February 5, 2021

Earth & Space

Microplastics are raining down from the sky

by Janice Brahney[1] | Assistant Professor

doi.org/10.25250/thescbr.brk467

[1]: Utah State University, Logan, US

This Break was edited by Ayala Sela, Scientific Editor - TheScienceBreaker

Microplastic waste has become so prevalent in the environment that it is being picked up and transported by the wind and the rain. We linked plastic fallout rates with air-mass movements to understand where plastics are coming from, how far they are travelling, and how much of them is raining out of the sky.

Image credits: Pixabay

It's entirely possible that tiny fragments of the windbreaker from your childhood, the straw you used sometime last year, or the label from a soft drink you had yesterday are now floating around in the atmosphere. The amount of plastic produced globally increases every year and so does the amount of mismanaged plastic waste that ends up in the environment. In 2017, 348 million metric tons of plastic were produced, and it is estimated that 12-18% of this total annual production ended up in the environment. Plastic is not readily biodegradable; it can spend decades and even centuries in the environment, breaking down into smaller and smaller pieces. Finally, these pieces are small enough to be entrained in the atmosphere and carried by the wind.

There are several possible pathways for plastic emissions to the atmosphere. A likely prominent source are emissions from the marine environment, where wave action can emit plastics through sea spray. Roads may also contribute to plastic emissions, not just from tire-wear plastics, but also from debris collected on the road surface and broken down to fine dust. Another likely prominent source is the erosion of agricultural soils that have been fertilized with biosolids collected at wastewater treatment plants. Because the filtration systems in these wastewater treatment plants are effective at retaining microplastics in the solid fraction, the produced fertilizer also has high amounts of microplastics.

To examine the type and source of microplastic in the atmosphere, we quantified plastic fallout due to

gravity (dry deposition) and plastic fallout within rain (wet deposition). We collected the sample at monthly (dry) and weekly (wet) intervals at 11 National Park and Wilderness areas across the western United States. We counted microplastics in 339 wet and dry samples collected over a 14-month period. Plastics were separated by color, size, fiber/particle, and whether they were primary or secondary plastics; Primary plastics are those formed in the size and shape they are found in the environment, like microbeads, whereas secondary plastics are derived from the fragmentation of larger plastic pieces.

Microplastics were present in 98% of the samples collected. Our analyses showed that about 4% of the aerosol particles in the atmosphere are now composed of plastic instead of natural components like minerals and bug parts. The total deposition rates were estimated between 1000 and 4000 metric tons per year, or between 120 and 450 million water bottles. About 70% of the atmospheric microplastics were fibers, likely sourced from textiles. The remainder were mostly derived from the fragmentation of commonly used plastics that were difficult to attribute to a particular source. However, about 30% of the particles were brightly colored microbeads. Due to the size and color distribution, it is likely that these beads are derived from paints and coatings where they are used to create texture and visual effects.

We then compared the plastic particles found in the dry and wet deposition, to try and get a better understanding of plastic emission sources and atmospheric pathways. We found that microplastics deposited dry and wet had different atmospheric life histories and source areas. Wet deposition plastics were associated with air masses travelling over nearby large cities or the amount of soil dust also within the sample. These observations, combined with the fact that the size distribution in the wet deposition was larger than in the dry deposition, suggests the source of the plastics in the wet deposition was more local (<1000 km). By contrast, dry deposited plastics were smaller in size and were more prevalent at high elevation. These observations suggest dry deposited plastics are travelling higher in the atmosphere and are arriving from much further afield. Moreover, dry deposition rates were associated with broad scale climate patterns - like the location of the Jet Stream - and 70% of particles were within the size range where global transport can occur. This provides further evidence that dry deposited plastics are likely moving between continents.

Though the effect of airborne microplastics for ecosystems and human health are not yet well understood, preliminary research suggests plastics can influence basic ecological processes. Furthermore, all aerosols, regardless of composition, can have consequences to human health. These findings should raise some alarms for the global community since the consequences are inescapable in the immediate future.

This research was funded by the Utah Agricultural Experiment Station research grants UTA01421 and UTA01384 and the National Science Foundation grant 1926559.