adsorption, hydrolysis, photodegradation, microbial degradation, volatilisation, and plant uptake that may overlap. The review identified removal extents for eight types of micropollutants in ICWs (**Table 1**). The results demonstrated that ICWs potentially act as effective barriers to stopping micropollutants from entering natural waters.

Retrieved ICW studies on micropollutants included 17 of the 41 substances with statutory EQS. Additionally, 2 out of 17 substances on the European Union Watch List were reported. Pesticides and pharmaceuticals were the main chemicals investigated. In ICWs, the removal of these substances ranged between 38.2 ± 7.3% and 90 ± 5%; the average removal across all substances was 61%. Overall, removals above 40% were measured for most chemicals, which provides an estimate of the efficiencies expected in ICWs.

Based on the recently published data from the Prioritisation and Early Warning System (PEWS) for England, pesticides, pharmaceuticals, and personal care products topped the list of micropollutants across English rivers *(2)*. Only 11 out of the 33 detected substances have been investigated in ICW studies whose suggested average removal was 40%

Table 1. *The removal efficiencies of different micropollutant in ICWs; mean ± standards deviation*

Micropollutants	Percentage removal efficiency	Number of types of compounds
Pesticides	57 ± 20	21 (herbicides)
	75 ± 22	10 (insecticides)
	61 ± 27	6 (fungicides)
Pharmaceuticals	52 ± 20	32
Personal care products (PCPs)	65 ± 29	7
Benzene	78 ± 21	1
Polycyclic aromatic hydrocarbons (PAHs)	65 ±19	16
Per- and polyfluoroalkyl substances (PFAS)	7	7
Microplastics	25 – 60	n/a
Antimicrobial Resistance (AMR)	59 – 78	14 (antibiotic resistance genes, AGRs)
	Efficient removal (non-quantitative study)	Antimicrobial resistance organisms (AROs)

Impacts of climate change

Based on the literature review and experts' experience, no quantitative study is available to explain how climate change affects the removal of micropollutant in ICWs. A workshop with key academics, practitioners, and water utility representatives was held to summarise knowledge and recommend actions. Featured experts were Professor Ulo Mander (University of Tartu, Estonia), Assoc. Professor Pedro Carvalho (Aarhus University, Denmark), Dr Caolan Harrington (VESI Environmental, Ireland), Dr David Naismith (Mott MacDonald, UK), Dr Matthew Simpson (35percent, UK), Dr Geoff Sweaney (Wetland Engineering, UK), Vyvyan Evans (Dwr Cymru Welsh Water), Dr Sean Ashworth (Southern Water), and Jonathan Rayers (Wessex Water).

Overall, the experts agreed that changing climate could increase the removal of micropollutants in ICWs, supported by these findings:

- Higher temperatures enhance microbial biodegradation processes.
- Better plant growth and higher evapotranspiration stimulate the phytoremediation of micropollutants.
- Increased UV radiation improves the photodegradation of photosensitive compounds.

Conversely, negative aspects may also occur:

- Higher rainfall induces shorter contact times between pollutants, biofilms, and plants.
- Increased runoff creates higher pollutant loadings in ICWs.

These negative impacts may be addressed by optimising the design and operation of IWC along with implementing management strategies (*e.g.* optimised flow control).

Conclusions

Our findings suggest that ICWs may be effective barriers to micropollutants entering natural waters. The current evidence base provides a partial picture owing to the lack of studies and the small number of micropollutants investigated in IWCs: 11 out of 33 priority substances included in PEWS and 17 out of 41 organic substances with statutory EQS. No quantitative study addresses the effects of climate change on micropollutants removal in ICWs; it is anticipated, however, that climate change will favour their removal.

More work is required to provide an updated benchmark for treating micropollutants in ICWs. Research should focus on the un-investigated compounds; for the studied compounds, more field-scale long-term projects are also needed.

References

1. The information can be found in the project website: https://www.cranfield.ac.uk/research-projects/surface-flow-treatment-wetlands-for-sustainable-phosphorus-removal-and-delivery-of-co-benefits Accessed 9th July 2022.
2. The information can be found in the government report: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/992489/HSAC-recommendations-for-the-prioritisation-and-early-warning-system.pdf Accessed 9th July 2022.

Article

The effects of climate change on land contamination and selected contaminants

Laura Thain (Environment Agency, laura.thain@environment-agency.gov.uk) and Joanne Kwan (CIRIA, joanne.kwan@ciria.org)

Climate change provides new and enhanced challenges for chemical regulation. The Environment Agency's Chemicals Programme is working to identify key evidence gaps and commission research to improve our understanding of chemical and climate risks and actions we can take to reduce environmental impacts.

Like all countries around the world, the UK's climate is changing and will continue to change because of greenhouse gas emissions. Even with global action, further climate change is now inevitable. Changing rainfall patterns are predicted, resulting in wetter winters, increases in winter runoff and mobilisation of contaminants, drier summers, and more extreme rainfall events. Hotter temperatures may result in increased wildfires and associated use of foams and fire suppressants as well as use of perfluorinated alkyl substances (PFAS)-containing ground source cooling schemes. Under drought scenarios, less water is available for attenuation and dilution or dispersion, resulting in higher concentrations of contaminants. Climate change impacts can lead to increased mobilisation of hazardous chemicals, as well as affecting their fate and transport.

Agricultural land use patterns, pest control requirements and human behaviour are all likely to alter in response to climate change. As a result, chemical use and associated risks will also change, as will treatment technologies and energy demands.

Project scope and findings

The Environment Agency worked with the Construction Industry Research and Information Association (CIRIA) on a literature review and industry consultation looking at the effects of climate change on land contamination and the behaviour and remediation of selected contaminants, specifically polychlorinated biphenyls (PCBs), brominated flame retardants (BFRs), poly- and perfluorinated alkyl substances (PFASes) (*1, 2)* mercury, volatile organic compounds (VOCs), and asbestos.

