

POLLUTION AND THE ENVIRONMENT

Not so fantastic plastic – What the latest research says about plastic pollution in SA environment

Speakers at a recent Water Research Commission webinar shared some gloomy statistics about how plastic pollution and, in particular, microplastics, is affecting the South African environment. Matthew Hattingh reports.



Film lovers of a certain age will remember the funny-sad *The Graduate* for its awkward hero (a young Dustin Hoffman in the title role), the older woman (Anne Bancroft) who seduces him, and its Simon & Garfunkel soundtrack, which includes the hauntingly beautiful, *The Sounds of Silence*.

Less celebrated, but rich in comedy value, is a scene from the film where a family friend corners Hoffman's character at his graduation party to share some career advice. "I want to say one word to you, just one word," says friend to hero, "are you listening: Plastics. There is a great future in plastics. Think about it, will ya."

Already, back then (the film first screened in 1967) plastic had become a byword for much that was wrong with society... sterile, mass produced and ugly. A generation later, it's safe to say

that many of us, like Hoffman's character, have grown disaffected with the polymer products that crowd our lives.

But the thing is, plastics are just so *bliksems* useful – a fact Carina Verster reminded guests of at a July webinar hosted by the Water Research Commission (WRC) and entitled 'Microplastics as environmental stressors: Risk communications and community engagements'.

Plastics are durable; lightweight (therefore cheap to transport); inert; made from readily available fossil fuels; and have a low melting point, making it easy to shape. Plastics help food stay fresh longer, improving food security. And it has assisted advances in medical technology, according to Verster. But the very things that have made it so useful are also among the

reasons it is so tough to deal with as waste. Take durability: "A bottle that's supposed shelf-life is, say, max a year, could end up in the ocean and stay there for a thousand years," said Verster, of North-West University's unit for environmental sciences and management.

And because it is easy to shape and made from cheap raw materials, there's a lot of it about. This has eroded prices paid for recycled plastic, discouraging collectors who must gather ever-larger volumes of the lightweight stuff to turn a profit. Plastic has bred a consumer mentality. "It's cheap, we can discard it," Verster explained.

What are microplastics? It includes plastic fragments ranging in size from 1 micron (one-thousandth of a millimetre) to 5 mm; nurdles (beads used in plastic production); fibres from textiles and clothing; and microbeads from cosmetics and personal care products. Fragments are frequently broken or scuffed off larger items, such as bottles that have been weakened by sunlight, knocked about by the elements and left to heat and cool repeatedly. Bacteria and fungi play a role too in degrading plastics, releasing chemical compounds, including monomers and additives.

Microplastics were widespread, said Verster, citing a 2018 WRC scoping study that found it in all ground, surface and drinking water samples taken. In the Vaal and Orange river systems, up to 40 particles a litre were recorded, comparable to polluted European rivers like the Rhine and Seine.

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A PET plastic bottle floating in Durban harbour. About 13 000 tons of these bottles leak into the South African environment every year.

Plastic pollution is a growing problem in Africa. China, the world's largest producer of plastics (31%), view the continent as its biggest export target. Africa's population is expanding at a brisk 3.5% a year, fuelling consumption, while waste management remains overwhelmingly (88.5%) poor. "That creates a really gloomy picture for waste and plastic management entering the environment in Africa," noted Verster.

South Africa generates more plastic waste per capita than the global average (an estimated 41 kg per capita a year versus 29 kg) and plastic makes up a "fairly high" share of the country's waste stream, according to Peter Manyara, co-ordinator of the International Union for Conservation of Nature's marine plastics and coastal communities programme for Eastern and Southern Africa.

While many of South Africa's landfills are doing well to contain plastic, this must be viewed against high overall use. The country generates more than 2.3 million tons of plastic a year (based on 2018 data). Of this, some 70% is collected and of the collected waste about 40% is disposed of in sanitary landfills or incinerators. A further 40% goes to unsanitary landfills and dumpsites while the balance is recycled (352 000 tons).

An estimated 107 000 tons of plastic leaks into the country's waterways and the ocean each year, the lion's share in the form of bigger pieces, known as macro leakage. Microplastic leakage figures stand at about 6 500 tons, or 6% of all leakage. Manyara viewed this percentage as high compared with Mozambique, Tanzania and Kenya. Tyre dust, he noted, accounted for most of this (5 800 tons).

Manyara singled out LDPE, PP, and PET bottles as the most significant in absolute leakage terms. PET bottles were the biggest contributor of absolute leakage (13,000 tons), although its leakage rate was low (5%), the likely consequence of high recovery and recycling, he said.

Disposable nappies, polystyrene food containers, PET food trays, and cigarette filters, also earned special mention. Manyara noted that about 2 500 tons of nappies, or about 11% of those produced, end up in the environment. Somewhat less than 1 000 tons of cigarette filters leak into the environment. No butts about it, a staggering figure if you consider a single filter weighs under 3.5g.

Plastic pollution by sector is revealing too. Packaging dwarfs all other sectors, with more than 60 000 tons entering rivers and oceans, followed by tyres and construction. The fishing and medical sectors were insignificant in absolute terms, but leakage rates were a high 14% and 12% respectively, said Manyara. An estimated 15 000 to 40 000 tons of South Africa's plastic reach the oceans each year. The figure was lower than previous estimates, Verster said, noting that most plastic stayed near its source rather than flowing far downstream. River sediment may be a major sink for plastics, she added.

