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A Study On Relationship Between Recycling Plastic And Proper Disposal.

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Abstract

This paper covers the plastic recycling and disposal process which is carried out by chemical and the mechanical means where several technologies and steps are involved. India and the world have witnessed substantial growth both in the production and consumption of plastics. In absence of appropriate waste collection and segregation processes, the management of waste especially for the discarded plastic used for packaging has become a challenging task. Growing plastic pollution is affecting ecosystem as well as human health. This paper provides an overview to of all the challenges due to plastic pollution, for recycling and disposal, ways to mitigate, interplay of plastic recycling and disposal and awareness among the humans over the globe.

Keywords: Recycling. Plastic Disposal, Environmental Pollution, Landfill, Green-house gases, Single-Use Plastic

INTRODUCTION

The plastic disposal and recycling in the global scale face significant challenges. Despite efforts to increasing recycling rates, a large portion of plastics waste still ends in the landfills, oceans or incineration. Improved waste management, infrastructure, awareness, and innovations in recycling technologies are crucial to address the issues. International cooperation is essential to develop sustainable solutions and reduce the environmental impact of plastic pollution. The first synthetic plastic was Bakelite, produced in 1907, that marked the beginning of the global plastics industry. However, rapid growth in global plastic production did not happen until the 1950s. In 1950 the global production of plastics was just 2 million tons over the next 70 years. However, annual production of plastics has increased nearly 230-fold to more than 460 million tons in 2022.

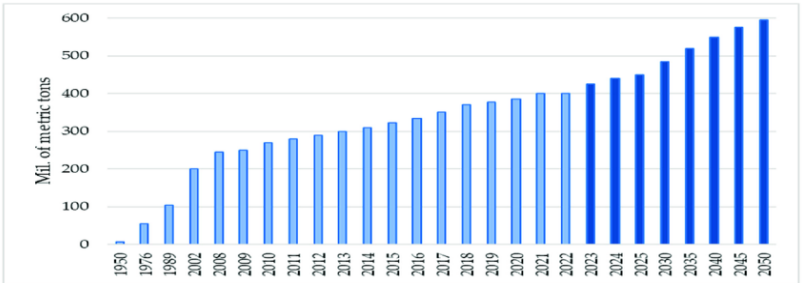

Fig 1: Production forecast of plastics worldwide from 1950 to 2050 in millions of metric tons

This overview will provide a general introduction to the issues regarding plastic disposal and recycling, awareness and how to avoid landfills due to plastic waste, ways to mitigate issues of plastic pollution, conservation of global ecosystem and human health.

OBJECTIVES

- To reduce environmental impact such as pollution and ecological harm including aquatic life thereby mitigating climate change and conserve oceans.
- To conserve natural resources.
- To create closed loop system of recycling that leverages the recycling and ensures the reuse of post-consumer products to supply the material used to create the new version of same product.
- To protect ecosystems by minimizing the impact of plastic disposal on wildlife and human health.
- To reduce energy consumption compared to the production of the new virgin plastic.
- To facilitate sustainable resource management thereby alleviating the social and environmental burdens on the communities affected by the improper plastics disposal.
- To promote the more efficient use of space reducing the large volume of plastic in the landfills.
- To educate and create awareness among the public about responsible plastic disposal and recycling and foster international address the trans boundary movement of plastic waste
- To encourage the development of new technologies for efficient recycling, that facilitates long term sustainability of plastic use and disposal on a global scale.
- To adhere to waste management regulations and standards for environmental protection.

MATERIALS AND METHODS

This paper were used of secondary data from the various sources like literature reviews, journals, articles, research papers etc. The entire study was carried out with the help of descriptive type of research methodology and Used of Statistical Techniques.