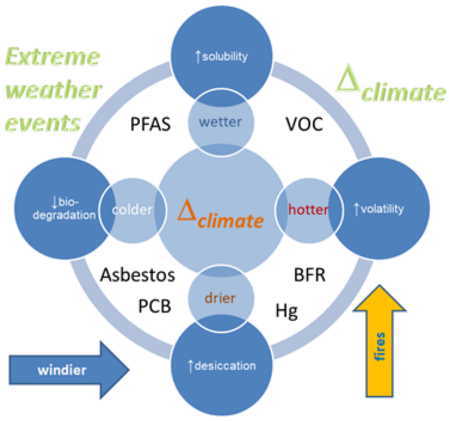


Figure 1. *Visual summary of extreme weather events and climate impacts on selected contaminants (P. Nathanail, paul@lqm.co.uk).*

Changes in ambient, soil or groundwater temperature, or in soil moisture and composition, could change the behaviour of contaminants, compromising quantitative risk assessments and the effectiveness of remediation approaches such as bioremediation, cover systems, permeable reactive barriers and monitored natural attenuation (**Figure 1**).

Extreme weather events, such as heatwaves, cold snaps, storms, droughts, exceptionally intense precipitation, and wildfires, can affect all land remediation techniques during the implementation phase. Wet weather with intense rainfall and flooding are seen as the biggest climate change concerns for land contamination projects.

Remediation solutions which break the contaminant linkage by removing the contaminant source, destroying, detoxifying or relocating the contaminants, are a permanent solution, and therefore less vulnerable to climate impacts. However, remediation solutions that operate over a longer time period, such as pathway interruption, which involves either stopping the pathway (*e.g.* capping or hydraulic containment) or gradually removing the contaminant (*e.g.* permeable reactive barrier) are more vulnerable to climate impacts. Remediation solutions that depend on the physical integrity of a barrier are also vulnerable to extreme weather events, especially erosion of cover systems. Long-term pathway interruption techniques are additionally susceptible to the chronic effects of climate change and associated environmental changes, such as sea level rise.

The study found that remediation techniques for PCBs, PFAS, BFRs, asbestos and mercury often involve erodible cover systems, including soils, which are vulnerable to extreme weather events such as flash flooding or compromising the integrity of capping material.

PFAS remediation techniques may also be vulnerable to changing groundwater conditions caused by extreme weather events, which could bypass or overwhelm groundwater and surface water management systems. The solubility of many PFAS means that reducing water infiltration should also be a design requirement.

Mercury requires different remediation and containment techniques depending upon whether it is in contaminated sediment, groundwater or soils. These techniques could be compromised by extreme weather events, leading to erosion from brief but significant increases in surface water velocity, changes in groundwater flow velocity, periods of extreme precipitation and climate impacts on soil chemistry.

VOC plume pathway interruption strategies, such as monitored natural attenuation and permeable reactive barriers, are susceptible to environmental changes in groundwater velocity and composition. Changes to the chemistry of groundwater as a direct or indirect result of long-term climate change may alter the ability of indigenous microorganisms to degrade contaminants. Climate impacts which result in fluctuating groundwater levels, saline intrusion, and rising soil temperatures, may impact volatilisation. Some bioremediation techniques are vulnerable to strong winds and intense precipitation.

Climate change is expected to lead to increased release of asbestos fibres during very strong winds and periods of prolonged drought or extreme heat. However, wet conditions would significantly suppress fibre release.

How seriously is the industry considering climate change?

Although climate change is recognised as a concern by many in writing contaminated land reports, this is mainly qualitatively, and only a small minority carried out sensitivity analyses to assess the effects of climate change on contaminant physical chemical properties. There is currently no consistent approach to the 'shelf' life of either land contamination risk assessments or remediation design.

Excavation and disposal to landfill are still commonly used remediation techniques for some contaminants. There is almost no documented experience of the UK industry remediating BFRs and PFASes and relatively little experience of PCBs and mercury. This reflects the emerging nature of BFRs and PFASes as contaminants of concern and how relatively rarely PCBs and mercury are encountered on UK sites.

There is currently limited practical guidance on how to consider climate change, and what guidance there is seems to be not widely known. Advice is needed on the design, construction and long-term maintenance of cover systems, and how to predict and assess their resilience to soil erosion and degradation caused by climate change. There is a need to raise awareness, promote further discussion and carry out research, to enable remediation design that accommodates potential future conditions or is adaptable as the climate continues to change.

CIRIA has been running a climate change and contaminated land interest group for a few years, and has developed a proposal to produce a good practice guidance report on climate change risk management in contaminated land projects. For more information, please contact Joanne Kwan at CIRIA (joanne.kwan@ciria.org).

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1. P. Nathanail, I. Ross, G. Williams, J. Nathanail, Good practice guidance for perfluoroalkyl and polyfluoroalkyl substances (PFAS) in soil and the water environment, CIRIA Report, 2022. *In preparation*.
2. Environment Agency, Poly- and perfluoroalkyl substance (PFAS): sources pathways and environmental data. (2021) Poly- and perfluoroalkyl substances (PFAS): sources, pathways and environmental data - report (publishing.service.gov.uk) Accessed 9th July 2022.

Article

SCMS: Insights into xenobiotic uptake

Alice Marshall (University of York, alicehl.marshall@gmail.com)

Pharmaceutical residues introduced to agricultural environments as a result of irrigation with reclaimed wastewater have been shown to have toxicological effects on crops and to accumulate in plant tissues. A high-resolution assessment of plant uptake and the distribution of priority compounds was accomplished through the application of **single-cell mass spectrometry (SCMS).**

SCMS was used to sample and analyse the contents of single plant cells exposed to exogenously applied pharmaceutical compounds. Parent compounds and transformation products were identified, including bioactive metabolites, some of which were previously undocumented in plant uptake studies thus providing an insight into the fate of pharmaceuticals once inside a cell following plant uptake.

Pharmaceuticals in the environment

Reclaimed wastewater is increasingly used for irrigation of arable crops to alleviate water scarcity pressures. However, wastewater is a known reservoir for pharmaceutical residues which are subsequently introduced into the soil-plant system (**Figure 1**). Pharmaceutical uptake in plants has thus been increasingly documented as an unintended side effect of this irrigation technique. Uptake and accumulation of several pharmaceutical groups has now been documented in the tissues of edible plant species (*1*). Not only has this frequently been associated with growth and nutrient abnormalities in exposed plants, but recent studies have demonstrated that consumption of crops irrigated with pharmaceutical contaminated wastewater provides a direct human and wildlife exposure pathway *via* the food chain (*2,3*).

