

# Plastics, Pollution, and Solutions

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## Quick Facts:

- Each minute, the equivalent of nearly two trucks of plastic is dumped into the ocean.
- Some plastic:
  - can be recycled (PET or PETE – polyethylene terephthalate);
  - cannot be mass recycled (food packaging);
  - contain chemicals that should not be used again (BPA – bisphenol-A).
- Of the 40 million metric tons of plastic waste managed in the U.S. in 2019, only 5% was recycled.
- In 2019, 187 countries agreed to coordinate efforts on the plastic pollution crisis by updating the 1989 Basel Convention, which only the U.S. and Haiti have not ratified.
- In March 2022, 175 nations at the UN Environment Assembly adopted a resolution to draft a legally binding agreement to tackle plastic pollution by 2024.



*Beach pollution at Kuta beach, Bali. Photo credit: Maxim Blinkov / Shutterstock*

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## I. Executive Summary

Plastic pollution is a problem that affects the entire world, polluting both land and water. The equivalent of nearly two trucks' worth of plastic litter is dumped into the oceans every minute, totaling 19-23 million metric tons annually. The entire marine ecosystem, from coral reefs and plankton to sperm whales, is negatively impacted by plastic pollution.<sup>[1]</sup>

Huge plastic islands are floating in the ocean and coming ashore on small island nations. Some of the plastic can be recycled (PET or PETE – polyethylene terephthalate), some plastic cannot be mass recycled (food packaging), and some plastic contains chemicals that should not be used again (BPA – bisphenol-A).

Some start-ups and organizations are coming up with solutions to plastic pollution that benefit poverty-stricken communities overwhelmed by plastic debris.

Since pollution from plastic waste affects the entire world and continues to grow, and China, which had been recycling around half of the world's waste, began refusing to accept some recyclables from other countries, new solutions are needed to recycle the world's plastic pollution washing up on all of the world's shores.

In 2019, most of the world's countries agreed to new restrictions on moving plastic waste to fight against the effects of plastic pollution.<sup>[2]</sup> That action followed a global petition signed by nearly one million people urging action to prevent western countries from "dumping millions of tonnes of plastic waste on developing countries instead of recycling it."<sup>[3]</sup>

On March 2, 2022, 175 nations at the UN Environment Assembly adopted the first-ever plastics pollution treaty.<sup>[4]</sup> The resolution pledged to draft a legally binding agreement tackling plastic pollution by 2024.<sup>[5]</sup> In a joint statement welcoming the resolution, US Senators Bob Menendez (D-NJ), Dan Sullivan (R-Alaska), and Sheldon Whitehouse (D-RI), stated: "We are very pleased to see this major step forward in the global fight against the marine debris crisis and look forward to collaborating with partner countries to reach a final agreement."<sup>[6]</sup>

On December 19, 2022, 196 states party to UN Convention on Biological Diversity adopted the Kunming-Montreal Global Biodiversity Framework. The framework sets out four goals and 23 targets against biodiversity loss to be achieved by 2030. Target 7 demands that states prevent, reduce and work toward eliminating plastic pollution from all sources.<sup>[7][8]</sup>

On March 4, 2023, participants at the Intergovernmental Conference on Marine Diversity of Areas Beyond National Jurisdiction (BBNJ) agreed on the text of a *Draft Agreement under the United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction*. The legally binding agreement, 19 years in the making, recognizes the need to address biodiversity loss and degradation of ecosystems of the ocean due to climate change, ocean acidification, pollution (including plastic pollution) and unsustainable use. The agreement is not yet open for signature at the United Nations with the start date still pending as of March 16, 2023.<sup>[9]</sup>

## II. Plastic Pollution – Facts and Challenges

### A. Some facts about plastic pollution:

1. The equivalent of nearly two trucks' worth of plastic litter is dumped into the oceans every minute, totaling 19-23 million metric tons annually. The entire marine ecosystem, from coral reefs and plankton to sperm whales, is negatively impacted by plastic pollution.<sup>[10]</sup>
2. According to a National Geographic.com article: "The prediction that by mid-century, the oceans will contain more plastic waste than fish, ton for ton, has become one of the most-quoted statistics and a rallying cry to do something about it."<sup>[11]</sup>
3. Most ocean plastic pollution comes from India, China and Indonesia.<sup>[12]</sup>
4. Results from a comprehensive plastic waste assessment by researchers from the National Renewable Energy Laboratory in Colorado (published in August 2022), estimated that a total of 44 million metric tons of plastic waste was managed in the U.S. in 2019, with approximately 86% heading to landfills, 9% combusted and only 5% recycled. Plastic waste sent to landfills may take up to 1,000 years to decompose.<sup>[13][14]</sup>
5. The World Economic Forum estimates that "32% of plastic packaging escapes collection systems," polluting the oceans and clogging urban environments.<sup>[15]</sup>
6. Only 14% of plastic packaging is collected for recycling, according to the World Economic Forum, noting that "the recycling rate for plastics in general is even lower than for plastic packaging, and both are far below the global recycling rates for paper (58%) and iron and steel (70–90%)."<sup>[16]</sup>
7. Pacific island nations deal with rising sea levels, overfishing and "remote islands are increasingly awash in plastic trash."<sup>[17]</sup>
8. According to a WashingtonPost.com headline on 1/20/2016: "By 2050, there will be more plastic than fish in the world's oceans, study says."<sup>[18]</sup>
9. "Microplastics – plastic particles smaller than 5 mm in diameter – have been shown to be contaminated with toxic chemicals. These microplastics are small enough to be ingested by marine species, potentially affecting species' and human health as they enter the food chain."<sup>[19]</sup>
10. A 2022 report by the Organisation for Economic Co-operation and Development (OECD) notes that "plastic waste produced globally is on track to almost triple by 2060, with around half ending up in landfill and less than a fifth recycled."<sup>[20]</sup>
11. A 2020 research article published in *Science*, found that "current commitments coupled with appropriate policies" will only reduce plastic pollution by a rate of 7.7% by 2040, and that a "coordinated global effort is urgently needed" to avoid future build-up of plastic in the environment.<sup>[21]</sup>
12. Greenpeace, in their 2022 report "Circular Claims Fall Flat Again," argue that "plastic recycling is a failed concept," noting that the lack of plastic recycling is due to "toxicity and economics."<sup>[22]</sup> The report goes on to say that "companies must take action to eliminate single-use plastics and packaging" rather than using "recycling as a smokescreen to divert attention away from the systemic changes that are needed" such as reuse and refill systems and packaging-free approaches.<sup>[23]</sup>
13. A March 2023 collaborative study by researchers in the United States, Sweden, Chile and Australia used new and existing data to estimate the amount of small plastics in the world's oceans. Using data from 1979-2019, the authors concluded that "today's global abundance [of ocean plastic] is estimated at approximately 82–358 trillion plastic particles weighing 1.1–4.9 million tonnes. We observed no clear detectable trend until 1990, a fluctuating but stagnant trend from then until 2005, and a rapid increase until the present."<sup>[24]</sup>

