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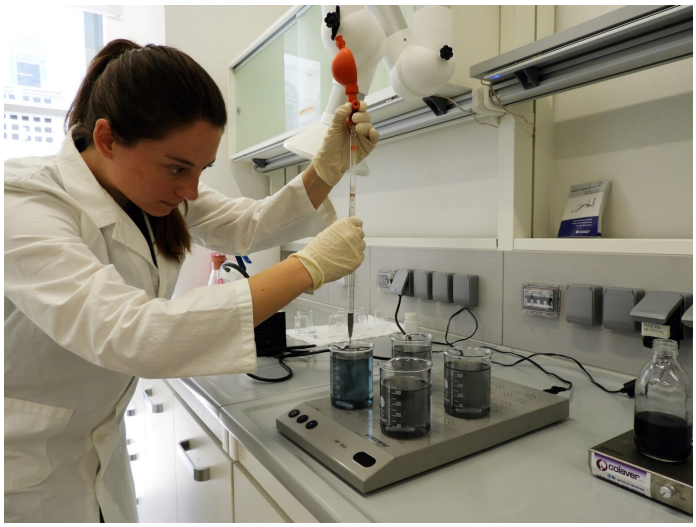
Engineering behind the tap

by Emanuele Sanzone



The production and use of the products we use every day, such as clothes, bottles, pans, cosmetics, drugs, etc., involve

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water pollution and this can have an impact on human health through water and food. In this context, we must be ready to face the future environmental challenges of the planet that will increasingly test the maintenance of water quality standards and will make it necessary to reuse it in a circular economy perspective. **Beatrice Cantoni** is a researcher at the Department of Civil and Environmental Engineering of the Politecnico di Milano who has won several awards and individual funding on these issues. His research focuses on the fate of emerging contaminants along the water cycle. On the one hand, a purpose is the development and application of a chemical risk quantitative assessment procedure due to the impact of these pollutants on human health and the environment. On the other hand, the second aim is the study of several technologies to reduce these risks in drinking water, in wastewater even in agricultural and drinking reuse areas of treated wastewater. Since his doctorate he has been collaborating with various water services, research centers, universities, technology experts and toxicologists to find multidisciplinary solutions in the sustainable management of water resources.

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« Initially I was more projected towards mathematical engineering but, after reading the environmental engineering study plan I decided to enroll in the latter – says the researcher – Since the first three-year thesis I understood that my path was to deal with water treatment. Here, then, is the choice to undertake the doctorate course, in the research group of Professor Manuela Antonelli, on the subject of the treatment of drinking water to minimize the potential risk to the health of the consumer.

We have developed a procedure to analyze this potential risk due to the presence of 'emerging contaminants', new contaminants that have only recently been detected and of which not much is known, neither their potential effect on human health, nor on how to treat them at their best or what concentrations to expect in drinking water.

The goal is to reduce the concentrations of these contaminants with a multidisciplinary job: I was most of the time here at the Polytechnic, but then I spent a period at the German Environmental Protection Agency (Umwelt, UBA) and at the Technical University in Berlin, where we studied a technology to reduce some of these

emerging contaminants. Then I went instead to the Netherlands, to the KWR (Water Research Institute), a very important water research institute at European level, where we collaborated with toxicologists, technology experts, data analysts, experts with different trainings. This allowed me to see the problem from various angles.

At the end of my doctorate, while remaining in the same research group, I broadened the research horizon also including wastewater, both civil and industrial, always with the aim of reducing these contaminants but with a view to greater reuse of water due to the climate crisis, just think of the impact on agriculture and therefore on food.

His work, therefore, is made up of models but also of experiments in the

laboratory.

"In the laboratory, we are going to test on a small scale the water treatment that takes place in a plant. This allows you to go and observe faster, within days, what will happen in larger scale within months. Thus, we can evaluate how the treatment works in different conditions at a limited time.

Then, thanks to simulations with models, we can predict what the performance will be even in situations that we could not test, perhaps because they have never occurred but could happen in the future, for example due to climate change.

Speaking of climate crisis and water scarcity, his doctorate was funded by Metropolitana Milanese. How is the situation of aquifers in Milan?