RESULTS AND DISCUSSIONS

Plastics have become an unavoidable part of our daily life as it is convenient to use, having strength and durability. Being a non-biodegradable product, it also reduces the chance of decomposition of the product it contains. But this feature of plastic is the major cause for concern today. As plastics are almost not biodegradable, they accumulate in the environment once produced. So, it is very important to be aware of the problems associated with plastic waste and the means to dispose them properly. Plastics are derived from fossil fuels, such as petroleum and natural gas, which are non-renewable resources. By reusing and recycling plastics, we can conserve these valuable resources and reduce our dependence on them. Recycling of plastics consume lesser energy than their new counterparts contributing to conservation of resources. Plastic pollution in the oceans has turned out as a global concern. Improperly disposed plastics can find their way into water bodies, where they disrupt marine ecosystems, and contribute to the formation of large garbage patches. Reusing and recycling plastics helps prevent them from entering our oceans, mitigating the devastating impact on marine ecosystems. The process of recycling plastic consumes less energy compared to producing new plastic. Manufacturing plastic from raw materials requires significant amounts of energy, including extraction, refining, and processing. By recycling plastics, we can save energy and reduce greenhouse gas emissions associated with the production of new plastic. As recycling of plastics needs lesser resources and energy lesser amount of expenditure can be done to produce the same amount of product. However, the collection, sorting, processing, and manufacturing from recycled plastics can help the local economy. The best way of waste disposal will always ultimately remain one of the waste minimizations through best practice by both manufacturers and the general public ensuring maximum environmental benefit.

RECYCLING AND DISPOSAL PROCESS

Plastic products if not disposed properly can cause a huge problem in the near and distant future. Studies suggests only 50% of the total plastic generated today gets a proper disposal. So, the goal should be production of as less amount of new plastic as possible. Depending on the quality and purity of the waste, the priority

should be given to reuse, then reprocessing (mechanical recycling), then DE polymerization to the monomer, then conversion to a hydrocarbon feedstock and, at last resort, energy recovery (using as a fuel).

PLASTIC DISPOSAL

Mixed with other products plastic can be combusted in incinerator to generate heat and electricity.

Fig 2: Landfill

Fig 3: Incinerator

These wastes to energy plants are a good alternative idea to dispose single use plastics. Landfill has become the most common and cheap form of plastic disposal it ranges between 40-60% of the total plastic disposal depending on the country. It is argued that it is the best way for carbon sequestration. However, even land filling has its own environmental hazards associated with it. It releases odorous components and greenhouse gases such as CO_2 and CH_4. It also contaminates the land and water by releasing leachable components trapped in plastics washed by rainwater. It is the biological degradation of waste especially organic waste to release CO_2. H_2O and biomass.

These degradations are carried out by microorganisms. However, there are not much evidences suggesting effective degradation of plastics with biological agents. Incineration is used to burn the plastic in an incineration chamber at very high temperature but it produces huge quantity of temperature. Thus, following the 5R is the best possible way to tackle the issues with plastic. The 5R previously called 3R (Reuse, Reduce and Recycle) has added two more words -Refuse and Repurpose. The recycling process ensures that not only waste plastics are being reused but also new plastics are being prevented from production.

PLASTIC RECYCLING

In today's situation plastic recycling is very much needed. Plastic recycling ensures conservation of non-renewable fossil fuels (oil), reduction of the consumption of energy used in the production of new plastic, helps to reduce the amount of solid waste going to landfill and reduce the emission of greenhouse gases like carbon dioxide, carbon monoxide and methane into the atmosphereRecycling of plastics is a step-by-step process that starts with Collection, Sorting, Washing, Shredding, or grinding followed by Extrusion.

Collection is first stage of the recycling process, which involves the collection of waste materials from our homes, industries, and schools. For this stage it is important that everyone is correctly sorting their plastic ready for collection. These waste materials are collected by a local authority either directly or using a waste management contractor. Other collection opportunities include recycling centers, front of store or local recycling sites. The collection of plastic is the key for recycling system to operate well. The more plastic suitable for recycling that is collected the

Fig 4: Plastic recycling process

more material available to be reprocessed and used back into new products. Sorting is the second stage in recycling. It is done by sorting plastic from other materials and this is done at a Material Recovery Facility. From there this material shall then be taken to a Plastic Recovery Facility. The mixed recycling materials are then mechanically placed onto conveyer belts. Conveyer belts are used to maintain the constant flow of waste passing through the sorting facility. A series of techniques are used to separate the material ready for further processing. There are different types of sorting techniques. They are Manual picking, Trammels, Old corrugated cardboard screening, ballistic separator and magnet separator. Once, the material has been sorted, it will be transferred for reprocessing to a plastic re-processor for the next stage. Washing is the stage where the action of people can make a big difference. By simply rinsing the plastic simply can remove the food or other materials before they become dry and stick more severely and helps to ensure that the whole. During the washing process the plastic may go through a range of washing methods depending on the contamination and processors. The next stage is Shredding or Grinding. This is a critical stage in recycling plastic is where the plastics are shredded into plastic into smaller flakes. Shredding machines are used to ground the washed and sorted plastics into smaller pieces of plastic. Plastic can be shredded in different manner depending on the shredder such as - Hammer Mills and Shear Shredders. Extrusion is the final stage of plastic recycling. It is the process of melting down the plastic and forcing this through an extruder. The plastic is cut as it comes out of the extruder to form pellets. These pellets are sold onto manufacturers for making the new plastics.

