



PLASTIC WASTE: UNDERSTANDING THE IMPLICATIONS AND MITIGATION STRATEGIES

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Mitigation Strategies

A. Introduction

By 2050, experts warn that the world's oceans could be engulfed by an unprecedented mass of plastic waste, surpassing the total weight of all marine life. The staggering daily deposit of 8 million tonnes of plastic garbage into our oceans has pushed authorities to confront this growing issue with unprecedented speed and determination. A recent report underscores the urgency, granting us a mere five-year window to take decisive action on plastic waste management, as time steadily slips away. Each passing day not addressed exacerbates the ecological implications, imperiling the delicate balance of our planet's ecosystems and its very existence.



Figure 1: Trends in Plastic Waste Deposited into the Ocean Over Time

Visualizing the scale of the crisis, Figure 1 showcases the trends of plastic waste deposited into the ocean over time. Startlingly, an astounding 11 million tonnes of waste find their way into the ocean annually, amounting to a staggering 2 lakh tonnes deposited every single day. This data reinforces the gravity of the situation, dispelling any notion of exaggeration. Table 1, below, provides a relatable comparison where the average waste generated per day and year is compared to the weight of a blue whale, Earth's largest creature.

Table: 1				
Waste Generated	Interval of time	Equivalent Weight of Whales		
2 lakh tonnes	1 Day	1,333 - 2,000 blue whales		
11 million tonnes	1 Year	73,333 - 110,000 blue whales		

Furthermore, plastic production currently accounts for approximately 3.7% of global greenhouse gas emissions, surpassing the total emissions generated by an entire country like Brazil. If the current trajectory persists, this figure is expected to rise to 4.5% by 2060.¹ The alarming growth in plastic-related emissions underscores the urgent need to address this issue and curb the environmental impact of plastic production. Despite pledges, policies, and the collective efforts of various organizations working towards solutions to resolving this pressing issue of plastic waste, it is evident that a paradigm shift is needed in how we approach plastic waste management and utilize our resources sustainably to safeguard the future of our planet.

B. Plastic Waste Generation: Factors and Trends

Single-use plastics (SUPs) make up 40% of the total plastic production, but only 12% of them are recycled, resulting in 85% being disposed of in landfills or the environment. To combat the growing issue of plastic pollution, the Parties of the Basel Convention added plastic waste to the convention in 2019.² This groundbreaking decision created the first international agreement specifically targeting plastic pollution and implementing controls on the cross-border trade of certain types of plastics. The Basel Convention has been regulating global plastic waste trade since January 2021 through the enforcement of the Plastic Amendments. It currently serves as the only internationally binding instrument dedicated to addressing the challenges posed by plastic waste. Additionally, the 16th Conference of the Parties in May 2023 adopted technical guidelines for the environmentally sound management of plastic waste, further advancing efforts in responsible waste management.

I. Global Efforts to Combat Single-Use Plastics

In a bid to address the mounting issue of plastic pollution, the European Union (EU) took a groundbreaking step in 2018 by unveiling its first strategy for plastics in a circular economy. The strategy set forth ambitious goals, including a ban on 10 single-use plastic (SUP) products and fishing gear, which account for 70% of marine litter, by 2021. By July 2018, a total of 127 countries had already implemented legislative measures targeting SUP products, materials, or production levels.

Out of these countries, 91 have enacted bans or restrictions on the manufacture, production, importation, and retail distribution of SUPs. Additionally, various measures such as environmental taxes, waste disposal fees, charges, and extended producer responsibility initiatives, such as deposit-refund and take-back schemes, have been implemented to curb plastic waste.

Alongside SUPs and fishing gear, microbeads and tiny particles found in personal care and cosmetic products have also faced bans in multiple countries, including Canada, France, Italy, the Republic of Korea, New Zealand, Sweden, the United Kingdom, and the United States.

