

# The Environmental Impact of Plastics and Recycling of Plastic Waste

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**Abstract:** Plastic can be titled as the friendliest foe of human being with all its uses and effects on man as well as on nature. Its invention brought tremendous changes and expansions in almost all fields especially medicines and other branches of sciences. Thousands of plastic factories are producing tons of plastic goods which are popularly used by peoples because of their ease, inertness, cheapness and convenience. Due to non-biodegradable nature they cause hazardous negative impact on environment, men and society. Plastic wastes are major causes of environmental pollution, becomes carcinogenic to human, cause birth defects in human, impaired immunity, endocrine disruption and much more. In addition to this, dumping of plastic material into seas, oceans and other water bodies is said to have harmed several organisms of marine world, which could even jeopardize the survival of entire species, especially since many are already endangered in and ingestion of the plastic litter. Less conspicuous form, such as plastic pellets and scrubber are also hazardous. Problems arising from biodegradable and toxic nature of plastic have lead to the invention of several other products and effective management ways using which, the harmful effects of plastic can be minimized. As a plastic is major scientific invention with strong influence on human life and nature, learning its properties and ways to manage it effectively is considered important and is even research level. Here, through this study, we discuss about plastic, its properties, various kinds of it, it's effect on human, nature, ways of effective management, especially recycling.

**Keywords:** Plastic, Recycling, HDPE, Environment, Pollution.

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## 1. INTRODUCTION

The modern saying of this generation should be as “A day begins with a form of plastic rather than a warm sunrise”. We humans dependents on plastic for a range of uses, from packaging products to medical aid.. Reducing our use of plastic bags is an easy step to start with in order to get our addiction under control. Many of the current application and predicted benefits of plastic follow those outlined by Yarsely and couzens in the 1940's. The durability of plastics and their potential for diverse applications, including widespread use as disposable items were anticipated but the problems associated with management of plastic debris was not. In fact the predictions were ‘how much brighter and cleaner a world it would be than that which preceded this plastic age’ (Yarsley & Couzens 1945, p. 152).

Considering plastic as a material we can tell that it is an inexpensive, lightweight, strong, durable, corrosion-resistant material, with high thermal and electrical insulation properties. The diversity of polymers and the versatility of their properties are used to make a vast array of products that bring medical and technological advances, energy savings and numerous other societal benefits. As a consequence, the production of plastics has increased substantially over the last 60 years from around 0.5 million tonnes in 1950 to over 260 million tonnes today. In Europe alone the plastics industry has a turnover in excess of 300 million Euros and employs 1.6 million people (Plastics Europe 2008). Almost all aspects of daily life involve plastics, in transport, telecommunications, clothing, footwear and as packaging materials that facilitate the transport of a wide range of food, drink and other goods. There is considerable potential for new applications of plastics that will bring benefits in the future, for example as novel medical applications, in the generation of renewable energy and by reducing energy used in transport. (Andrady & Neal 2009).

The word plastic is derived from the Greek word 'plastikos', meaning capable of being shaped or molded. Plastic that is made up of polymers having only aliphatic (linear) C atoms in their backbone chains. e.g.: poly propylene. Plastics that are made up of hetero chain polymers contain O, N, S in their backbone chains, in addition to C. e.g.: poly carbonate. Plastic behavior of polymers is influenced by their morphology (arrangement of molecules). they are either amorphous or crystalline. Most thermosets are amorphous; while thermoplastics may be amorphous or semi crystalline Plastics are a range of synthetic or semi-synthetic polymerization products that can be molded into a permanent object having the property of plasticity. Plastic are found extensive industrial applications. Plastics having a variety of properties are available at present. They have low specific gravities, ease of fabrication, resistance to low thermal and electrical conductivities. Many plastics can take range of color to enable them useful for decorative purposes. Plastics are widely used in making electrical instruments, telephones, paneling for walls and instrument boards, automobile parts, lamps, goggles, optical instruments, household appliances, etc.