SCMS and current research

Although numerous studies have investigated the fate of pharmaceuticals following plant uptake, these findings exclusively use techniques which analyse tissues in bulk and isolate cells from their *in situ* environments (*1*). The results of these studies are therefore representative of a perturbed state, describing analytes as they occur under altered conditions, compared with those in undisturbed plant tissues (*4*). These studies also lack the resolution required to identify if pharmaceutical xenobiotics are able to enter single plant cells or elucidate the mechanisms and pathways occurring within cells to transform, fix and eliminate pharmaceuticals following uptake. Existing research also often uses a targeted approach, focusing almost exclusively on the detection of parent compounds in plant tissues, without considering potential transformation products that may have formed following plant uptake and thus are relevant when considering food chain exposure.

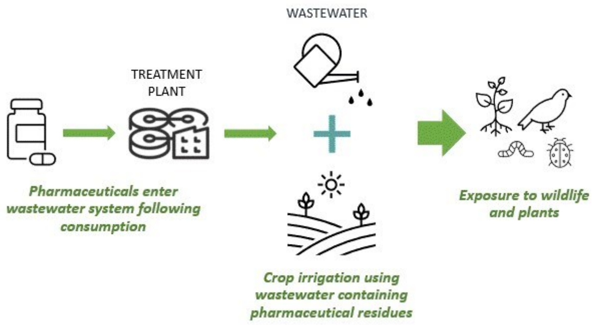

Figure 1. *Pathway for pharmaceuticals entering terrestrial food chains following agricultural irrigation with reclaimed wastewater.*

With this in mind, a novel combination of experimental approaches was developed at the University of York in collaboration with the Centre of Excellence in Mass Spectrometry. Exogenously applied pharmaceutical compounds were screened and analysed in single plant cells using SCMS. SCMS is a technique by which the contents of individual cells can be rapidly analysed *in situ* using high resolution mass spectrometry (*5,6*). Using SCMS, it is possible to detect and identify directly molecules in complex biological samples through analysis of a detailed spectrum of molecular peaks derived from molecular species that reveal the sample composition. Our study aimed to determine whether unchanged pharmaceutical residues and transformation products could accumulate in detectable concentrations within single plant cells.

Experimental approach

Seedlings were hydroponically exposed to high concentration pharmaceutical solutions containing either the antiepileptic compound levetiracetam, or one of four antibiotic compounds (metronidazole, clarithromycin, sulfadiazine and lincomycin).

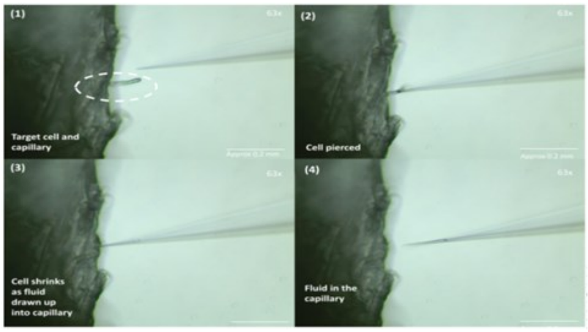

Figure 2. *Image sequence showing the process of sampling single cellular material from a root hair cell of an Arabidopsis seedling.*

Fine cross sections were taken from the stem of the seedlings and visualised under a stereo microscope equipped with a micromanipulator and suction device. Hand-pulled, sharply tapering borosilicate capillaries were then used to puncture the cell wall of single cells from each of the cross sections (**Figure 2**). Under negative pressure conditions, the contents of each cell were drawn up into the sampling capillary and flash frozen at -80°C. The collected sample volumes were very small as a consequence of sampling single cells (<low µL). The cellular contents were then sprayed directly from the sampling capillary into a high resolution, high mass accuracy Orbitrap mass spectrometer using a static nanospray ionisation source. This technique provides a means of analysis that uses a soft ionisation technique to convey analytes into the mass spectrometer, minimising fragmentation of constituent molecules, making it suitable for analysis of complex biological samples. The mass spectra from each sample were then screened for the parent compounds and potential pharmaceutical metabolites and conjugates.

Summary of findings

For the first time, this study demonstrates the detection of exogenously applied pharmaceutical compounds in the contents of live, single plant cells using SCMS. Following exposure *via* saturated hydroponic solutions, four of the five studied pharmaceutical compounds (levetiracetam, metronidazole, clarithromycin and lincomycin) were detected in parent form. These compounds are thought to be translocated to other tissues *via* the symplastic pathway following root adsorption which allows them to cross cell membranes and thus explains their detection (*7*). Sulfadiazine, however, was not detected. This is likely because sulfadiazine is thought to follow the intercellular apoplastic pathway which prevents it from traversing the cell wall (*7*). This lack of detection thus highlights the efficacy of this technique for identifying the distribution of xenobiotic compounds in plant tissues.

Alongside these parent compounds, two transformation products of metronidazole and eight transformation products of clarithromycin were identified including two biologically active metabolites of clarithromycin that have not been previously documented in plant uptake studies.

These findings confirm the suitability of this application of SCMS for sampling and analysis of the contents of single cells *in vivo*. The work demonstrates accumulation and transformation of exogenously applied antibiotics in single cells in detectable concentrations for the first time and could have important implications for research into the ultimate chemical fate of xenobiotic compounds in environmental settings by helping to elucidate possible mechanisms and pathways for fixation and detoxification of xenobiotic compounds in plants.

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Further reading

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https://doi.org/10.1039/9781782622345

Activity sheet

Bee balls

Making wildflower seed balls and sowing them in the right soil can help support bees and our local ecosystems.

Neonicotinoids or "neonics" are pesticides sprayed on food crops to poison pests. However, they harm other non-target species including bees. Bees pollinate 87.5% of food crops including fruits, nuts, seeds, and vegetables, so without them we could face a food crisis, and the natural ecosystem could be disrupted.

You will need

- 1 spoonful of meadow flower seeds
- 4 spoonfuls of peat-free compost
- 1 spoonful of clay or powdered clay and water

Recommendations for the soil ratios vary, so adjust as needed to make nice balls that stick together well.

Suggested seeds for bees

Wild thyme, knapweed, chamomile, buttercup (The Wildlife Trust)

Lettuces, wild grasses (Growtherainbow.com)

Sunflower seeds (Green Squirrel)

Aquilegia, nigella (RHS)

Instructions

1. Mix, roll to marble-sized, leave to dry.

2. Throw onto

- Soil areas

NOT

- Industrial sites, roadside verges, grassy wastelands, trampled playgrounds
- Overgrown spots
- Very shaded areas or too close to a fence
- Very puddly places
- Fertile farm fields

3. …add water

Tips

Try breaking up the soil where you plant the seeds, and seed after the last frost at the start of spring.