### B. Different types of plastics before recycling – These can be recycled:

- #1 plastics known as PET or PETE (polyethyleneterephthalate) are usually made into water bottles and peanut butter containers, and can be recycled into carpets and furniture.<sup>[25]</sup>
- #2 HDPE (high-density polyethylene) plastics are usually made into milk jugs and shampoo bottles and may be recycled into pens and picnic tables; #5 polypropylene plastics are in yogurt cups and syrup containers and may be recycled into brooms and signal lights.<sup>[26]</sup>

### C. Different types of plastics before recycling – These either pose problems for recycling or cannot be recycled:

- #3 PVC (polyvinyl chloride) plastics are not usually picked up for recycling, can be harmful when incinerated, contain toxic dioxins, and may be recycled into flooring and park benches among other items.<sup>[27]</sup>
- #4 LDPE (low-density polyethylene) is used for grocery bags and bread bags and are usually not recycled.<sup>[28]</sup>
- #7 are plastics that contain chemicals not in categories 1-6 (#6 includes Styrofoam products) and may contain BPA (bisphenol-A) which has been linked to health issues such as obesity and infertility.<sup>[29]</sup>

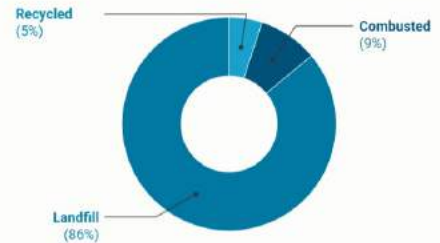
According to an article on Livestrong.com, there are certain plastic items that cannot be recycled, and they include plastic pill bottles, plastic straws and utensils, and Styrofoam.<sup>[30]</sup>

### D. China, which has had some controversy over its recycling practices, stopped accepting some plastics for recycling from outside the country for various reasons starting on Sept. 1, 2017.<sup>[31]</sup>

- "China had been processing at least half of the world's exports of waste paper, metals and used plastic — 7.3 million tons in 2016, according to recent industry data. Last July, China notified the World Trade Organization that it intended to ban some imports of trash, saying the action was needed to protect the environment and improve public health. ... Chinese officials also complained that much of the recyclable material the country received from overseas had not been properly cleaned or was mixed with non-recyclable materials."<sup>[32]</sup>
- "'PlasticChina' an award-winning documentary released in late 2016, ignited further public outrage by highlighting the human and environmental costs of the under-regulated, Wild

### Plastic Waste Management in the US by Process (2019)

44 million metric tons of plastic waste was managed in the U.S. in 2019, with approximately 86% heading to landfills, 9% combusted and only 5% recycled.



The chart above shows results of a comprehensive plastic waste assessment by researchers from the National Renewable Energy Laboratory in Colorado (published in August 2022).

Chart: A-Mark Foundation • Source: National Renewable Energy Laboratory • Get the data • Download image • Created with Datawrapper

### Top 10 Countries That Dump the Most Plastic into the Oceans, 2020

In 2020, the top 10 dumpers of plastic waste threw 325.2 million kilograms (or 716.9 million pounds) of plastic into the oceans.

Rank	Country	Amount of Plastic (kg)
1	India	126.5M
2	China	70.7M
3	Indonesia	56.3M
4	Brazil	38M
5	Thailand	22.8M
6	Mexico	3.5M
7	Egypt	2.5M
8	USA	2.4M
9	Japan	1.8M
10	UK	0.7M

Table: A-Mark Foundation • Source: RAJA • Get the data • Download image • Created with Datawrapper

...recycling, an article in the documentary released in late 2010, ignited further public outrage by highlighting the human and environmental costs of the under-regulated, thin West-style recycling industry.”<sup>[33]</sup>

### III. Plastics Recycling and Its Application

**A. “Plastic waste has three fates — recycling, thermal destruction [combustion] and landfills.”<sup>[34]</sup>** Plastics that are recycled for other uses may be separated, washed then chopped, creating plastic flakes. A bottle cap and a bottle have to be separated because they are two different materials.

