Novel method of analyzing microplastic particle pollution can facilitate environmental impact assessment

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In the last decade, growing numbers of researchers have studied plastic pollution, one of the world's most pressing environmental hazards. They

have made progress but still face challenges, such as the comparability of results, especially with regard to microplastic particles.

There is no standard sample collection and analysis methodology, for example. Most studies present conclusions based on numbers of particles as if they were environmentally equivalent regardless of size, volume, mass or surface area.

An article by three Brazilian researchers published in *Environmental Science and Pollution Research* aims to contribute to progress in this field by proposing a novel perspective on particle morphology.

Using a theoretical approach, the authors argue that including morphological attributes in the analysis can reveal significant differences between samples of microplastic particles, demonstrating that samples initially considered equivalent because they contain the same number of particles actually have different environmental impacts because of variations in particle size and shape.

Microplastic particles (MPs) are artificial polymers with a length of between 0.001 and 5.0 millimeters, or 1-5,000 micrometers (μm), and are found in all kinds of environment. Few studies of pollution by MPs have been published in Brazil, especially regarding inland aquatic areas.

"Most of the research that's been done on MPs reports the number of particles in terms of the unit adopted for the sample type, ranging from volume in the case of water, to mass when the analysis involves soil and sediment, and individuals for biota. We've been researching MPs in the laboratory for several years, and we've confirmed that size is important and makes a difference. We measure particle size in all samples. In this study we found samples with similar numbers of MPs but significant variations in particle size and very different levels of plastic pollution based on particle mass and volume," Décio Semensatto, first author of

the article, told Agência FAPESP. He is a professor at the Federal University of São Paulo's Institute of Environmental, Chemical and Pharmaceutical Sciences (ICAQF-UNIFESP).

The other authors of the article are Professor Geórgia Labuto and Cristiano Rezende Gerolin, a former researcher at UNIFESP.

According to Semensatto, the group is finalizing an article on the Guarapiranga reservoir, a source of drinking water for São Paulo and two nearby towns, Itapecerica da Serra and Embu-Guaçu. "We collected samples in the wet and dry seasons and found more MPs in one season than another, with an even greater difference in terms of each sample's mass and total volume of plastic. Using only numbers of particles as a parameter focuses on just one dimension and ignores that fact that different particle sizes have different effects on ecosystems," he said.

Comparisons

According to the recent article, the researchers analyzed seven samples with 100 MPs each. These would be considered equivalent based on conventional pollution metrics. However, the comparisons made showed that their impact on the environment would be very different. In one sample, the MPs were larger in terms of volume, mass and specific surface area. It therefore had more plastic than the others and was likely to give rise to a larger number of even smaller particles when broken down by physical and chemical degradation.

In another comparison, they analyzed samples with 100 MPs and 10 MPs respectively, noting that if only the number of particles were considered, the conclusion would be that the former had ten times more plastic than the latter, although both had the same total mass and volume of plastic, while particle size and specific surface area were larger in the former.

The authors also highlight the question of morphology or particle shape. Samples containing fibers had less volume, mass and surface area, for example.

"We also explore the question of specific surface area, which is highly relevant, especially when studying MPs as carriers of other pollutants, such as metals or pharmaceuticals," Semensatto said. "Particle size influences the surface area available for adsorption of these pollutants. In addition, MPs also form a plastisphere that serves as a substrate for organisms and disperses these organisms to other environments, with consequences for global health."

The plastisphere is the community of bacteria, fungi, algae, viruses and other microorganisms that have evolved to live on man-made plastic.

"By considering particle volume, mass and specific surface area, we can better understand how MPs pollute water bodies and transport other agents responsible for pollution, including microorganisms," Semensatto said. "Analyzing all attributes of samples brings new possibilities into view and extends the comparability of the results."

The vast scale of the problem

World production of plastic reached 348 million metric tons in 2017, up from only 2 million tons in 1950. The global plastic industry is valued at USD 522.6 billion, and its capacity is expected to double by 2040, according to a report by The Pew Charitable Trusts and SystemIQ, partnering with Oxford and Leeds Universities in the UK.

Plastic production and pollution affect human health and fuel greenhouse gas emissions. Plastic can be ingested by more than 800 marine and coastal species or cause accidents involving them. Some 11 million tons of plastic waste enter the oceans every year.

In 2022, 175 countries represented at the UN General Assembly adopted a historic resolution to sign up by 2024 to a legally binding commitment to end global plastic pollution. To this end, they established an intergovernmental negotiating committee, which held its first session in December.

"With this study, we set out to contribute to academic efforts to develop routines and methodologies for dealing with plastic pollution," Semensatto said. "Our article proposes a discussion within the academic community. The proposal is open to debate. We're inviting other scientists to measure MPs and report their morphological attributes, as a contribution to the discussion of their environmental significance."

In this context, a group at UNIFESP linked to Semensatto are working with the São Paulo State Environmental Corporation (CETESB) to develop protocols for collecting water samples and analyzing MPs in the coastal region of the state. The main aim is to find a way to compare results so that MPs can become part of continuous environmental monitoring, which they are not right now in São Paulo.

This project is being conducted under the aegis of Rede Hydropoll, a network of researchers at various institutions engaged in studying water source pollution.

More information: Décio Semensatto et al, The importance of integrating morphological attributes of microplastics: a theoretical discussion to assess environmental impacts, *Environmental Science and Pollution Research* (2022). DOI: 10.1007/s11356-022-24567-4

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