The reasons why

Sites that have a lot of people trampling them get compacted: the hard earth is difficult to aerate and hydrate, and young roots can't push their way through.

Sites that are very bare, like industrial sites, tend to lack the chemical nutrients in the soil to grow wildflowers. They might even suffer from chemical pollution, which can directly harm the seeds or microorganisms in the soil.

What is the pH of your soil? Wildflowers grow best in neutral (pH 7) soil. If you have pH paper or indicator, you can take a sample of soil from your chosen site, mix it with water, and test to see if it is suitable.

Farm fields, including abandoned farm fields, contain fertilisers, which are rich in nitrogen and phosphorus. Many wildflowers are nitrogen fixing and compete well when nutrients are scarce. Fertiliser promotes other plants such as grasses and nettles, which outcompete the wildflowers. Removing these nutrients is challenging – comparable with removing salt from seawater. Continuously removing vegetation and tearing away the topsoil to expose lower-nutrient subsoil can help.

ECG Environmental Brief No. 33 **ECGEB No. 33**

Reducing the nitrate contamination of water with cover crops

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Ground and surface water contamination from use of nitrates in agriculture has negatively impacted the environment for decades. This ECG Environmental Brief summarises the major impacts and alternative methods for reducing the effect of nitrate leaching on water pollution.

As world population grows, there is an increasing food demand that leads to an intensive use of pesticides and fertilisers in the agricultural sector to maximise outputs obtained from the soil. The improper use of nitrogen (N) fertilisers, with the aim of achieving high crop yields, has resulted in worrying levels of water contamination in many areas of the world, especially in developing countries with higher population densities (*1*).

During the nitrogen-cycle, loss of nitrogen occurs through the processes of volatilization, denitrification and leaching. Due to human activity, the cycle may be disturbed, resulting in an increase of nitrate leaching (**Figure 1**), which negatively affects both surface and groundwater (*2*).

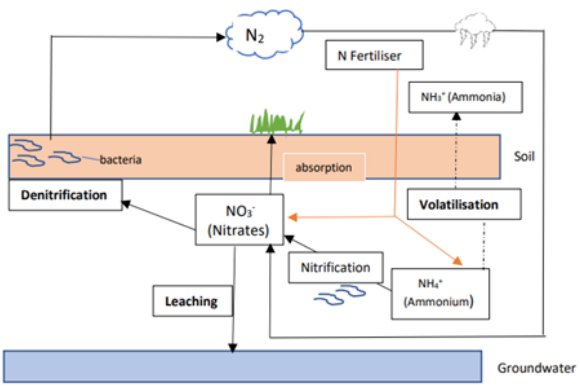

Figure 1. *Nitrate leaching from agricultural practices.*

Impact

Water contaminated with nitrates from agricultural practices can provoke damaging effects for human health and for ecosystems. Human health may be compromised by the presence of high nitrate concentrations in drinking water leading to diseases in babies, such as blue baby syndrome, and stomach cancer, hypertension, thyroid disease, or diabetes in adults (*3*).

Ecosystem health may also be compromised. As mentioned by Nieder *et al.* (*3*), excess of nitrate from fertilisers can be carried off, leading to eutrophication (extreme richness of nitrates causing a disproportionate growth of plant life and algae) of surface water (streams, rivers, lakes etc.) This causes a decrease of oxygen production, reducing biodiversity.

Drinking water quality standards and legislation

Table 1 shows the international standards of permitted nitrate concentrations in drinking water. The World Health Organisation (*4*) and the EU Nitrates Directive (Council Directive 91/676/EEC, 1991) established a maximum concentration of nitrates in drinking water as 50 mg L^{-1}, and warned about the negative effects of higher concentrations. However, in some highly populated areas and/or with intensive agriculture, such as Spain, nitrate concentrations can reach 100 mg L^{-1} or 500 mg L^{-1} (*1*).

Table 1. *Permitted nitrate levels in drinking water (2).*

Canada	10 mg L^{-1}
China Environmental Agency	10 mg L^{-1}
Japan	10 mg L^{-1}
US Environmental Protection Agency (EPA)	10 mg L^{-1}
EU Nitrates Directive	5.6 mg L^{-1}
WHO	11.3 mg L^{-1}

The EU Nitrates Directive (91/676/EEC), which is transposed into UK law and implemented by the Nitrate Pollution Prevention (Amendment) Regulations 2016 (*5*), aims to protect water against pollution with nitrate from agricultural practices.

Methods for reducing nitrate leaching: cover crops

Some methods for mitigating nitrate water pollution such as reverse osmosis, adsorption, ion exchange, chemical denitrification etc. may be expensive and many of them can also produce secondary pollutants (*6*).

The use of cover crops is a recognised method of reducing nitrate leaching from agriculture. They are off-season crops, grown during the fallow period after the main crop has been harvested, when most nitrate leaching takes place, since there are no crops that can take the nitrogen surplus (*7*). They can reduce the nitrate leaching into the groundwater and they return nutrients to the soil when they are destroyed before the next main crop is planted (**Figure 2**). Generally, cover crops are not harvested.

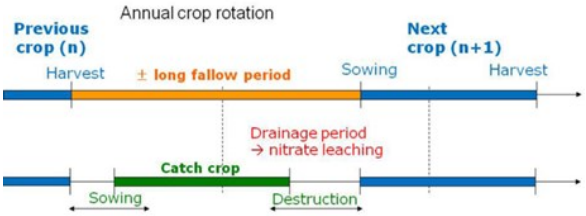

Figure 2. *Use of cover crops (bottom) during the fallow period in a crop rotation (top) (INRA, 2012)*

Types of cover crops

Many plants can be used as cover crops. There are two main groups: leguminous (peas, lentil, clover species, etc.) and non-leguminous (grasses and broadleaf species). Mixtures of leguminous and non-leguminous can also play an important role in minimising nitrate leaching.

Some studies have concluded that non-leguminous cover crops can limit nitrate leaching. According to Thapa, Mirsky, and Tully (*7*), cover crops reduce nitrate leaching by 35% to 70% depending on the climate, soil, and cropping management. The planting date is key for optimum limitation of nitrate leaching. When planted between August and October, reductions in nitrate leaching are considerably more advantageous over planting carried out in November.

The studies also stated that leguminous cover crops are not as effective as non-leguminous when reducing nitrate leaching. Therefore their use is only recommended if the risk of leaching is relatively low. Leguminous cover crops fix nitrogen from the atmosphere and make it available for other plants.

