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Evaluating The Environmental And Health Risks Of Single-Use Plastics: Insights Into Plastic Bans And Mitigation Efforts

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Abstract

Plastic products, especially single-use plastics (SUP), have become ubiquitous and are an indispensable part of our daily lives. However, poor management of plastic waste, often culminating in its presence in coastlines, riverbanks, and landscapes, contributes significantly to increased greenhouse gas (GHG) emissions into the atmosphere. This dual threat of plastic pollution and climate change not only disrupts ecosystems but also endangers our water resources, air, and soil quality by releasing harmful pollutants. This study examines the complex interactions between plastic waste pollution, and climate change and their profound impact on the environment. In addition, the report scrutinizes a wide range of innovative policies and strategies around the world, all aimed at reducing plastic pollution and minimizing its harmful effects on public health. This present review seeks to highlight the urgent need for collective action to protect our planet and promote sustainability in the face of these pressing challenges.

Keywords: Single-use Plastic, Pollution, Climate, Plastic Ban, Policies

Introduction

Plastics are synthetic polymers produced by the polymerization reaction of monomers, which are mostly obtained through the extraction of gas and oil (Okoffo et al., 2019). These polymeric materials are well-endowed with intriguing qualities including lightweightness, adaptability, flexibility, strength, resistance to humidity, and most importantly, economic benefits, which has made them an appropriate choice for many industrial and residential applications (Iroegbu et al., 2020). A large number of plastic products are made in such a way that they must be disposed of after only one usage. The use of SUP has increased most in the packaging industry (Srinivasan & Sharma, 2022).

Plastic wastes have accumulated in the ecosystem and pose a serious environmental danger all over the world due to the non-biodegradable nature of these polymeric materials, growing use, and lax waste management requirements (Ribeiro et al., 2019). In different parts of the world, different actions were taken to address the situation, including implementing policies, bans, and levies. To address the effects of plastic and climate change on the environment, a real approach is required. This review's major goal is to demonstrate how plastic pollution affects climate change and how the two are related. This review also discusses various methods for lessening the effect of plastics on the environment and suggests a few solutions.

Methodology

A systematic search methodology was used for this review. The data was gathered from a variety of online resources (including the search engines Google Scholar, PubMed, Scopus, and Web of Science), and relevant information was then retrieved for review writing after the search results were assessed.

Types of Plastics

According to their tendency to set when heated and chemical composition, plastics can be divided into two primary categories: thermoplastics and thermosets. The most common type is thermoplastic; it is a form of plastic that can melt and stiffen when heated and cooled, respectively (Banu, 2019). Thermoplastics, such as polypropylene (PP) (21%), low-density polyethylene (LDPE) (18%), high-density polyethylene (HDPE) (15%), polyvinyl chloride (PVC) (17%), polystyrene (PS) (8%) and polyethylene terephthalate (PET) (7%) dominate the plastic demand on the global market (Hahladakis et al., 2018). The plastic used in thermosets undergoes a chemical change every time it is heated, resulting in the formation of a three-dimensional network (Banu, 2019). The term "single-use plastics" (SUP) refers to plastics that are often only used once before being recycled or discarded.

Plastic production and GHG emission

Commercial plastics are nonbiodegradable, and after being dumped into the environment, they go through numerous phases of disintegration by various means, such as photo-degradation, thermal degradation, UV radiation, and hydrolysis, and ultimately lose their structural integrity. Due to the deterioration of the plastic, tiny microplastics with sizes ranging from a few micro-meters to 500µm are produced. Further degradation of these microplastics results in nanoplastics with a size of 100 nm or less (Sharma & Chatterjee, 2017). These microplastics and nanoplastics eventually find their way into the food chain and pose serious health risks to both humans and other species (Sharma & Chatterjee, 2017). The most recycled plastic, polyethylene terephthalate (PET), decomposes in about 450 years (Sharma et al., 2023).

Crude oil, gas, and coal are the main components of plastic building blocks, and throughout the whole plastic lifecycle, greenhouse gases are released (Sharma et al., 2023). According to a report by the International Energy Agency (IEA), plastic production has suddenly increased since 1950 and is expected to

continue to rise exponentially in the years to come, reaching over 540 million metric tonnes by 2040 (Bassetti, 2020).