**B. Plastic flake is made** when certain types of plastics are chopped up in the recycling process. Companies are finding new uses for plastic flakes:

“Dark colored plastic flake is generally utilized in products that just get dyed black. For this reason, darker colored plastic has a narrow end-use, which results in low demand in the world market. ... Thread was able to bring a customer, HP, to the table and create a demand for dark colored flake. This meant the price of that dark colored plastic increased. Furthermore, we were able to negotiate on behalf of the collection center owners for an additional two cents per pound. As that higher price flows through the entire collection network, more volume is collected. In fact, the recycling center that HP is purchasing from reported a 15% increase in collection volume shortly after the price increase. That increased volume means that more cash is being infused into the collection network, which allows collection centers owners to reinvest in their businesses or use the profits to further support their families. Thread and HP were able to increase the value of material that was priced so low it was barely being collected. In turn, that same material that was polluting the environment is now being picked up because of the higher price. Both of these factors come together to result in an increased amount of plastic moving through the system.”<sup>[35]</sup>

**C. There is the possibility of energy as a by-product of the plastics recycling process:**

- Recycling Technologies created a machine in which “plastics are turned into the new oil called Plaxx. The energy needed to run the machines will partly be supplied by the gas emitted during processing and the Plaxx produced will be sold on for reuse.”<sup>[36]</sup>
- “EcoFuel technologies’ (EFT) portable plastics-to-fuel technology can create about a gallon of diesel from 10 pounds of plastic. ... Two proof-of-concept units designed to produce 20 gallons per day are available for observation, examination and sample processing.”<sup>[37]</sup>

**D. Solar power solutions from plastics:**

- “An Hungarian company called **Platio** developed pavement tiles with solar panels integrated into them, made from recycled plastic.”<sup>[38]</sup>
- A NGO in Argentina, **Sumando Energias**, shows people how to make a solar heating system using discarded plastic bottles.

**E. Clothing and accessories from plastics:**

- A team from the International Development Design Summit (IDDS) has created “a way to add value to waste plastic by using a low-cost process to transform it into something useful: plastic sheets. From these sheets can be made a number of other products ... [including] shoes, bags, pencil cases and folders.”<sup>[39][40]</sup>



The plastic recycling press used to create plastic sheets.



Many things can be made from these, including shoes and bags.



Photo credits: Erik (HASH) Hersman / Flickr

**F. The downside of plastics recycling:**

- “After downcycling, plastic is generally unfit for another round of recycling. This means that it ends up in a landfill despite having seen a secondary use as a less useful product. Downcycling simply delays the process, and manufacturers have the same demand for new plastics.”<sup>[41]</sup>
- “The same people who are removing plastics from their lives, who know that plastic bottles contain estrogenic-releasing toxins, may not be aware they are wearing those same plastic bottles. ... Instead, wear a long sleeve cotton shirt under the fleece or polyester fabric so there is a buffering layer between potential leaching BPA or other plastic toxins and the skin that absorbs these toxins.”<sup>[42]</sup>

### IV. Some Organizations & Technologies Dedicated to Plastic Pollution Solutions

**A. Organizations**

1. **4Ocean.com** – “Through worldwide support and the purchase of 4Ocean products, we’ve pulled 21,650,932 pounds of trash from the ocean, rivers, and coastlines thanks to the ongoing support of the clean ocean movement.”<sup>[43]</sup>
2. **Ecodom.mx** – “Ecodom is a social and environmental enterprise dedicated to prefabricated ecological dwelling development to provide safety and sustainable life. Our products are developed with recycled elements such as plastics and cardboard to the end of reducing waste in our surroundings.”<sup>[44]</sup>
3. **Lego / Sustainable Materials Center** – “Lego pumped \$155 million into a new Sustainable Materials Center. ... About 25 different Lego shapes, many of them plants, will now be made from sugarcane-based polyethylene rather than oil-based plastic. ... By the end of the year, under two percent of Lego bricks will use the new polyethylene. ... While the percentage sounds small, keep in mind that Lego sells 75 billion elements every year.”<sup>[45]</sup>
4. **Liter of Light** – NGO – “Liter of Light was born from an original idea by Alfredo Moser in 2002, and consists of giving plastic bottles full of water and bleach (to prevent algae from growing in the water) to households and schools in areas without access to electricity. This method can also be of use in areas where the regular network is faulty, or where being connected to the grid is simply too expensive. One bottle is inserted into a [sic] whole made in the roof of the house, and provides the equivalent of a 55-Watt bulb during the day, with the sunlight refracting through the water in the bottle and into the house.”<sup>[46]</sup>
5. **MacRebur** – “In the case of recycled plastic roads, the future is now. U.K. startup is already working with a number of local municipalities on enhancing asphalt roads with tiny pellets of plastic made from recycled bottles, thereby reducing the amount of fossil fuel bitumen in the mix. The company claims the result is 60 percent stronger, longer-lasting, and more eco-friendly than traditional roads.”<sup>[47]</sup>
6. **NOAA Marine Debris Program** – “The NOAA Marine Debris Program is authorized by Congress to work on marine debris through the Marine Debris Act, signed into law in 2006 and

