From Boon to Bane: The Plastic Predicament

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Introduction

Plastic pollution is one of the key environmental problems that the world is currently grappling with. Statistics indicate that global plastic production stood at a staggering 460 million tonnes in 2019. PlastIndia Foundation Report (2021) indicates that the total plastic production in India is 20 million tonnes. On the other hand, as per a recent report by the Central Pollution Control Board (CPCB), India generates around 4.1 million tonnes of plastic waste annually. As per an analysis of CPCB data done by CSE[1], India recycles merely 12 per cent of its total plastic waste. Plastic waste equalling the capacity of almost 2,000 garbage trucks is dumped into the world's water bodies — its oceans, rivers and lakes — every day (UNEP, 2023)[2]. This is choking our freshwater sources, exacerbating marine pollution and adversely impacting aquatic life.

The Government of India has taken many measures to curb the use of plastics, such as banning certain single-use plastic items and increasing the thickness of plastic bags to 120 microns from earlier 50 microns. However, the on-ground implementation of these measures has faced several challenges, proving that the issue is not a linear one; it involves an interplay of social, economic, ethical, and political issues associated with the excessive use and disposal of plastics.

Types of plastics and their impact on the environment

Plastics can be of different types such as rigid mono-material plastics, flexible mono-material plastics, multilayered plastics, and multi-materials (The Pew Charitable Trusts and Systemiq 2020[3]).

- Rigid mono-material plastics: An item made from a single plastic polymer that holds its shape, such as a bottle or tub.
- Flexible mono-material plastics: An item made from a single plastic polymer that is thin, such as plastic wraps and bags.
- Multilayered plastics: An item, usually packaging, made of multiple plastic polymers that cannot be easily and mechanically separated.

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[1] https://www.cseindia.org/the-plastic-life-cycle-11509

[2] https://www.unep.org/news-and-stories/story/why-we-need-fix-plastic-pollution-problem

[3] https://www.pewtrusts.org/-/media/assets/2020/10/breakingtheplasticwave_mainreport.pdf

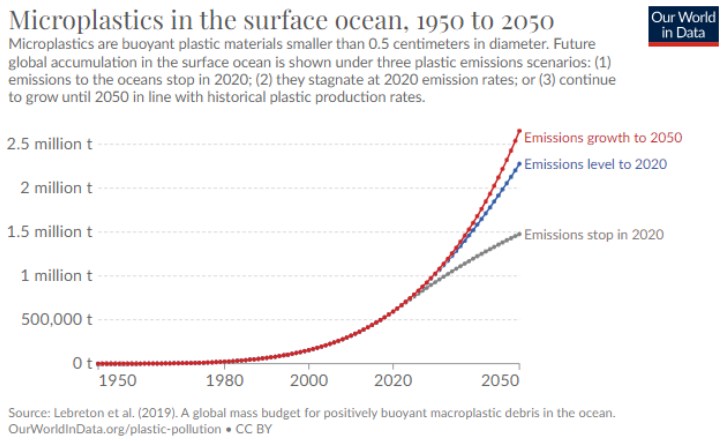
- Multi-materials: An item, usually packaging, made of plastic and non-plastic materials (such as thin metal foils or cardboard layers) that cannot be easily and mechanically separated.

Rigid mono-material plastics are the easiest to separate or reduce into smaller parts that can be disintegrated or recycled. With advancements in technology, chemical recycling holds promise to make it possible to convert plastics into fuel or virgin plastics (The Pew Charitable Trusts and Systemiq 2020). This chemical recycling technology, although theoretically promising, is still in nascent stages and needs to be tested on ground, along with exploration of the possibilities of scaling up.

According to the Resin identification Code (RIC) system, plastics can be categorised into seven categories. Of these, Plastics like PET and HDPE are recyclable. Multi-layered plastics pose a problem because they are either difficult to recycle or non-recyclable. PVC is known for its toxicity due to presence of chlorine, and hence prone to release dioxins and furans on burning.

Microplastics

Microplastics are pieces of plastic debris under 5 mm in length that can enter the food chain through a variety of sources[4]. The burgeoning levels of production of these microplastics have led to their increased levels in the ocean (refer to Graph 1) which is a looming threat to organisms inside the ocean. Microplastics due to their smaller sizes are able to adsorb or leach toxic substances such as organic pollutants and metal particles and even lead to the development of thin film of pathogenic particles on the particle surfaces (Xu. et.al., 2018). Humans can also get exposed to these Microplastics through water, air, soil, and food pathways (Revel et al., 2018). Out of the major pathways, direct gastrointestinal (GIT) ingestion, pulmonary inhalation and dermal infiltration are the predominant pathways through which humans are exposed to these microplastics, followed by some others including indirect pathways, including bioaccumulation of microplastics through the food chain (Raamsdonk et al., 2020). In a new study, scientists have detected microplastics in the lungs of living organisms[5] which could lead to even more drastic consequences.



