

EMERGING POLLUTANTS

Study explores microplastic pollution

Microplastics are causing marine pollution problems of global concern. Researchers are now also looking at the hidden impacts of these tiny plastic particles on our local freshwater environment.
Article by Jorisna Bonthuys.



Plastic is considered an essential part of our everyday (modern) life. It is durable, inexpensive and has thousands of uses. The invention of plastic has changed the way we dress and package things, among others.

This has, however, come at an environmental cost. A staggering amount of waste, including millions of tons of plastic, enters the oceans each year. Recent studies have suggested that the ocean receives an estimated 8 million metric tonnes of plastic waste per year.

Plastic debris in our oceans is a complex contaminant of increasing concern. It is now considered one of the significant global challenges facing the marine environment, alongside climate change, biodiversity loss, sea-level rise and ocean acidification.

The plastic waste we produce on land that does not get reused or recycled or are poorly managed at waste facilities and may eventually reach the oceans. This happens either through dumping or from runoff through drains and rivers. This plastic can travel a long distance – even some of the most isolated islands are now affected by it. Some plastics may have a half-life of 400 years, meaning it will be around for centuries in the marine environment.

Many plastic objects, including plastic bags, packaging material, earbuds or straws, are consumed by marine animals. This is because plastic garbage is often mistaken for food by marine animals. High concentrations of plastic material have, for instance, been found in the stomachs of albatrosses, whales, and turtles.

This plastic waste comes in many shapes and sizes. This includes large visible items you can collect during beach clean-ups as well as small particles that are often invisible to the naked eye. Over time some of these objects degrade, breaking down into even smaller particles.

Scientists warn: Microplastics are playing an increasing role in the uptake of industrial pollution in marine life. It has now been introduced to the food web. These tiny fragments or particles are ingested by some species. This could be contributing to high levels of chemical contamination of marine organisms.

The big problem with microplastics

Microplastics (< 5 mm size) come from a variety of sources. Some are from places you would expect, such as broken down plastic bags. The origins of others are more surprising. Turns out, every time you wash your synthetic clothing or carpets, tiny plastic fibres are also released into the environment.

Many common household items, including toothpaste and cleaning supplies, also have microbeads in them. These tiny manufactured plastic particles can pass through water filtration systems. Other sources include the abrasion of large plastic objects during manufacturing processes, or from the erosion of tyres.

Scientists have grouped these and other sources into two broad categories: primary and secondary sources. Manufactured microplastics (primary sources) include industrial pellets, scrubbers (used in personal care products like shower gels) and abrasives (used in synthetic sand-blasting). Secondary microplastics are derived from the degradation of larger objects (like plastic milk bottles).

Researchers have found microscopic tiny plastic particles (called microplastics) are now almost everywhere – even in deep ocean sediments. It is estimated that approximately 1,5 million tons of microplastics end up in the oceans annually. This is according to a recent study published by the International Union for Conservation of Nature (IUCN).

This figure corresponds to a world equivalent per capita release of 212 grams. This is comparable with 43 plastic grocery bags thrown into the ocean per person per week (roughly one bag per week per person worldwide).

According to the IUCN, 98% of microplastics are generated from land-based activities. Only 2% is generated from activities at sea. The main pathways of these tiny pollutants into the oceans are through road runoff (66%), wastewater treatment systems (25%) and wind transfer (7%), according to this study.

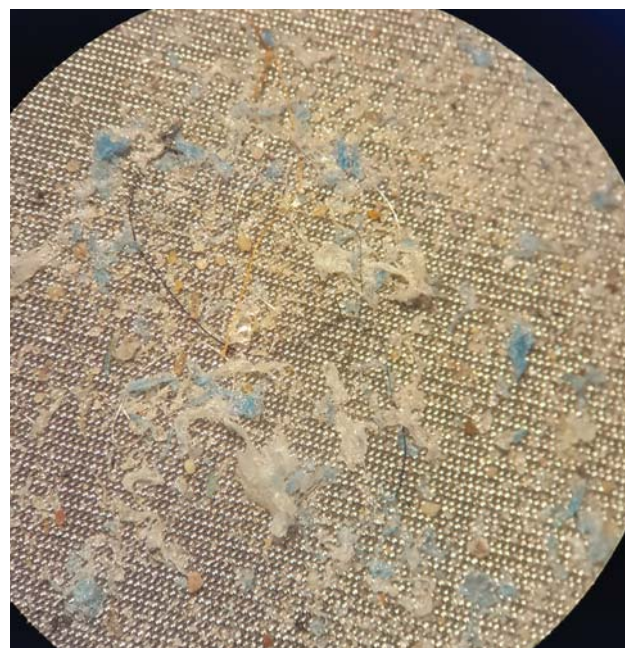
Assessing microplastic risks

Microplastic pollution is nothing new. Studies on the presence of small plastic fragments in the oceans were, for instance, first published in the 1970s. Scientists say they are only starting to understand the risks and the chemical pollutants associated with it.