¹ <u>https://pubmed.ncbi.nlm.nih.gov/36969097/</u>

² <u>https://www.ohchr.org/en/press-releases/2023/06/un-experts-warn-toxic-tidal-wave-plastic-pollutes-environment-and-threatens</u>

II. Pandemic-Led Demand Surge:

The COVID-19 pandemic has compounded the already intricate challenges surrounding plastic waste management. As governments worldwide were implementing policies to reduce plastic usage and promote sustainable alternatives, the pandemic presented a dual challenge. The demand for single-use plastics soared due to the necessity of items like face masks, personal protective equipment (PPE), and medical supplies. Consequently, bans on these products were lifted, resulting in a surge of plastic pollution during the pandemic. Additionally, increased medical waste and the prioritization of incineration and landfill further complicated plastic waste management efforts.

A study focusing on mismanaged plastic waste (MMWP) reveals a substantial increase in plastic waste generation during the pandemic, with hospitals accounting for the majority (87.4%) of this excess. The individual usage of PPE (7.6%), packaging materials from online shopping, and COVID-19 test kits contribute to a lesser extent (4.7% and 0.3% respectively) to the overall waste.

In another study, researchers utilized a hydrological model and data on plastic waste production to estimate the discharge of microplastics (less than 5 mm) and macroplastics (greater than 5 mm) from 369 major rivers and their watersheds into the global ocean. The findings indicate that these rivers and watersheds contribute significantly to plastic pollution, with an estimated total discharge of pandemic-associated plastics reaching 25.9 ± 3.8 thousand tons. Among them, 12.3 thousand tons consist of microplastics, while 13.6 thousand tons are microplastics. Notably, the Shatt al-Arab, Indus, and Yangtze Rivers in Asia emerged as the top three rivers in terms of pandemic-associated plastic waste discharge. Table: 2 below projects the percentage of plastic discharge contributed by the rivers to the oceans.

Continent	Pandemic Plastic Discharge Percentage	
Asia	73%	
Europe	11%	

Table: 2

The high population density near the mouths of these rivers, large runoff, fast water velocity, or a combination of these factors contribute to their significant role in plastic waste accumulation.

III. China's Decision to Halt Waste Imports Sparks Global Recycling Crisis

Policy shifts in numerous Western countries, transitioning from multi-bin recycling systems to single-stream recycling, brought about changes that made plastic recycling more challenging for China. The increased levels of contamination and the presence of various plastic types posed difficulties, ultimately contributing to the implementation of the ban. China's recent move to halt the acceptance of waste from Western nations has undoubtedly reverberated across the global stage, prompting a crucial question: Will there perpetually be a nation like China to assume the responsibility of handling the recycling industry, and what would happen if no one stepped up to shoulder this responsibility?

China, known as one of the largest recyclers, has witnessed a staggering 99 percent drop in its imports of plastics, triggering a massive shift in the processing and management of materials discarded in recycling bins worldwide.³ Prior to China's ban, European Union countries relied on Chinese processors for recycling 95 percent of their collected plastics, while the United States relied on them for 70 percent. Consequently, the abrupt change in China's import policies has left countries like Australia and the U.S. scrambling for alternatives to handle their mounting recyclable waste.

Australia finds itself in the midst of a recycling crisis as it struggles to cope with a massive stockpile of 1.3 million tons of recyclable waste that was previously shipped to China. The country's recycling industry is now faced with the daunting task of finding new avenues for processing and disposing of this vast quantity of waste.

This unprecedented situation underscores the urgent need for countries worldwide to reevaluate and revamp their recycling infrastructure and practices. It also highlights the necessity for nations to develop sustainable domestic solutions for waste management, including investing in innovative technologies and establishing robust recycling networks.

As the global recycling landscape undergoes a transformative shift, policymakers, industry leaders, and environmental advocates are compelled to collaborate and explore new avenues for waste reduction, recycling, and sustainable resource management.