[4] **Source:** https://www.unep.org/resources/report/microplastics

[5] **Source:** https://www.weforum.org/agenda/2022/04/microplastics-lungs-living-people

Graph 1: Growth of Microplastics globally

Managing plastic waste

Plastic waste management is the need of the hour owing to the increasing levels of plastic waste being generated every day. Multiple ways of managing plastic waste are being practised. The American Society for Testing Materials (ASTM) classifies plastic recycling into four categories: Primary (ASTM1), Secondary (ASTM2), Tertiary (ASTM3), and Quaternary (ASTM4) (Figure 1).

Primary recycling refers to the mechanical processing of plastic scraps, secondary recycling includes the regeneration of lower-performance products out of used plastics, tertiary recycling involves the recovery of chemical intermediates from plastic scraps in solid, liquid and gaseous forms, while quaternary recycling is the energy recapture of the used plastics.

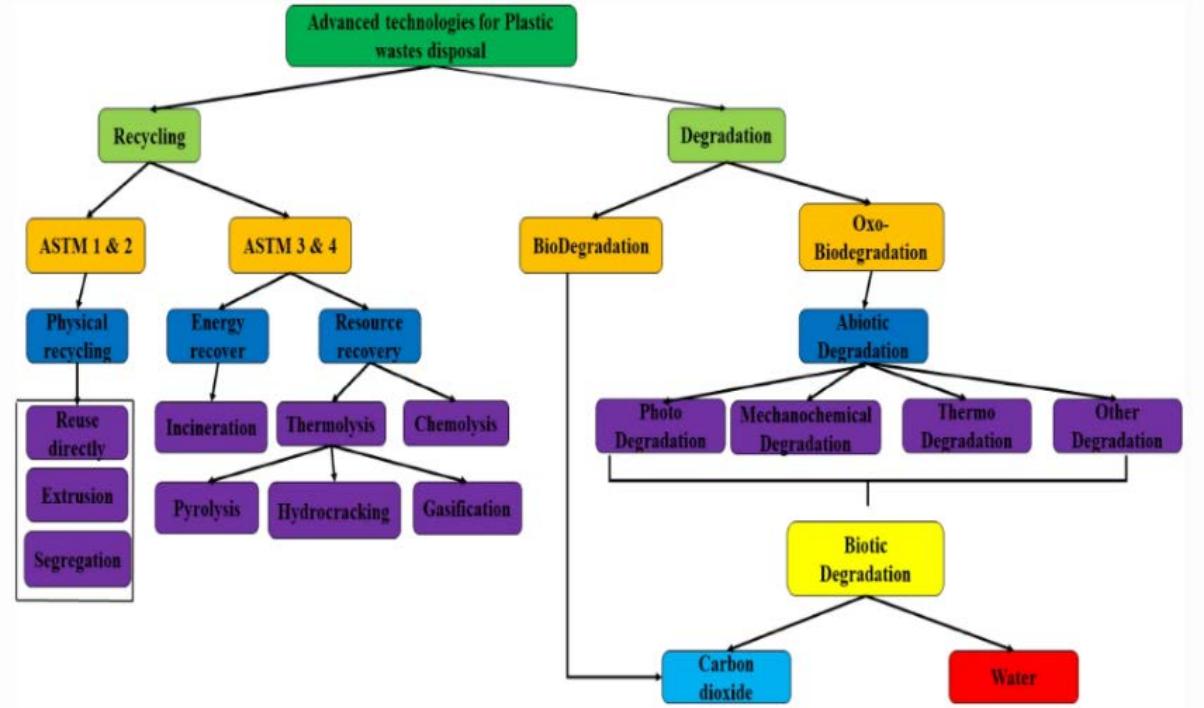


Figure 1: Advanced Methods of Plastic Waste Management (Kibria et al., 2023)

Other methods of plastic waste management include:

Refuse Derived Fuel (RDF): It is made out of household and commercial waste including biodegradable material as well as plastics. The RDF can be used to generate power in recovery plants or for heating water.

Solid Recovered Fuel (SRF): This is an elevated source of energy mostly made from textiles, paper, wood or plastics. It has a higher heating value than RDF and is used in places like cement kilns.

Some common practices for plastic waste disposal at the mass level include:

- ***Recycling:*** It involves collection of plastic waste and treating it to make something useful out of it. This process of recycling is performed in six steps: collection; sorting plastics into categories; washing to remove impurities; shredding and resizing; identifying and separating plastics; and compounding (Szostak et al., 2021).
- ***Co-processing:*** This refers to the process of complete burning of plastic waste that releases water molecules and carbon dioxide into the atmosphere. In India, cement plants have been mandated to co-process non-recyclable plastic waste. The process helps in reducing the quantity of plastic waste but releases ash and other harmful gases which leads to environmental pollution and health issues.
- ***Pyrolysis:*** In this process, plastics are degraded into crude petrochemicals to generate energy by heating plastics at high temperatures (Sharuddin et al., 2016).
- ***Bioremediation:*** It involves excavating plastic waste and treating it with the help of microorganisms, which converts it into chemically stable, comparably less-toxic material.

