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THE IMPACT OF PLASTIC POLLUTION ON CLIMATE CHANGE

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Abstract

Almost all plastic is derived from materials (like ethylene and propylene) made from fossil fuels (mostly oil and gas). The process of extracting and transporting those fuels, then manufacturing plastic creates billions of tonnes of greenhouse gases. Plastic dumped in landfills can take hundreds of years to break down using a process called photodegradation. Over time, plastic breaks down into methane and ethylene which also contribute to climate change, albeit slowly. Other toxins are also released into the local ecosystems causing ground pollution. The waste management of plastic products has long been a problem. Burning plastic waste is a source of air pollution that is harmful to human health but also releases toxins and carbon dioxide into the atmosphere that impacts global warming. In our oceans, plastics directly chokes and smothers a host of marine animals and habitats and can take hundreds of years to break down. As our climate changes, the planet gets hotter, the plastic breaks down into more methane and ethylene, increasing the rate of climate change, and so perpetuating the cycle. The tiny powerhouses (microplastics) play a critical role in taking carbon dioxide from the atmosphere and water and sequestering it in deep ocean sinks. Our studies show that plastic can affect the water-holding capacity of drains, river channels and reservoirs. This leads to flooding of adjacent lands and loss of biological diversity and livelihoods. To combact plastic pollution some steps need to be taken such as government should levy a high fee on each plastic bag that shoppers get at mall and markets because it will discourage people from discarding them after single use; the people should be educated on the three Rs: reduce, recycle and reuse plastic material; the dangers imposed by discarding water satchet and bottles in the environment. Paper bags should be encouraged; government should launch a campaign to crack down on plastic bags and bottles in the country; government should pass the "plastic pollution bill" into law to serve as a guide for the citizens.

Keywords: Photodegradation, microplastic, greenhouse gases, landfill, global warming

Introduction

Climate change refers to long – term alterations in temperature and weather patterns across the globe resulting primarily from human activities and natural factors. These human activities such as the burning of fossil fuels like coal, oil and natural gas are primary sources of greenhouse gas emissions. Climate change is major global threat, already affecting every region across the world and displaying increased ocean temperatures, sea – level rise, ocean acidification and more frequent and extreme weather events that are causing widespread ecological and socio – economic harm that is predicted to intensify (IPCC,

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2021, IPCC, 2019; Ummenhofer and Meehl, 2017; Vicedo-Cabrera et al., 2021; Vitousek et al., 2017). The impact of plastic pollution on climate change has become a pressing and widely recognized issue in recent years. Plastic, a versatile and a durable material, has undoubtedly contributed to advancements in various sectors, but its widespread use and improper disposal have led to significant environmental consequences. Plastic pollution has reached alarming levels globally, with an estimated 8 million metric tons of plastic waste entering our oceans each year (Jambeck et al., 2015). The waste accumulates in our environment, disrupting natural ecosystems and posing threats to marine life. However, the implications of plastic pollution extend beyond the obvious environmental concerns, as it also has a significant impact on climate change. The production and disposal of plastic contribute to greenhouse gas emissions, exacerbating global warming. The production of plastics heavily relies on fossil fuels, which release large amounts of carbon dioxide (CO2) during extraction, refinement and manufacturing processes (Geyer et al., 2017). Consequently, plastic production contributes to the accumulation of greenhouse gases in the atmosphere, directly contributing to climate change. Furthermore, the improper management of plastic waste further exacerbates the problem. When plastic waste ends up in landfills, it decomposes anaerobically, releasing substantial amounts of methane gas, a potent greenhouse gas (Narayan and Law 2021). These methane emissions intensify the greenhouse effect, trapping heat in the atmosphere and contributing to the overall warming of the planet. Additionally, plastic waste that enters aquatic environments undergoes photo-degradation releasing CO2 and further contributing to climate change.

Moreover, the ecological impacts of plastic pollution have indirect effects on climate change. Plastic waste in our oceans disrupts marine ecosystems affecting the natural processes that regulate carbon sequestration and nutrient cycling (Carson et al., 2013). These disruptions can alter the balance of greenhouse gases in the atmosphere, impacting the Earth's overall carbon storage capacity and further complicating efforts to mitigate climate change. Recently the public's eagerness to help solve marine plastic pollution has intensified and sparked controversy as a distraction from the greater and more pressing issue of climate change (Stafford and Jones, 2019). However, plastic pollution has an equally global distribution; it is found across all regions of the ocean, from shallow coastal areas to the deepest regions sampled to date and in the most remote and sensitive locations on earth (Free et al., 2014; Napper et al., 2020; Obbard et al., 2014; Woodall et al., 2014).