IV. Implications for Environmental and Human Health

Scientists are finding plastic fibers contaminating the environment. These fibers are the main source of plastic pollution, found in beaches, mangroves, and even in our food and drinks. A recent study reveals that the average person ingests over 5,800 particles of synthetic debris each year, mostly plastic fibers.⁴

Plastics contribute to health risks linked to climate change. As per the plastic-associated chemicals Polybrominated diphenyl ethers (PBDE), Bisphenol A (BPA), and Di(2-ethylhexyl) phthalate (DEHP), the production of plastic-associated chemicals costs over \$250 billion globally and over \$920 billion in the US alone, in 2015. Plastic pollution affects workers, communities, and vulnerable groups, including children, raising concerns about human rights and environmental injustice. Notably, the concentration of plastics plants between Baton Rouge and New Orleans has earned the area the notorious nickname "cancer alley," as the plastic plant around it emits toxic pollutants that contribute to adverse health effects, such as prematurity, birth defects, impaired lung growth, and childhood cancer.⁵

³ <u>https://www.plasticexpert.co.uk/china-plastic</u>

recycling/#:~:text=For%20years%2C%20China%20had%20accepted,put%20a%20stop%20to%20it.

⁴ <u>https://www.vox.com/the-goods/2018/9/19/17800654/clothes-plastic-pollution-polyester-washing-machine</u>

⁵ <u>https://www.vox.com/recode/23056251/nurdles-plastic-pollution-ocean-microplastics</u>

Figure 2: Countries experiencing severe flooding due to plastic waste blocking the drainage system



Table 3

Nations		Size of the Great Pacific Garbage Patch (GPGP) compared to the area of the Country		
•	Ghana	× 6		
	Cameroon	x 4		
0	Nigeria	× 2		
	Bangladesh	x 11		
-	Indonesia		GPGP covers 84% of Indonesia	
	Democratic Republic of the Congo (DRC)		GPGP covers 68% of (DRC)	

The Great Pacific Garbage Patch, an enormous accumulation of plastic debris floating in the Pacific Ocean, has recently been revealed to be even larger than previously estimated. Stretching across an astonishing expanse of approximately 1.6 million square kilometers, this colossal mass of waste is now known to be over 11 times larger than the total area of Bangladesh, 6 times larger than Ghana, 4 times larger than Cameroon, and twice the size of Nigeria. Figure 2 and Table 3 following the figure give a visual perspective on the situation faced worldwide. These alarming figures underscore the urgent need for global action to address the escalating plastic pollution crisis.

Additionally, around 13,000 chemicals are used in making plastic. Only 3,200 are verified as potential concerns, while 6,000 lack hazard data.⁶ Health impacts are also observed all along the plastic value chain. Plastic additives, like endocrine disruptors, are linked to infertility, obesity, diabetes, prostate or breast cancer, thyroid problems along with the increased risk of cardiovascular disease and stroke, growth, cognitive impairment and neurodevelopment disorders, and other health issues. Women and children are particularly susceptible. A new report published in 2023, Chemicals in Plastics, released by UN Environment Program and the Basel, Rotterdam, and Stockholm Conventions Secretariat, shows that these exposures have severe and long-lasting effects on women and children.⁷ The adverse effects are acutely observed in children in the womb and young ones, with increased risks of prematurity, stillbirth, birth defects of the reproductive organs, neurodevelopmental impairment, impaired lung growth, and childhood cancer.

Currently accounting for 3.4%⁸ of global emissions, plastic production surpasses the emissions generated by an entire country such as Brazil⁹. Disturbingly, this figure is projected to rise to 4.5% by 2060 if the current trajectory persists. Plastic pollution presents a global crisis, characterized by inadequate disposal and recycling rates that fall below 10%. Shockingly, the World Economic Forum reveals that 32% of all plastic packaging produced each year ends up in our oceans, equivalent to dumping one garbage truck's worth of plastic into the ocean every minute. This dire situation leads to devastating consequences, as 14,000 mammals and 1.4 million seabirds tragically perish annually due to plastic ingestion.¹⁰ However, hope emerges from a U.N. Environment Programme report, which underscores the potential to reduce plastic pollution by a remarkable 80% through the implementation of existing technologies and significant policy changes by 2040.¹¹ Urgent and decisive action is imperative to protect marine life and ecosystems, as more than 90% of birds and fish already harbor plastic particles, and it is estimated that 99% of the world's seabird species will be impacted by plastic ingestion by 2050 if immediate measures are not taken.

