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News & Highlights

Satellite Tracking and Global Treaty Effort Open New Front on Plastic Waste Problem

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As the rate of plastic production continues to climb towards a projected billion tonnes (Gt) a year by 2050 (Fig. 1) and the volume of plastic waste grows accordingly, a new satellite-based platform launched in May 2022 has begun to monitor the world's land-based plastic pollution. Global Plastic Watch (GPW) is a freely accessible online platform that combines the 13 bands of spectral data from the European Space Agency's Sentinel-2 satellites with machine learning to identify and monitor the many thousands of piles of plastic-rich garbage strewn across the world [1]. It is another example of the growing use of increasingly sophisticated satellite technology to address climate change and other long-standing environmental concerns [2].

The aim of the tool, developed and currently funded by the Perth, Australia-based philanthropic Minderoo Foundation, is to support governments, industries, and communities in preventing plastic leakage into the aquatic ecosystems where it becomes particularly damaging. GPW not only shows the current scale of plastic-rich waste dumps—down to resolution of 5 m × 5 m—but also how they have changed over time, how close they are to waterways, characteristics of the soil and terrain, local population density and more (Fig. 2).

"The Global Plastic Watch is focused on what happens to plastic when it leaves households and ends up either in formal landfills or in undocumented or illegal dumpsites," said Fabian Laurier, Minderoo's lead for Technology and Innovation as well as Ocean Conservation. "Plastic reaching the ocean is like milk dropped into tea—it is almost impossible to recover. It must be prevented from entering river systems in the first place."

While a significant amount of plastic is dumped directly in the ocean, the contribution from land-based sources is much bigger, said Laurent Lebreton, head of research at The Ocean Cleanup, a Rotterdam, the Netherlands-headquartered international organization that develops technology to remove plastic pollution from the surface of the ocean and intercept it in rivers. "The current consensus is that about 20% comes from marine sources and 80% from land-based sources. But really, we are not sure. And most of the floating trash released into the ocean from rivers quickly beaches back onto the shore" (Fig. 3).

The GPW platform currently covers 25 countries identified in a 2021 *Science Advances* paper as having the highest release rates of

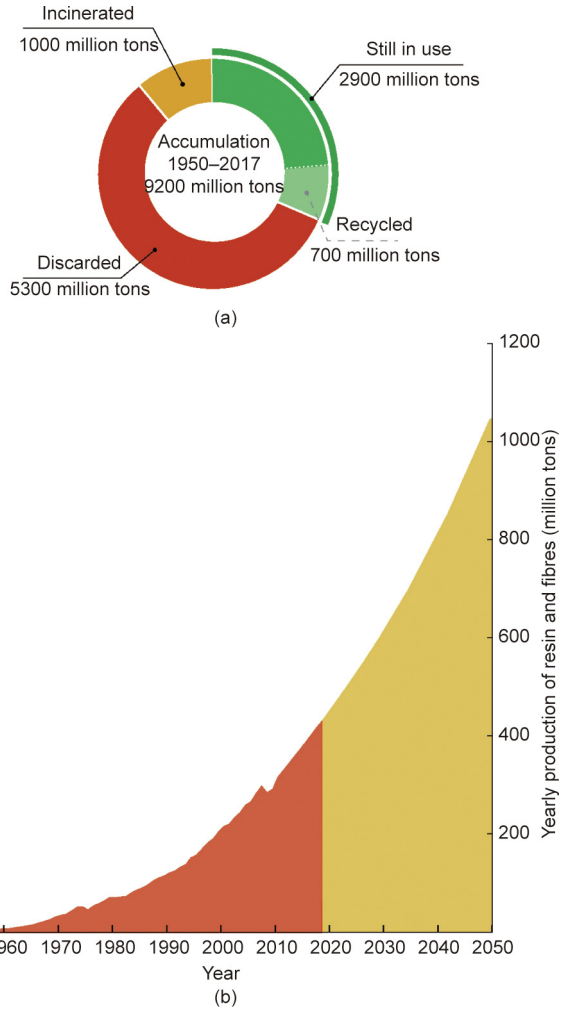

Fig. 1. (a) In 2017, the total amount of plastic ever produced reached about 8.3 Gt (9.2 billion tons). (b) Projections estimate that annual production will exceed 1 Gt annually by 2050. Credit: United Nations Environment Programme (UNEP) and GRID-Arendal, with permission.