The main contributors to greenhouse gas emissions during the production of plastic raw materials are various procedures involved in extracting and transporting fossil fuels (Sharma et al., 2023). Drilling into the Earth's deepest layer enables the extraction of gas and oil from the core. Fracking is the act of forcing a pressurized liquid (fracking liquid) through cracks in deeply stratified rocks to release natural gas (Alhazmi et al., 2021).

Crude oil is refined to produce petroleum products. The monomers that act as the basic building blocks of plastic polymers are then produced utilizing these petroleum products (Sharma et al., 2023). Up to 1.4 million tons of GHG will be released yearly from an ethylene plant constructed by ExxonMobil's Baytown refinery in Texas (Hamilton & Feit, 2019). Plastic polymers, which are used for producing commercial items made from plastic, are combined with additives to provide the product with certain characteristics (Wiesinger et al., 2021). Due to their genotoxicity, these additives pose significant threats to both human and animal health (many are classified in the Stockholm Convention on Persistent Organic Pollutants (POPs) (Secretary-General UN, 2009).

Plastic pollution and global climate change

The world's ineffective handling of this plastic garbage affects the global climate scenario both directly and indirectly. It is a serious environmental problem because each year, 12 million tonnes of unregulated plastic trash, 40% of which is single-use plastic, are released into the environment (Jambeck et al., 2015). More than 250,000 tons of plastic fragments have been deposited in marine bodies as a result of improper plastic waste management (Eriksen et al., 2014). According to Prata et al. (2020), the coastal nations discharge 4.8 to 12.7 million metric tons of plastic waste into water bodies each year. Global city populations are predicted to produce more than 6 metric tonnes of plastic waste each day by the end of 2025 (Hoornweg et al., 2013). By 2050, the increased plastic output will be responsible for almost 13 % of the total carbon budget of the entire earth, equating to approximately 615 coal-fired power station emissions (Hamilton & Feit, 2019). Sea levels are already rising, the ocean is becoming more acidic, and there are more extreme weather events than usual (Ford et al., 2022) (Figure 1). These effects have a negative influence on society's economy and environment. According to research (de Souza Machado et al., 2018), earthworms and springtails play an important role in the transport of microplastics within the soil system in both vertical and horizontal directions. As a result, the entire productivity of the soil has been severely harmed, which has resulted in poor crop yields and a serious worldwide food crisis (Kumar et al., 2021).

Therefore, it is imperative to conduct an in-depth study on how plastic pollution affects climate change so that decision-making bodies can develop mitigation strategies to combat this threat.

Different strategies to lessen the effects of plastic pollution on the climate

In general, the lifecycle GHG emissions of bio-based plastics are lower than those of conventional plastics (Zheng & Suh, 2019). The assumption is that 65.8% of people worldwide would choose bio-based plastics over traditional plastics, saving 241-316 metric tonnes of CO2 equivalent annually (Spierling et al., 2018).

Another tactic is to use a low-carbon energy-based method to produce plastic which can minimize the emission of GHG during plastic production. Using a low renewable energy-based approach, greenhouse gas emissions were lowered by 50–75% in the US (Posen et al., 2017). By choosing low-carbon energy sources throughout the production stage of plastic polymer, GHG emissions can be reduced by 50%, according to a Material Economics analysis to reduce the climate impact of plastic pollution (Bauman, 2019).

Another strategy for minimizing GHG is recycling. Recycled plastic can meet the high demand of various sustainable companies because it is one of the least expensive alternatives for plastic polymers (Hopewell et al., 2009).

One of the common strategies to lessen the negative effects of plastic on the climate is to outlaw single-use plastic. A United Nations Environment Programme study from 2018 stated that around 127 nations had approved legislation limiting the use of plastic bags (Cho, 2020). India has banned all single-use plastic items since July 2022. By enacting various rules and obstructing the import of various plastic items, state government officials also tried to reduce the production of plastics by various industries (Sampath Kumar, 2019). However, in practice, the use of plastic bags and items is still very high due to the inhabitants' lax attitude toward the issue, making India one of the top four countries in the world that generates plastic garbage (Bhatia, 2017).