⁶ <u>https://www.genevaenvironmentnetwork.org/resources/updates/plastics-and-health/</u>

⁷ <u>https://pubmed.ncbi.nlm.nih.gov/36969097/</u>

⁸ <u>https://www.oecd.org/environment/plastics/increased-plastic-leakage-and-greenhouse-gas-emissions.htm</u>
⁹ <u>https://www.google.com/search?q=how+much+emission+does+brazil+produce&rlz=1C1GCEU_enNP1012NP1012&</u>
<u>oq=how+much+emission+does+brazil+&aqs=chrome.1.69i57j33i160l3.11636j0j4&sourceid=chrome&ie=UTF-8</u>

¹⁰ https://www.onegreenplanet.org/environment/paris-2024-olympics-single-use-plastic-ban/

¹¹ <u>https://www.globalcitizen.org/en/content/effects-of-plastic-pollution-facts-you-should-know/</u>

C. Solutions for Plastic Waste Management

As plastic waste continues to mount, the once-promising solution of recycling is proving to be inadequate in addressing the excessive production and disposal of plastics. Only a mere 6-9% of all plastic ever produced has been recycled, with a paltry 2% being remade into the same or similar products.¹² Recycling can only be done a limited number of times before the material loses its necessary properties, resulting in downgraded materials unfit for the original purpose. Moreover, recycling facilities themselves release hundreds of tonnes of microplastics into the environment each year. To address the growing plastic pollution threat, it is crucial to shift the focus from recycling as the sole solution and make efforts to:

- **Redesigning products** to use less plastic, reimagining packaging and shipping methods, and creating systems that prioritize reuse and recyclability:
 - Redesigning products to use less plastic.
 - Reimagining packaging and shipping methods.
 - Creating systems that prioritize reuse and recyclability.
- Establishing transparent and effective labeling systems can empower consumers to make informed choices, preventing contamination of recycling loads with non-recyclable waste and toxins.
- **Transforming the market to achieve a circular economy**. The emphasis is on strategies such as reuse, recycling, and reorienting and diversifying the market, supported by a legal framework. By prioritizing the reuse of plastic products, moving away from a disposable economy becomes more economically feasible. Accelerate the growth of the plastic recycling market to ensure its profitability.

Sidebar 1: Paris Olympics 2024: A Historic Move Against Plastic Pollution

Paris is set to make a groundbreaking statement in the fight against plastic pollution during the 2024 Olympic Games. Mayor Anne Hidalgo announced that the city will become the first to host a major event to ban single-use plastic, a notable step in global sustainability efforts. Temporary Olympic sites will only permit visitors without plastic bottles, as Coca-Cola, the official sponsor, distributes its beverages in reusable glass bottles. With this initiative, Paris aims to leave a lasting legacy by setting up over 200 soda fountains and making reusable cups the norm for refreshments during the games.

Pioneering Ban on Single-Use Plastic

The decision comes as part of a larger plan to combat the world's plastic crisis. Mayor Hidalgo's office emphasized the urgent need for action, as thousands of mammals and millions of seabirds die annually due to plastic waste ingestion. Additionally, Paris aims to reduce its carbon footprint by 50% compared to the previous Olympic Games, aligning with the United Nations' goal of an 80% reduction in plastic pollution by 2040. Paris' leadership sets a new standard in reshaping our relationship with single-use plastic, urging individuals to make their own sustainability pledges and work towards a healthier, plastic-free future.

¹² <u>https://theconversation.com/plastic-recycling-is-failing-heres-how-the-world-must-respond-206338</u>

- **Reorient** the market towards sustainable alternatives to plastic, requiring shifts in consumer preferences, regulatory frameworks, and cost structures. These measures aim to encourage the adoption of environmentally friendly options and address the challenges posed by plastic pollution.¹³
- **Regulatory frameworks** to promote sustainable practices supported by a legal framework:
 - Implementation of a "polymer premium" on fossil fuel-based plastic polymers
 - Prevent plastic leakage through effective waste management.
 - Develop a broad, inclusive, and innovative agreement that tackles the issue of plastic pollution, leaning on scientific knowledge and stakeholder input while ensuring support for developing nations.

