The Chitransh Academic & Research
International Journal of Multidisaciplinary Reseaech
An Online Peer Reviewed / Refereed Journal
Volume 01| Issue 4September|2025
ISSN: 3049-303X (Online)
Website: www.thechitranshacadmic.in

ENVIRONMENTAL DEGRADATION *VIA* PLASTIC:A REVIEW

[1, 2]Rekha Vijay, 2Barkha Shrivastavaand 3Poonam Hariyani

[1, 2] Department of Chemistry, JECRC College, Jaipur (Rajasthan)

[3]Department of Chemistry, JECRC University, Jaipur (Rajasthan)

ARTICLE DETAILS

Research Paper

Received: **30/08/2025**

Accepted: **10/09/2025**

Published: **30/09/2025**

Keywords: Disposal, Ecosystems, GHGs,Recycling.

ABSTRACT

The environment is facing a serious issue of improper disposal of plastics, which is a key challenge to the environment. This paper examines the multifaceted impacts of plastics on ecosystems, biodiversity, climate change, and human health, with a focus on the persistence of plastics as micro- and Nano plastics across diverse environments. It explores the persistence of plastic pollution, its effects on wildlife habitats, the involvement of plastic production and disposal in causing emission of greenhouse gases (GHGs), and is responsible for the toxicity of the ecosystem. The analysis highlights the need for innovative solutions, including sustainable solutions, better recycling skills, and comprehensive waste management approaches, to alleviate the negative effects of plastics and encourage a healthier planet. The paper highlights the critical requirement for sustainable changes and better-quality waste management approaches.

1. Introduction

Plastics have become basic part of modern life, revolutionizing industries and daily ease with their adaptability, resilience, and cost-effectiveness. But their extensive usage and deprived removal have led to significant and far-reaching environmentally harmful consequences. This paper highlights the multi-sided impact of plastics on various ecosystems, biodiversity, climate, and negative effects on health.

2. Persistence and Ubiquity of Plastics

Fossil fuels are primary compounds from which synthetic polymers *i.e.*, plastics, are derived. Over 460 million metric tons of plastic [1] are produced globally per annum, and a considerable portion of them is intended for single-use. Plastics are non-biodegradable, but still, their fragmentation leads to the production of micro plastics and Nano plastics, which remain in the environment for hundreds to thousands of years [2]. These fragments have been found in every ecosystem, from Arctic ice to deep ocean trenches and agricultural soils.

3. Environmental Pollution

3.1 Terrestrial and Aquatic Ecosystems

3.1.1 Landfills and Soil Contamination: Most plastic waste ends up in landfills or as litter. Plastics clog drainage systems, reduce soil fertility, and degrade land quality [3].

3.1.2 Freshwater and Marine Pollution: Plastic pollution is most visible in oceans [4], where massive amounts accumulate in gyres (such as the Great Pacific Garbage Patch) and wash up on shores. Rivers transport plastic debris from inland to marine ecosystems, bullying aquatic life.

3.2 Microplastics and Nanoplastics

Larger plastic debris breaks down under sunlight and physical forces into microplastics (less than 5mm) and nanoplastics (smaller than 100 nm).

3.2.1 Bioaccumulation: These small particles are ingested by a wide range of organisms, from plankton to larger mammals, and enter the food chain, eventually reaching humans. Micro- and nanoplastics can be transported by wind and water, polluting even the most remote regions of the planet.

4. Impacts on Biodiversity

4.1 Wildlife Hazards: Marine and terrestrial species ingest or become entangled in plastic debris [5], leading to injury, suffocation, starvation, and death. More than 1,500 species are known to be affected. Ecosystem Disruption: Plastics can alter habitats, change species distribution, and disrupt the services ecosystems provide.

Corresponding Author:rekhavijay.chem@jecrc.ac.in

4.2 Toxicity: Additives and processing chemicals in plastics, as well as absorbed persistent organic pollutants, can leach into soils and water bodies, posing toxic threats to plants and animals.

5. Climate Change Connections

5.1 Fossil Fuel Extraction and Production:Nearly all plastics are derived from petrochemicals. The extraction, refinement, and manufacturing processes emit large amounts of greenhouse gases. *e.g.* Extraction and transportation emit 1.5 to 12.5 million metric tons of greenhouse gases annually [6]. Refinement releases an additional 184 to 213 million metric tons each year [7].

5.2 Disposal and Decomposition: Landfills storing plastic waste produce methane, a potent greenhouse gas. By 2040, plastics could account for up to 19% of total global greenhouse gas emissions [8-9].

5.3 Feedback Loops: The growth of plastic production undermines efforts to mitigate climate change, as it increases demand for fossil fuels and exacerbates global carbon emissions.

6. Human Health Risks

6.1 Toxic Chemical Release: Plastics release hazardous substances such as dioxins, furans, heavy metals, and phthalates during manufacturing, use, and disposal.

6.2 Food and Water Contamination: Microplastics and their additives can leach into drinking water and be found in food supplies, with health consequences not yet fully understood but linked to inflammation, endocrine disruption, neurological effects, and cancer [10].

6.3 Occupational and Community Exposure: Communities near production plants, landfills, and incinerators are disproportionately exposed to plastic-related pollutants, worsening health inequalities.

7. Socio-economic and Inequity Impacts

7.1 Waste Burden onVulnerable Communities: Developed nations frequently export plastic waste to developing countries that lack the infrastructure for safe recycling or disposal, resulting in local environmental and health crises.

7.2 Livelihood Threats: Pollution negatively impacts agriculture, fisheries, tourism, and other economic sectors reliant on healthy ecosystems.

8. Solutions and Mitigation

8.1 Waste Management Improvements: Enhancing collection, recycling, and waste processing infrastructure can curb plastic leakage into the environment.

