



# Review of Plastic Debris' Negative Effects on the Environment and Public Health

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## Abstract:

The majority of the existing research on the subject was compiled in order to assess the harmful impacts of plastic waste on the environment and public health. Plastic and plastic-related goods are in high demand as a result of population growth, which also contributes to environmental pollution[1]. Plastics can leach toxic chemicals into food, drinks, and water if used for a long time and exposed to high temperatures. It is difficult to solve the problem of plastic debris in the environment, and several solutions are urgently needed. Additionally, some solutions to the issue are presented and discussed in this paper.

**Keywords** - Plastic debris, Public health, plastic additives, pollution, Toxic chemicals.

## I. INTRODUCTION

The creation of water bottles, clothing, food packaging, medical supplies, electrical products and construction materials are just a few examples of the many applications for plastics, which are made from synthetic organic polymers[2]. Initially it presume that plastic was harmless and inert. However, after a long time, it becomes clear that plastics indispensable and adaptable behavior makes it both very useful and very harmful to the planet and planet living species[3].

The first plastic material was engendered in 1850 followed by way of the origination of bakelite in 1907[2]. Now days it is apprehend that plastic pollutes everything such as environment, human life, marine life, soil, food and so on[4]. The annual

production of plastics has increased by just 317 million tonnes in the modern era. According to the

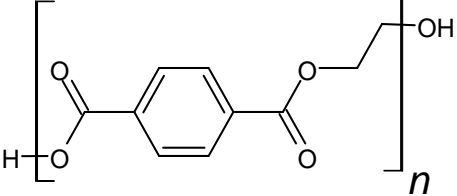

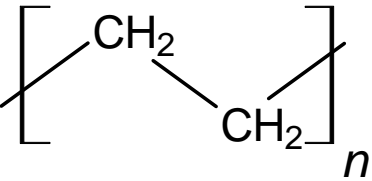

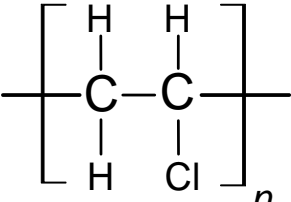

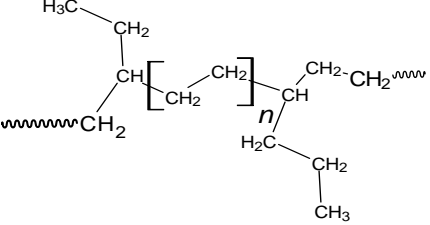

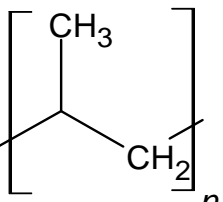

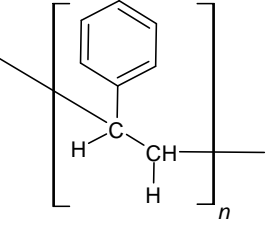


International energy agency, the large amount of plastics are used in packing (26% of the total volume) is expected to continue growing strongly and potentially double in the next 15 years[5]. Since 1950-2018, around 6.8 billion tonnes of plastic have been produced[6]. At this time some of plastic waste is used by recycle them. After many years we found that ocean may contain more plastics by weight than marine animals. There are roughly 500 billion or more plastic bags used, and 14 million tonnes of those end up in the ocean and some of other are end up in soil or some plastics at the end of life[2]. Plastics include a variety of harmful substances that can seep out and have negative effects on the environment and people's health, including poly-fluorinated, BPA, phthalates, and antimony tetra oxide. India-based researchers have found evidence that hazardous plastics from trash are migrating away from processing facilities and into the environment[2].

The most commonly used polymers are high-density polyethylene (HDPE), low-density polyethylene (LDPE), polyvinyl chloride (PVC), polystyrene (PS), and polypropylene (PP)[1]. Due to corrosion-resistant properties, most plastics are regarded as "Hard-to-Degrade" materials, which will persist in the environment for a large period of time. Over the years, the world was not paying strict attention to the impact of rapid growth in plastic use[7].