The mixture of non-leguminous and leguminous cover crops can reduce nitrate leaching, compared to non-leguminous, but is significantly better than leguminous alone. The mixture combines nitrogen scavenging (non-leguminous) with nitrogen supply (leguminous).

Costs and benefits of cover crops

Planting, destruction and management of cover crops requires time and is costly. These crops result in public benefit by reducing the level of nitrates in water bodies, while the benefits for the farmer are mainly related to the improvement of soil in the long-term.

Some studies carried out on corn yields concluded that non-leguminous cover crops do not impact the succeeding corn yields while leguminous cover crops and leguminous/non-leguminous cover crop mixtures tend to result in an increase of yields compared to non-cover crop control. However, this depends on the climate, soil and cropping systems (*7, 8*).

Conclusion

Recent studies show that non-leguminous cover crops are an efficient way of decreasing nitrate leaching when they are incorporated into cropping systems during the fallow period. Cover crops are capable of taking up nitrogen that moves through the soil and limiting the excess of nitrate leached to groundwater from fertilisers, decreasing the negative environmental impact. However, information in the current literature does not allow conclusions to be drawn on the *degree* of improvement in water quality which could be achieved through the use of cover crops.

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ECG Environmental Brief No. 34 **ECGEB No. 34**

Synthetic textiles: A primary source of microplastics

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Plastic pollution is a growing issue globally with many potential and recognised sources. This ECG Environmental Brief focuses on microfibres as a source of microplastics and their impact on ocean organisms and human health.

Microplastic pollution from washing synthetic textiles has been identified as the primary source of ocean microplastics. Microplastics are defined here as plastic particles with a diameter of < 5 mm, and include microfibres (MFs). Plastic pollution is released into the ocean from multiple sources. However, recent literature and news articles have been primarily focused on the effects of plastic garbage entering the ocean. Therefore the public often has a more limited understanding of MFs in comparison to single-use plastics. In part this is due to their novelty. MFs have been in use in textiles for more than 50 years, but were only identified as a source of plastic pollution in 2011 (*1*).

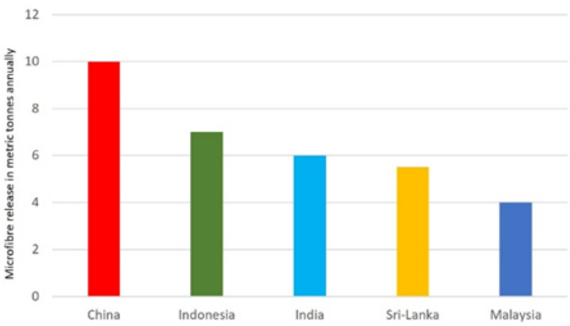

Figure 1. *The top five countries that release the most microfibres (4).*

MF pollution is primarily caused by the chemical and mechanical stress that fabrics undergo during the washing process in a domestic laundry machine. As a result, MFs detach from clothing threads. Frequently used textiles such as polyester, continue to release fibres for the entire lifetime of the product. Furthermore, the estimated quantity of MFs released during a standard washing machine cycle, ranges from 124 to 308 mg per kg of clothing (*2*).

Synthetic textiles account for 60% of fibres globally (*3*). However, five countries have been identified which produce the majority of microfibres (**Figure 1** (*4*)). These fibres typically consist of polyethylene, polyester, acrylic or elastane. Significant amounts of these synthetic fibres were observed in multiple *in situ* sampling studies of marine sediments and open water.

Due to their small size, detached MFs pass from domestic washing machines through wastewater treatment plants (WWTPs) and reach open water bodies, such as rivers and oceans. The proportion of MFs that are filtered out by WWTPs is debated; however, MFs have been detected in WWTP effluents, regardless of the treatment plants' efficiency. It has also been recognised that, due to the large volumes of effluents constantly entering water bodies, only a low concentration of MFs passing through WWTPs would likely be required for them to quickly become abundant in rivers and oceans.

Impacts on wildlife

The negative impacts of MFs are less obvious than other forms of plastic pollution, as they are often not visible to the naked eye. Their release into aquatic environments, however, has far reaching consequences.

Table 1. *Taxa commonly affected by MFs.*

Taxa affected	Some primary consumer species found to contain MFs
Invertebrates	MFs were present in 60% of macro-invertebrates found in three wetlands, along the Eastern Atlantic (4).
Mammals	Of 102 turtles dissected for a study, 85 had synthetic particles in their gut (5).
Fish	Microplastics were found in 52 of 263 fish from 26 species. 65.8% were present as MFs (6).
Crustaceans	24% of dissected bivalves contained textile fibres (7).

Due to their small size, many primary consumer species mistake MFs for prey, ingesting them (**Table 1**). This can cause physical damage to the organisms' digestive system, such as creating a blockage, potentially leading to starvation. Primary consumers may then be eaten by larger organisms, allowing the MFs to bioaccumulate up the food chain, affecting a range of ocean taxa. There is also increasing awareness and concern over the ability of microplastics such as MFs to break down into smaller fragments (nanoplastics) releasing further toxic pollutants that can cause harm to organisms. Ultraviolet light from the sun can cause the further degradation of MFs. Toxic pollutants which could be released include cadmium, lead and bisphenol A.

Impacts on human health

Research suggests that human health can also be negatively impacted by MFs. Routes of MF exposure include ingestion (*e.g.* by consumption of contaminated seafood), inhalation and dermal contact. A 2018 study found that MFs can absorb chemicals such as pesticides, which leach into organisms ingesting the fibres (*5*). Many pesticides are neurotoxins, meaning MFs have been proposed as a cause of neurotoxicity, and immune system dysfunction. Nanoplastics have also been hypothesised to cross the blood-brain barrier. Furthermore, MFs can remain in the body for long periods of time, potentially causing irritation of the digestive tract, cancer, and lung issues. The nature and severity of MFs' impact on the human body is still being debated among scientists, and further research on this topic is needed.

What are the solutions?

Potential solutions for reducing MF release from synthetic textiles have been developed, with more being suggested as research on the topic increases (**Table 2**).

There is currently very little legislation on synthetic textile pollution in the UK. The UK government has even rejected proposals aiming to reduce MFs, stating that current voluntary measures are sufficient. There is only one main regulation relating to MFs in place: *The Textile Products (Labelling and Fibre Composition) Regulation 2012* (*6*). This states that textiles sold must have labels detailing names and weight (as a percentage) of each fibre, the marketer or manufacturer's name and the country of manufacture. This allows consumers to make more environmentally friendly purchasing choices.