amended in 2012, 2018, and 2020.<sup>[48]</sup>

7. **Ocean Conservancy's 'Trash Free Seas Alliance'** – "Ocean Conservancy has mobilized millions of people around the world to remove trash from our ocean and waterways. But removal is just one part of the solution. We must also prevent trash from reaching our waterways and the ocean, which is why in 2012 Ocean Conservancy launched the Trash Free Seas Alliance®. The Alliance unites industry, science and conservation leaders who share a common goal for a healthy ocean free of trash. The Alliance provides a constructive forum focused on identifying opportunities for cross-sector solutions that drive action and foster innovation."<sup>[49]</sup>
8. **Ocean Recovery Alliance** – "The Ocean Recovery Alliance is also a founding member of the Ocean Conservancy's 'Trash Free Seas Alliance' which was announced at the Clinton Global Initiative in 2011. ... We are the founder of the unique Plasticity Forum, focused on the future of plastic, and where the leaders are going with design, innovation, materials, recycling and solutions, for a world with reduced waste."<sup>[50]</sup>
9. **PagaBags and French NGO Couleur Baobab** – "PagaBags was born from plastic bags. ... the founding members of the French NGO Couleur Baobab, Françoise Chevallier and her husband Jacques, ... connected PagaBags with an association of women farmers in Boussouma. ... The technique involves prodding small chunks of pre-cut plastic onto a metal stick. The stick is then slowly rotated over a fire until the plastic softens. It does not take long but it does take skill and concentration."<sup>[51]</sup>
10. **Parley.tv** – "Since partnering with Parley in June 2018, American Express has taken steps to reduce the use of single-use plastics, support beach cleanups and educate employees to be part of the solution. The collaboration now announces expanded commitments to the Parley AIR Strategy with a global campaign to #BackOurOceans and the introduction of a new symbol for change: the launch of the first-ever Card made primarily with reclaimed plastic intercepted by Parley from beaches, shorelines and coastal communities."<sup>[52]</sup>
11. **Plastic Bank** – "The company, formed in 2013, pays people to collect plastic waste and take it to recycling markets in Haiti and, more recently, the Philippines. (There are plans to expand to Brazil and Indonesia, followed by South Africa, the Vatican, Panama and India). Collectors can receive payment in money, of course, but they also can draw on the credit to buy stuff, like cook stoves or fuel, at special stores."<sup>[53]</sup>
12. **Plastics For Change** – "Our program is designed to make it profitable for companies to transition away from virgin plastic and start sourcing recycled. ... 1% of the urban population in developing countries relies on recycling as their primary household income. Life at the base of the recycling supply chain is tough. Our ethical sourcing platform can help break the poverty cycle and create lasting change. ... Our program is designed to provide predictable and sustainable livelihoods to some of the world's most marginalized and exploited people groups. Our inclusive business and fair trade practices ensure dignified work to some of the poorest communities."<sup>[54]</sup>
13. **Plastic Oceans** – "Our Mission: Through programs in Education, Activism, Advocacy and Science, we work to inspire changes in consumer behavior, corporate practices and public policy, with the goals of ending plastic pollution and fostering sustainable communities worldwide."<sup>[55]</sup>
14. **Plastic Pollution Coalition** – "PPC was founded in 2009 as a platform to amplify a common message through strategic planning and communication. Our more than 500 member organizations and a growing coalition of individuals seek to increase understanding of the plastic pollution problem and to find sustainable solutions. We aim to empower more people and organizations to take action to stop plastic pollution and to live plastic-free."<sup>[56]</sup>
15. **Recycling Technologies** – "The recycling startup has built a machine that vaporizes all types of plastics and petroleum-based products like carpeting through thermal cracking into a product it calls Plaxx. Plaxx is actually a catch-all name for a number of different products, ranging from Plaxx-8, a feedstock for producing new plastics, to Plaxx-30, for heavy fuel oil."<sup>[57]</sup>
16. **Renewlogy** – "Renewlogy (new branding for PK Clean) solves the problem of plastic waste entering landfills and oceans by turning it into fuel. While reduction, reuse, recycling and single-use plastic bans are the best answers, these answers can sometimes be slow to enact on the large scale needed to address the plastic pollution problem. ... We are currently fundraising to get a portable plastic to fuel converter to the Haitian people as a means to cleanup the island and provide clean fuel that otherwise has to be imported."<sup>[58]</sup>
17. **Sumando Energias** – Argentinian NGO: "Things have changed thanks to ingenious but very simple solar panels made from recycled plastic bottles. ... The homemade system is made of used soda cans, plastic bottles and milk cartons. As the sun heats the tubes of the solar collector, hot water flows into the storage tank. Volunteers paint the pipes black to adsorb heat from the sun. In this way, the solar collector keeps water hot all night long without the need for electricity or gas."<sup>[59]</sup>
18. **The Ocean Cleanup** – "The Ocean Cleanup's team consists of more than 70 engineers, researchers, scientists and computational modelers working daily to rid the world's oceans of plastic. ... The Ocean Cleanup's passive system is comprised of a floater with a solid screen underneath, concentrating the debris and leading it to a collection system. The system is slowed down by a drift anchor suspended at an approximate depth of 600 meters, making the system move slower than the plastic and therefore catching it. ... The Ocean Cleanup has estimated to be able to remove 50% of the Great Pacific Garbage Patch in just 5 years' time."<sup>[60]</sup>
19. **University of Portsmouth, UK** – "Biologists at the U.K.'s University of Portsmouth were studying the structure of an enzyme that can break down polyester when they found a way to tweak it. The result, according to a study published this week in the Proceedings of National Academy of Sciences, is a 'mutant enzyme' that can degrade plastics 20 percent more efficiently than its original form. ... So, in theory, if McGeehan's accidental discovery proves successful, the world could see a future in which we no longer need to dig up more oil to make plastic bottles."<sup>[61]</sup>
20. **University of Texas at Austin** - "An enzyme variant created by engineers and scientists at The University of Texas at Austin can break down environment-throttling plastics that typically take centuries to degrade in just a matter of hours to days. This discovery,... could help solve one of the world's most pressing environmental problems: what to do with the billions of tons of plastic waste piling up in landfills and polluting our natural lands and water."<sup>[62]</sup>
21. **VolkerWessels** – "By recycling the plastic into sturdy, hollow road segments, not only are we putting an invaluable and hardy material to good use, but being more environmentally (and economically) responsible by giving plastic a second life."<sup>[63]</sup>
22. **Waste2Wear** – Founder Monique Maissan: "It is a very new concept to link third-world production and products directly to first-world consumer markets. By collaborating with a famous Dutch designer, Monique Collignon, we created The Conscious Collection, high-end fashion made from recycled plastic fabrics. The collection debuted in Amsterdam's 2016 Fashion Week in summer 2016. People were amazed!"<sup>[64]</sup>
23. Separating mixed materials for recycling: a. German company **Saperatec** "has raised about €4.3 million (about \$5.3 million) to tackle one of the toughest problems of plastic recycling—mixed materials..."<sup>[65]</sup>; b. "**Shred-Tech**® has engineered and manufactured custom systems to shred, separate and recover the component materials that make up these electronic products."<sup>[66]</sup>

