COVID-19 AND THE ENVIRONMENT

COVID-19 sanitisers – What is the impact of the pandemic on our aquatic environment?

Some of the chemicals we rely on to slow the spread of the coronavirus may be harming the aquatic environment. Matthew Hattingh reports.

An ounce of prevention trumps a pound of cure and a little handwashing goes a long way to slowing the spread of infectious disease. It's true of the common cold and it's true of COVID-19. But what's inside all those sanitisers and disinfectants flooding the market, that we've been using so liberally in our homes, offices and public spaces?

How much is getting into the environment? What are the likely consequences for natural systems and public health? And what should be done to remedy matters? These are not really new concerns. It's been established for some time that concentrations of some chemicals used in sanitisers and disinfectants are high in the environment, but levels have likely spiked since the onset of the pandemic.

Chemical pollution of all kinds is a global phenomenon. It's responsible for an estimated 9 million deaths worldwide every year and scientists have shown how it finds its way into practically everything. How this applies to South Africa, particularly with chemicals used in sanitisers and disinfectants, was the subject of a virtual seminar hosted by the Water Research Commission (WRC) earlier this year.

Delegates heard that these products contain a 'lot of chemicals' and they are accumulating in our aquatic systems, posing a possible risk to living organisms including fish, crustaceans, plants and bacteria. Ndeke Musee, one of the guest speakers, said this was despite the work of wastewater treatment plants, some of which have "pretty low efficiencies" when it comes to removing chemicals. Moreover, the University of Pretoria associate chemical engineering professor noted heightened concerns that some sanitisers and disinfectant brands "contain ingredients that have been banned elsewhere but are still being used in South Africa".

Examples of such chemicals include fragrances like Butylphenyl Methylpropional and Alpha-isomethyl Ionone. These substances have been banned or restricted for certain uses in some countries after being linked to skin irritation and infertility among rats. Other compounds banned or restricted

in other countries, but found in sanitisers and disinfectants in South Africa, are 4-Methylbenzylidene camphor, Ethylhexyl Methoxycinnamate and Benzophenone-3. There is some evidence that these ultraviolet filters, commonly found in sunscreens, may disrupt the production or function of the female sex hormone, oestrogen.

University of Pretoria researchers examined the sanitisers and disinfectant products most widely used in South Africa and identified 187 chemical compounds. To their surprise, said Prof Musee, they found that the data accessible nationally and internationally limited them to assessing the risk levels of a mere 21 compounds. Inadequate data prevented the team from assessing the chemicals most frequently used across brands that when found in sufficient concentrations in rivers and lakes, according to the literature, can be toxic to organisms.

Concentrations of certain chemicals in the aquatic system in South Africa and elsewhere may be approaching a "point of no return" where ecological balances are tipped irreversibly, with consequences for human wellbeing. "It will compromise the quality of water. Bacteria and other organisms are very important and they are good bioindicators of water quality. That will increase costs of treating water because it is highly polluted. Wildlife can also be affected," Prof Musee said.

In addition, the increasing use of recycled water for agriculture means a greater risk of chemicals getting into crops and accumulating in the bodies of those who eat them. However, Prof Musee noted that the team has been careful not to "become big scare-mongers" over potential threats to the food chain. This included making premature pronouncements on possible accumulation of toxins in fish or crops and the risks, if any, to the people who eat them. Rather, the team hopes to produce robust findings in the coming years on the risks posed by some of the identified compounds to the environment, including water quality.

Responding to questions from the floor, Musee said he was cautious about calls to ban or restrict certain chemicals. Reliable data must first be gathered, a process that can take years, but failure to do so risked "serious litigation". He called for a systematic evaluation of risks and a transparent approach. This would include pre-market registration of products and screening of chemical pollutants and assessing risk. "We need to be protected from COVID-19, but at the same time we need to balance the risk to the environment."

Proper modelling is necessary to learn which compounds were persistent in the environment, which accumulated in the bodies of living things and which were toxic. Also needed, he said, was an inventory of household products and their chemical constituents. This will help identify problem chemicals, but can the compounds in sanitizers and disinfectants in use since COVID-19 be quantified?

A University of Johannesburg team has been looking for answers. "Almost all of us are sanitising and using disinfectants to make sure our houses are clear of the virus," said Philiswa Nomngongo, a professor in environmental analytical chemistry at the university. She makes the very reasonable point that "when we buy more, it means we release more". It's another matter, however, to demonstrate this with scientific rigour and Nomngongo sketched some of the difficulties the team faced.

She and her colleagues have been taking samples at wastewater treatment works and from the rivers they discharge into to gauge the occurrence of sanitizer and disinfectant chemicals in the aquatic environment in Gauteng and KwaZulu-Natal (KZN). She noted that treatment works were never really intended to take these chemicals out of the wastewater. "But we want to see what levels are being removed… and how much goes to the environment," she said.

The study, which began in March 2021, collected samples during the second, third and fourth COVID-19 waves (an uptick in chemicals was observed during the third) and work was continuing. The idea was to get a "fingerprint" of the chemicals in the system at different places so comparisons could be made with current data nationally and globally.