Conclusion

MFs can cause severe harm to wildlife and human health. They can bioaccumulate up food chains, often blocking digestive systems, leading to starvation. MFs can break down into smaller particles, releasing toxic chemicals which can also affect humans, causing a range of potential illnesses. Current solutions generally relate to consumer choice, such as using a gentle wash cycle or using a filter in washing machines. There is very little government enforced legislation on synthetic textile pollution. Without legislation imposed by the government, MFs will continue to be a problem for ocean life. Further research is needed to enable changes to washing machine technology and clothing design that will help limit the emissions of synthetic textiles.

Table 2. *Some solutions (with explanation) for reducing synthetic textile pollution in the environment.*

Solution	Explanation
Use gentle wash cycle	Low temperatures with low spin speeds will agitate fabrics less, releasing fewer fibres.
Re-wear clothes	Wear clothing items as many times as possible before washing them. Fewer washes mean fewer fibres are released.
Filters in washing machines	Install filters in washing machines that can remove the majority of fibres, reducing the amount that enter WWTPs and the ocean.
Buy used clothing	Clothing that has already been worn and washed will shed fewer fibres in a wash cycle than brand new, unwashed clothing.
Textile innovation	Natural textiles that do not undergo chemical processing and are biodegradable will have a lessened environmental impact.

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ECG Environmental Brief No. 35 **ECGEB No. 35**

Chemicals of concern: a prioritisation and early warning system for England

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Addressing Chemicals of Emerging Concern is a global challenge. There are more than 350,000 chemicals and mixtures of chemicals registered for production or use (*1*), and that number is predicted to double by 2030. The UK Government's 25-Year Environment Plan (*2*) highlights the need for early identification of chemicals of concern, so that effective intervention can be undertaken prior to damage being caused to the environment, wildlife, or human health. To address this chemical challenge, the Environment Agency (EA) have developed a Prioritisation and Early Warning System (PEWS) for England.

The EA's aim has been to establish a system which ensures appropriate regulatory focus on individual and groups of substances of emerging concern. This is based on a suitable risk assessment, considering each substance in terms of readily available usage data, fate and ecotoxicological parameters and monitoring data.

The PEWS process, as shown in **Figure 1**, includes nomination and sifting of substances, then screening of substances for potential risks to surface waters (freshwater and marine), groundwaters, soils, biota, and sediments and to human health *via* the environment. Chemicals are then prioritised for environmental regulation if there is considered sufficient risk. For some substances, the process demonstrates a need for further environmental monitoring to understand current concentrations and increase certainty in prioritisation outputs.

This brief describes the development and use of PEWS, illustrating some of the substances which have been screened for potential risks to date, and the link from PEWS to potential regulatory intervention where this process has shown to be appropriate.

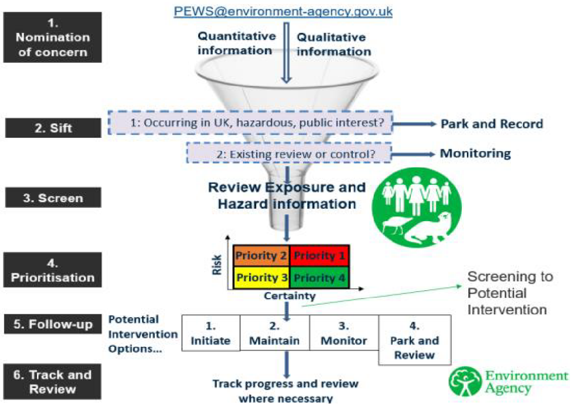

Figure 1: *Prioritisation and Early Warning System process.*

Nominating chemicals of concern

We invite readers of this ECG Environmental Brief to be part of the solution to emerging contaminants with the opportunity to nominate substances considered to be of concern. To nominate a chemical of emerging concern into PEWS, email PEWS@environment-agency.gov.uk, with the name of the substance and any explanation as to why it should be considered.

Nominations from interested parties and monitoring evidence are routinely included within PEWS. Following advice from the Hazardous Substances Advisory Committee, the EA is now systematically screening a sub-set of scientific literature for chemicals of emerging concern through an RSS feed. In 2021, we have also been part of the first ever horizon scan specifically focusing on chemical issues, mirroring the horizon scan approaches taken previously for biodiversity (*3*). Several of the issues flagged within the horizon scan will form areas of focus for identifying relevant substances to be nominated into PEWS in the coming years.

Sifting chemicals of concern

For each nominated substance, sifting gives a ranking of 'High', 'Medium' or 'Low', based on whether it is anticipated to occur in the UK and whether it has the potential to become dispersed in the environment. We also consider whether the chemical poses a hazard, and the substance's toxicity (based on the Predicted No Effect Concentration (PNEC) from the NORMAN network factsheets (*4*)) and incorporate an understanding as to whether the substance is of public interest.

A second level of sifting is undertaken to consider the current reviews and controls in place through existing regulations. Substances which score as 'High' are put forward for more detailed consideration in a screen.

Screening chemicals of concern

Screening considers both exposure data and chemical hazard data. Exposure data is based on EA monitoring data. The EA currently monitors surface and groundwaters with GC-MS and LC-MS target scans (*5*) for 1527 substances. Screening is undertaken on blocks of substances referred to as tranches. As of February 2022, 169 substances have been screened in six tranches. The limitations of taking a single substance approach to screening are recognised, so a group approach has also been adopted where possible, such as for quaternary ammonium compounds, glycol ethers, linear alkyl sulfonates, neonicotinoids, pet flea and tick treatments, phenolic benzotriazoles, synthetic pyrethroids and flame retardants. A fast-track approach has also been taken on groups of substances which have already been subject to detailed consideration at the EA, with these substances bypassing the screening step entirely to move straight to the potential intervention step.

Prioritising chemicals of concern

The result of screening is a set of prioritisation scores for each chemical of emerging concern, which are collated into heat maps. Water matrices (surface water and groundwater) have a result of 1 to 4, where 1 is 'High risk, high certainty', as shown in step four of Figure 1. Soil, biota, and sediment are either flagged for further consideration or not. This approach gives a systematic approach for determining whether each substance (or group of substances), based on current evidence, is considered to be of concern to the environment in England.