The recent publicity in the media surrounding plastic waste has created a massive drive to do something about it.

## II. TYPES OF PLASTICS

**Table I:** Types of Plastic, their structures and their uses[1].

Sl. No.	Types of Plastics	Structure	Uses	Recycling Symbol
1.	PET (Polyethylene Terephthalates)		Plastic Bottles Mouth Wash Bottles Cosmetic Containers Food Tray, Soft Drink Containers Detergent Bottle, Sampoo Bottle, Milk Bottles, Grocery Bags, Juice Bottle, Hard Agricultural Pipes, Ice-Cream Containers, Freezer Bags	
2.	HDPE (High Density Polyethylene)		Water Pipes Window Frames Blood Bags Blister Packs, Rain Coat	
3.	PVC (Polyvinyl Chloride)		Bread Bags, Squeezble Bottles, Cling Film, Garbage Bags, Irrigation Tubes, Mulch Films, 6 Pack Rings	
4.	LDPE (Low Density Polyethylene)		Medicine Bottles, Caps, Straw, Yogurt Container, Potato Chip Bags, Lunch Boxes, Microwave Dishes.	
5.	PP (Polypropylene)		Egg Cartons, Meat Trays, Disposable Plates & Cups, Toys, CD & Video Cases, Building & Food Insulation.	
6.	PS (Polystyrene)		Sun Glasses, Nylon Bullet Proof Materials, 3 & 5 Gallon Water Bottles, Computers, Cooler Bottles, Electronics.	
7.	OTHERS	-		

### 2.1. Polyethylene Terephthalates:

PET consists of repeating unit  $(C_{10}H_8O_4)_n$  and derived from terephthalic acid by using an inorganic catalyst *antimony trioxide*. PET is resistant to solvent and softness at  $80\text{ }^{\circ}\text{C}$ , hence prevent the leaching of toxic additives[8]. PET is transparent and smooth and frequently used in the production of water bottle, containers, Trays and so on. PET is commonly recycled hence produced for a single use only. **Fig. 1** shows the example of PET bottles[1].



**Fig. 1-**  
PET Bottles

### 2.2. High Density Polyethylene:

HDPE consists repeating unit of ethylene monomer by using Zeigler-Natta catalyst. It has chemical formula  $(C_2H_4)_n$ . It is a thermoplastic polymer and sometimes called alkathene when used for HDPE pipes[1], [8] . It is a petroleum-based, heat-resistant plastic. It is used for production of milk containers, varieties of plastic grocery bags, toys, detergent bottles and refrigerators and so on, given in (**Fig. 2**).

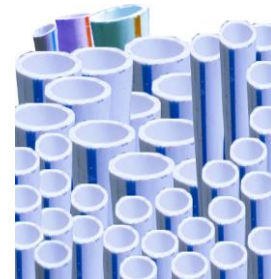


**Fig. 2-** HDPE Plastic

### 2.3. Polyvinyl chloride:

Polyvinyl chloride is the synthetic plastic polymer obtained from vinyl chloride monomer. It has chemical formula  $(C_2H_3Cl)_n$ . It is

chemically resistant to acids, salts, base, and alcohol but soluble in ethyl chloride[8]. It has very poor stability and has excellence resistant to weathering. PVC used for making pipes (**Fig. 3**), pneumatic tubes, electrical insulator and bottle for consumable liquids.



**Fig. 3-** PVC Plastics

### 2.4. Low Density Polyethylene:

It is a thermoplastic and prepared via free radical polymerization. It is made from *ethylene* monomer and has more branching as compare to HDPE[1]. It has excellence resistant to dilute and concentrated acids, alcohols, bases and esters. As a result, their use is considered safe for food and drink. It is frequently utilized in the packaging (**Fig. 4**), juice, and frozen foods.



**Fig. 4-** LDPE Plastics

### 2.5. Polypropylene:

Polypropylene is the synthetic polymer that can be formed by polymerization of *propylene*[1]. It has chemical formula  $(C_3H_6)_n$ . the thermal expansion is very high and its properties depends upon crystallinity, molecular weight[9]. It is used in production of medicine bottles, lunch boxes, caps of bottles (**Fig. 5**) and so on.