TYPES OF RECYCLING

The two broad categories of recycling process are Mechanical recycling and chemical recycling.
Mechanical recycling is a process to treat plastic scraps through a series of mechanical processes such as sorting, grinding, purification and revaluation without making significant changes in their chemical constitution. It is a cyclic process where the same type of plastic material undergoes rigorous sorting and following processes to turn into same flake or pellet sub stock. For example, the input can be a clean PET bottle and after mechanical recycling the output is also a same PET bottle of a lower quality. Most common recycled plastics are PET and HDPE over time these products become completely useless after several mechanical recycling. At that time chemical recycling can be used.

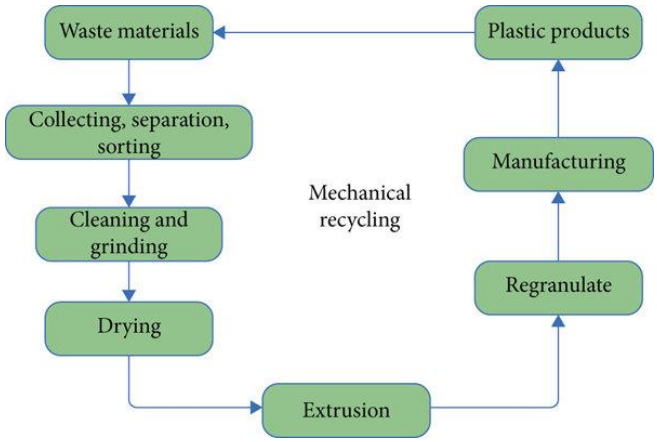

Fig 5: Steps of Mechanical Recycling

Chemical recycling is the process of recycling plastics through chemical change of polymer structure forming raw materials that can be used to manufacture new products. It can deal with the plastics that that may not be suitable for mechanical recycling. Chemical recycling can be done through Dissolution, precipitation, Pyrolysis and Gasification. In case of dissolution and precipitation the polymer is completely dissolved in an appropriate solvent. After that the polymer solution is then separated from the insoluble impurities and additives. The polymer is the precipitated again after the addition of an antisolvent. The solvent and antisolvent are then separated for reuse at the dissolution or precipitation stage of the process. Dissolution processes have been developed for recycling PS, PVC, nylon, PMMA, PE/PP cotton/PET mixed fibers, PLA/PET mixtures, and multilayer films. Pyrolysis refers to the process of converting plastics into solid, liquid, or gaseous fuels through thermal degradation of long-chain polymers into less complex molecules in the absence of oxygen. The process is divided into two parts.

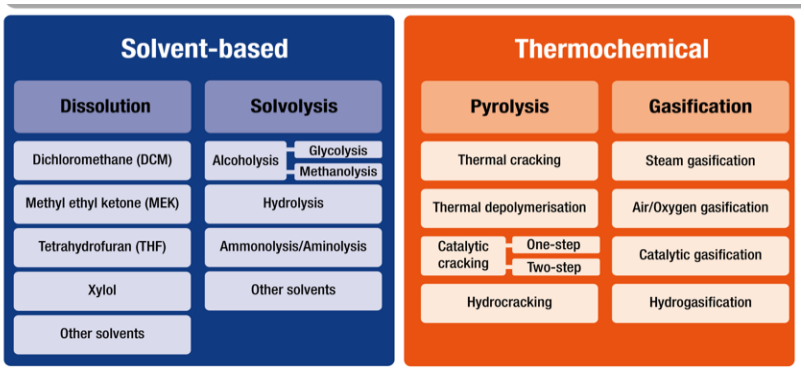

Fig 6: Types of Chemical Recycling

Firstly, the plastic is cleaned and cut into smaller pieces. Then the waste is pyrolyzed at >700°C. DE polymerization requires harsh pyrolysis conditions leads to complex mixture of hydrocarbons. A fraction of these hydrocarbons are very good to be used as a source of transportation fuel. Gasification is a method where the plastic is converted to synthetic gas or syngas which can be used for electric power generation or converted into fuel or chemical feed stocks such as methanol or ethanol which can be used for production of new products.