Potential Interventions

Prioritised substances are considered for potential interventions and, if appropriate, regulatory planning work is conducted. To establish where there may be outcome gaps, we consider a substance's source-pathway-receptor model, the existing legislative framework that applies and any known ongoing interventions by the EA (or other regulators).

We consider all three environmental compartments (air, land, and water), and also consider the waste streams, given that waste disposal is often a significant pathway through which a chemical can enter the environment. Where we identify an outcome gap, we consider a range of possible interventions to close that gap, and where resources allow, we look to introduce these. Our regulatory planning work highlights common gaps or themes across a range of substances, and we are currently developing a number of work packages to address these. Delivery often involves working with partner organisations. For most emerging contaminants, new monitoring can be required. Recent additions to our target scans, linked to PEWS are 6PPD-quinone – a product of tyre breakdown which may pose a risk of mortality to Coho salmon in the US, and UV-328, a candidate Persistent Organic Pollutant. The lessons learned from regulatory planning work are used to provide feedback to Defra to help inform the proposed chemical strategy.

The next steps

Initial discussions have taken place to begin to explore the potential for PEWS to be a UK-wide system in the future, rather than England-only. The EA recognises the challenge in monitoring the growing number of chemicals of emerging concern. To address this gap, the EA is now beginning to invest in non-target screening approaches, which should give the presence or absence of up to 65,000 different substances. The insights from non-target screening will be fed into PEWS. If you would like to receive updates on the PEWS project, please get in touch to be added to the mailing list.

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Upcoming Meetings

State-of-the art in the analysis of complex environmental matrices

A one-day meeting for environmental analytical chemists

Where: The Royal Society of Chemistry, Burlington House, London, W1J 0BA

When: 16th September 2022, 9:00-16:10

Royal Society of Chemistry Environmental Chemistry Group, Separation Science Group and Water Science Forum Joint Meeting

Synopsis

The 5th meeting in this biannual series on the Analysis of Complex Environmental Matrices will bring together analytical chemists from across the environmental sciences and across chromatographic, spectroscopic and mass spectrometry techniques. The day will consist of 9 invited talks (see below) and ample time for community building and ideas exchange.

Conference Aim

The aim of the conference is to showcase state-of-the-art work in the analysis of complex environmental matrices in the UK.

This meeting is aimed at:

- Academic researchers
- Professional environmental analytical chemists
- Environmental practitioners

Registration

RSC members £90

BMSS/Chromatographic Society Members £90.00 with discount code BMSS30

Non-members £120

Student RSC members £25

Retired/unwaged members £25 with discount code RET65

Student non-members £35

Registration: https://www.rsc.org/events/detail/72851/state-of-the-art-in-the-analysis-of-complex-environmental-matrices

Registration includes:

- Attendance at the sessions
- Refreshments throughout the meeting
- Lunch

Confirmed Speakers

Leon Barron, Imperial College

Rapid monitoring and risk assessment of chemicals of emerging concern at scale.

Barbara Kasprzyk-Hordern, University of Bath

Wastewater based epidemiology and One Health.

Nicholle Bell, University of Edinburgh

Using NMR and FT-ICR-MS to tackle natural and man-made mixtures in our changing environment. A journey from peatlands to drinking water.

David Scurr, University of Nottingham

Reducing combustion engine emissions with secondary ion mass spectrometry.

Jacqui Hamilton, University of York

Are emissions from green spaces important for urban air quality? Using high resolution methods to understand the interactions of biogenic emissions with air pollution in cities.

Brett Sallach, University of York

Increasing our understanding of xenobiotic uptake and fate in plants using single-cell mass spectrometry.

Caroline Gauchotte-Lindsay, University of Glasgow

Non-targeted analysis for the evaluation, monitoring and prediction of environmental engineering processes.

Mark Perkins, Anatune

Rapid analysis of soils and water using selected ion flow tube mass spectrometry (SIFT-MS)

Richard Cross, CEH

Monitoring microplastics in the environment – experiences in detection and interpretation of microplastic contamination in increasingly complex media.

Upcoming meeting

Disposable attitude: electronics in the environment

A one-day conference organised by the Environmental Chemistry Group exploring the environmental implications and defences, material scarcity and modern attitude associated with electronics manufacture and disposal.

Where: The Royal Society of Chemistry, Burlington House, London, W1J 0BA

When: Friday 9th September 2022

The **ECG Distinguished Guest Lecture (DGL) and Symposium** is our annual flagship event, and focuses on a specific contemporary environmental chemistry topic. Previous DGLs have included antimicrobial resistance, fuel emissions and nanomaterials. The Distinguished Guest Lecturer is a scientist who is recognised to have made a significant contribution to the field, and is awarded the ECG medal.

Speakers

Professor Ian Williams (University of Southampton)

Ian Williams is a Professor of Applied Environmental Science and Associate Dean within Engineering and Physical Sciences at the University of Southampton. He has an established track record in the field of environmental pollution and waste management. Professor Williams will speak on the recovery and recycling of materials used in electronics.

Fiona Dear (Restart Project)

Fiona Dear is Co-Director at The Restart Project, which aims to fix our relationship with electronics. She has spent over 15 years working to engage public audiences in calling for a more sustainable society.

Ms Dear will speak on the disposable attitude associated with modern electronics and alternatives to recycling.

(To be confirmed)

Our third speaker will talk on sustainable practices around manufacture, consumption and/or disposal of electronics.

2022 Distinguished Guest Lecturer: Mr Steve Cottle (Edwards EMS Ltd)

Steve Cottle is a Senior Applications Manager at Edwards Vacuum. During his 25-year tenure at Edwards, he has worked in multiple technical roles leading advanced development of customer specific solutions for Exhaust Management. He is an industry recognised expert in exhaust management and knowledgeable in all technical aspects of exhaust management. He holds a BSc in Chemistry from Bristol University.

Mr Cottle will speak on the management and pollution of exhaust gases associated with the manufacture of electronics.

Registration

To register, visit the RSC events pages and search for "Disposable Attitude: Electronics in the Environment".

Early Bird Members: £40 (free to join as an RSC member)

Early Bird Non-members: £55

Members: £55 (free to join as an RSC member)

Non-members: £70

Upcoming Meeting

3B's in Circular Economy – Best practices, Benefits, and Barriers

A joint webinar in partnership with the RSC Management Group and the RSC Environmental Chemistry Group.