Teacher Aide: Integration with Undergraduate Curriculum

It is crucial to direct the attention of today's youth toward the pressing problem of plastic pollution, an escalating threat that demands immediate action. Education serves as a potent tool to steer individuals toward the sustainable utilisation of plastics for a cleaner planet. Within undergraduate education, plastic pollution can seamlessly be integrated into courses on environmental pollution, as well as solid and hazardous waste management. The objective extends beyond merely imparting knowledge about this issue; it involves devising strategies to reduce its use and mitigate its effects by adopting lifestyle changes and promoting active research on the matter.

Pedagogically, addressing plastic pollution necessitates a deeper exploration of the causes and the challenges encountered at personal, local, national, and global levels when striving to control or, at the very least, diminish it. In addition to presenting the latest data to students, it is crucial for them to comprehend the underlying reasons behind this environmental crisis and actively work to reduce its impact. The classroom can serve as a platform for various activities, such as:

Activity Ideas:

1. Data Analysis of Plastic Pollution in India: Ask students to work in groups to collect data on plastic pollution in different states of India and compare the figures. Statistical tools can be used to represent and study the trends in the data.
2. Campaign on ‘Stop Plastic Pollution’: The campaign can take the form of a thinking group where students study the local issues and practices of an area with regard to plastic pollution and interact with the community.

Project Ideas

- Conduct a small survey to find out data on plastic waste generation and disposal/management methods in a nearby community. Identify the major reasons for plastic pollution.
- Conduct a study on water and soil testing (requires laboratory support) for nearby areas where the impacts of plastic pollution are felt more, outskirts for instance, and compare the data with other areas. Also identify the major pollutants by performing different chemical tests.

Other Resources

- Global Plastic Treaty Negotiations: CSE explains what INC2 meeting was about, 2023
- CSE Implementation Report on Single-use Plastic Ban, 2023
- Plastic pollution increasing relentlessly, says OECD, 2022

Syllabus Tracker

This article is relevant for the following topics from the UGC syllabus for Environmental Studies:

- Environmental Pollution (Air, Soil & Water Pollution)
- Solid Waste Management
- Field Work

References

- E. Szostak, P. Duda, A. Duda, N. Gorska, ´ A. Fenicki, P. Molski (2021). Characteristics of plastic waste processing in the modern recycling plant operating in Poland, Energies 14 (1), pp. 35.
- Jaiswal, S; Sharma, B; and Shukla, P (2020). Integrated approaches in microbial degradation of plastics, Environmental Technology & Innovation, 17, pp. 100567.
- Kibria, M.G., Masuk, N.I., Safayet, R. *et al.* (2023). Plastic Waste: Challenges and Opportunities to Mitigate Pollution and Effective Management. *Int J Environ Res* **17**, pp.20. https://doi.org/10.1007/s41742-023-00507-z
- Pei Xu, Guyu Peng, Lei Su, Yongqiang Gao, Lei Gao, Daoji Li (2018). Microplastic risk assessment in surface waters: A case study in the Changjiang Estuary, China, *Marine Pollution Bulletin*, Volume 133, pp. 647-654.
- Van Raamsdonk, L. W., van der Zande, M., Koelmans, A. A., Hoogenboom, R. L., Peters, R. J., Groot, M. J., & Weesepoel, Y. J. (2020). Current insights into monitoring, bioaccumulation, and potential health effects of microplastics present in the food chain. *Foods*, *9*(1), 72.
- Revel, M; Châtel, A; Mouneyrac, C. (2018). Micro(nano)plastics: A threat to human health? *Current Opinion in Environmental Science & Health*, volume 1, pp. 17-23. https://doi.org/10.1016/j.coesh.2017.10.003.
- S.D.A. Sharuddin, F. Abnisa, W.M.A.W. Daud, M.K. Aroua (2016). A review on pyrolysis of plastic wastes, Energy Convers. Manag., 115, pp. 308–326.
- Y. Zheng, E.K. Yanful, A.S. Bassi (2005). A review of plastic waste biodegradation, Crit. Rev. Biotechnol. 25 (4), pp. 243–250.

About the author

Dr Astha Saxena is currently working as an assistant professor at Azim Premji University, Bhopal, India. She is a Green Educators' Network member of Centre for Science and Environment. She has a deep interest in environmental education and education for sustainable development and has been actively writing articles and papers for renowned publications. She has also worked with national and international organisations such as NCERT, CBSE, UNICEF, UNFPA to develop curriculum material for science education, biology textbooks, and adolescent health manuals.