## 2. TYPES OF PLASTICS AND THEIR USES

There are around 30 different types of plastic in regular use. Plastics can be classified broadly into two according to their effects. Probably Polyethylene Terephthalate or (PET) is the most easily identifiable **Good plastic**. It is used for making the clear plastic bottles which we find in supermarkets, containing fizzy drinks such as lemonade and cola. It was known as the safest and easy to be recycled. High-density polyethylene or (HDPE) plastic is used in the manufacture of garden furniture, flower pots, toys, dustbins and various other sorts of plastic containers. HDPE is a solid material that can tolerate high temperature and strong chemicals. HDPE is considered safe and easy to recycle where (**LDPE**) **Low density polyethylene**, is highly non-reactive material and withstand up to 100<sup>0</sup>C of temperature. It is used in grocery plastic bags, some bottle and most of the plastic wraps. In other words, it is almost 1 million plastic bags used per minute. it was popularized by its safety but is difficult to recycle. The Bad plastic is (PVC) or (V) or (DEHA): they are cost effective to produce and are highly resilient to chemical and biological damages. Polyvinyl chloride used for wraps, some types of plastic compress cooking oil, peanut butter jars and bottle, window cleaner bottles and detergent bottles. (PVC) is famous to be connected with liver cancer. Polystyrene (PS) also known to affect liver, red blood, kidneys and stomach in animal's case and it is not easy to recycle this type of plastic. Polypropylene is strong and flexible and it's a hard wearing plastic used for clothing, surgery tools and supplies.

Millions of plastic products are manufactured each year throughout the world. As the technology for their production increases, even more products will enter the "plastic age". We are living in plastic age, with many advantages of it. Unfortunately, it is an age which brings inevitable and serious problems to our earth. Few of the most trending applications of plastics include *plasticulture*, "the practice of using plastic materials in agricultural activities and polyethylene is the major plastic used for this activity". *Plastisphere* it's a term used to refer ecosystem that have evolved to live in human made plastic environment. The *plastiglomerate* was proposed by Patricia Corcoran, for a stone that contain a mixture of sedimentary grains and natural debris.

## 3. ENVIRONMENTAL IMPACTS

Substantial quantities of plastic have accumulated in the natural environment and landfills which affects soil, air, water and land. The distribution of plastic debris is highly variable as a result of factors like wind in urban areas, and ocean current cause adverse effects on nature. The human population plays a major role in plastic pollution.

**Effect of plastics on animals and marine life:** Environmental impacts are wide ranging and can be both direct and indirect. Direct impacts occur when life of organism i.e. physically harmed by debris through ingestion or entanglement. Environmental impacts can also be indirect, such as a marine debris cleanup resulting in ecological changes.

**DIRECT IMPACTS** According to 2014 edition of the scientific journal, *the marine pollution bulletin*, and animals in almost 400 species have been injured or killed after ingesting or becoming entangled in our trash. Includes all 7 sea turtle species, more than 50% of all mammal species and almost 2/3 of all seabird species 92% of the time, the trash was plastic. More than 10% of all species that have fallen victim to debris are threatened with extinction. So these entanglement and ingestion leads to starvation, drowning, suffocation which leads to extinction.

**Ingestion:** Seabirds, sea turtles, fishes, and marine mammals often ingest marine debris that they mistake for food. Ingesting marine debris can seriously harm marine life. For example, whales and sea turtles often mistake plastic bags for squid, and birds often mistake plastic pellets for fish eggs. At other times, animals accidentally eat the marine debris while

feeding on natural food. Ingestion can lead to starvation or malnutrition when the marine debris collects in the animal's stomach causing the animal to feel full.

**Entanglement:** Marine life can become entangled in marine debris causing serious injury or death. Entanglement can lead to suffocation, starvation, drowning, increased vulnerability to predators, or other injuries. Marine debris can constrict an entangled animal's movement which results in exhaustion or development of an infection from deep wounds caused by tightening of material. For example, volunteers participating in the 2008 International Coastal Cleanup event discovered 443 animals and birds entangled or trapped by marine debris. (2008 ICC Report, Ocean Conservancy) (Marine Debris in the 21st century)

**Ecosystem Alteration:** The direct impacts of marine debris are not limited to mobile animals. Plants, other immobile living organisms, and sensitive ecosystems can all be harmed by marine debris. Coral reefs can be damaged by derelict fishing gear that breaks or suffocates coral. Plants can be smothered by plastic bags and fishing nets. The ocean floor ecosystems can be damaged and altered by the movement of an abandoned vessel or other marine debris. (2008 ICC Report, Ocean Conservancy)

#### **INDIRECT ENVIRONMENTAL IMPACTS:**

**Ecosystem Alteration:** Efforts to remove debris can harm ecosystems. Mechanical beach raking uses a tractor or other mechanical device to remove marine debris from beaches and marine shorelines and can adversely impact shoreline habitats. This removal technique can be harmful to aquatic vegetation, nesting birds, sea turtles, and other types of aquatic life. Beach raking can also contribute to beach erosion and disturbance of natural vegetation when the raking is conducted too close to a dune.