Up to two-fifths of the country's wastewater is untreated, and this partly explains the high volumes of microplastics in rivers. Verster shared a photograph of Gauteng's Klip River, near Germiston, with webinar guests. "Basically, it looks like plastic



Microplastic pollution levels in South Africa's main rivers, the Orange and the Vaal, have been compared to those of the Rhine and Seine.

soup," she said, "that is raw wastewater, sewage water." Similar examples were "unfortunately the case in so many places in South Africa".

Are microplastics in the water bad for you? The short answer: scientists aren't certain.

Yvonne Liew, a senior water quality adviser with Rand Water, told the webinar that most research focused on marine animals and found that plastics indeed blocked digestive systems, affecting feeding and enzyme production and doing other harm. She felt microplastics might potentially affect human health, but noted a World Health Organisation report that concluded the effects were not known and more research was needed. The UN-mandated health body said microplastics could enter the body as fragments or chemicals. There was, however, limited evidence of it harming humans.

"It is important that communication of risk should not be sensational. It must be based on credible evidence, and it needs to be transparent about how the data was generated."

Liew said that Rand Water, which supplied about 14 million Gauteng citizens, investigated the prevalence of microplastics

in its source surface water and in water before and after it was treated for drinking. North-West University did the analysis work, sampling for six different plastic monomers and additives and counting and identifying microplastic fibres and fragments. Samples were filtered and examined using stereo microscopy and fourier-transform infrared spectroscopy.

The researchers found "negligible amounts" of microplastics in fragments or fibre form from the different sites, said Liew. Neither did they find it leached into treated water from the pipes and reservoirs that carried and contained it. By the same token, no evidence emerged that treatment works in the study reduced the amount of microplastics in drinking water.

None of the monomers or additives analysed for could be detected in water from 10 sampling sites. And lower concentrations of microplastics were found in the samples than in studies done in the US, Europe and China. "It was concluded at Rand Water that microplastics were not of a high risk factor in our treatment works or distribution systems and the water that was being supplied was regarded as safe to be consumed," noted Liew. She said a monitoring programme was in place to analyse microplastics levels at least twice a year.

It came down to concentration levels. There is certainly plenty of microplastic pollution in the environment, but it might be spread too thinly in most places to pose much risk. Indeed, this was the topic of another talk at the webinar, entitled 'Are microplastics toxic at environmentally realistic concentrations?'. Ntombekhaya Mgaba, of Rhodes University's Unilever Centre for Environmental Water Quality – Institute for Water Research, shared a few of the



A member of the Youth Employment Services programme team recovers a plastic bag from Durban harbour as part of a project supported by the International Union for Conservation of Nature and run by WildOceans.

results of her WRC-funded study on microplastics as physical and chemical stressors.

First a look at the chemical stressors. Mgaba investigated the effects of three common plasticizers (used to give plastics elasticity) in different concentrations and over different durations on four freshwater species: red-rimmed melania snails (*Melanoides tuberculata*); zebrafish (*Danio rerio*); shrimps (*Caridina nilotica*) and banded tilapia (*Tilapia sparrmanii*). She monitored how the plasticizers affected the growth of the four. For the tilapia and shrimps, she also monitored reproduction.

Fish egg hatchings were measured against concentrations of the plastic raw material bisphenol A, but the “dose response curves were not found to be statistically significant”. Dibutyl phthalate, another plasticiser, appeared not to affect snail growth, although reproduction of this species had a clear response to bisphenol A. Increased concentration of plastic additive calcium stearate did not appear to affect fish growth. However, fish egg hatching did appear to be affected by dibutyl phthalate and calcium stearate. Mgaba concluded most of her tests did not produce clear responses to plasticisers at environmentally relevant concentrations.

For the physical stressors, she sought to measure the effects of microplastic particles on the four species. For the fish, she measured growth and number of particles excreted in faecal

matter. Snails were watched for reproduction and size. And shrimp growth was monitored. No significant toxicological response was found in the concentrations considered. However, particles of polypropylene (a widely used plastic) affected fish growth, but only in higher concentrations, said Mgaba.

Apart from more research, what should be done? According to Manyara, South Africa already recycles an impressive 352 000 tons or about 14% of its plastic waste a year. Although few people separate waste and recyclables at home, the country has as many as 90 000 informal waste-pickers. “They do a very good



An estimated 1 000 tons of cigarette filters end up in the environment.

job in promoting segregation of recyclables from other types of waste."

There was also much informal recycling by small-scale initiatives. The country's recycling capacity was "quite high" and growing, with a "lot of innovation", but Manyara questioned whether the region perhaps overemphasised recycling at the expense of other approaches, including reduction and substitution. Other ways must be found to stem the plastic tide if the marine pollution battle was to be won, he said, mentioning efforts to better manage unofficial dumpsites.

Like Vester, he was against bans and felt preventative measures at source would be cheaper than dealing with plastic waste at the end of its life in the long term. "It is very important to avoid producing and importing plastics objects that do not benefit from recycling solutions in the country." A drive was needed to reduce demand for single-use plastic. Subsidies should be developed to encourage affordable ways to deal with plastic waste. And consumers and producers needed to be made better aware of plastic's environmental cost.

Nelson Odume, of Rhodes University's Unilever Centre for Environmental Water Quality – Institute for Water Research, said the risks plastics posed needed to be communicated to the public, decision-makers and industry in a forthright fashion. "It is important that communication of risk should not be sensational.

It must be based on credible evidence, and it needs to be transparent about how the data was generated."

If this was done. If people talked. If they worked together. And if waste was viewed as a resource for development rather than an evil, then in time, progress was possible. "A vision softly creeping," to quote Simon & Garfunkel. Yes, plastics can certainly be sterile, mass produced and even ugly, but now was not the time for the sounds of silence.



Some of the plastic recovered from Durban harbour.

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