## B. Portable and local plastics recycling machines

1. **Plastic Fischer** - "Plastic Fischer is a Germany based social enterprise that develops cost-efficient technologies to collect plastic waste from rivers before it can enter the oceans. The company follows the 'Triple L Approach' by using locally built and low-tech solutions to operate at low cost. Avoiding high-tech-imports saves time, carbon, money and ensures quick repair and high scalability. The plastic is manually collected from the systems on a daily basis and brought to sorting facilities. All recyclables are reintroduced into the supply chain. Unfortunately, the vast majority of the collected material is not recyclable and is sent to thermal processing at certified incineration plants."<sup>[67]</sup>
2. **Precious Plastic** – Dave Hakkens, the Dutch founder, makes portable plastics recycling machines from which people make coasters and tiles. According to FastCompany.com: "One set of instructions explains how to build a low-cost machine that shreds plastic into flakes. Another modular machine extrudes plastic that can be used for 3D printing; an injection machine and a compression machine can form plastic into molds. A series of videos explain how to build the machines using basic materials and universal parts."<sup>[68]</sup> Online retailer Bazar.preciousplastic.com was created by Precious Plastics for people who use these portable plastics recycling machines to sell their products.<sup>[69]</sup>
3. **RiverRecycle** - "RiverRecycle takes action by closing the loop on plastic waste in the most affected areas close to rivers and reintroducing the recovered material into the economy. In a circular economy, we create a waste management system that supports local municipalities to effectively manage plastic waste; offer communities safe and fair work and help to stimulate the economy by involving companies who will buy the end products of the river cleaning and recycling system. Our developers are working on projects in seven different countries, and we plan to install 500 river cleaning solutions over the next five years."<sup>[70]</sup>

4. **Seabin Project** - "The Seabin V5 moves up and down with the range of the tide collecting all marine debris. Water is sucked in from the surface with a submersible water pump capable of displacing 25,000 LPH (litres per hour), and passes through a catch bag inside the Seabin V5. The unit is plugged directly into 110/220V outlet. The water is then pumped back into the marina leaving marine debris trapped inside the catch bag to be either recycled or sent to a waste management facility. ... The Seabin V5 retains all marine debris 2mm or larger."<sup>[71]</sup>
5. **Searial Cleaners** - "THE SEARIAL CLEANERS has developed a range of innovative and complementary products to collect marine waste in ports, marinas, waterways and on sandy beaches. Our mission is to contribute to the reduction of pollution wherever it is found through innovative processes in tune with the times."<sup>[72]</sup>
6. **Trashpresso** - "The TRASHPRESSO machines are housed on a 40-foot container platform that is movable anywhere by trailer truck. It is powered by a solar-charged energy storage unit housed on a separate 20-foot container platform. ... The TRASHPRESSO can upcycle up to 50KG of waste per hour. Waste is converted into architectural tiles that have both a utilitarian and raw material value. ... The TRASHPRESSO can upcycle any thermoplastic that has a melting point lower than its burning point."<sup>[73]</sup>
7. **Protoprint** - "Protoprint [founded by environmental engineer Sidhant Pai and his parents] partnered with SWaCH, a Pune-based cooperative wholly owned by waste pickers. Together they have set up a low-cost filament production facility at a local rubbish dump in Pune operated by SWaCH waste pickers to convert plastic waste - specifically high-density polyethylene (HPDE) mostly used for plastic bottles - into 3D printing filament to eventually be sold to Indian or international 3D printing companies. Protoprint buys filament from SwaCH for 300 rupees (£3.50) per kg - if waste pickers sold the plastic waste directly to scrap merchants the pickers would receive around 19 rupees (23p) per kg, says Pai."<sup>[74]</sup>