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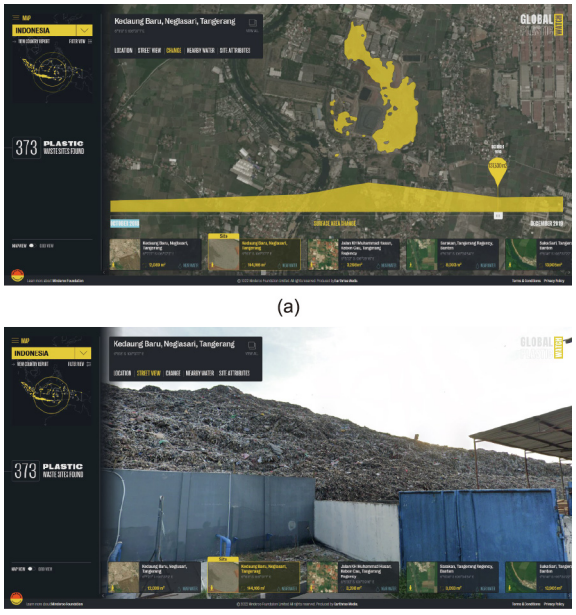

Fig. 2. The GPW platform allows anyone to home in on thousands of plastic-rich waste dumps in the 25 countries in which most plastic waste enters aquatic ecosystems. These sample GPW screen shots show: (a) The physical extent of individual dumps in a province of Indonesia at different time points overlaid onto a Google Earth-style map; and (b) a Google Street View image of one of the dumps identified in the previous screenshot. Credit: Global Plastic Watch, with permission.

Fig. 3. Much of the floating trash that reaches the ocean from rivers, the primary source of plastic waste entering the oceans, quickly ends up covering beaches, like this one in Honduras. Credit: The Ocean Cleanup, with permission.

plastic pollution into rivers and ultimately into the oceans [3]. Lebreton, the senior author of that paper, provided an example of how GPW has already proved useful. He was working on a garbage-interception project on the Rio de Las Vacas, a tributary of the Rio Motagua in Guatemala (Fig. 4). "I had never seen so much plastic in a river before," said Lebreton. "We found out that upstream in Guatemala City there is a huge, out-of-control, open-air landfill built right on the river—it popped up on the GPW platform." This additional documentation of the cause of the problem facilitated discussions with the country's administrators, said Lebreton: "Just documenting it was very powerful. It focused attention upstream. And this can have a big impact on policymaking."

While GPW coverage of the rest of the world is planned, European nations and the United States are not included among the 25 countries currently monitored by the platform. "We know

Fig. 4. Plastic waste temporarily captured by an experimental "trashfence" constructed by The Ocean Cleanup across the Las Vacas River in Guatemala. In this May 2022 pilot effort, the sheer amount of waste ultimately resulted in the failure of the barrier. Credit: The Ocean Cleanup, with permission.

that developed countries export waste to poorer countries, and we also want to understand what that contribution actually is," said Laurier. "But this is not a finger pointing tool."

Although the GPW does not address the problem of plastic waste shipped from Western countries to developing ones, the additional surveillance of plastic waste is welcome, said Steph Borrelle, a conservation research fellow at the University of Toronto in Canada, and Pacific regional coordinator for BirdLife International in New Zealand. The amount of plastic entering the world's aquatic ecosystems every year is "staggering," said Borrelle, lead author of a 2020 *Science* paper that modelled how the predicted growth in plastic waste will far outstrip efforts to mitigate plastic pollution [4]. "When I was running the analysis, I kept thinking 'this cannot be right,' but we went over the numbers again and again." According to Borrelle and her co-authors, 19–23 Mt of domestic plastic waste entered aquatic ecosystems in 2016, equivalent to about 11% of all the plastic waste generated globally that year. Under the research team's "business as usual" scenario, that annual ocean-bound plastic waste could rise to 90 Mt annually by 2030 [4].

When plastics enter rivers and oceans, wave action, sunlight, and wind cause them to gradually break down into microplastic particles, defined as being less than 5 mm in length, which harm and kill a range of aquatic life. And microplastics are now found virtually everywhere—in the oceans, on land, at the poles, even on mountaintops [5]. "Microplastics are now found in human bodies, in the placentas of unborn babies [6], in most animals, even in the air—we are truly living in the 'Plastisphere,'" said Borrelle.

Since the 1950s, an estimated 5.7 Gt of the 8.3 Gt of plastic ever created has become waste, with only about 9% of this waste recycled and the rest discarded into landfill or incinerated (Fig. 1) [7,8]. While recycling efforts are laudable, they are not the answer to the problem of plastic pollution, Borrelle said. "Plastic cannot be recycled infinitely. It can only be 'downcycled.' So, eventually, whatever is recycled still ends up as waste."

Economics poses another problem for plastic recycling. Over the course of 2021 in Europe, for example, the cost of the most common type of recycled plastic—post-consumer polyethylene terephthalate—doubled, and it became more expensive than its virgin-plastic equivalent [9].

Against this bleak global backdrop of plastic pollution, there is cause for optimism. On 2 March 2022, on what the United Nations Environment Programme (UNEP) hailed a "historic day in the campaign to beat plastic pollution," world leaders at the fifth session of the United Nations Environment Assembly (UNEA-5) in Nairobi, Kenya, unanimously agreed on a historic resolution to tackle

plastic pollution at the global scale [10]. The resolution—"End plastic pollution: towards an international legally binding instrument"—triggers negotiations for a global treaty that will address not only plastic pollution in all environments but also the full lifecycle of plastics, including primary (virgin) production, product design, and waste management. The resolution established an Intergovernmental Negotiating Committee with the ambitious goal of completing a draft of the legally binding agreement before the end of 2024.