ADVANTAGES OF PLASTIC RECYCLING

Plastic Recycling conserves the energy, processing the raw materials that come from the trees and the other natural resources takes more energy than recycling materials. Recycling of plastics reduces the water pollution and air pollution caused from land filling by reducing the need for conventional waste disposal and it reduces greenhouse gases emissions emitted from landfills. Recycling conserves the natural resources and the energy that would be required to produce plastic from scratch, Recycling of old and waste products into new products reduce the amount of waste that goes to the landfills, and recycling one ton of plastic can save 7.4 cubic yards of landfill space. Plastic Recycling helps in mitigating global warming and in reducing the pollution, The fossil fuels use that emit such harmful gases will be minimized. And, by recycling non-biodegradable waste, the air pollution and greenhouse gas emissions will be reduced.

DISADVANTAGES OF PLASTIC RECYCLING

Plastic recycling can be harmful to the environment. When the plastic material is melted down, VOCs are released into the atmosphere, VOCs (volatile organic compounds) released from plastic recycling harm the environment. They, also present health risks to the people who use the recycled plastic, Plastic resin is manufactured from the petroleum and it can leech into the foods that are stored in the recycled plastic containers. Heat is required to melt the plastic. The process such as pyrolysis or incineration also generates carbon emissions, The harmful greenhouse gases contribute to the global warming and they are already taking showing harmful effects, As the plastic carries the potential health threats, much of recycled plastic will be less useful product.-After the plastic has been recycled once, it is very rarely suitable for the second round of recycling, So, the material will end up in the waste, If the plastic recycling continues in this way then the manufacturers will always have the same demand for new material. Plastic Recycling will produce the pollutants, including the chemical stews after breaking down the waste materials. This can hurt the environment, if not planned well, Plastic Recycling can increase low-quality jobs, These, include sorting the garbage, cleaning toxins and doing the other manual and the intensive labor, This can result in low morale, low income and poor quality of life in the community. Recycling tons of garbage will require separate factories causing more pollution and energy consumption to clean, sort, store and transport the waste materials, The need for extra bins for different kinds of trash will be needed, This, can equate to more trucks to pick them up, increasing the air pollution. Plastic Recycling can create more environmental problems, if not done right, recycling companies might abandon dump sites and leave the harmful chemicals to contaminate the land and the environment. Recycling is not always cost-efficient and it can result in net loss overall. Most importantly recycled plastic does not guarantee good quality products and thus more emphasis should be given on lesser generation and use of plastics in general. The recycled products are reusable just once or twice and then will end up in landfills giving people a false sense of security that plastics are being recycled.

AWARENESS

Recycling of plastics is being done more and more everyday but still it is not enough. The latest data from the Organization for Economic Co-operation and Development (OECD) a body made of 36 of world's richest countries serve as the warning of situation. The members of this club barely recycle 36% of their municipal waste on average. At an individual basis only seven countries 50% and regions such as OCED Europe were within 6b points of approved rate with 44%.

Fig 7 :Plastic awareness rally

Fig 8 *:* Ban single use plastic

In the meantime, waste is gaining ground. The World Bank in 2018 warned that urban areas produce 2 billion tons of solid waste annually. They warned that this figure can increase by 70% by 2050 if we do not take serious actions. The World Bank itself urges countries to improve their waste management and control the generation of waste products.

Awareness of plastic recycling can be done through various games and activities for children.

- Draw the different recycling containers.
- Make toys out of waste.
- Prize for reusing and recycling waste.
- Cartoon promoting Recycling for children.
- Activities such as debates and presentation about plastic management and recycling.
- Videogames about recycling.