## V. Plastic Pollution Solutions Around the World

The Basel Convention on Hazardous Wastes was adopted in 1989 and set restrictions on the export of hazardous waste to other countries requiring that the importing country provided written consent and would handle the waste in an environmentally sound way. As of February 9, 2022, 189 countries were party to the Convention; only the U.S. and Haiti had not yet ratified it, although both countries did sign the treaty.<sup>[75]</sup> The United States signed the treaty in 1990, and the U.S. Senate provided advice and consent to ratify in 1992, but the U.S. has not ratified it because, according to the State Department, "it does not have sufficient domestic statutory authority to implement all of its provisions."<sup>[76]</sup>

In November 2019, the governments of 187 countries (excluding the US) agreed to add plastic to the Basel Convention in an effort to "combat the dangerous effects of plastic pollution around the world."<sup>[77]</sup> The move came after "nearly 1 million people signed a global petition ... urging the governments of the Basel Convention to take action, by preventing western countries from 'dumping millions of tonnes of plastic waste on developing countries instead of recycling it.'"<sup>[78]</sup>

On March 2, 2022, "in a historic move to deal with the global problem of plastic waste, 175 nations across the world adopted a historic resolution at the fifth United Nations Environment Assembly (UNEA) in Nairobi to forge an international 'legally binding agreement' by 2024 to end plastic pollution. The landmark resolution addresses the full lifecycle of plastic, including its production, design and disposal."<sup>[79]</sup> In a joint statement, U.S. Senators Bob Menendez (D-NJ), Dan Sullivan (R-Alaska), and Sheldon Whitehouse (D-RI), commented: "We are very pleased to see this major step forward in the global fight against the marine debris crisis and look forward to collaborating with partner countries to reach a final agreement. ... We are committed to doing our part to enhance global cooperation so the United States is part of the solution to mitigate plastic pollution and its harm to marine life."<sup>[80]</sup>



Plastic waste turned into an installation outside the UN assembly in Nairobi, 2022. #TurnOffThePlasticTap © Von Wong Productions

On December 19, 2022, in a "sweeping deal to protect nature," 196 states party to the UN Convention on Biological Diversity (UN CBD) adopted the Kunming-Montreal Global Biodiversity Framework.<sup>[81][82]</sup> The framework, containing four overarching goals and 23 targets for how to achieve those goals by 2030, commits the global community to protect and restore nature and remove pollution in the world's lands, inland waters, coastal areas and oceans, while also mobilizing "at least \$200 billion per year in domestic and international biodiversity-related funding."<sup>[83][84]</sup> Target 7 specifically targets plastic pollution, demanding states prevent, reduce and work toward eliminating plastic pollution from all sources.<sup>[85]</sup> Despite being only one of two states who are not a party to the UN CBD, the United States did send a special biodiversity envoy in observer capacity to the Conference of Parties to the UN CBD (COP15) where the framework was agreed.<sup>[86][87]</sup>

Below are some initiatives and actions being taken by some nations to address the crisis of plastics pollution.

### 1. Australia

- o "Yet another initiative that repurposes plastic waste into much-needed housing is the NevHouse, an initiative by Australian surfer and entrepreneur Nev Hyman. Speaking at the Plasticity Forum, Hyman outlined an effort by his company to build houses in the Pacific island nation of Vanuatu from recycled plastic materials, agricultural waste, and even electronic waste, which has been turned into construction panels."<sup>[88]</sup>
- o In 2022, researchers from the University of Tasmania and the Commonwealth Scientific and Industrial Research Organisation reported that plastic coastal litter in Australia had decreased 29% in six years. They found that the greatest reductions in trash in the environment came about when awareness raising (information and signs) were provided alongside tools and infrastructure (e.g. trash cans), "or when people were motivated through economic measures."<sup>[89]</sup>

### 2. Democratic Republic of Congo

- o In Bukavu, in the eastern Democratic Republic of Congo, local businessman Elie Mapeenzi Matabaro and his company, FDA Group, collect discarded plastic bottles and other plastic waste and transforms them into cheap, hard-wearing paving slabs that are used across the city. The World Economic Forum report that, "every day, Mapeenzi's trash collectors deposit mountains of plastic at the factory, where it is melted down and scraped into hexagonal metal moulds. Once the plastic has cooled, it is tapped out, piled high and sold to customers." Mapeenzi's company not only provides environmental protection but allows him to make money and provide jobs for the city's residents.<sup>[90]</sup>

### 3. France

- o France has enacted a multi-year government program to phase out plastic, including the provision of water fountains in public spaces to discourage the use of plastic bottles. Plastic straws, cups, cutlery and styrofoam takeaway boxes were banned in 2021, followed by a packaging ban for a selection of fruit and vegetables in 2022 that will continue to be phased in through 2026. Other bans include a 2022 ban on plastic wrapping for press and publicity publications as well as a ban on free plastic toys with fast food sales. In 2023, fast food restaurants will no longer be allowed to use single-use crockery for meals consumed on site.<sup>[91]</sup>

### 4. Haiti

- o Locals are paid by Plastic Bank to harvest plastics: "After bringing plastic to a recycling center that's managed by a local entrepreneur and staffed by local employees, people receive payments on a mobile Blockchain app that they can then use toward goods. This method is used because it's more secure and can be better monitored by Plastic Bank to ensure accurate payments, according to the company. ... The recycling centers then turn the plastic waste into pellets that are sold to multinational brands that repurpose the pellets into products. Over the past several years, growing demand for plastic pellets of this kind has greatly expanded the market potential for recyclers."<sup>[92]</sup>