The second session of the Intergovernmental Negotiating Committee (INC-2) in Paris, in June 2023, marked progress in the development of an international agreement on plastic pollution. The negotiations in Paris for an international agreement concluded with a mandate for the INC Chair to prepare a zero draft of the agreement for the next session in Nairobi in November 2023.¹⁵ These efforts demonstrate the global commitment and collaborative approach towards addressing the urgent issue of plastic pollution and pave the way for further advancements in finding effective solutions.

Sidebar 2: Africa– A Model Country in the Global Movement Against Plastic Pollution¹⁴

Driving Sustainable Practices and Policy Changes

African nations have taken significant strides in addressing plastic pollution. In Rwanda, the government has implemented a ban on single-use plastic bags, leading to the transition of local factories toward producing bamboo and paper-based materials. This innovative approach showcases Africa's commitment to sustainable practices and sets an example for other regions to follow.

Sharing Knowledge and Pioneering Innovative Solutions

African countries have valuable knowledge and initiatives that contribute to a plastic-free future. Practices such as reusing and repairing products are already culturally ingrained in the daily lives of millions of Africans. By sharing these practices and promoting legislation that encourages new business models and sustainable alternatives to single-use plastics, African governments are leading the way in driving innovative solutions to combat plastic pollution.

A Just Transition and Solidarity

African nations emphasize the importance of a just transition to tackle plastic pollution. They advocate for addressing the needs of developing countries and groups, such as informal waste sector workers, ensuring they receive decent jobs and a clean environment. African nations recognize the global solidarity required to support developing countries financially and work together towards a sustainable future.

¹⁵ <u>https://www.unep.org/events/conference/second-session-intergovernmental-negotiating-committee-develop-international/media#PressRelease</u>

¹³ <u>https://www.unep.org/resources/turning-off-tap-end-plastic-pollution-create-circular-economy</u>

¹⁴ <u>https://www.unep.org/news-and-stories/opinion/african-nations-have-power-tools-re-design-plastic-pollution-free-future</u>

Biodegradable Plastic and Alternative Recycling Technologies

Biodegradable plastics, also known as bioplastics, offer a promising alternative to traditional plastics by utilizing renewable resources and natural decomposition in composting facilities. These eco-friendly materials substantially reduce plastic waste accumulation in landfills and prevent ocean pollution. Various types of bioplastics exist, each with distinct properties and applications. Polyhydroxyalkanoates (PHAs), produced by microorganisms, find use in packaging, agriculture, and medical devices. Polylactic acid (PLA), derived from sources like corn starch, serves purposes such as food packaging, 3D printing, and textiles. Starch-based bioplastics made from corn or potato cater to food packaging and bags, while mushroom-based foam, derived from mushroom mycelium, is suitable for packaging and insulation. Algae-based bioplastics are also emerging, holding potential in packaging, cosmetics, and pharmaceuticals.

Despite their potential, biodegradable plastics and enzymatic recycling technologies remain costly and resource-intensive to implement. Questions persist regarding the durability and versatility of these alternatives compared to traditional plastics. Enzymatic¹⁶ recycling, a breakthrough technology, employs enzymes to break down plastic waste into smaller building blocks. French biotech company Carbios has achieved remarkable results, recovering over 95% of the material from polyethylene terephthalate (PET), a commonly used plastic in beverage bottles and packaging. Additionally, molecular recycling/pyrolysis technology, used by Nexus Fuels, enables

the breakdown of 50 tons of plastic daily for reuse in new plastic production. Pyrolysis technology effectively converts plastic polymers into oils, waxes, and non-condensable gases through the heat without oxygen, eliminating toxic emissions. This process sequesters carbon and has already diverted millions of pounds of plastic from landfills.

Several companies are embracing biodegradable plastics to reduce their environmental footprint. Dell, for instance, employs mushroom-based foam for packaging to safeguard tech products during transport. Lego is committed to using bioplastics derived from sugarcane, ensuring sustainability in its iconic Lego bricks.