**Fig. 5- PP**  
Plastics

### 2.6. Polystyrene:

Polystyrene is a synthetic aromatic hydrocarbon polymer made from the monomer styrene[8]. It has chemical formula  $(C_8H_8)_n$ . It is prepared by free radical addition polymerization of styrene using  $AlCl_3$  and  $Al_2O_3$  as catalyst. It has low tendency for moisture absorption and moderate chemical resistance[1]. PS plastic is hard but brittle. It allows all wave lengths. It is used for house wares, combs, brush handles, container for talcum powder, paper dish (**Fig. 6**) and so on.



**Fig. 6-** PS Plastics

### 3. HEAVY METALS

Heavy metals are nature occurring elements with densities of at least 5 gm/cm. These are present in our

environment their ecological pollution begun from different anthropogenic exercises[10]. Heavy metal toxicity can be measured by various parameters, including dosage, species of chemical, age, gender, heredity and nutritional status of the affected person. According to IARC (International Agency for Research on Cancer) Cr, Pb, Hg, As are “probably” or “known” human carcinogens that have been linked to cancer incidence in humans and animals[1]. .

In the production of PVC & Polyethene polymer, Chromium (Cr) mostly used as additives. Zinc Carbonate ( $ZnCO_3$ ), Aluminium Oxide and Antimony Oxide are well known flame retardants have Cl and Br[10]. Copper, Cobalt, Chromium, Nickel, Selenium, Tin are metal estrogens that can mimic estrogen activation and have high affinity for estrogen receptors[11]. As a result they are regarded as harmful and may be linked to breast cancer[12].

Stabilizers, depending on the additive category are used to prevent plastic degradation caused by high temperatures, UV light, and other forms of atmospheric agents in order to boost product life[1].

**Table 2:** Utilization of heavy metals as additives in plastic products and their effects.

Heavy Metals	Types of Polymers	Additives	Effects on Public Health	Reference
Barium (Ba)	PVC	UV stabilizers & Inorganic Pigments	Mental disorder, breast cancer, metal-estrogen, cardiovascular & Kidney Diseases.	[10][10], [12]
Chromium (Cr)	PP, PVC, PE	Inorganic Pigments	Nasal Septum ulcer, severe cardiovascular, respiratory, gastrointestinal, renal, hepatic, allergic reaction to body and possibly death.	[11]
Cobalt (Co)	PET Bottles	Inorganic Pigments	Cardiovascular and endocrine deficits, formation of reactive, neurological disorder.	[12][11]
Arsenic (As)	LDPE, Polyester and PVC	Biocides	Carcinogen, lungs, gastrointestinal damage, , carcinogen: lung, skin, liver, bladder, kidneys.	[10], [12]
Copper (Cu)	-	Biocides	Formation reactive oxygen species (ROS); Inducing DNA strand breaks and oxidation.	[11][12]
Cadmium (Cd)	PVC	UV stabilizers, Heat stabilizers and inorganic pigments	Carcinogenesis, Cellular apoptosis, DNA methylation, Cellular apoptosis.	[11][12][10]

Antimony (Sb)	Various Plastics	Flame retardants and biocides	Breast cancer, Metal-estrogen	[12][10]
Aluminium (Al)	PET, PE, PVC, PBT	Stabilizers, Inorganic pigments and flame retardants	Breast cancer, Metal-estrogen	[12][10]
Zinc (Zn)	PE, PP, PVC	Flame retardants, inorganic pigments, Het stabilizer	-	[12][10]
Mercury (Hg)	PU	Biocides	Brain damage, Induction of the disruption of DNA molecular structure and mutagen & Carcinogen	[10]
Manganese (Mn)	-	Inorganic pigments	Neurodegenerative disorder	[12]
Titanium (Ti)	PVC	UV stabilizers and inorganic pigments	Cytotoxicity on human epithelial lung and colon cells	[12]
Tin (Sn)	PVC and PU foam	UV stabilizers & Biocides	Breast cancer, skin rashes, stomach complaints, nausea, vomiting, metal-estrogen.	[12][10]