Awareness in adults can be done by various campaigns, workshops, and activities. Better salary to the people associated with recycling such as scrap collectors, cleaners and workers at recycling plants would encourage more people.

GLOBAL SITUATION

Germany has the highest Recycling Rate. It recycles about 99.8% of its plastic waste. There are norms of four bins across the country- Blue Bin for paper and cardboard, Yellow Bin for plastic and soft metals., Green or Brown Bin- for organic waste and Grey Bin- for general household. waste. Pfand is a deposit return scheme followed in Germany where whenever a person buys some product such as bottle and can in supermarket or kiosk, they pay a small amount on top of that price. When they return it they gets refunded. In 2016, France became the first country to ban the management of single use plastic cups, cutlery, and takeaway food boxes. In 2018, Great Britain's Royal Statistical Society statistic of the year was all about the plastic waste. Researchers calculated that about 21% of plastic waste has been incinerated, while about 79% is either landfills or polluting the environment. In 2018 Collins Dictionary named "single-use" citing a 4-fold increase in usage since 2013.

Plastic free July is a global movement that helps people be part of the solution to plastic pollution. Participants reduce their household waste and recycling by 21 kilos per person per year and contribute to a total saving of 940 million kilos of plastic waste each year. In India the use of plastic is fully decoupled from the consumption of finite resources. Reuse Model is applied which is relevant reducing the need for single use packaging. India produces 3.4 million tons of plastic waste in a year and only 30% of it is recycled. The theme for World Environment Day on 5 June 2023 will focus on solutions to plastic pollution under the campaign "Beat Plastic Pollution." The world is being inundated by plastic. More than 400 million tons of plastic are produced every year, half of which is designed to be used only once.

RELATIONSHIP BETWEEN RECYCLING AND PLASTIC DISPOSAL

The relationship between recycling and the plastic disposal lies in the fact that recycling mitigates the negative environmental impact of plastic disposal. It helps conserves resources, reduces energy consumption and minimizes pollution associated with the plastic production. Additionally, recycling contributes to circular economy, where materials are reused, and promoting sustainability. However, effective recycling requires the public awareness, proper infrastructure and the commitment from the individuals and the industries alike. Recycling plastics contributes significantly to nations by conserving the environment and minimizing the waste to landfills. It promotes the resource efficiency creating a circular economy and fostering sustainable practices. The recycling industry also generates job, contributing to the local economies. Moreover, embracing recycling helps nations reduce their carbon footprint, aligning with the global efforts to address the climate change. It encourages the innovation in the waste management and strengthens international cooperation in tackling the plastic pollution. Overall robust recycling practices contribute to a more environmentally conscious and economically sustainable future for nation. By adopting robust recycling practices, nation can contribute to the global efforts to address plastic pollution. Collaboration on the recycling initiatives can enhance the international environmental sustainability. It's important for nation to implement effective recycling programs, educate the public on the importance of recycling and invest in the infrastructure to maximize the contributions. Integrating plastic recycling process is very essential for maintaining the balance and health of all interconnected Earth Systems. It aligns with the broader goal of sustainable development and environmental stewardship.

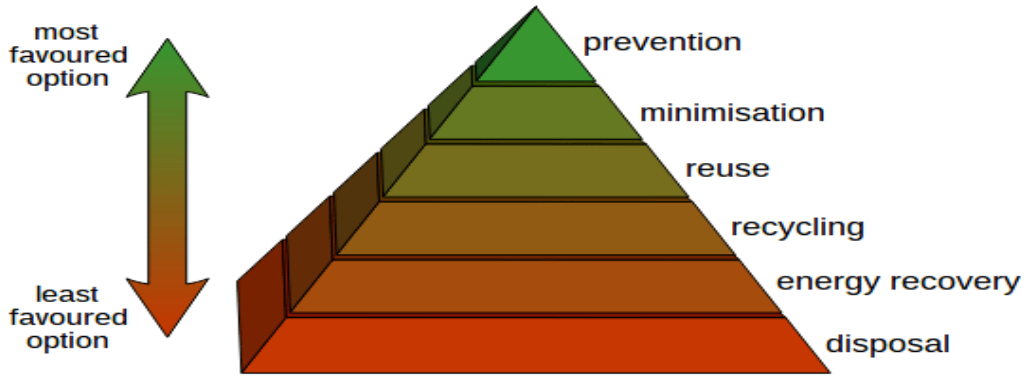

Fig 9: Plastic waste management methods and from most favoured to least favoured options