Corresponding Author:rekhavijay.chem@jecrc.ac.in

8.2 Policy and Global Action: International agreements and national regulations are being implemented to reduce plastic production, ban single-use plastics, promote alternatives, and address plastic pollution holistically.

8.3 Innovation in Design: The development of biodegradable alternatives, reduction in unnecessary packaging, and a shift towards a circular economy are crucial in minimizing plastic's environmental footprint.

9. Greenhouse Gas Emissions from Plastics

Plastics are a significant and growing source of global greenhouse gas (GHG) emissions, affecting every stage of their lifecycle-from raw material extraction and production to disposal. These emissions are rapidly increasing as global demand for plastics soars.The production stage is by far the most emissions-intensive, primarily due to the energy required to convert fossil fuels to monomers and polymers. Disposal also generates substantial emissions, especially from incineration and landfill methane. Landfills containing plastics contribute to more than 15% of global methane emissions [11].

10. Key Statistics and Projections

93% of plastics are made from fossil fuels, with 14% of all extracted oil used for plastics production [12].If plastic production and waste management continue on their current trajectory, annual emissions could more than double by 2050, reaching 4.7–6.8 billion metric tons CO_2 equivalent per year [13].The cumulative emissions from plastics could exceed 56 gigatons by 2050, representing 10–13% [14] of the full remaining carbon budget to avoid breaching 1.5°C of warming.

11. Environmental and Policy Implications

Escalating GHG emissions from plastics undermine efforts to mitigate climate change, especially given the rapid expansion of the plastics industry and its fossil-fuel dependence.

Adoption of bio-based plastics, improved recycling, and circular economies could reduce emissions, but current trends indicate plastics will increasingly dominate global industrial GHG profiles without policy and technological interventions.

12. Contribution to Global Emissions

In 2019, plastics were responsible for an estimated 1.8 to 2.24 billion metric tons of CO_2 equivalent emissions, accounting for 3.4% to 5.3% of total global GHG emissions [15].This share is greater than emissions from the aviation (1.9%) and shipping (1.7%) industries.Without major intervention, plastic-related emissions could comprise 13–19% of the global carbon budget by 2040–2050, threatening the Paris Agreement target of keeping temperature rise below 1.5°C [16].

13. Conclusion

The environmental impact of plastics spans ecosystems, climate, health, and society at large. Addressing this complex challenge requires concerted global action, technological innovation, robust policy, and a collective shift in consumption and waste habits. The challenge is daunting but essential for the protection of our planet and future generations.

14. References

[1] https://www.earthday.org/plastic-packaging-is-a-pain.

[2] A.F.R.M. Ramsperger, E. Bergamaschi, M. Panizzolo, I. Fenoglio, F. Barbero, R. Peters, A. Undas, S. Purker, B. Giese, C.R. Lalyer, A. Tamargo, M.V. Moreno-Arribas, H.-P. Grossart, D. Kühnel, J. Dietrich, F. Paulsen, A.K. Afanou, S. Zienolddiny-Narui, S. Eriksen Hammer, T. Kringlen Ervik, P. Graff, B.C. Brinchmann, K.-C. Nordby, H. Wallin, M. Nassi, F. Benetti, M. Zanella, J. Brehm, H. Kress, M.G.J. Löder, C. Laforsch, Nano- and microplastics: a comprehensive review on their exposure routes, translocation, and fate in humans, NanoImpact. 29 (2023) 100441. https://doi.org/10.1016/j.impact.2022.100441.

[3] I. Sa'adu, A. Farsang, Plastic contamination in agricultural soils: a review, Environ. Sci. Eur. 35 (2023) 13. https://doi.org/10.1186/s12302-023-00720-9.

[4] https://www.rts.com/blog/plastic-pollution-in-the-ocean-facts-and-statistics/.

[5] S. Lincoln, B. Andrews, S.N.R. Birchenough, P. Chowdhury, G.H. Engelhard, O. Harrod, J.K. Pinnegar, B.L. Townhill, Marine litter and climate change: Inextricably connected threats to the world's oceans, Sci. Total Environ. 837 (2022) 155709. https://doi.org/10.1016/j.scitotenv.2022.155709.

[6] https://www.colorado.edu/ecenter/2023/12/15/impact-plastic-climate-change.

[7] Hamilton, L.A., Feit, S., Muffett, C., Kelso, M., 2019. Plastic & Climate: The Hidden Costs of a Plastic Planet. Center of International Environmental Law.

[8] https://stories.undp.org/what-do-plastics-have-to-do-with-climate-change.

[9] https://unfccc.int/news/a-new-plastics-economy-is-needed-to-protect-the-climate.

[10] C. Campanale, C. Massarelli, I. Savino, V. Locaputo, V.F. Uricchio, A Detailed Review Study on Potential Effects of Microplastics and Additives of Concern on Human Health, Int. J. Environ. Res.

Public Health. 17 (2020) 1212. https://doi.org/10.3390/ijerph17041212.

[11] https://www.colorado.edu/ecenter/2023/12/15/impact-plastic-climate-change.

[12] https://blog.cleanhub.com/how-plastic-pollution-impacts-climate-change.

[13] https://eta-publications.lbl.gov/sites/default/files/climate_and_plastic_report_final.pdf.

[14] https://www.ciel.org/project-update/plastic-climate-the-hidden-costs-of-a-plastic-planet/.

[15] https://cen.acs.org/environment/greenhouse-gases/Plastic-production-belches-over/102/web/2024/04.

[16] https://unfccc.int/process-and-meetings/the-paris-agreement.

Corresponding Author:rekhavijay.chem@jecrc.ac.in