Figure 1. Plastic Beach. Ravi Khemka. https://shorturl.at/438EJ. cc-by-2.0

Conclusions

Plastic has now permeated every aspect of our way of life and poses serious hazards to both the environment and public health. In this context, the implementation of various plastic regulations restricting the manufacture and use of plastic-based products will be beneficial. To ensure that our next generation inherits a sustainable environment for the duration of their lives, many legislators, environmental researchers, governmental agencies, and philanthropic fundraisers must be active in the effort to eradicate plastic and its related effects on the global climate and environment.

References

1. Alhazmi, H., Almansour, F. H., & Aldhafeeri, Z. 2021. Plastic waste management: A review of existing life cycle assessment studies. *Sustainability*, *13*(10), 5340. https://doi.org/10.3390/su13105340
2. Banu, N. 2019. Single-use plastic ban and its public health impacts: A narrative review. *Annals of SBV*, *8*(1), 14.d
3. Bassetti, F. 2020. The future of plastics is uncertain. *Foresight*. https://www.climateforesight. eu/articles/the-future-of-plastics-is-uncertain/. Accessed March 20, 2022.
4. Bauman, B. 2019. How plastics contribute to climate change. *org/2019/08/how-plastics-contribute-to-climate-change/*. (Accessed 25 March 2022). https://yaleclimateconnections
5. Bhatia, A. 2017. Plastic ban: What India can learn from other countries. Plastic waste. https://swachhindia.ndtv.com/plastic-ban-india-can-learn-countries-6161/. Retrieved February 6, 2022
6. Cho, R. 2020. More plastic is on the way: What does it mean for climate? State of the planet. https://news.climate.columbia.edu/2020/02/20/plastic-production-climate-change/. Retrieved May 20, 2022
7. de Souza Machado, A. A., Kloas, W., Zarfl, C., Hempel, S., & Rillig, M. C. 2018. Microplastics as an emerging threat to terrestrial ecosystems. *Global Change Biology*, *24*(4), 1405–1416. https://doi.org/10.1111/gcb.14020
8. Eriksen, M., Lebreton, L. C., Carson, H. S., Thiel, M., Moore, C. J., Borerro, J. C., Galgani, F., Ryan, P. G., & Reisser, J. 2014. Plastic pollution in the world's oceans: More than 5 trillion plastic pieces weighing over 250,000 tons afloat at sea. *PLOS ONE*, *9*(12), e111913. https://doi.org/10.1371/journal.pone.0111913
9. Ford, H. V., Jones, N. H., Davies, A. J., Godley, B. J., Jambeck, J. R., Napper, I. E., Suckling, C. C., Williams, G. J., Woodall, L. C., & Koldewey, H. J. 2022. The fundamental links between cli[1]mate change and marine plastic pollution. *Science of the Total Environment*, *806*(1), 150392. https://doi.org/10.1016/j.scitotenv.2021.150392

10. Hahladakis, J. N., Velis, C. A., Weber, R., Iacovidou, E., & Purnell, P. 2018. An overview of chemical additives present in plastics: Migration, release, fate and environmental impact during their use, disposal, and recycling. *Journal of Hazardous Materials*, *344*, 179–199. https://doi.org/10.1016/j.jhazmat.2017.10.014

11. Hamilton, L. A., & Feit, S. 2019. *Plastic and climate: The hidden costs of a plastic planet* [CIEL report].

12. Hoornweg, D., Bhada-Tata, P., & Kennedy, C. 2013. Environment: Waste production must peak this century. *Nature*, *502*(7473), 615–617. https://doi.org/10.1038/502615a

13. Hopewell, J., Dvorak, R., & Kosior, E. 2009. Plastics recycling: Challenges and opportunities. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *364*(1526), 2115–2126. https://doi.org/10.1098/rstb.2008.0311

14. Iroegbu, A. O. C., Sadiku, R. E., Ray, S. S., & Hamam, Y. 2020. Plastics in municipal drinking water and wastewater treatment plant effluents: Challenges and opportunities for South Africa—A review. *Environmental Science and Pollution Research International*, *27*(12), 12953–12966. https://doi.org/10.1007/s11356-020-08194-5

15. Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., Narayan, R., & Law, K. L. 2015. Marine pollution. Plastic waste inputs from land into the ocean. *Science*, *347*(6223), 768–771. https://doi.org/10.1126/science.1260352

16. Kumar, R., Verma, A., Shome, A., Sinha, R., Sinha, S., Jha, P. K., Kumar, R., Kumar, P., Shubham, S., Das, S., Sharma, P. V., & Vara Prasad, P. V. 2021. Impacts of plastic pollution on ecosystem services, sustainable development goals, and the need to focus on circular economy and policy interventions. *Sustainability*, *13*(17), 9963. https://doi.org/10.3390/su13179963

17. Okoffo, E. D., O'Brien, S., O'Brien, J. W., Tscharke, B. J., & Thomas, K. V. 2019. Wastewater treatment plants as a source of plastics in the environment: A review of occurrence, methods for identification, quantification, and fate. *Environmental Science: Water Research and Technology*, *5*(11), 1908–1931. https://doi.org/10.1039/C9EW00428A

18. Posen, I. D., Jaramillo, P., Landis, A. E., & Griffin, W. M. 2017. Greenhouse gas mitigation for US plastics production: Energy first, feedstocks later. *Environmental Research Letters*, *12*(3), 034024. https://doi.org/10.1088/1748-9326/aa60a7

19. Prata, J. C., da Costa, J. P., Lopes, I., Duarte, A. C., & Rocha-Santos, T. 2020. Environmental expo[1]sure to microplastics: An overview on possible human health effects. *Science of the Total Environment*, *702*, 134455. https://doi.org/10.1016/j.scitotenv.2019.134455

20. Ribeiro, F., O'Brien, J. W., Galloway, T., & Thomas, K. V. 2019. Accumulation and fate of Nano and micro-plastics and associated contaminants in organisms. *TrAC Trends in Analytical Chemistry*, *111*, 139–147. https://doi.org/10.1016/j.trac.2018.12.010

21. SampathKumar, Y. 2019. Plastic bans spread in India. Winners and losers aren't who you'd expect. https://www.nationalgeographic.com/environment/2019/02/india-single-useplastic-bans-maharashtra-tamil-nadu/. Retrieved September 6, 2023

22. Secretary-general UN. 2009. http://chm.pops.int/Convention/tabid/54/language/en-US/Default.aspx. Retrieved March 21, 2022. *B & C*. Stockholm convention on persistent organic pollutants adoption of amendments to annexes A.

23. Sharma, S., & Chatterjee, S. 2017. Microplastic pollution, a threat to marine ecosystem and human health: A short review. *Environmental Science and Pollution Research International*, *24*(27), 21530–21547. https://doi.org/10.1007/s11356-017-9910-8

24. Sharma, S., Sharma, V., & Chatterjee, S. 2023. Contribution of plastic and microplastic to global climate change and their conjoining impacts on the environment review. *Science of the Total Environment*, *875*, 162627. https://doi.org/10.1016/j.scitotenv.2023.162627

25. Spierling, S., Knüpffer, E., Behnsen, H., Mudersbach, M., Krieg, H., Springer, S., Albrecht, S., Herrmann, C., & Endres, H. J. 2018. Bio-based plastics review of environmental, social, and economic impact assessments. *Journal of Cleaner Production*, *185*, 476–491. https://doi.org/10.1016/j.jclepro.2018.03.014

26. Srinivasan, M., & Sharma, J. 2022. Single-use plastic ban and marketing scenario: Policy and implementation. *Academy of Marketing Studies Journal*, *26*(2), 1–11.

27. Wiesinger, H., Wang, Z., & Hellweg, S. 2021. Deep dive into plastic monomers, additives, and processing aids. *Environmental Science and Technology*, *55*(13), 9339–9351. https://doi.org/10.1021/acs.est.1c00976

28. Zheng, J., & Suh, S. 2019. Strategies to reduce the global carbon footprint of plastics. *Nature Climate Change*, *9*(5), 374–378. https://doi.org/10.1038/s41558-019-0459-z