In the Earth system, the process of plastic recycling and disposal plays a crucial role in environmental sustainability. Plastic waste, if not properly managed, can have far-reaching impacts on various Earth systems. Inappropriate disposal of plastic waste can contaminate soil, affecting the geosphere and potentially harming ecosystems and agricultural productivity. Recycling helps mitigate this impact by reducing the need for new plastic production. Plastic pollution in oceans and water bodies is a significant concern. Recycling contributes to the preservation of the hydrosphere by minimizing the amount of plastic reaching water sources and ecosystems, thereby protecting aquatic life. The production of virgin plastics involves significant energy consumption and greenhouse gas emissions. Recycling helps decrease these emissions, contributing to a cleaner atmosphere and supporting efforts to mitigate climate change. Plastic waste poses threats to biodiversity when it enters ecosystems. Recycling reduces the demand for new plastic production, lessening the environmental impact on the biosphere and helping to protect flora and fauna. While the direct impact of plastic on ice and snow is limited, the overall reduction in energy consumption through recycling indirectly supports the preservation of polar ice caps and glaciers by mitigating climate change. Recycling plastic is integral to sustainable human activities. It reduces the need for landfill space, conserves resources, and supports a circular economy, contributing to a more harmonious coexistence between human activities and the Earth system. The extraction of raw materials for plastic production involves mining and drilling, impacting the lithosphere. Recycling helps minimize these activities, promoting a more sustainable use of Earth's geological resources. Plastic pollution affects the quality of soil and can disrupt ecosystems. Recycling prevents the accumulation of plastic waste in the pedosphere, preserving soil health and biodiversity. While plastic disposal may not directly impact the outermost layer of the Earth's atmosphere, the overall reduction in environmental pollution through recycling supports the health and sustainability of the entire Earth system.

MAJOR CONTROVERSIES ON A GLOBAL SCALE

Several major controversies surround plastic recycling and disposal on a global scale, reflecting the challenges and debates in addressing plastic waste.

A significant controversy involves the export of plastic waste from wealthier nations to developing countries. This practice raises environmental justice concerns, as it can lead to improper disposal and environmental pollution in the receiving countries. Contamination of recyclable materials and difficulties in sorting different types of plastics pose challenges. Contaminated materials can compromise the quality of recycled products, and inadequate sorting processes can hinder the efficiency of recycling facilities. Many regions lack sufficient recycling infrastructure, hindering effective plastic waste management. The absence of collection systems, sorting facilities, and recycling plants contributes to increased reliance on land filling or incineration. The continued production and consumption of single-use plastic items, such as packaging and disposable utensils, exacerbate the plastic waste problem. Efforts to reduce reliance on these items face resistance from industries and consumers. Technological limitations in recycling certain types of plastics, particularly those with complex compositions or multi-layered packaging, present challenges. Innovations are needed to address these limitations and enhance overall recycling efficiency. Limited awareness and understanding among consumers about proper recycling practices contribute to contamination issues. Improving public education and incentivizing responsible disposal behavior are crucial aspects of addressing this controversy. The economic viability of recycling compared to the production of new plastics is a point of contention. Fluctuations in commodity prices can affect the profitability of recycling operations, impacting the sustainability of recycling programs. The fragmentation of plastic into microplastics poses environmental and health concerns. Controversies arise regarding the extent of the impact of microplastics on ecosystems and human health and the effectiveness of recycling in mitigating this issue. Divergent policies and regulations across countries and regions contribute to inconsistencies in plastic waste management. Harmonizing and enforcing effective regulations is challenging but essential for a unified global approach to plastic recycling. Addressing these controversies requires international collaboration, innovative technologies, improved infrastructure, and a shift in consumer behavior. It underscores the complexity of managing plastic waste on a global scale and the need for comprehensive, sustainable solutions.

LIMITATIONS

While recycling and disposal methods play a crucial role in managing plastic waste, there are certain limitations and challenges associated with these approaches. Contamination of recyclable materials, especially in single-stream recycling systems, remains a significant issue. Mixed materials or improperly cleaned items can compromise the quality of recycled products. Some types of plastics are challenging to recycle due to their complex composition or multi-layered structures.