#### 4. Environmental pollution by plastic wastes:

Plastic waste distribution is correlated to human populations. The demand for plastics and products made of plastic has increased as the human population has grown[13]. The indiscriminate disposal of waste from plastics and plastic products can pollute the environment in a number of ways, including the destruction of natural beauty of earth, death of aquatic organism, production of foul odors and fosters conditions that allow mosquitoes and other ill health carrying vectors to reproduce[14]. The different environmental pollution by plastic given below:

##### 4.1. Land Pollution:

Plastic additives can leach and eventually percolate into various aspects of the environment, resulting in soil and water contamination, which can be caused by dumping plastics on land (**Fig. 7**) or land filling them. Inside the soil it increases the soil temperature that's why the earth worm, ants, centipedes & other soil insect loss their lives. In microbial biodegradation of plastic some toxic gases are released, methane is one of them which is a dangerous green house gas which is responsible for global warming. Some plastics are secretly present in

the deep of the soil, that's why crops are not growing that much the farmer wants. So it makes a financial problem in farmers home. It also pollutes the underground water.



**Fig. 7-** Plastic debris on Land

##### 4.2. Water Pollution:

According to a survey, nearly 9 million tonnes of plastic are dumped into the ocean (**Fig. 8**) each year[15]. In general, plastic in the water can gradually but not fully decompose over time. At the shame of plastic some toxic chemicals released i.e. polystyrene, BPA are released in to the water to pollute it, due to such behavior the marine life destroyed. Some plastics are float above the water

and come to the side of the sea by the helps of wave and destroy the beauty of beaches. Now a day's some of the animal are no longer exist in earth due to pollution. Ocean pollution is one of the most serious and biomental issues for currently facing the species[16]. According to United Nations environment programme, about 1million ocean birds and about 90,000 oceanic animals are destroyed by plastic debris in the ocean every years[17]. Minimum 50% to 80% of dead sea turtles have plastic in them. Many sea birds have been found with stomachs full of plastics[3]. 60% of all the sea birds species have eaten pieces of plastic in their lifetime. Corals that in contact with plastics have 89% chance to contracting disease[4]. We know that some plastics float above the water so that under water plant does not found sunlight, so they are not growing up and lastly loss their life[6]. Some plastics are sharp in size so some fishes or other marine animal have get serious injury. Plastics can rip through the intestines of marine animals and block the passage of food through their bodies[14]. The micro plastics are very hard to clean up from water. Due to polluted water some transmission of disease causes in human being such as cholera, diarrhoea, dysentery, hepatitis a, typhoid and polio and so on[7].



**Fig. 8-** Plastic debris on water body

4.3. Air Pollution:

Basically air is full of different types of gases. Some toxic gases like CO<sub>2</sub>, methane are released from the plastic waste when it was going to burnt (Fig. 9). CO<sub>2</sub> gas also released when we burn the plastic or plastic products and it has capable of catch the radiant heat and responsible for the global warming[18]. Some industry, which produce plastics

release more toxic gases to air and water. The blaze of plastics or synthetic products release pollutants like hard core rocke, BCPs (polychlorinated biphenyls), mercury, furans, CO<sub>2</sub>, dioxins and so on[19]. These pollutants are the main cause of air pollution[20]. Due to air pollution the ozone breaks and the toxic UV lights are direct contact with people and disease occur. After studying such type things it is recognize that the future generation may faces many

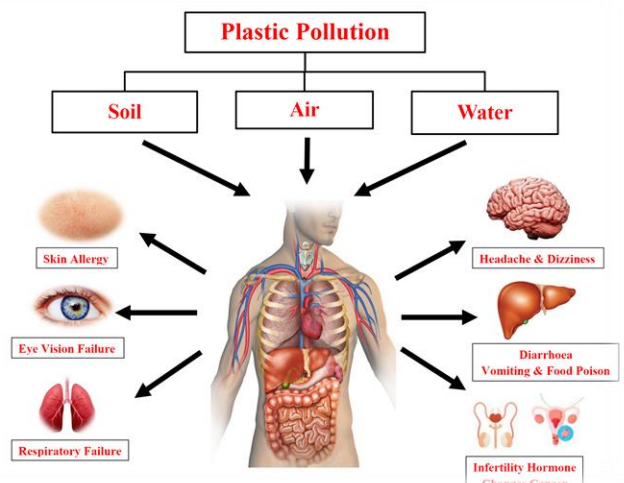


difficulties.