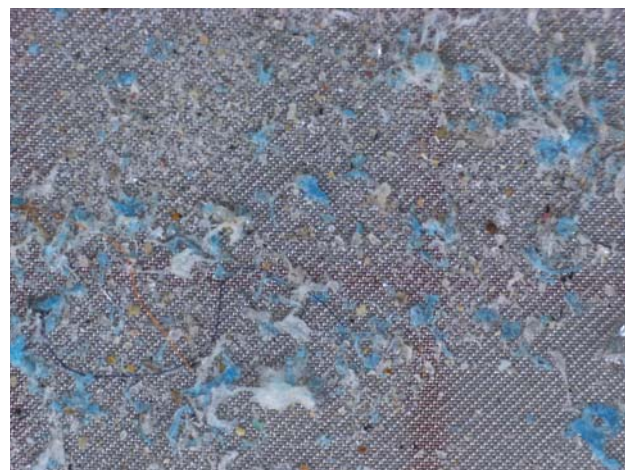
In recent years, there has been a renewed interest in microplastics. Most of the work done on microplastics in South Africa relate to persistent organic pollutants and in the marine environment. Very little is known about microplastics in freshwater resources.

Now a scoping study funded by the Water Research Commission (WRC) is underway to look at microplastic pollution in local waterways, wetlands and urban freshwater resources. Prof Henk Bouwman, a specialist in ecotoxicology from North-West University is leading this work. The study is part of the WRC's research focus on (emerging) water quality challenges related to complex chemical and microbial pollutants.

The researchers want to determine just how many microplastics are present in our freshwater resources. They are also interested in what impact this has on biodiversity and ecosystems. Based on their findings, they will come up with recommendations for further research.



Carina Verster



Small plastic particles and fibres from surface water samples.

The problem with microplastic pollution of freshwater resources might be more significant than we think. "Research indicates the real and potential risk of microplastic at many levels," Prof Bouwman points out. This issue, along with climate change, water scarcity and urbanisation, could exacerbate our freshwater problems even further.

South Africa is already facing a dual crisis of water availability and deteriorating water quality. The deteriorating state of the environment, poor past land-use planning, and patchy success in the delivery of services such as sanitation, are increasing the exposure of people to contaminated water sources.

"Microplastics can affect the metabolism, fertility, and mortality of aquatic organisms."

Increasingly, more emerging contaminants of concern (including microplastics) are detected in the environment. "Often these contaminants are largely unregulated," Prof Bouwman points out. "The potential health impacts of individual compounds or mixtures are also mostly unknown."

The ingestion of plastic particles by filter feeders at the base of the food web raises toxicity concerns from pollutants. "Microplastics can affect the metabolism, fertility, and mortality of aquatic organisms," Prof Bouwman explains. "This can affect the ecosystem and potentially human health and is cause for concern."

Microorganisms can also attach to these tiny plastic particles. "This means that microplastics can carry persistent organic pollutants and toxins over long distances. The full impact and risks of microplastics pollution in water is yet to be discovered.

"Seeing that accumulated pollutants have been found in plastic debris on some of the most remote places on earth, the transport of pollutants from polluted areas to less polluted areas in freshwater systems is therefore entirely feasible."

The risks posed by microplastics may be enhanced when local communities remain dependent on freshwater. The small size of these particles makes it also nearly impossible to get rid of with current wastewater treatment processes. This was pointed out by Carina Verster recently in an article published in the *Integrated Environmental Assessment and Management Journal*. Verster, one of Bouwman's students, is also doing research on this subject.

As part of the WRC-funded scoping study, municipal water was tested in metropolitan municipalities in three provinces (North West, Gauteng and the Free State). At each site, 90 litres of water was collected for analysis. The scientists also collected samples from river systems such as the Vaal River, Mooi River and Wasgoedspruit. They are currently investigating the presence of microplastics in the drinking water of four different municipalities (Ekurhuleni, Mbombela, Tshwane, and Tlokwe Municipality).

"The preliminary results confirmed the presence of microplastics in the municipal water of all four cities," says Prof Bouwman. One municipality had the highest number of 15 particles per litre tap water, and another the lowest average of only four particles per litre. Water tested at the two other municipalities contained eight particles per litre.

In freshwater sources, some samples had more than 40 particles (including fibres) per litre, greater than 20 µm.

The concentrations found in this study are far greater than the 0.9 particles per litre found in a study done in Austria in 2014 on the Danube River. Unfortunately, due to the lack of standardised units to report the concentration of microplastics in the environment, it is at this stage difficult to compare the results.