**Invasive Species:** Marine debris can contribute to the transfer and movement of invasive species. Floating marine debris can carry invasive species from one location to another. Invasive species use the marine debris as a type of "raft" to move from one body of water to another. In a study performed by the British Antarctic Survey in 2002, it was estimated that man-made debris found in the oceans has approximately doubled the number of different species found in the subtropics. (Barnes, D.K., 2002).

**Economic Impacts:** debris can harm three important components of our economy: tourism, fishing, and navigation. Economic impacts are felt through loss in tourism dollars and catch revenue, as well as costly vessel repairs.

**Tourism:** debris is unsightly and unwelcoming to beachgoers, which can result in lost revenue from tourism. In severe cases, marine debris can even cause beach closures. The costs for the removal and disposal of the marine debris can be high and the loss of tourism dollars can be even higher. In an attempt to stop the draining of trash to the ocean, the Los Angeles County's Department of Public Works and the Flood Control District spends \$18 million each year on street sweeping, catch basin cleanouts, cleanup programs, and litter prevention and education efforts. (L.A. County Boards of Supervisors Staff Report, 2007). The dumping of plastic debris on back water leads to deterioration of quality of water which affects the house boat tourism in India.

**Fishing:** Fisheries experience significant economic impacts from debris. Commercial fisheries are impacted when commercial fish and shellfish become by catch in lost fishing nets or other fishing gear. This type of by catch can result in both immediate losses in the standing stock of available seafood, and decreases in the long-term sustainability of the stock due to negative impacts on its reproductive ability. For example, the Gulf States Marine Fisheries Commission has predicted blue crab ghost fishery leads to a loss of up to 4 to 10 million crabs a year in Louisiana alone (Virginia Institute of Marine Science, 2006). Fisheries also can be financially affected when fishing gear and vessels are entangled or damaged by marine debris. The high cost of replacing fishing gear and vessels, as well as loss of days at sea for fishing, can cause small fisheries to go out of business. (Moore, C. J. 2008 ) (Gregory, M. R. 2009)

**Navigation:** Floating marine debris is a navigational hazard that entangles propellers and clogs cooling water intake valves. Repairing boats damaged by marine debris is both time consuming and expensive.

**EFFECT ON LAND:** Due to the action of various microorganisms on the plastics dumped on the land, it speeds up the process of biodegradation of plastics. So, during the breakdown of these biodegradable plastics may release methane which significantly leading to the global warming. Plastic bags will generally make soil less fertile as it remains for thousands of year and contaminates the water resources. Highly toxic plastic materials may decompose and liberate the toxic pollutants into soil and gradually it pollutes the ground water. (Aggarwal, et .al), (Biello David;2013)

**HEALTH IMPLICATIONS:** plastic contain chemicals that cause damage to the nervous system and some genetic diseases. If the plastics are treated at high temperature it forms a substance called dioxins, causing tumors, birth defects, genetic mutations. Due to excessive use of chemicals additives during the period of manufacture, the plastic have potential effects on human which may cause carcinogenic or promote endocrine disruption. The pervasiveness of various plastic products, majority of human population is exposed to chemical constituents of plastics. The exposure of toxicant BPA causes disruption in fertility, reproduction and sexual maturation. Bisphenol-A affects gene expression related to thyroid hormone and affects biological function of metabolism and development. The workers in chemical factories related to the plastic production are affected by dermatitis upon contact with the human skin. It can also affects humans in which it may create an eyesore that interferes in enjoying the environment. Body burdens of chemicals that are used in plastic manufacture have also been correlated with adverse effects in the human population, including reproductive abnormalities.(Lang .et al 2009), (swan .et al 2008), (Swan .et al 2005). A further important observation regarding adverse responses to developmental exposures of animals to very low doses of BPA is that many relate to disease trends in humans. Less has been published on effects of the flame retardant TBBPA, but there are evidences of effects on thyroid hormones, pituitary function and reproductive success in animals.( Talsness .et al 2009)

#### 4. RECYCLING OF PLASTIC WASTE

Plastic recycling is the process for recovering waste plastic and reprocessing the material into useful products. The basic aim of this technique is to reduce the high rate of plastic pollution. The recycling message is simple; both industry and society need to regard end-of-life items, including plastics, as raw materials rather than waste. At present, our consumption of fossil fuels for plastic production is linear, from oil to waste via plastics. It is essential to take a more cyclical approach to material usage, but achieving this goal is complex (Hopewell .et al 2009). Greatest energy efficiency is achieved where recycling diverts the need for use of fossil fuels as raw materials, good examples being the recycling of old polyethylene terephthalate (PET) bottles into new ones (closed-loop recycling) or where low-density polyethylene bottles are converted into waste bins (semi-closed loop). From a waste management perspective, the three R's—reduce, reuse and recycle are widely advocated to reduce the quantities of plastic and especially plastics packaging the waste we generate outline, the benefits and limitations of these strategies. They show that to be effective we need to consider the three R's in combination with each other and together with a fourth 'R', energy recovery. Indeed we also need to consider a 5th 'R', molecular redesign, as an emerging and potentially very important strategy. Hence, the three R's become five: 'reduce, reuse, recycle, recover and redesign'.