- Ramase Lajan [Picking Up Money]: "Through our program, local collection centers will increase the number of opportunities for Haitians to have competitive paying jobs to provide for their families, clean up the streets and help reduce the disease spread from unsafe water in the canals. We also expect to see the behavior of people change. Once plastics are seen as money rather than garbage, they will gradually and forever, disappear from the otherwise beautiful landscapes and beaches of Haiti."<sup>[93]</sup>
- "ThreadInternational plans to recycle plastic bottles collected by workers in Haiti, Honduras and Taiwan into fabric and use it to manufacture shoes, clothing and a new line of high-end backpacks, reports Trib Total Media. The company's founder and CEO is Ian Rosenberger, who appeared on the reality show Survivor in 2005. Rosenberger founded Thread in 2012 and has been selling fabrics to the likes of Timberland, Reebok, Marmot and Aerie."<sup>[94]</sup>
- "What if pieces of plastic strewn across the world's beaches ended up in brand new computer boxes, not floating in the middle of the ocean or lodged inside seabirds? That's what computer company Dell has set out to do, testing a supply chain that sees litter picked up from Haiti's beaches and worked into recycled packaging. Anyone now buying the XPS 13 2-in-1 laptop can expect to find the machine sitting on a tray that's 25 per cent ocean plastic – complete with an image of a whale and a link that leads to information about marine litter."<sup>[95]</sup>
- "Reyel Bonhomme is the foreman at Arris Desrosiers, a small company founded by two Haitians who decided to do something about the plastic waste that was invading their town. ... Bonhomme, his sons and many residents of the town now collect any stray plastic they find – especially bags – and turn it in at the factory. Thousands of plastic bags are now transformed every month into backpacks and lunch boxes for local students."<sup>[96]</sup>



Prospective employees at a Thread-affiliated recycling facility are shown products made with the recycled materials, Haiti, 2014. Photo credit: Jovan Julien / Flickr

## 5. India

- In July 2022, the government of India announced a ban on single-use plastic items including "straws, cutlery, ear buds, packaging films, plastic sticks for balloons, candy and ice-cream, and cigarette packets, among other products." Plastic bags are no longer on the banned list but manufacturers have been urged to make bags thicker to encourage reuse.<sup>[97]</sup>

## 6. Japan

- Zero Waste Academy is "a nonprofit that works toward Kamikatsu's sustainability goals."<sup>[98]</sup> "Now 80% of the town's garbage is recycled, reused, or composted, with the rest going to a landfill. The process saves the village a third of its former costs from waste incineration. By 2020, Kamikatsu hopes to be completely zero-waste."<sup>[99]</sup>

## 7. Maldives

- "Maldives is known for its pristine waters and picturesque views, but what many not see is the overburdening plastic pollution that is hampering the clear waters of the island nation in the Indian Ocean. ... The Maldivian government took to immediate action and sought an ambitious plan to fight the plastic pollution by utilising the islands' 1200 fishing boats and fishermen, who'd sweep the plastic rubbish from the sea when they fish and bring it back to the capital, Male, from where it will be transferred for recycling into plastic-based fabrics. Not only this, a 400% tax has been imposed on plastic bags which has managed to make many parts of the island absolutely plastic-free, which is gradually spreading through the island."<sup>[100]</sup>

## 8. Micronesia

- The Federated States of Micronesia include the four states of Yap, Chuuk, Pohnpei and Kosrae, and these island communities have some recycling programs and other initiatives in place to target plastic pollution.<sup>[101]</sup> For example:
  - In Yap: "After a six month period of raising awareness in the communities of Yap, the Yap State government has banned the use of plastic shopping bags in the interest of preservation and reducing pollution within the state. Effective July 4, 2014, retailers will be monitored by police officers and Yap EPA officials for compliance. Those found to be distributing plastic bags will be fined \$100 per violation."<sup>[102]</sup>
  - In Chuuk: The Chuuk State Solid Waste Management Strategy 2019-2028 contains within its action plan an idea to reestablish a container deposit system. Such a system was operational between 1979 and 2002 however it was deemed "erratic in operation" and the strategy notes that, "by learning from the success of Yap and Kosrae, it is an appropriate time for Chuuk to consider re-introduction of a CDL system, which will surely contribute to reducing littering and beautifying the island."<sup>[103]</sup>
  - In Pohnpei: The government of Japan funded a new recycling center that is "able to collect and pressure to downsize 4 million additional cans annually compared to the current Recycling Center which pressed around 3 to 5 million cans per year."<sup>[104]</sup>
  - Kosrae: The state of Kosrae has enacted a bottle deposit legislation. The legislation covers aluminium, plastic and glass, and has an 86% return rate. The deposit is 6 cents: 5 cents is returned to the consumer at the time of return, the remaining 1 cent is non-refundable and is used to cover operational costs of the program.<sup>[105]</sup>

- 9. The Moana Taka Partnership, a memorandum of understanding (MOU) between the China Navigation Company (CNCo) and the Secretariat of the Pacific Regional Environment (SPREP) that "allows for CNCo vessels to carry containers of recyclable waste from eligible Pacific island ports, pro bono, to be sustainably treated and recycled in suitable ports in Asia Pacific. ... Under this agreement, Pacific island countries who have insufficient or inappropriate landfill space to store waste, have inadequate waste treatment facilities, and the financial inability to ship recyclable waste are eligible for this opportunity. The types of materials that are considered recyclable include plastics, aluminium cans, waste oil and ozone depleting substances"<sup>[106][107]</sup>

## 10. Peru

- "Visitors will no longer be allowed to carry in single-use plastics into Peru's 76 natural and cultural protected areas, from Machu Picchu to Manu to Huascarán, or national museums."<sup>[108]</sup>

