Is the Plastic Pandemic a Greater Threat to Humankind than COVID-19?

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ABSTRACT: The advent of the COVID-19 pandemic has initiated a radical attention shift of society toward the severe consequences it has had over human health, shadowing a symmetrically, if not more, important issue of the rapid intensification in the amount of plastic waste that has been generated over the due course of time. Such a growth in the plastic footprint across the globe has led to a carbon positive environment with an increased amount of greenhouse gases (GHGs) released due to the processing of the waste plastic. We aim to address and provide our perception to this pressing challenge that can be decoded via the advancement of upcycling technologies, utilized and augmented worldwide. With the establishment of such sustainable policies and strategies, the global plastic footprint can be systematically mitigated, accelerating the world into economic circularity and environmental sustainability.

KEYWORDS: Plastic pandemic, COVID-19, Sustainability, Upcycling, Policy and governance

THE CHANGING FACE OF PLASTIC: MIRACLE TO CATACLYSM

Innovative development in the domain of materials typically not found in nature has been a growing interest for researchers, with the fundamental objective of providing convenience and benefit to people across the globe. The fastest ever transition from the Paleoplastic age to the Neoplastic age taking place in the chronological time frame of the 19th century symbolizes the inception of the paradigm-altering “Plastic Era” for humankind, leading to the development of the first synthetic and industrially produced plastic Bakelite. While the modern society without plastic appears unthinkable to exist, there has been a progressive evolution in the R&D on plastics along with global commercial expansion in recent years, incorporating plastic products and their escalating use as an integral segment in our lives.

Nonetheless, in the current anthropospheric world of accelerated economy amidst the exceptionally rapid production–disposal cycle in a supply chain, the volume of waste plastic on Earth has surpassed the measure of any known material waste.1 With time, the ecosystem wavefront in the existent terrestrial and aquatic plane has transformed to an environmentally unfavorable structure, where plastics have undergone fragmentary degradation into microplastics and nanoplastics.2 A comprehensive assessment of the plastic lifecycle performed by Hamilton et al. provides us with the statistic of a yearly release of more than 0.6 billion metric tons of greenhouse gases (GHG), which has been one of the prime causal sources for the drastic increase in the global warming, leading to an amplified dynamics of climate change. With such ecological deterioration, the expected growth of the emission will be 4 times the current value by 2050.3 A similar standpoint of a cradle-to-grave assessment explicates the greenhouse gas (GHG) footprint in the overall life cycle of plastic products, validating the inference about the environmental negativity being spread in a dual manner: plastics as well as plastic production. Recent research conducted by Bardow and Meys et al. investigates a thorough utilization of biomass and CO2 capture technique to circularize the carbon flow via the proposal of maximal recycling of plastic waste, providing a cradle-to-grave assessment for the year 2050.4 Though such an extensive analysis will prove extremely useful across different branches of science and technology, an additional analysis for the upcycling of plastic instead of conventional recycling is required to be examined. Furthermore, the ecological impact of plastic waste growth and the fate of the world during such unprecedented circumstances such as a worldwide pandemic has not been added in the assessment, which is extremely important from the industrial, governance, and geographical standpoint, as evident from the industrial and geopolitical

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Figure 1. Integrating sustainable technology with a segment of policy will strengthen the efforts made toward the global core objective of reducing plastic and converting it into upvalued products. Traversing the road to a sustainable future, the present Red Earth (portrayed as red car) full of plastic waste can be transformed into a near-zero plastic Green Earth (portrayed as green car) via the adoption of the 4R principle of removal—responsibility—reduction—revival, which may provide a fresh perspective to a novel International Treaty on Plastic Waste mitigation and net-zero greenhouse emission plastics. The metaphorical visualization can be seen with the transition in color of the car, representing the state of the planet.
disruptions caused by the COVID-19 pandemic specifically related to the use of plastic products. Since the monomeric units of ethylene and propylene that are used extensively for plastic production are derived from fossil-based hydrocarbons existing in a limited quantity as a nonrenewable resource, it considerably shifts the goal of sustainability away from humanity. From a comparison perspective, an approximate estimation provides us with the evidence that the overall plastic weight of more than 10 billion metric tons is 25-fold larger than the entire human population weight on Earth, where 79% of the plastic waste stays accumulated in the landfills and oceans, impeding the sustenance of terrestrial and aquatic life forms.5,6 Furthermore, a recent predictive estimation performed by Lebreton and Andrady in the year 2019 depicts that the accumulative growth rate in the class of Mismanaged Plastic Waste (MPW) can increase to as high as 265 million Mt y\(^{-1}\) by the year 2060, approximately three times the current growth rate.7 Consequently, this rise in the overall global plastic footprint has been an ever-growing concern for a diverse cohort of material researchers, chemical and environmental engineers, and sustainability scientists, with its direct linkage to the increasing carbon footprint leading to severe alterations in the geophysical and biological ecosystem, and consequently the climate change. From the human health perspective in a consumer-resource system, the unsolicited biomagnification in the food chain might lead to the accumulation of microplastics in the human system that will trigger the inception of dreadful implications to the Plastic Pandemic.8