Given the low dilution potential of local freshwater resources, coupled with ongoing waste management problems, the impacts of microplastics on local freshwaters resources and the biological processes dependent on it remains unclear.

With South Africa being a water-scarce country, the quality of its freshwater resources is at an even greater risk. When microplastics-contaminated water and soil are used for drinking and crop production, water and food security as well as the well-being of the population, may be affected. "This direct link between the human population and the environment, now (most likely) also with an increasing microplastics burden, is of concern," Verster pointed out in her article.

South Africa and many African countries also still use persistent organic pollutants, such as DDT for malaria control, especially in remote rural areas. "The links between pollutants in microplastics and potentially more vulnerable rural populations need to be examined. Although the full impact of microplastics on the environment and biota is not yet understood, the potential threats should not be taken lightly," according to Verster.

Greening the (plastic) future

South Africa has a vibrant plastics manufacturing industry, but recycling is limited and insufficient. Lots of unmanaged waste enters the environment. Plastics are used in every sector of the economy and contributes significantly to the local manufacturing sector.

The South African government has also identified the industry as a priority sector to help promote economic growth through the Department of Trade and Industry's Industrial Policy Action Plan. This document (based on 2014 data) states that "an overwhelming" 72% of plastic packaging is not recovered at all: 40% of this is landfilled, and 32% leaks out of the collection system. This means it is not collected at all or collected but then gets illegally dumped.

However, the situation seems to have improved since then with Plastics SA indicating that 45.7% of all plastics have been collected in 2015, with 20.8% being recycled or exported. The South African plastics industry has set itself the ambitious and laudable target of no plastics to go to landfills by the year 2030, Bouwman points out.



Microbeads can be found in personal care items such as toothpaste, soap and shower gels.

In the meantime, the risks posed by microplastics must be tackled on various levels. Currently, most plans and interventions focus on end-of-pipe solutions.

At the heart of the matter are unsustainable production practices and consumption patterns, inadequate waste management and inappropriate disposal of plastics. This was highlighted in a recent study on marine debris by the Global Environment Facility's Scientific and Technical Advisory Panel.

Prof Bouwman, a member of this panel, says we should reduce, reuse, recycle, redesign and recover plastics as far as possible. "But the consumer alone cannot be held responsible for dealing with this, although their waste management, product choices, and recycling efforts can and will make a difference," he emphasises.

"We need a collective effort between global institutions, governments, manufacturers, retailers, and consumers alike. We also need to promote best practices in water, waste, and wastewater management, amongst other things. Plastics can be designed to be inherently recyclable, and there is lots of potential to turn waste items into new products. Single-use plastics is also something that should be reduced significantly."

Lots of work is underway to rethink the future of plastics. The British Ellen MacArthur Foundation, for instance, promotes a transition to a so-called circular economy. This aims to keep products, components, and materials at their highest value and utility at all times. The idea is that this provides an alternative to the current consumption and discard model that includes plastics, and thereby reduce the leakage of waste into the environment.

An international treaty, like the Stockholm Convention that banned the use of certain persistent organic pollutants, may be required to bring about the sea change needed. "The aim would be not to ban plastics, but that countries need to adhere to an international negotiated set of standards and practices to protect human health and the environment," says Prof Bouwman.

While the impacts of microplastics on local freshwater resources are still poorly understood, better water purification, as well as

strategies to reuse and recycle plastics as a resource stream, should receive more attention. This can help to minimise future negative costs and impacts.

"This is a global issue, which needs a global solution. All countries need to take up their responsibilities in this regard," Prof Bouwman concludes.

Did you know?

- Most of the marine plastic pollution comes from land-based sources.
- Plastic is very slow to break down in the ocean. Eventually, some of it breaks down into smaller and smaller pieces. Sometimes these pieces are so tiny they can only be seen under a microscope.
- Once in the ocean, these microplastics can either float or sink. Microplastics have been found 1000 m deep on the ocean floor in the Atlantic Ocean.
- Plastic debris can travel long distances via the ocean currents and can also be consumed by many marine life forms. A plastic bag has even been found inside the stomach of a coelacanth in Indonesian waters.
- Approximately 1,53 million tons of primary microplastics are released annually.
- In 2012, Unilever decided to phase out microplastics from their personal care products globally by 2015, based on environmental concerns.
- South Africa, Egypt, Nigeria, Algeria and Morocco are among the top 20 countries contributing to marine debris each year.
- Synthetic textiles are the main source of primary microplastics in Africa, Asia and the Middle East.
- About 64 000 people are employed (formally and informally) across the local plastic supply chain in South Africa. In 2015, 315 600 metric tons of plastics were recycled in South Africa, mainly by small businesses.

Source: Plastics SA; UNEP, Global Environmental Facility; Marine Policy.