¹⁶ <u>https://earth911.com/eco-tech/biodegradable-plastics-and-new-recycling-tech/</u>

Sidebar 3: Empowering Citizens to Combat Plastic Pollution with a WhatsApp Chatbot

In an initiative led by the World Wildlife Fund-India (WWF-India), a revolutionary tool called the 'Plastic Reporter', an innovative WWF WhatsApp chatbot developed by Parmanoo Data Labs, has emerged to address the urgent issue of plastic pollution in Goa. This innovative solution harnesses the power of WhatsApp, enabling concerned citizens to play an active role in reporting plastic dumps and fostering a cleaner and greener environment through:

Reporting Made Easy

Engaging with the WWF chatbot is as easy as sending a WhatsApp message. By simply typing "plastic" and sending it to the dedicated WhatsApp number, 7498982409, citizens can interact with the user-friendly chatbot. The chatbot guides participants through a series of questions, gathering essential details about the type and quantity of plastic waste. Users can also provide precise location information and share photographs of the plastic dump.

Harnessing Data for Action

WWF-India utilizes the data collected through the chatbot to analyze the extent and locations of plastic dumps. This valuable information serves as a foundation for developing a comprehensive strategy to address the issue, with a particular emphasis on combating plastic pollution in marine environments. Collaborative efforts with local panchayats and disposable plastic product manufacturers ensure a holistic approach to tackling the problem.

Convenience and Inclusivity: Empowering Change Together

The WWF WhatsApp chatbot revolutionizes the reporting process for plastic dumps in Goa, offering a user-friendly and accessible platform through the widely used WhatsApp messaging service. By eliminating the need for additional applications, WWF-India ensures convenience and inclusivity, allowing more individuals to actively participate in reporting plastic pollution. This inclusive approach enables citizens to contribute to the fight against plastic pollution and work towards a cleaner and greener environment.

Conclusion

The world is rapidly hurtling towards an environmental catastrophe of unprecedented proportions as the issue of plastic pollution reaches critical levels. Recent data and expert warnings paint a grim picture, with the potential for the oceans to become overwhelmed by a mass of plastic waste, surpassing the weight of all marine life by 2050. In the face of this dire scenario, authorities have been forced to confront the escalating problem with unparalleled urgency. However, despite some notable efforts and incremental progress, the global response falls short of what is required to address the scale and urgency of the crisis. This analysis delves into key findings, challenges, and potential solutions related to plastic waste management, underscoring the need for immediate and decisive action.

Plastic pollution not only devastates marine ecosystems but also poses significant risks to human health. Synthetic debris, primarily in the form of plastic fibers, contaminates the environment and finds its way into our food and drinks.

Furthermore, the production and use of plastic-associated chemicals have been linked to various health risks, including reproductive problems, cancers, growth impairments, and neurodevelopmental disorders. The concentration of plastic plants in certain areas has led to environmental injustices, with adverse health effects disproportionately affecting vulnerable communities.

Plastic production is not only choking the oceans but also contributing to greenhouse gas emissions. The implications of plastic-related emissions on climate change and ecological balance cannot be underestimated. It is evident that a paradigm shift is necessary to transform how we approach plastic waste management and prioritize sustainable resource utilization to safeguard the future of our planet.

Efforts to combat plastic pollution have gained momentum in recent years, with various countries and organizations implementing measures to tackle the problem. The European Union's ban on single-use plastics and microbeads, coupled with legislative measures enacted by 91 countries targeting single-use plastic (SUP) products, demonstrate progress on a global scale. However, the COVID-19 pandemic posed new challenges, as the demand for single-use plastics surged, leading to an increase in plastic waste generation. The resulting global recycling crisis underscores the need for countries to reassess and revamp their recycling infrastructure and practices.

While recycling has long been considered a solution, its limitations have become apparent. Only a small fraction of all plastic produced has been recycled, and recycling facilities themselves contribute to environmental pollution. Likewise, while biodegradable plastics show promise in combating plastic waste, overcoming cost and operational challenges, and ensuring their durability and versatility remain critical for widespread adoption. However, with continued advancements in recycling technologies and increasing corporate commitment to sustainable practices, the future looks promising for a world with reduced plastic pollution.