■ DENATURING THE NATURE: PLASTIC USE DURING THE COVID-19 PANDEMIC

The worldwide spread of the SARS-CoV-2 virus led us to the unending COVID-19 pandemic in the present world, predominantly attributed to the abuse of nature by us, that vastly amplified its fatality, economy, and ecology. As a figurative connection, humanity in the past invaded the habitat of viruses and bacteria to accumulate their plastic waste, and therefore the COVID-19 pandemic has now invaded our livelihood. Amidst the established expedited number of global cases, the overlooked focal point of the event has constantly been the amplification in the amount of plastic waste generated in the form of medical waste, viz., face masks and plastic shields, diagnosis equipment, PPE kits, medicinal syringes, etc. This specified form is characterized as single utility plastic, the production and disposal of which have exponentially magnified during the stay-at-home phase of institutionalized lockdown due to the outbreak of Coronavirus disease. Microanalyzing the impact at a country-level, the research study by Law et al. presents the data until the year 2016 where the USA generated a maximum plastic waste of 42 million metric tons.9 Connecting the present statistical information with the study conducted by Borrelle et al., the planetary threat of plastic pollution is bound to increase exponentially, particularly amidst the COVID-19 pandemic, surpassing the efforts to reduce the plastic footprint. Substantiating this threat of plastic growth, an estimation of the daily worldwide plastic waste generation of 1.6 million tons from the inception of the COVID-19 pandemic leads us to more than 900 million tons of total plastic waste generated in 2 years of the pandemic.10 With the occurrence of COVID-19 among people rise close to 376 million, the researchers assert that the economic, public health, and behavioral responses to the COVID-19 pandemic have transformed plastic waste production, composition, and treatment methods in unquantified ways across the globe, majorly accounted for by the medical-use-based plastic, establishing the gravity with which the world must ensure proper processing of its plastic waste.11 Conclusively, the use of plastic in fighting against the COVID-19 pandemic saved millions of lives; however, the non-systematized management and disposal of medical waste plastics will emerge as an ecology-threatening polluting material stream in the post-COVID-19 era.

■ SYNERGISTIC SUSTAINABILITY: A POLICY OUTLOOK

Worldwide advancement on the research front continually focusing on solving the problem of growing plastic waste necessitates an equivalent development of the policies and regulations at a societal level, federal level, and international level, which can substantially commit to lowering the plastic waste footprint from the face of the Earth (Figure 1). Amidst the globally existent environmental concerns, the upsurge of plastic waste leading to plastic pollution has constantly been one of the topmost pressing issues, as published in a UN Treaty Report of 2019, accompanying water pollution and climate change as the other two. While several cities and nations have affirmed a plastic ban policy in their society in the last 20 years, the ease of plastic use, along with the disagreements and non-transparency encircling the global plastic trade, has made it challenging to govern and gain control over the accumulation of plastic within the borders of a polity. From our viewpoint, the notion of the plastic ban has become a past due to its impracticability, evident from the extensive and overwhelming use of plastic products in all the countries during the ongoing spread of the COVID-19 pandemic, where the doctors and nurses are covered with single-use personal protective plastic aprons and hand gloves as well as the use of several ubiquitous medical supplies like COVID-19 detection kits, face masks, and vaccine syringes.

With no international treaties or protocols focusing on plastic waste, we attempt to introduce the concept of a synergy connection, amalgamating global sustainable upcycling technology and policy governance for plastic waste, which can considerably mitigate the plastic footprint and create an efficiently functioning supply chain of plastic waste upcycled products. The integrative methodical strategy can be visualized from Figure 1, which embeds the technical and policy-based goals and responsibilities of diverse entities viz. international bodies, government organizations, industries, and civil society. Although the scientific community has been investing their efforts profoundly toward the R&D course for the removal of plastic waste, thus fulfilling the first objective, an extensive focus on laws, regulations, and environmental awareness programs is required, associated with the effective conversion and mitigation of plastic waste by the national and international government organizations.12 Furthermore, such synergy can be reinforced if the citizens in society metamorphose their plastic-based lifestyle toward zero-plastic use conduct. At the same time, the industries can execute their part in limiting plastic pollution by adopting the circular economy via upcycling approach while dealing with plastic waste.13 Conclusively, with this application of the 4R principle (removal—responsibility—reduction—revival), our human community can advance into a near-zero-plastic world in an efficient and more sustainable-healthier direction.
A COLLECTIVE INTENT: GENERATING VALUE FROM WASTE

The persistent global precedence of human health over environmental health has represented the supremacy of humans over nature, and the authors aim to concentrate that ecological health needs to be prioritized as the leading priority. We strongly believe in the technological principle of upvaluation to lower the plastic footprint instead of the conventional destruction of plastic waste via incineration or the novel methods of time-consuming bacterial decomposition. Moreover, restoration of plastic waste by keeping it in the recycling loop maintains the invariability of the plastic footprint and will never be an efficient technique in minimizing it, and will exponentially increase the environmental emissions associated with the recycling over time. Strengthening the opinion analogously, there has been a significant accelerating trend in the research of upcycling plastic waste, where the researchers have been successful in upvaluing/upcycling the plastic into carbon nanotubes, carbon spheres, organic compounds, and detergents, along with the deconstruction of plastic into hydrogen and high-value carbons utilizing novel approaches. Moreover, a concept application such as Trash-to-Tank (3T) also provides a viable solution to the persistent problem of plastic waste accumulation specific to the developing countries. The sole gap that needs to be bridged for the universal implementation is the systematic scalability of the technology across all of the continents, and the authors give credence to the significance of imminent scalable research and development activities that will be devoted toward the exhaustive elimination of the generated waste plastics in an environmentally benign fashion, sooner than later.

With the major industries across the globe redirecting their focus from the linearized economy to circular economy, and the funding organizations such as the Ellen MacArthur Foundation promoting and advancing circular economy, the pursuit of designing innovative materials from plastic waste has been gaining traction among scientists. It can be safely predicted that the post COVID-19 global society will possess the technology that can support them with the mitigation of plastic footprint (Figure 2) from the face of Earth and create valuable materials out of it which will save us from the Plastic Pandemic, leading to a sustainable and healthy environment for the future generation. As hundreds of viruses and bacteria are beneficial to human existence, keeping space available for their growth and survival via minimizing waste plastic debris on Earth would mitigate the risk of a new pandemic.

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Notes

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