"Wins are hard fought and incredibly rare in environmental campaigning and advocacy," said Christina Dixon, Ocean Campaign Leader at the Environmental Investigation Agency (EIA), a London, UK-based charity that rallied support for the resolution ahead of the meeting, including via a "Scientists' Declaration" on the eve of the Nairobi negotiations, a document endorsed by hundreds of scientists and research institutes [11]. "The collective spirit and common goal at UNEA-5 was extremely powerful," said Dixon.

The resolution covers the creation of national reporting standards for plastic production and includes the option to create a dedicated fund to support poorer nations in implementing the treaty. Crucially, it also holds scope for the negotiation of a legally enforced phasing down of the production of virgin plastic. "Tackling plastic pollution means tackling plastic production—the two are indistinguishable from one another," said Tom Gammage, the EIA Ocean Campaigner who coordinated the Scientists' Declaration.

And there is also growing recognition of the problem and action on it being undertaken on a local level. For example, many countries have made independent inroads in tackling plastic pollution by banning some forms of single-use plastics [12,13], and in July this year the US state of California passed new laws limiting the use of plastics and obliging manufacturers to facilitate recycling, among other actions [14].

But such efforts alone will not solve the problem, said Gammage, who foresees the United Nations (UN) treaty ultimately providing new regulations, globally coordinated and nationally implemented, on the types and volumes of plastics produced, the manufacture of plastic products, and new regulations on plastics in diverse industries, from fishing and agriculture to plastic packaging and textiles.

The primary producers of virgin plastic are the petrochemical industries. According to the Plastic Waste Makers Index, a report produced by the Minderoo Foundation, just 20 polymer producers account for more than half of the planet's single-use plastic that eventually ends up as waste [15]. The United States-based firms ExxonMobil and Dow, and China-based Sinopec, top the list (Fig. 5).

Environment campaigners expect fierce lobbying from a petrochemical industry financially incentivized to dilute the future treaty's controls on plastic production. "For such companies, it is about refusing to acknowledge the human health or environmental impacts of their products and deferring responsibility to their customers," said Borrelle.

Dixon is also concerned. "The oil and gas business model relies on no controls on plastics production. They want to keep making as much as possible," he said. "The industry lobby was somewhat behind the scenes at the Nairobi meeting. We expect a lot more interest from that powerful constituency group during the treaty negotiations."

Meanwhile, the GPW will be put to good use, said Laurier: "We are working very closely with UNEP to explore ways to use the tool to inform the development of the treaty, and to gain a clearer picture of trends in waste and waste management, or lack thereof, all over the world."

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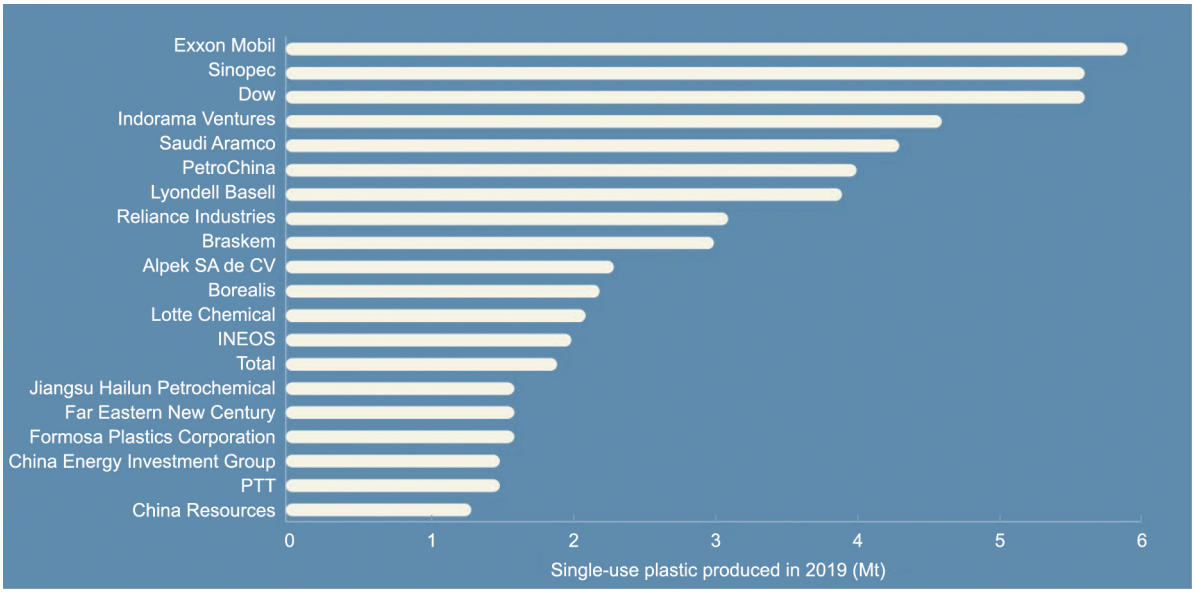

Fig. 5. The top 20 polymer producers generating single-use plastic. PTT: Petroleum Authority of Thailand. Credit: Minderoo Foundation, with permission.

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