Plastic recycling includes taking any type of plastic, sorting it into different polymers and then chipping it and then melting it down into pellets. After this stage, it can then be used to make items of any sort such as plastic chairs and tables. Soft Plastics are also recycled such as polyethylene film and bags. The Recycling technique deals with the tones of plastic waste that is choking earth. So in addition to developing smarter plastics that takes the place of conventional plastics, we also need to deal with the immense quantities of toxic wastes already out there and hurting humans and the environment. Smarter sorting of Municipal Solid Wastes, more energy efficient ways of getting rid of the plasticizers from these items and increasing the scale of this entire process is very vital to overcome this challenge.

Terminology for plastics recycling is complex and sometimes confusing because of the wide range of recycling and recovery activities. These include four categories: primary (mechanical reprocessing into a product with equivalent properties), secondary (mechanical reprocessing into products requiring lower properties), tertiary (recovery of chemical constituents) and quaternary (recovery of energy). Primary recycling is often referred to as closed-loop recycling, and secondary recycling as downgrading. Tertiary recycling is either described as chemical or feedstock recycling and applies when the polymer is de-polymerized to its chemical constituents. Quaternary recycling is energy recovery, energy from waste or valorization.

Plastic Identification code (PIC), The PIC code is an identification code of plastic numbering from one to seven indicating the extent of recyclability. The PIC appears inside a three-chasing-arrow recycling symbol. The PIC was introduced by the society of plastic industry to provide uniform system of identification for various polymer types.( Standard Practice for Coding Plastic Manufactured Articles for Resin Identification"), (plastic packaging resins, American chemistry council)The symbol is used to indicate whether the plastic can be recycled into new products and each number inside the triangle indicates a specific type of plastic as follows:

1. Polyethylene terephthalate (PET): Safe and recyclable, plastic bottles and containers made of it used for water, juice, soft drinks packaging.

2. High-density polyethylene (HDPE): Safe and recyclable and resistant to the moisture permeability. Its used for the manufacturing of packages for shampoo, detergents and milk, as well as plastic toys..
3. Polyvinyl chloride (PVC): Harmful and toxic if used for long time. It Low-density polyethylene.
4. Polypropylene (LDPE): One of the best and safest types of plastic, suitable for cold and hot liquids.
5. Polypropylene (PP): Dangerous and unsafe, and used kitchen ware, yoghurt containers and soft drink bottles.
6. Polystyrene (PS): it is easily formed and widely used in manufacturing plates ,cups and cutlery
7. Others (ABS or polycarbonate): Such material does not come under any category of the above mentioned types of plastic.



**Conversion of plastic waste into liquid fuel:** The entire process is undertaken in closed reactor vessel followed by condensation, (if required). Waste plastics while heating up to 2700 to 3000°C convert into liquid- vapor state, which is collected in condensation chamber in the form of liquid fuel. The tarry liquid waste is topped-down from the heating reactor vessel. The organic gas is generated which can be used in dual fuel diesel generator set for generation of electricity.

**Polymer blended bitumen roads:** Recent studies in this direction have shown some hope in terms of using plastic wastes in road construction i.e. 'plastic roads'. Plastic roads' mainly use plastic-carry bags, disposable cups and PET bottles that are collected from garbage dumps as an important ingredient of the construction materials. When mixed with hot bitumen, plastics melt to form an oily coat over the aggregate and the mixture is laid on the road surface like a normal tar. Merit is **Stripping and pothole formation:** bitumen film is often stripped off the aggregate because of the penetration of water which results in pothole formation. This is accelerated during the movement of vehicles. When polymer is coated over the aggregate, the coating reduces its affinity for water due to non-wetting nature of the polymer and this resists the penetration of water. Thus the stripping can be resisted and hence no pothole formation takes place on roads.