"In Milan we are very lucky, these contaminants are at very low levels that are not worrying about human health, but the research serves to understand if and how in the future this situation could evolve. Climate change could lead to an increase in contaminant concentrations or a worsening of the quality of the ailment. We must prevent and anticipate these critical issues,

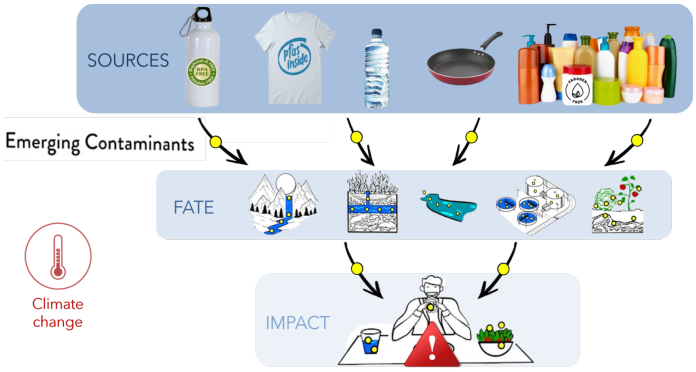
giving managers all the useful tools to be able to manage them.

At the outreach events or at the Open Day we ask the public if you have ever wondered where the tap water comes from. We often take flush for granted, we do not know the engineering, design and design of the treatment and distribution: everything very well thought out and controlled in real time, so that the water is always 100% safe in the present but always ready for the future. The environmental engineer at the bottom is 'hidden' inside the faucet."

He is working on climate change with research projects. What is it about?

«I participated in the launch of the **project** "SafeCREW" funded by the European Union in the context of the Horizon Europe calls, a three-year project started in November in which my research group with several European partners, including its own Metropolitana Milanese, is involved. The goal is to understand the impact of climate change on available water resources and how we will have to adapt the disinfection of drinking water to minimize any type of risk: microbiological on the one hand, and chemical on the other. In fact, we are facing

a trade off: we must disinfect to reduce microorganisms in the water but at the same time we could generate by-products. The management of this process is currently very well controlled even with real-time tools. But this project wants to evaluate what needs to be done in the future. For example, some German partners, who do not disinfect the waters currently, have other strategies, but with climate change they may have to resort to this process, they want to be ready to understand when and how they will have to act.



Last year I received **the Individual Fellowship of the AXA Research Fund** (the AXA Research Foundation). The call was specific to the impact of climate change on human health. The project I proposed, and which has been selected among the 8 projects funded in the world, analyzes how climate change can affect the water cycle and lead to an impact on human health due

to water and food consumption. We need to understand what the actions we will have to take in place in the future to minimize the risk could be.

And I am concerned about risk in the **project PNRR RETURN** Extended Partnership funded by the European Union Next-GenerationEU, in which I was involved since March 2023. The goal is to develop new techniques for assessing, managing and minimizing human health risk in complex contexts such as the water-food cycle."

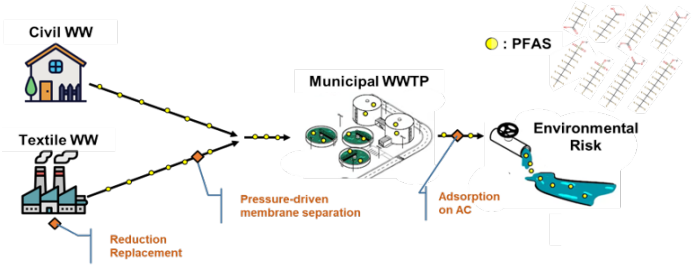
She was selected to participate in this year's European Talent Academy, what does she say?

«"The European Talent Academy involves about twenty young researchers from three universities, Politecnico di Milano, the Technical University of Munich and Imperial College London. Of the Polytechnic we are in 8 from different departments. The theme here is human health and from 29 to 31 March last here in our university we met with the other researchers and each presented their research to seek collaborations and propose joint projects between the different universities. It is a very useful initiative for young researchers like us at the beginning of

our career, because the project also includes visits to other universities and their laboratories. It is a very stimulating time because problems such as health are addressed with different skills, for example with architects, designers, engineers, doctors, toxicologists."

What are the most studied and contaminants at this time?