Statement of problem

Plastic pollution has become a major environmental issue, affecting ecosystems and human health. While the adverse effects of plastic pollution are well-known, the connection between plastic waste and its contribution to climate change often goes overlooked. This statement aims to address the problem of how plastic pollution exacerbates climate change and highlights the need for urgent action to mitigate

its impact. The problem lies in the life cycle of plastics, starting from their production to their disposal. Plastic production heavily relies on fossil fuels, mainly crude oil and natural gas, which emit large amounts of greenhouse gases during extraction and manufacturing processes. The extraction of these fossil fuels also leads to habitat destruction and further contributes to climate change. Furthermore, plastic waste poses a significant challenge in terms of proper disposal and management. Improperly managed plastic waste often ends up in landfills or enters water bodies, where it undergoes degradation through photochemical processes. This degradation releases greenhouse gases, including methane and CO2, into the atmosphere, thereby contributing to the greenhouse effect and the exacerbation of climate change. Plastics also have an indirect impact on climate change through their role in disrupting ecosystems. Marine plastic pollution, for example, affects marine life and ecosystems, leading to altered carbon sequestration rates and disrupting the balance of aquatic food chains. These ecological disruptions, in turn, impact carbon cycling and storage, which can further contribute to climate change. With the scale of plastic pollution continuing to increase globally, urgent action is necessary to address its impact on climate change. Innovative approaches are needed to reduce plastic waste generation, enhance recycling and waste management systems, promote the use of sustainable alternatives, and raise awareness about the environmental consequences of plastic pollution.

Materials and Methodology

Data used for this study is derived from the literature review of published works including academic articles, journals, conference papers textbooks and internet materials. The researchers gathered much materials for the research but summarized the characteristics that centered more on “The Impact of Plastic Pollution on Climate Change Globally”. This enabled the researchers to generate the synthesis of various researchers’ views on the subject matter.

Result and Discussion

Plastics are threating the ability of the global community to keep global temperature rise below 1.5^{o} C, as greenhouse gases (GHG) are emitted throughout the plastic life cycle (Anabaraonye *et al.*, 2022). Indeed, extraction, refining and manufacture of plastics are all carbon intensive activities. In 2015, CO_2 and other GHGs emission from plastic production reached 1.96 Gt of CO_2e for a cost of $341 billion annually. At the disposal stage, incineration of plastic waste releases significant GHG into the atmosphere, along toxic pollutants. Other disposal methods, including recycling, also come with their share of GHG emissions. The rapid global growth of the plastic industry, largely fueled by natural gas, undermines efforts to reduce carbon pollution and prevent a climate catastrophe.

The Link between plastic production and greenhouse gas emissions

The link between plastic production and greenhouse gas emissions is complex but significant. Plastic production is a major source of greenhouse gas emissions at multiple stages of its lifecycle from production of raw materials to produce plastics to the recycle and disposal period. The production of the raw materials used to make plastics, such as oil and natural gas, involves the extraction and processing of fossil fuels. These activities release greenhouse gases such as carbon dioxide (CO_2) and methane (CH_4). The process of converting these raw materials into plastic products requires energy, typically derived from fossil fuels. This manufacturing stage also emits CO_2 and other greenhouse gases. These plastic products are often transported over long distances, contributing to emissions from transportation vehicles, which also rely heavily on fossil fuels. Also when they are discarded, they can release greenhouse gases as they break down. Some plastics may persist in the environment for a very long time, contributing to ongoing emissions. In most cases these discarded plastics improperly in there various landfills which when burned they release carbondioxide (CO_2) and other pollutants, contributing to air pollution and greenhouse gas emissions. Recycling plastics can be energy-intensive, and not all plastics are easily recyclable. The extent of these emissions depends on factors like the type of plastic, production methods, and waste management practices. Efforts are being made to reduce the carbon footprint of plastic production by using alternative materials, improving recycling rates, and adopting more energy-efficient manufacturing processes. Reducing plastic consumption and promoting sustainable alternatives can also help mitigate the environmental impact associated with plastic production and disposal.