## 11. Philippines

- In the Philippines, a group calling themselves the Plastic Flamingo (or Plaf for short), collect discarded plastic waste including bottles, single-use sachets and food wrappers from restaurants, businesses and consumers and turn them into building materials. The collected waste is shredded and then molded into posts and planks that can be used for fencing, decking, or disaster relief shelters. "(It) is 100% upcycled material, 100% made from plastic waste materials, we also include some additives and colorants and it is rot-free, maintenance-free, and splinter-free," said Erica Reyes, The Plaf's chief operating officer."<sup>[109]</sup>

## 12. Taiwan

- According to the GlobalCitizen.org article: "Taiwan Announces Ban on All Plastic Bags, Straws, and Utensils" dated 2/22/2018: "It will be one of the farthest-reaching bans on plastic in the world, and it demonstrates the momentum of the anti-plastic movement as the scale of environmental harm caused by the substance is fully realized. 'We aim to implement a blanket ban by 2030 to significantly reduce plastic waste that pollutes the ocean and also gets into the food chain to affect human health,' said Lai Ying-yaun, a Taiwanese Environmental Protection Agency official, in a statement."<sup>[110]</sup>

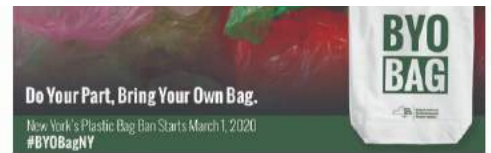
## 13. United States

- On Oct. 11, 2018, President Donald Trump signed S. 3508, the "Save Our Seas Act of 2018."<sup>[111]</sup> "The Save Our Seas Act, which passed the House and Senate with bipartisan [sic] support in July, reassures funding to clean-



up marine debris via funding through the National Oceanic and Atmospheric Administration Marine Debris Program.<sup>[112]</sup>

- "San Diego has joined a growing number of cities to ban containers made of polystyrene, better known as Styrofoam ... in Washington, D.C., as of January 1. By July, businesses in the district will begin receiving fines if they continue to offer plastic straws. The law follows Seattle's ban earlier in 2018 and aims to reduce the impact of plastic straws as litter. ... Branded as "No Straw November," the campaign is a push to eliminate single-use plastic. The effort is led by the Aquarium Conservation Partnership (ACP), comprising 22 aquariums in 17 different states."<sup>[113]</sup>



Bring Your Own Bag - Recycle Right NY campaign billboard highlighting New York's plastic bag ban. Photo credit: New York State Department of Environmental Conservation / Flickr

## VI. Conclusion

Although plastic pollution is a problem for the entire world, many organizations are tackling the problem with solutions that may benefit people in small island nations like those in Micronesia and Haiti. This paper is just a quick research project on plastic pollution, its challenges and solutions. There are so many more issues to cover and organizations and technologies to discover.

## VII. Appendix: Chart of the Seven Types of Plastics

There are seven categories of plastics. They are numbered and given chemical names.<sup>[114]</sup> Some can be recycled after use, and others may or may not be recycled.<sup>[115]</sup> This chart shows the different types of plastics, their uses and those that can and cannot be recycled.

Plastics: Types, Uses & Recycling Potential

A. Name / Chemical Name	B. About the Plastic	C. Can or Cannot be Recycled
1. #1 PET or PETE (polyethylene terephthalate)	#1 plastics are made into (but not limited to) water bottles and peanut butter containers, and can be recycled into carpets and furniture. <sup>[116]</sup>	Can be recycled
2. #2 HDPE (high-density polyethylene)	#2 plastics are made into (but not limited to) milk jugs and shampoo bottles and may be recycled into pens and picnic tables. <sup>[117]</sup>	Can be recycled
3. #3 PVC (polyvinyl chloride)	#3 plastics are made into (but not limited to) clear plastic food wrapping, cooking oil bottles, teething rings, and toys for children and pets; <sup>[118]</sup> not usually picked up for recycling, can be harmful when incinerated, and contain toxic dioxins. <sup>[119]</sup>	Cannot be recycled, but may be repurposed for non-food or non-toy products
4. #4 LDPE (low-density polyethylene)	#4 plastics are made into (but not limited to) grocery bags, bread bags, clothing and furniture, and are usually not recycled. <sup>[120]</sup>	Sometimes not recyclable, but may be recycled depending on the facility
5. #5 PP (polypropylene)	#5 plastics are made into (but not limited to) yogurt cups, syrup containers, potato chip bags, plastic bottle tops and disposable diapers; may be recycled into brooms and signal lights. <sup>[121]</sup>	Can be recycled depending on the facility
6. #6 PS (polystyrene)	#6 plastics are made into (but not limited to) Styrofoam containers, plastic cutlery, and egg cartons; chemicals in this plastic have been linked to some human health concerns. <sup>[122]</sup>	Recycling possible but limited depending on the facility
7. #7 OTHER (BPA, Polycarbonate LEXAN, and compostable PLA)	#7 is a category of plastics not in categories 1-6; some are made into (but not limited to) baby bottles, water cooler bottles and car parts. Some category #7 plastics contain chemicals like BPA (bisphenol-A); which has been linked to health issues such as obesity and infertility. <sup>[123]</sup> Some #7 plastics are made from bio-based polymers like corn starch and may be compostable. <sup>[124]</sup>	Can or cannot be recycled depending on the product since this is a catch-all category

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