«"In the 'classification' I would put PFAS because regulations begin to include these emerging contaminants in regulations for drinking water, waterways and wastewater. To understand PFAS are those used to produce our clothes with waterproof fabrics, but also to make the pans non-stick. In September, a four-year **LIFE-CASCADE** project will start in which my research team is involved to assess and reduce the possible contamination of both PFAS and microplastics due to the textile industries. The goal is to evaluate whether it is appropriate to work on purification directly at the level of industry or in the centralized purifiers that collect water from both the industries and our cities.



Another contaminant that is often heard about and that is already present in the European legislation on drinking water is bisphenol A (BPA), which is an additive in the production of different materials, especially plastics and metal resin coatings: often on the bottles we find the indication "BPA free" because there is greater awareness about these pollutants that we also find in receipts and plastic bottles.

In our small, what can we do?

"We must inform and consciously choose the products we use. Speaking of drinking water, Italy is the second country in the world for bottled water consumption (Source: Report Beverage Marketing Coorporation 2022). At disclosure events, the public claims that tap water is too hard or you have doubts about its safety and you trust bottled water more. In fact, within the project " **ASAP! – Sustainable Water at the Polytechnic!** "funded by the Cariplo Foundation, thanks to the blind tasting of different bottled water

and tap, made on more than 50 people, we understood that most of the participants have preconceptions against tap water that often do not even coincide with their tastes, but that they are born precisely from the fact that the quality control process is not known.

We conducted a study compared to some families of these contaminants, used as plasticizers, alkylphenols and phthalates, and we observed that although in low concentrations they are more present in bottled water, because they are plastic and sometimes are not well preserved, perhaps left in the sun or in suboptimal conditions during transport. The tap water is 100% controlled, we know where it comes from and what treatment it receives. To this add the CO_2 emissions saved in the transport and management of waste from bottles and we

try to move towards a more sustainable water consumption.

The other way to have less impact concerns, however, the choice of our products, starting from cosmetics and clothes: now there are more and more PFAS free brands, reading well the labels or the INCI for cosmetics, there are the tables to refer to. We also deal with drugs because only a part is assimilated in the body, everything else ends up in wastewater and consequently in the environment. Here too, a conscious consumption reduced to the necessary can make a difference. Other pollutants that we deal with are pesticides, for example, all those chemicals used in conventional agriculture that impact not only the human health of the farmer but also on the environment. We find them in the water and as a result they can return to us through food or drinking water. Choosing a food grown in respect of nature is also a way to protect our health.

There is no need for alarmism but a good awareness does not hurt: the contaminants whose effect on health we know exactly are already regulated and the managers have limits not to be exceeded to guarantee

safety.

In Europe we also have fairly stringent regulations compared to the rest of the world.

«“Compared to the rest of the world, the EU is ahead; for example, PFAS are already within our law on the treatment and quality of drinking water, while in the rest of the world they are starting to include with longer times.

Then there are ‘watch lists’, lists of emerging contaminants to be monitored, on which research in a few years is making enormous thanks to technology. On the one hand, the technological advancement is used to evaluate its concentrations: in fact, they are present at very low concentrations, nanograms per liter, a bit like dissolving a sugar cube in the hydroscall. On the other hand, toxicologists are wondering if such concentrations are dangerous or if they will

be dangerous in the future and if there are more convenient solutions than others."

What plans do you have for the future?

"In the future I would like to continue in my academic career, I like the combination of research and teaching. Our research has a direct social impact because it gives policy makers the data on which to build legislation, and I would like to be able to have an impact on new horizons, knowing that today 40% of the world's population is not guaranteed safe drinking water.

For example, Africa was the spring that made me choose engineering and therefore remains a long-term goal. To date, I am more focused on these contaminants that are more common in industrial areas, in our most 'advanced' cities. There are, however, different possibilities of going to decline what we do now for these contaminants in other situations because we are witnessing a decentralization of the industries that were previously only in the West. We deal with the water pollution that this process brings.

Last year I was in Canada for a few months of a doctoral post. There they are studying a

technology to treat wastewater and reuse it immediately as drinking water, because in situations of communities that live in remote areas and with more and more water scarcity can be a useful technology. Of course it was designed for Canada, but in Africa it could be a very useful solution. Many diseases also result from lack of access to safe drinking water. Our priority is to make water more accessible and safe for all."

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