Plastic waste and its contribution to air pollution

Plastic waste contributes to air pollution primarily through the process of plastic incineration. When plastics are burned in open-air or uncontrolled incinerators, they release toxic fumes and particulate matter into the atmosphere. These emissions can include harmful chemicals like dioxins and furans, which are known to be carcinogenic and can harm human health. Additionally, the production and transportation of plastic materials contribute to greenhouse gas emissions, which contribute to climate change and its associated air quality issues. Plastic waste can also indirectly affect air quality by contaminating water bodies. When plastics break down in the environment, they release microplastics into the water, which can later evaporate into the atmosphere, potentially carrying with them any pollutants they have absorbed. Efforts to reduce plastic waste, promote recycling, and develop more sustainable materials can help mitigate these air pollution impacts.

The effects of plastic pollution on oceans and marine life

Plastic pollution has devastating effects on oceans and marine life. It can lead to harm of Marine Animals, toxicity, disruption of food chains, coral reef damage, habitat destruction and ocean

acidification. Plastics can release harmful chemicals when they break down, contaminating and acidifying the water by reducing the water's ability to absorb carbon dioxide and harming aquatic organisms. Small marine creatures may ingest these harmful chemicals, which can then move up the food chain, potentially impacting larger predators and even humans who consume seafood. Plastic pollution and accumulated plastic waste can smother and damage coral reefs, which are vital ecosystems for marine biodiversity and destroy habitats like mangroves and estuaries, critical for many species. These issues can be addressed through reduced use, recycling, and proper disposal of plastics which is essential to protect our oceans and marine life.

Relationship between plastic decomposition and release of greenhouse gases

Plastic decomposition and the release of greenhouse gases are interconnected through various processes. When plastics degrade, they can release greenhouse gases, primarily methane and ethylene. Over time, plastic materials break down into smaller particles called microplastics due to environmental factors like UV radiation and mechanical forces. These microplastics can serve as substrates for microbial activity in soil and water. Some microorganisms can metabolize these plastics, leading to the production of methane as a metabolic byproduct which can be released into the atmosphere. Methane is a potent greenhouse gas, with a much higher heat-trapping potential than carbon dioxide over a short time frame. Plastics can also emit ethylene gas as they degrade. Ethylene is another greenhouse gas that can contribute to global warming. As plastics deteriorate, they can release carbon dioxide (CO_2) as well. While CO_2 is a less potent greenhouse gas per molecule compared to methane, the vast amounts of plastic waste in the environment can still contribute to overall CO_2 emissions. In otherwords, plastic decomposition can indirectly contribute to the release of greenhouse gases, particularly methane and ethylene, which have more significant warming potential than carbon dioxide over shorter timeframes. Reducing plastic waste and promoting responsible waste management practices can help mitigate these environmental impacts.

Impact of plastic pollution on land and soil degradation

Plastic pollution can have several negative impacts on land and soil degradation such as soil contamination, disrupt ecosystem and reduction in nutrient availability. When plastic waste is improperly disposed of on land, it can release harmful chemicals and additives as it breaks down, contaminating the soil. These toxins can affect soil quality and harm microorganisms essential for healthy soil. Plastic debris on the surface can block sunlight and hinder rainwater absorption, leading to reduced soil moisture and fertility. This can affect plant growth and agricultural productivity. Over time, larger plastic items can degrade into tiny microplastic particles. These microplastics can enter the soil and negatively impact soil structure, nutrient availability, and potentially harm soil-dwelling

organisms. Plastic waste in natural ecosystems can disrupt habitats for various species, affecting biodiversity. Altered ecosystems may lead to soil erosion and other forms of land degradation. Plastics littered on land reduces the aesthetic appeal of landscapes and can deter tourism and recreation. This, in turn, can impact the economic well-being of local communities. Efforts to remove plastic pollution from land and soil can be costly, diverting resources that could be used for other environmental conservation and restoration projects.

