Plugging the leak on laundry pollution

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Joaquim Goes, an ocean biochemist at Columbia Climate School's Lamont-Doherty Earth Observatory, had to look twice when he first saw the tiny strands of fiber floating in a water sample from the Hudson River. An expert in microplastics detection, he has seen a lot of tiny particles in urban waterways before.

Microplastics are showing up in every nook of the planet, from fresh snow in Antarctica to seafood dinners. They come from a variety of sources, including food and beverage containers, fishnets, tires and cosmetic products. But the particles that Goes saw struck him as clothing-related.

"As I looked closer, I could see that they were not phytoplankton or zooplankton, but fibers that had likely come from laundry," he said. Sure enough, as Goes and his students continued to sample the river, they found plumes of the fibers around drains from water treatment plants, supporting the idea that laundry was the culprit.

On top of that, "some of our students characterized a few samples that we collected in the waterways, and in most cases, they were polyester or its derivatives used in clothing," said Goes.

With these factors in mind, added Goes, "we believe that the laundering of clothes and the effluents that are released from washing machines are the biggest source of microplastic fibers in our waterways."

Washing out to sea

Goes reached out to his friend and collaborator Beizhan Yan, an expert in plastic identification. Yan had also seen the fibers as part of his own research in the Hudson River, and had read that they had also been found in more than one third of plastic waste in the ocean.

"We were discussing ideas for a proposal, and I suggested we should carry on where the students left off and find a solution to prevent microplastics from coming into the ocean," said Goes. "I told him that no one would think of this as a huge issue, but we have data to prove it, and it would be a standout kind of project."

More research is needed to better understand the effects of microplastic consumption on human health, but a recent study found that people who had tiny plastic particles lodged in a key blood vessel were more likely to experience heart attack, stroke or death. Microplastics are inhaled and ingested through contaminated seafood, water (both tap and bottled) and many other types of foods.

"Clearly, there is a dominance of these particles in our rivers and oceans, and if we don't deal with them, they will end up in our food chains and cause trouble," said Yan. "I was really interested to see if we could solve the problem at the source."

In this case, Yan is referring to the laundry room. An average three-pound load of shirts, pants and socks sheds hundreds of thousands of microfibers into the sewer system, where they slip undetected past water chemical treatment plants and enter river and ocean ecosystems. In the U.S., most treatment plants are designed to reduce organic material in the water, said Yan, and are not efficient in removing an abundance of fine synthetic particles such as microplastics.

Most modern clothing contains some sort of synthetic material. Unlike natural fibers such as cotton which completely break down, the synthetic materials stay in the environment forever. Goes and his students found that polyester fabrics are the worst shedders. Detergent also plays a role: laundry washed with detergent produces, on average, 86% more microfibers than laundry washed with pure water. With the average family washing 300 loads of laundry per year, the waste adds up.

To address the problem, Yan assembled a team of multidisciplinary researchers from Columbia University, SUNY Stony Brook University, Cornell University and North Carolina State University. With expertise in areas as diverse as chemistry, sustainable textiles, filtration and urban mining, the researchers are developing and testing a water filtration system to capture microfibers before they even leave the washing machine. The project, funded by the National Oceanic and Atmospheric Administration (NOAA), launched in 2023 and will run through 2025.

Designing for scale

One of the greatest challenges of the project will be to develop a filtering system that can not only detect and extract the microfibers, but also process large volumes of water at a fast rate, said Nicholas Frearson, senior staff associate at Lamont-Doherty Earth Observatory.

A typical washing machine puts out about eight gallons of water during a cycle, he said, and microfibers can be as small as a millionth of the width of a hair. On top of that, the filter will likely become clogged quickly, requiring some sort of automated self-cleaning cycle.

"The filters work well initially, but then they slowly get worse and worse because they're just catching everything and clogging themselves up," he said. "So one of the biggest problems we're trying to solve is how do you unclog them?"

With an engineering background, Frearson specializes in developing sensor systems for scientists working in remote areas of the world, and most recently collaborated with Yan on a microplastic detection project in the South Pole. He was eager to join the team working on the problem of laundry pollution.

"If we can prevent the fibers from actually getting into the river, we might be able to go a long, long way in slowing down the process of the ocean filling up with them," he said.

The current prototype of the equipment is a five-foot-tall labyrinth of pipes and valves, almost the size of an actual washing machine. A secondgeneration model will ideally be much smaller—about the size of a small suitcase—and a final model would be small enough to build into commercial washing machines.

The technology will serve to keep microfibers out of the sewer system but will also contribute to a circular economy, said Frearson. When dried out, the microfiber sludge extracted from each cycle will resemble a thin cake-like disk that can be recycled to produce more clothes.

Taking the concept to market

Once a prototype of the filtering system is ready, the team will test it in residential buildings at Columbia University, which could happen as early as fall 2024, said Yan. After that, they will actively seek to transfer the developed technique to industry and are already in conversation with several manufacturers.

Community education programs to inform the public about microplastics and also potential remedies for laundry pollution will be developed and implemented by Katherine Bunting-Howarth, associate director of New York Sea Grant and a co-PI on the project.

Other co-PIs on the project include Benjamin Hsiao, distinguished professor of chemistry at Stony Brook University; Karen K. Leonas, professor of textile science at North Carolina State University; Wei Min, professor of chemistry at Columbia University; and Thanos Bourtsalas, lecturer in sustainable development and circular economy at Columbia University.

"Our goal is that the new microplastic removal technology tested through the project will, over time, become available for all communities, including traditionally underserved communities, and benefit everyone," said Yan.

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