Technological limitations in processing these materials can reduce overall recycling efficiency. Recycling processes, particularly mechanical recycling, still require energy. While generally lower than producing virgin plastics, the energy consumption associated with recycling is a consideration in terms of overall environmental impact.

The market demand for recycled materials can fluctuate, impacting the economic viability of recycling operations. Dependence on market conditions can influence the success of recycling programs. Recycling can be economically challenging, especially when the cost of collection, sorting, and processing exceeds the value of the recycled materials. Economic considerations can influence the sustainability of recycling initiatives. Inadequate recycling infrastructure, particularly in developing regions, hinders effective waste management. Insufficient collection systems, sorting facilities, and recycling plants limit the scalability and success of recycling efforts.

The lack of standardized recycling symbols, labeling, and collection systems globally contributes to confusion among consumers and challenges in sorting and processing materials efficiently. Incomplete understanding and awareness among the public about proper recycling practices and the environmental impact of plastic waste can lead to improper disposal and contamination of recycling streams. While advanced recycling technologies show promise in addressing some limitations, the initial costs of implementing these technologies can be high, posing financial barriers to widespread adoption. In some cases, plastics that are not recycled end up in landfills or incineration facilities, contributing to environmental concerns.

Landfilling poses risks of soil and water contamination, while incineration can lead to air pollution and greenhouse gas emissions. Recognizing these limitations is crucial for developing more effective and sustainable strategies for plastic waste management. Addressing these challenges requires a holistic and

integrated approach involving technology development, infrastructure improvement, policy implementation, and public engagement.

MITIGATIONS

Mitigating the controversies surrounding plastic recycling and disposal requires a multifaceted approach involving various stakeholders. Implementing and enforcing international agreements or regulations to restrict or ban the export of plastic waste to developing countries, ensuring responsible disposal and preventing environmental injustices. Investing in advanced sorting technologies to improve the efficiency of separating different types of plastics. Automation and artificial intelligence can help reduce contamination and enhance the quality of recycled materials. Governments and industries should invest in building and upgrading recycling infrastructure, including collection systems, sorting facilities, and recycling plants, to create a robust and efficient waste management system. Enforcing Extended Producer Responsibility (EPR) policies, making manufacturers responsible for the entire lifecycle of their products, including collection and recycling. This encourages the design of products that are more easily recyclable. Implementing strict regulations on the production and use of single-use plastics. Encourage alternatives, such as reusable or compostable materials, and incentivize businesses to adopt sustainable packaging practices. Investing in research and development to overcome technological limitations in recycling complex plastics. Innovations in chemical recycling and advanced recycling technologies can improve the recyclability of a broader range of plastic materials. Conducting comprehensive public awareness campaigns to educate consumers about proper recycling practices, the environmental impact of plastic waste, and the importance of reducing single-use plastics. Providing economic incentives, such as tax breaks or subsidies, to businesses adopting sustainable practices and investing in recycling technologies. This can enhance the economic viability of recycling operations. Implementing regulations addressing the release of micro plastics into the environment. Encourage the development of technologies to capture and manage micro plastics, along with research on the long-term effects of micro plastics pollution. Fostering international collaboration and standardization of policies and regulations on plastic recycling and disposal. Facilitate knowledge sharing, technology transfer, and joint initiatives to address the challenges on a global scale. By combining these strategies, nations can work towards creating a more sustainable and effective approach to plastic recycling and disposal, ultimately mitigating the controversies associated with plastic waste management.

Fig 10: The principles of social ecology

CONCLUSION

Plastic recycling and disposal are critical components of addressing the pervasive issue of plastic waste. While recycling offers a sustainable solution by reducing the need for new plastic production and minimizing environmental impact, it faces challenges such as contamination, technological constraints, and economic considerations. Efforts to improve recycling infrastructure, advance sorting technologies, and promote public awareness are essential. Additionally, the limitations of recycling highlight the importance of adopting a comprehensive waste management approach that includes reduction of single-use plastics, extended producer responsibility, and exploration of innovative disposal methods. A global commitment to standardized practices,

collaborative research, and responsible consumer behavior is necessary for achieving a more sustainable and environmentally conscious management of plastic waste on a global scale.

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