Plastic recycling and its potential for reducing climate impact

Plastic recycling has the potential to significantly reduce its climate impact. By recycling plastic, it consumes less energy compared to producing new plastic from raw materials. This reduction in energy use leads to lower greenhouse gas emissions. When plastic is recycled, there is less demand for the production of virgin plastic which is resource-intensive and contributes to carbon emissions. Recycling also reduces the need for extracting and processing petroleum-based feedstocks used in plastic production. This conserves natural resources and decreases associated emissions. Recycling diverts plastic from landfills, where it can release methane, a potent greenhouse gas. By reducing landfill emissions, it helps mitigate climate change. Some recycled plastics can also be used in durable applications, prolonging the life of products and reducing the need for replacements and new plastic production. Where materials are reused and recycled in a close loop, it minimizes waste and emissions which is a key component for circular economy. However, it's important to note that the effectiveness of plastic recycling in reducing climate impact depends on factors like collection rates, recycling processes, and market demand for recycled materials. Maximizing these aspects is crucial for realizing the full potential of plastic recycling in the fight against climate change. Additionally, reducing plastic consumption and promoting alternatives to single-use plastics are essential steps in addressing the environmental impact of plastic.

Alternatives to single-use plastics and their role in mitigating climate change

Alternatives to single-use plastics play a significant role in mitigating climate change by reducing greenhouse gas emissions and minimizing environmental pollution. There are some alternatives to plastics which can contribute in mitigating climate change. These alternatives includes the use of biodegradable plastics, paper and cardboard materials, reusable containers, cloth bags, plant – based packaging materials, metal straws, natural fibre products e.t.c. Most of these materials break down easily and can reduce carbon emissions during production and often result in biodegradable waste. Encouraging the use of reusable containers such as stainless-steel water bottles, metal straws, cloth bags and glass food storage reduces both plastic consumptions and plastic pollution both in oceans and landfills. Materials like cornstarch-based plastics or sugarcane-based packaging are renewable and have

a smaller carbon footprint. Bamboo, coconut husk, and other natural fibers can be used for products like toothbrushes and utensils, reducing plastic use. These alternatives play a major role in mitigating climate change which lies in their ability to reduce the carbon footprint of production, decrease the demand for fossil fuels used in plastic manufacturing, and reduce the release of methane gas from plastic decomposition in landfills. Additionally, they can also help in combating plastic pollution, which can harm ecosystems and wildlife, further contributing to climate resilience.

Global efforts and policies to address plastic pollution and climate change

Global efforts to address plastic pollution and climate change have gained momentum in recent years. Some key policies and actions like the Paris Agreement, adopted in 2015, is a landmark international treaty aimed at combating climate change. It encourages countries to reduce greenhouse gas emissions and limit global warming. While it primarily focuses on climate change, it indirectly addresses plastic pollution by emphasizing sustainable practices. International Agreements like the Basel Convention and the Stockholm Convention address the movement and disposal of hazardous waste, including certain types of plastic waste. Also SDG 13 (Climate Action) and SDG 14 (Life Below Water) include targets related to climate change mitigation and the reduction of marine pollution, which can help address plastic pollution in the oceans. Many countries have implemented measures to reduce plastic waste, such as bans on single-use plastics, promoting recycling, and encouraging the use of sustainable alternatives. Transitioning to a circular economy model, where products are designed to be reused, recycled, or repurposed, can help reduce plastic pollution and greenhouse gas emissions associated with the production of new materials. Governments and organizations should invest in research and innovation to develop more sustainable materials and technologies to combat both plastic pollution and climate change. Raising public awareness about the environmental impact of plastics and climate change is crucial for changing behavior and driving policy changes most especially in the rural areas. It's important to note that addressing these global challenges requires collaborative efforts from governments, businesses, and individuals to achieve meaningful and lasting change.

Conclusion

The impact of plastic pollution on climate change is a complex issue. Plastic pollution doesn't directly cause climate change but does contribute indirectly through its lifecycle. Reducing plastic use, promoting recycling, and transitioning to more sustainable materials are essential steps to mitigate these impacts and address both plastic pollution and climate change. By recognizing the link between plastic pollution and climate change, policymakers, industries, and individuals can work together to develop effective strategies and take concrete steps towards a more sustainable future. It is essential to address

the problem of plastic pollution holistically, considering its environmental, social, and economic impacts, while striving to mitigate its contribution to climate change.

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