New study suggests we're likely underestimating the future impact of PFAS in the environment

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Per-and poly-fluoroalkyl substances—commonly known as PFAS—are a group of over 14,000 human-made chemicals that have been popular

since the 1950s for their diverse skills in resisting heat, water, grease and stains.

They've been commonly found in household products like non-stick frypans, clothing, cosmetics, insecticides, and food packaging, as well as specialty industry products, like firefighting foam.

But despite their broad skillset, the chemicals have a dark side: they're known as 'forever chemicals' as once they're in the environment—or our bodies—they don't degrade further.

PFAS have been linked to environmental and health issues, including some cancers, but a lot remains unknown about the true scale and potential impacts of the problem—including how much is in our water supply.

A new UNSW-led international study, published in *Nature Geoscience*, assessed the levels of PFAS contamination in surface and groundwater around the globe.

It found that much of our global source water exceeds PFAS safe drinking limits.

"Many of our source waters are above PFAS regulatory limits," says senior author of the study, UNSW Engineering Professor Denis O'Carroll.

"We already knew that PFAS is pervasive in the environment, but I was surprised to find out the large fraction of source waters that are above drinking water advisory recommendations," he says. "We're talking above 5%, and it goes over 50% in some cases."

The research team pulled together PFAS measurements from sources

around the world, including government reports, databases, and peer-reviewed literature. Altogether, they collated more than 45,000 data points, which span over roughly 20 years.

It's the first study to quantify the environmental burden of PFAS on a global scale.

The study also found high concentrations of PFAS in Australia, with many locations above recommended drinking water levels. This tended to be in areas where firefighting foams had been used in the past, like military institutions and fire training facilities.

Prof. O'Carroll stresses that these PFAS traces are found in source water, such as dams, and not drinking water itself—drinking water goes through treatment plants, some of which are designed to reduce the amount of chemicals such as PFAS in our water before it comes out of the tap.

But some water providers—for example, Sydney Water—don't routinely measure the broad range of PFAS potentially in our drinking water, says Prof. O'Carroll.

"Drinking water is largely safe, and I don't hesitate drinking it," he says. "I also don't suggest that bottled water is better, because it doesn't mean that they've done anything differently than what comes out of the tap.

"But I certainly think that monitoring PFAS levels and making the data easily available is worthwhile."

A contentious debate: how much PFAS is too much?

Most people in Australia—and in many places around the world—are likely to have low levels of PFAS in their bodies.

But the potential health risks of PFAS chemicals are poorly understood and haven't been agreed on universally.

According to an Australian Government expert health panel, there is limited to no evidence that PFAS poses clinically significant harm to human health—although further afield, peak bodies in the U.S. and Europe suggest that PFAS is linked to adverse health outcomes, such as lower birth weight in babies, higher levels of cholesterol, reduced kidney function, thyroid disease, altered sex hormone levels, reduced vaccine response, and liver, kidney, and testicular cancers.

In 2023, the World Health Organization (WHO) declared PFOA, a type of PFAS, a category one human carcinogen.

While PFAS has been linked to many of these health outcomes, they haven't necessarily been shown to cause them—but given the potential risks and 'forever' nature of these chemicals, many regulatory bodies have tightened PFAS use and introduced safe drinking water limits as a precaution.

"Two forms of PFAS initially raised of concerns about 20 years ago: PFOS and PFOA," says Prof. O'Carroll.

"These chemicals are regulated to different extents around the world. In the US, the proposed drinking water limits for PFOS and PFOA are four nanograms per liter."

A third PFAS is also regulated in Australia, called PFHxS. Here, the sum of PFOS and PFHxS is limited to 70 nanograms per liter—well above the four nanograms per liter combined PFOS and PFOA limit in the US.

But our acceptable levels for PFOA in drinking water is even higher.

"PFOA, on the other hand, is regulated in Australia at 560 nanograms per liter, which is two orders of magnitude higher than in the US," says Prof. O'Carroll.

While Australia's limits seem relaxed compared to the US, both countries' recommended drinking water guidelines pale when compared to Canada's: here, rather than limiting only two or three forms of PFAS in drinking water, Canada tallies up the sum of all 14,000 PFAS and limits the overall number to 30 nanograms per liter.

The study found that 69% of global groundwater samples with no known contamination source exceeded Health Canada's safe drinking water criteria, while 32% of the same samples exceeded the US's proposed drinking water hazard index.

"There's debate about what level PFAS should be regulated to," says Prof. O'Carroll. "Australia has much higher limits than the US, but the question is why.

"Both health bodies would have different reasoning for that, and there's not a really strong consensus here."

An underestimated risk

The study suggests that actual PFAS pollution in global water resources could be higher than suspected.

This is, in part, due to us only monitoring and regulating a limited number of the 14,000 PFAS in existence, and also because the levels of PFAS in consumer products are higher than expected.

"There's a real unknown amount of PFAS that we're not measuring in the environment," says Prof. O'Carroll. "Commercial products like

garments and food packaging have a lot more PFAS in them than we realize.

"This means we're likely underestimating the environmental burden posed by PFAS."

Prof. O'Carroll and his team are now trying to develop their research by quantifying these levels of PFAS from commercial products in the environment.

They're also working to develop technologies that can degrade PFAS in drinking water systems, and looking at developing predictive models that determine where PFAS will go in the environment.

"Part of this is figuring out how PFAS will associate with different parts of the environment and our bodies—proteins, for example," says Prof. O'Carroll.

These studies will be in progress over the next two years and aim to be completed by 2026.

In the meantime, Prof. O'Carroll says manufacturers and consumers alike need to be careful and do their due diligence when using products containing PFAS.

"We manufacture and distribute a lot of chemicals without having a full assessment on their potential health impacts," he says.

"We should have judicious use of some of these chemicals. Just because they're available, doesn't mean that we should use them."

More information: Denis O'Carroll, Underestimated burden of per- and polyfluoroalkyl substances in global surface waters and groundwaters, *Nature Geoscience* (2024). DOI: 10.1038/s41561-024-01402-8. www.nature.com/articles/s41561-024-01402-8

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