**Fig. 9-** Toxic Gas release from Burning waste

4.4. Effects of plastics on human health:

Plastics are important for human beings and plastic products are utilized by human not by the animals hence the more effect of plastic products are observe in human body or health (Fig. 10). Due to the uses of plastic regularly we found many types of diseases like cancer that may be breast or ovarian, reproductive disorder, abnormal menstrual cycle, behavioral disorder and so on[21]. Scientist found micro plastic substance in human body because we take many micro plastic without knowing regularly. There are different types of additives used in the plastic industry that have very harmful effects on human health[22].



**Fig. 10-** Effects of Plastic Debris on Human Health.

## 5. PLASTIC WASTE MANAGEMENT

Waste management plays an important role in reducing toxic effects of plastic debris on the environment and public health. Hence some management methods are discussed below:

### 5.1. Public Awareness about Toxicity of Plastics:

After a research it was found that some micro plastics are also present in human blood[23]. No doubt plastics are very useful but due to lots of usages of plastics different types of disease occurs, so that it is important to aware the people. Maximum times human bodies come in contact with plastics by the different ways[24]. It is clear that, in regular contact with plastics it makes skin disease, these whole things are important to know the human beings[1].



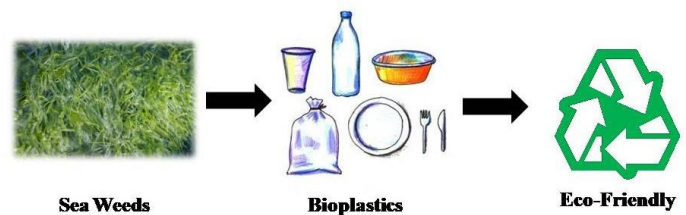
**Fig. 11-** Utilization of Public Dustbin

Everyone know that plastic is harmful and if we are not aware about the uses of plastic then it affects on our daily life and the environment[25]. In different level of education we found a syllabus according to the plastic pollution and waste management system[26]. By the help of television, showing something about plastic we can aware the people. Currently some NGO try to consciousness people (**Fig. 11**) about the toxicity of plastic through the physical meeting.

### 5.2. Bio-plastic as an Alternative:

In 1850s, cellulose that is made up of wood pulp from which plastic produced known as bioplastics[27]. These plastics require less fossil fuels during production hence these are environmentally friendly[28]. Now a days bioplastics produces using starch, corn, weeds, hemp, potato (**Fig. 12**), which are biodeterioration and nonbiodeterioration[29].

Biodegradability, with minimum toxic residue will significantly reduce the threat posed by conventional plastic debris to our natural environment, safeguard or planets and increase human society[30].



**Fig. 12-** Bio-plastics from sea Weeds

## CONCLUSION

Plastic wastes have created a significant environmental problem, according to research on the global manufacturing of plastic and related environmental contamination. Plastic production is increased due to the increasing of population or the major need of plastic in human life[1]. The body of a leaving organism can take microplastics through respiration, body contact and through contaminated food. The micro plastics are small in size about  $20\mu$  that is should be able to pierce some organs and some plastics have size  $10\mu$ , should be able to pass all organs, cross the brain blood barrier, cross cell membranes, secondary tissues such as the muscles, livers and the brain etc. The plastics are less than  $10\mu$  in size they are undergoes nanoplastics. To ensure environmental and health safety, it is crucial to closely monitor the harmful chemicals used in the production of plastic. If reduce the toxicity from the plastic debris then we will found a clean or beautiful and healthy society. Now is the time for authority and health officials to develop and implement regulations that will regulate the manufacture, use, and disposal of plastics.

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