Microsoft

AI for Earth Grantee Profile

The Ocean Cleanup

Identifying and quantifying plastic debris removed from rivers

Summary

The Ocean Cleanup (TOC) is a non-profit group headquartered in Rotterdam whose goal is a 90 percent reduction in ocean plastic by 2040. Knowing that millions of tons of plastic enter the oceans via rivers each year, the group focuses on both preventing plastics from reaching the ocean (via river cleanup) and on cleaning what exists in the ocean. Reducing and preventing pollution in waterways will improve environmental health, economic factors, and human wellbeing, and TOC is now using AI and other technology to improve the efficiency of waste removal and identification in the 1 percent of Earth's rivers that contribute 80 percent of ocean-bound plastics.

Classifying and removing plastics from diverse waterways

Plastics are ubiquitous in modern life, from water bottles and food packaging to tools, toys, containers, and more. However, the qualities that make plastics so common in daily use—the ease of mass production, versatility, and durability—also make them a problem after use, especially when waste plastic makes its way into the oceans. Plastics do not decompose into naturally usable byproducts; instead, they break apart over time into tiny pieces called microplastics. Because plastics are indigestible, they can clutter up the stomachs of animals that eat them by mistake and cause direct injury or starvation, and as microplastics they can infiltrate the entire food chain from the largest to smallest creatures. Microplastics also can absorb other pollutants and toxic chemicals, adding to the harm when the plastics are eaten. Furthermore, the clutter of plastics damages various marine habitats, threatening aquatic biodiversity, and can damage vessels and cause navigation hazards as well. Finally, the ubiquity of plastics means the problem only grows over time as more accumulates in the oceans.

"We're on a mission as an organization to help rid the world's waters of plastic, which is an easy thing to say and more difficult to do," explains Ewan Topping, Senior Partner Manager at The Ocean Cleanup (TOC), a non-profit organization headquartered in Rotterdam whose goal is a 90 percent reduction in ocean plastic by 2040. Although much initial research was focused on removing plastic waste from the ocean, it's important to identify the source of this debris—Earth's rivers. "It's not enough to clean up the existing legacy plastic in the ocean. We need to do something to turn off the tap of that plastic coming into the ocean as well," says Topping. Following its work on ocean plastics, TOC commissioned research into plastic pollution originating in rivers and

found that 80 percent of ocean-bound plastics comes from a mere 1 percent of Earth's rivers (1,000 rivers globally).

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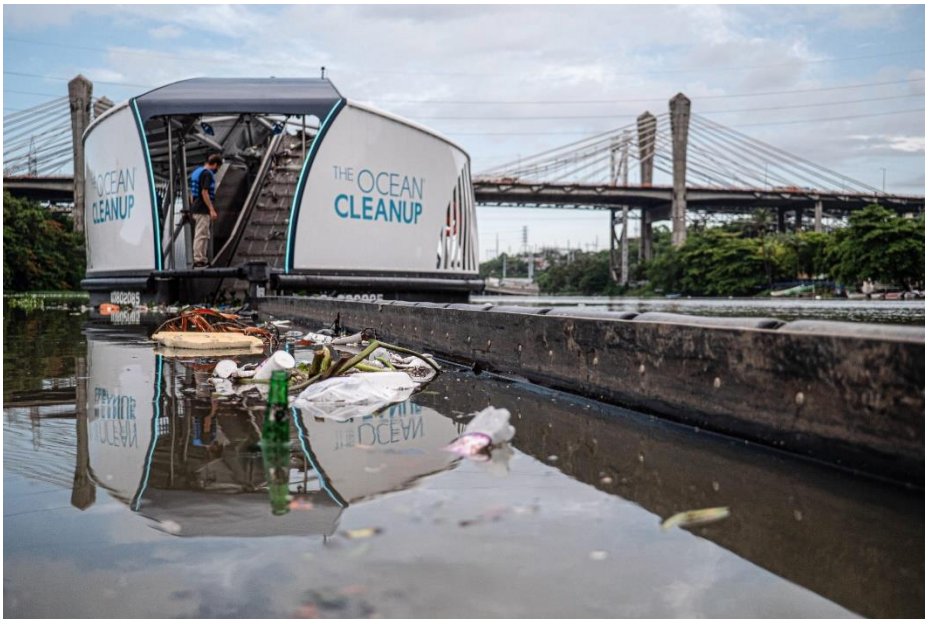
>
> —Ewan Topping, Senior Partner Manager, TOC

Work began to identify plastics, types of plastics, and organic waste in rivers. Prior to the adoption of AI, the identification and labeling of debris, initially deployed in Indonesia and Malaysia, was a manual process. The resulting information is key to understanding the scope and type of plastic pollution and necessitates the ability to differentiate between natural material (like sticks and leaves) and plastics. "I hadn't embarked yet on doing machine learning and image recognition, but I really wanted to," recalled Kees Van Oeveren, TOC Project Engineer, also noting the tediousness of the work.