In Gauteng the team gathered samples from rivers at 11 sites near wastewater treatment works, in Johannesburg, Tshwane and Vaal. In KZN they were able to sample at treatment works as well as up- and downstream of these in eThekwini, Pietermaritzburg, Albert Fall and Howick.

With the assistance of the University of Venda, the team used

While people require the means to protect themselves from COVID-19 it needs to be balanced with the risk to the environment.

solid-phase extraction to concentrate and purify samples and analyse these using liquid chromatography-mass spectrometry. This is a well-established technique that uses chemical formulas and molecular weights to identify chemicals. The chemicals found were tallied up by site and classified into 10 broad types, including antibacterial, fragrance, ultraviolet filters, pharmaceuticals and preservatives.

Nomngongo noted that a single sanitiser or disinfectant product typically contains a number of chemicals. Some, such as alcohols, have a short lifespan once released, so the team's focus has been on those that persist in the environment for more than 180 days. Sampling and analysis at wastewater treatment works has historically been used to gauge the use of drugs – legal and otherwise – in particular communities at different times. Consistent with this, the study frequently found pharmaceuticals, with levels varying at the different works, as well as from river to river.

The biggest difficulty, said Nomngongo, is the dearth of studies on many chemicals in South African waters. This and the prohibitive cost of chemical standards or reference data made it hard to determine background levels. These are concentrations of different chemicals present in the waters before COVID-19 – essential data for drawing meaningful comparisons.

Nomngongo raised the likelihood that the pandemic had increased chemical levels in the environment but found it hard to say so with confidence: "We don't have prior information. Can't comment on whether concentrations are higher or lower." However, sampling continues as the team seeks to identify and quantify a limited number of chemicals, including those found in pharmaceuticals likely to have been used to treat COVID-19. These included parabens, a preservative and antibacterial that had been identified in South African waters prior to the pandemic.

Another problem was narrowing the search for chemicals. For example, the labels of some sanitisers and disinfectants list "fragrances" but give no specifics, including concentrations. And cosmetics and pharmaceuticals, which the study detected, contain fragrances too, making it hard to pin down the source of these.

The highest numbers of chemicals were identified in Gauteng, said Nomngongo, with the most (92) being recorded at a sampling site on the Rietspruit River. This was not necessarily because the site was near a wastewater treatment works. Other activities in the area, which is near the township of Sebokeng and in an industrialised part of southern Gauteng, probably contributed too.

In Gauteng the team detected high numbers of pharmaceuticals, fragrances and antimicrobials. The antimicrobials included quaternary ammonium compounds, a class of disinfectants commonly used in homes and in industry. Nomngongo noted that while these were effective in preventing disease they were also "very persistent in the environment", affecting aquatic life. A similar picture emerged in KZN, although levels of quaternary ammonium compounds were lower than in Gauteng.

She said a number of chemicals, including triclosan, are found in disinfectants, soaps and sanitizers recommended for use against COVID-19 in South Africa despite being regulated or banned in some countries including the US, Canada and in the European Union. The bans were prompted by concerns the chemicals may disrupt hormone development, make microbes resistant to antibiotics and affect environmental health.

"Can't we keep up with what the rest of the world is doing in terms of what we can use?" Nomngongo asked, calling for better labelling of chemicals. Specifics, including concentration details, were needed, combined with policies and standards, to protect the environment.

A delegate asked from the floor for details about which countries had banned triclosan. Musee confirmed that the US, Canada, and the European Union have done so, but noted this had not happened in many developing countries, including South Africa. He stressed there were no quick fixes. The court cases that led to the banning of triclosan and triclocarban in the US and elsewhere started in 1974 and were only resolved in 2016, with the ban coming into effect in 2017.

"It's not that you are going to wake up and do the banning, it takes years and years," he said.

Bonani Madikizela, of the WRC, wanted to know which government departments were responsible for regulating which chemicals in South Africa. Musee replied that he had been in touch with the departments of Agriculture; Forestry, Fisheries and the Environment; Trade, Industry and Competition; and the South African Bureau of Standards.

What did he learn? "To be honest, to be frank with you, in South Africa there is a need for a conversation about who is supposed to deal with these matters," said Musee. He said an environmental specimen bank would be a valuable aid to research and chemical management. Specimens from the environment could be collected, stored and managed and chemical analysis could be done when required or once resources allowed. This would let researchers establish baseline values, including concentrations, of different chemicals for particular places, making meaningful comparisons possible. This, in turn, would support evidence-based policy and decision making.

Calling for suggestions and dialogue on the establishment of an environmental specimen bank, he said that carefully stored and archived samples drawn regularly from plants, animals, humans, water, sediments and the broader environment could provide a picture of which chemicals were accumulating, and therefore of concern.

Africa has no specimen banks, he said, with most found in Europe, North America and the Far East. Yet more people die from chemical pollution in Africa than on any other continent. Quoting from a study he co-authored with UNISA agriculture and animal health professor Khanyisile Mbatha, on specimen banks, chemicals and Covid, Ndeke sketched the process of establishing a bank. This included feasibility assessments (including the skills and financing required) through design and development, to commissioning and beyond.

Further work was needed to establish whether there was sufficient demand in South Africa to justify an environmental specimen bank which would probably come with a price tag in the "millions of dollars".