#### **The Effect of Recycling Plastic:**

1. **Resource Conservation:** Recycling of plastic waste saves a lot of energy and natural resources as these are main ingredients for production of virgin plastic. Saving petroleum, water, and other natural resources help conserve the balances in nature.
2. **Energy Conservation:** The process of finding new materials from existing materials needs much less energy than what is needed for rare materials. Recycling one pound of the most common plastic used in water bottles called polyethylene terephthalate (PET) can conserve heat energy according to the Environmental Protection Agency. The process of recycle needs less energy by two- third than usual manufacturing which help in reducing the damage of the usual power grid. That depends on burning fossil fuels.
3. **Reduced Greenhouse Gas Emissions Decreased Pollution:** The process of producing plastic is able to increase the greenhouse gasses in air like carbon dioxide. Which is known as a major reason of global warming? Because recycling plastic require less energy and fossil fuels it result in reducing greenhouse gas revival. Besides reducing greenhouse gasses recycled plastic can decrease the amount of pollutants in air and water, in addition many of landfill operations will burn the plastic bottles to keep waste that is able to secrete toxic pollutants and other materials that irritants into the atmosphere. The plastic resin is useful to produce water bottles. Besides it contain unsafe chemicals.
4. **Recycling ensures sustainable use of resources:** Recycling guarantees that existing resources will be used sensibly and sustainably. The recycling process alleviates the possibility of discriminate use of raw materials when they are obtainable in huge supply. Governments these days have stepped in to encourage recycling from lower levels, for instance, schools, small-sized organizations and also at global levels. This means that manufacturing industries can leave existing natural resources for exploitation by our children in the future without affecting current production.

**5. Recycling contributes to creation of jobs:** To add to the benefits it brings to the environment; recycling opens up job opportunities. Recycling means many recycling plants will be set up, thus, leading to a long chain of collection and delivery. All these activities are performed by humans, so this will trigger an explosion of opportunities.

**6. One main source of economic benefits** resulting from recycling plastics involves a reduced cost in materials for new goods. Depending on the materials, manufacturers can save up to 90% of their production costs by using recycled materials rather than obtaining, refining, and extracting brand new substances such as aluminum, paper, and plastics. This can also reduce the resulting prices of manufactured goods and allow consumers to save on out of pocket expenses.

**7. Effect of plastic recycling on marine Wildlife:** Debris remain a serious problem for marine wildlife. Recycling offers a simple solution. Recycling plastic helps keep these hazardous substances away from wildlife, while humans also benefit from clean beaches and wetlands. By keeping these habitats healthy, humans can take advantage of the recreational and economic uses of these areas for purposes such as fishing and tourism.

Plastic Recycling can also reduce the need for the allied activities such as the transportation and mining which are the biggest producers of the greenhouse gases and the pollution. So it not only promotes proper utilization of plastic waste but also helps to conserve the environment making it cleaner and greener.

## 5. CONCLUSION

Plastics offer considerable benefits for the future, but it is evident that our current approaches to production, use and disposal of it are not sustainable and concerns for wildlife and human health. We have considerable knowledge about many of the environmental hazards, and that human health effects is growing, but many concerns and uncertainties remain. There are solutions, but these can only be achieved by combined actions. There are **roles for individuals**, via appropriate use and disposal, particularly recycling; **for industry** by adopting green chemistry, material reduction and by designing products for reuse and/or end-of-life recyclability and **for governments and policymakers** by setting standards and targets, by defining appropriate product labeling to inform and incentivize change and by funding relevant academic research and technological developments. These measures must be considered within a framework of lifecycle analysis and this should incorporate all the key stages in plastic production, including synthesis of the chemicals that are used in production, together with usage and disposal.

Plastic is one of the best and useful inventions of man. But due to improper production, mismanagement and lack of proper treatment of wastes, it has grown as a huge threat to the mother planet. The only and most effective step to overcome the deadly impact of plastic is raising awareness in people. To raise public awareness, different levels of educational curriculums must include the waste management systems from the grass-roots as information. In addition to creating public awareness on the importance of a healthy environment, mechanisms of controlling the generation of wastes at the source, alternative disposal ways and plastic recycling facilities are also recommended. Helping communities to reduce their exposures to health toxicants will increase the likelihood for a healthy society and clean environment for forthcoming generations. It must be emphasized that plastic waste recycling and management are not merely the concern of large-scale schemes and companies. Every individual can take action to deal effectively with plastic waste in our lives, and in this small ways make an essential contribution towards improving our environment by putting our own selfish needs aside the needs of everything around us now and for the lives of future generations.

Plastics are directly comparable to the life of a virus as they still stand as a puzzle of being living or non-living. Plastics also possess both positive and negative faces, it is in the way in which we use and treat them decides it's effects on us.

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