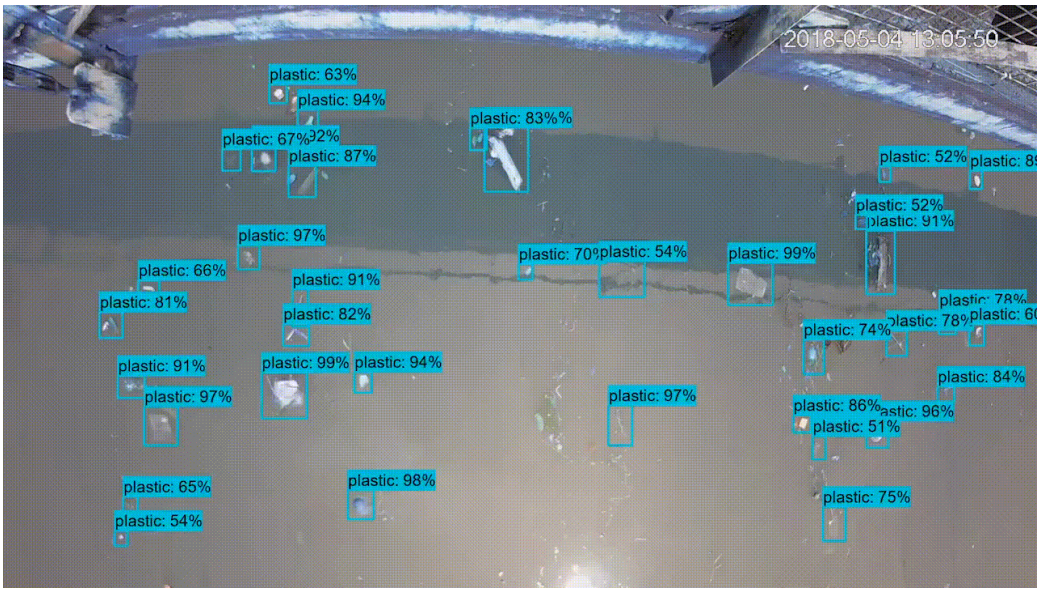
Generating machine learning models through hackathons

In 2018, TOC received a grant from Microsoft AI for Earth, supporting their advancement of machine learning techniques in quantifying plastic pollution in rivers. Microsoft employees, including machine learning specialists, data scientists, software engineers, and cloud architects, participated in the hackathon's development of a machine learning model, with subsequent models developed to be used with cameras mounted on drones and ships. TOC Geospatial Analyst Robin De Vries says, "We labeled over 30,000 ocean photos with the help of [the 2019] Hackathon volunteers and their network." The resulting model helps in the identification and classification of plastics and can be used in river environments as well.



Interceptor 004 installed in the Rio Ozama, Dominican Republic, summer 2020 (Image courtesy The Ocean Cleanup)

These advances also moved much of the image classification to the cloud, rather than using local computing resources. Van Oeveren says, "I remember mounting security cameras with power banks attached to them at rivers that would just simply store some images locally." Now, solar-powered cameras are used, and depth meters are installed on bridges, with the data feeding into the new model and improving customization of solutions at each unique river. In addition to differentiating between plastic and organics (shown in the following image), models are working to identify types of plastics, as this informs where the collected waste, caught by an Interceptor, can be processed and how it can be reused.



Animation showing the AI model identifying plastics floating in the river (Image courtesy The Ocean Cleanup)

Accelerating progress with technology resources

"Using the AI for Earth grant, we've been able to set up and run the machine learning models," De Vries says. "Having the resources at our fingertips has greatly accelerated the technical progress, by taking away practical concerns and letting us focus on the development. It allowed us to develop the vision that this is something we can do, not just for one river, but eventually for rivers across the globe." Additionally, the 15 rivers currently home to debris interceptors will help to fine-tune the AI model and allow for further customization in future projects. Solutions will vary based on geography, flow, river depth, seasonality, and even the availability of local partners. The ability to inform AI-driven models with these early projects will allow for greater measurable impact in the remaining locations, and help TOC meet its goal of removing 90 percent of ocean plastics by 2040.

About The Ocean Cleanup

The Ocean Cleanup (TOC), founded in 2013 by Boyan Slat in the Netherlands, works to solve ocean plastic pollution (totaling millions of tons per year) by cleaning up existing plastic pollution and capturing new inflow of debris. Left unchecked, these plastics drift into large patches known as gyres, eventually breaking down into microplastics that are harmful to sea life and the food chain. TOC's work aims to protect across three pillars: environment, economy, and health.

Resources

Websites

The Ocean Cleanup home site: https://theoceancleanup.com/

Publications

Lourens J. J. Meijer, Tim Van Emmerik, Ruud Van Der Ent, Christian Schmidt, and Laurent Lebreton. "More than 1000 rivers account for 80% of global riverine plastic emissions into the ocean." *Science Advances* 30 Apr 2021, Vol 7, Issue 18. DOI: 10.1126/sciadv.aaz5803 https://www.science.org/doi/10.1126/sciadv.aaz5803

Documentation

"Why is Marine Debris a Problem?" NOAA Marine Debris Program. September 28, 2021. https://marinedebris.noaa.gov/why-marine-debris-problem/

"Clean Seas Campaign promotes the right to a healthy environment, including plastic-free oceans." United Nations Environment Programme. June 9, 2021. https://www.unep.org/news-and-stories/story/clean-seas-campaign-promotes-right-healthy-environment-including-plastic

"A Guide to Plastic in the Ocean." NOAA National Ocean Service. February 26, 2021. https://oceanservice.noaa.gov/hazards/marinedebris/plastics-in-the-ocean.html

"Feature: UN's mission to keep plastics out of oceans and marine life." United Nations News. April 27, 2017. https://news.un.org/en/story/2017/04/556132-feature-uns-mission-keep-plastics-out-oceans-and-marine-life