When: Wednesday 7th September - 12.30 (UK time) to 13.30 (a lunchtime webinar)

Speaker: Dr Helena Gomes, University of Nottingham

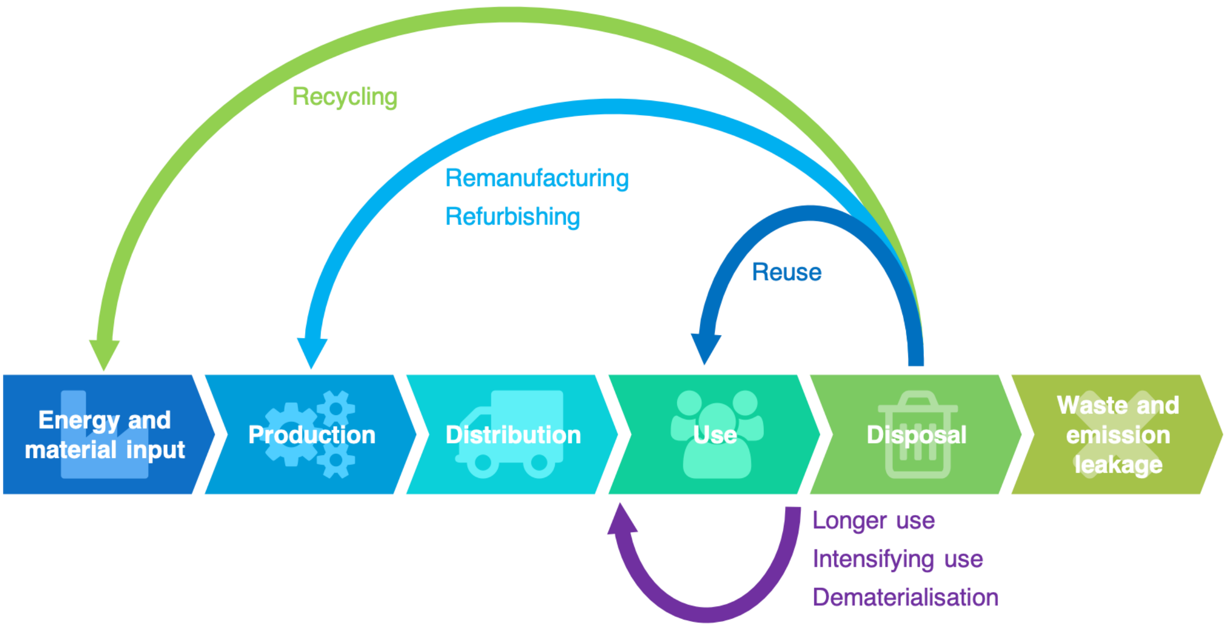
A circular economy offers solutions for global sustainability challenges by transitioning from the linear take-make-use-dispose economy to better managing resources.

This talk will discuss best practices, benefits, and barriers to implementing a circular economy, with a particular focus on metals.

Dr Helena Gomes is an Assistant Professor in the Faculty of Engineering at the University of Nottingham. She has more than 10 years experience in environmental remediation and resource recovery from waste. Dr Gomes worked as an Environmental Consultant and Project Manager and, from 2006 to 2011, she led the environmental and radiological monitoring programme of uranium abandoned mines in Portugal. She is an active researcher with over 40 peer-reviewed publications, more than 30 conference contributions including keynote presentations and five book chapters on resource recovery and circular economy topics.

Registration

Meeting Registration - Zoom



The circular economy: "An economic system in which resource input and waste, emissions, and energy leakages are minimised by cycling, extending, intensifying, and dematerialising material and energy loops. This can be achieved through digitalisation, servitisation, sharing solutions, long-lasting product design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling."

Geissdoerfer, M. *et al.*, (2020). Circular business models: A review. *Journal of Cleaner Production*, p.123741.

Three charterships available through membership of the Royal Society of Chemistry

Chartered Scientist

Chartered Scientist (CSci) is a professional qualification that can be applied across a range of sectors. The RSC awards CSci under licence from The Science Council.

Requirements

To be considered for Chartered Scientist status, you need to fulfil all of the following criteria:

- Membership of the Royal Society of Chemistry (MRSC or FRSC);
- Masters-level (M-level) qualification;
- Five years' postgraduate experience at Masters level;
- Currently employed (including part time, self-employed and consultants) utilising your scientific background.

Costs

This application cost includes a registration fee paid to the Science Council and a small administration charge that is retained by the Royal Society of Chemistry.

- Application fee of £75;
- Retention of CSci is £60 per year, paid along with membership renewals.

For more information please see the Chartered Scientist section of the RSC website.

Chartered Scientist (CSci) (rsc.org)

Chartered Chemist

Chartered Chemist (CChem) is a professional qualification for those working in the chemical sciences. It can be applied across a range of sectors, and may be gained by teachers, writers, science communicators and other practitioners, as well as academic or industrial chemists.

Requirements

To be considered for Chartered Chemist status, you need to fulfil all of the following criteria:

- Membership of the Royal Society of Chemistry (MRSC or FRSC);
- Masters-level (M-level) qualification;
- Qualification in the chemical sciences, or an equivalent experience;
- Evidence for the CChem attributes;
- Commitment to continuing your professional development.

Costs

This application cost includes a registration fee and a small annual administration charge.

- Application fee of £75
- Retention of CChem is £30 per year, paid along with RSC membership renewals

For more information please see the Chartered Chemist section of the RSC website.

Chartered Chemist (CChem) (rsc.org)

Chartered Environmentalist

Chartered Environmentalist (CEnv) is a professional qualification that can be applied across all sectors. It provides a respected benchmark for individuals working to mitigate and solve environmental challenges. The RSC awards CEnv under licence from the Society for the Environment (SocEnv).

The process to apply is two-step. The first is an application form and CV. Once this has satisfied the assessors you will be invited for an interview.

Requirements

- Membership of the Royal Society of Chemistry (MRSC or FRSC)
- Masters-level (M-level) qualification, or an equivalent experience four years' postgraduate experience at Masters level with key responsibilities relating to the environment and/or sustainability
- Evidence for the CEnv attributes in four areas:

1. Application of knowledge and understanding of the environment to further the aims of sustainability
2. Leading sustainable management of the environment
3. Effective communication and interpersonal skills
4. Personal commitment to professional standards, recognising obligations to society, the profession and the environment.

Costs

- Application fee of £200.
- Retention of CEnv is £57 per year, paid along with membership renewals.

For more information please see the Chartered Environmentalist section of the RSC website.

Chartered Environmentalist (CEnv) (rsc.org)