# Plastics Addiction: Humanity's Existential Crisis

**Pratibha Singh**[1] and **Om Pal Singh**[2]
[1]Ssheetal Prathom Aahaar Society, Bijlipur, Balrampur 271201 UP India
[2]Advanced Level Telecom Training Centre, BSNL, Ghaziabad 201002 UP India
[1]singh.pr14@gmail.com, [2]raviom30@gmail.com

*Abstract* -- **When plastic was invented almost over a century ago, it was never thought that plastics will permeate every facet of our life, including all branches of engineering. We started with Plastiphilia (love for plastics items) few years back and now we are having Plastimania (Craziness for plastic) with full Plastidependency (Plastic Dependency). This may lead to Plasticimea (Death by plastic use) which is life threatening for all of us.**

**Today humanity is virtually Plastidicted (*i.e.* Plastic Addicted). Made from fossil fuels, plastic is not only troubling the humans but also mammals, plants and aquatic animals. The whole ecosystem is completely disturbed. Every piece of plastic ever made is still around, and may well be for the next few thousand years, either in the ocean or as a toxic time bomb in the landfill.**

**In developing countries with inadequate solid waste management regulations, plastic bag litter aggravates pandemics. By blocking sewage systems and providing breeding grounds for mosquitoes and other pests, plastic bags raise the risk of transmission of vector-borne diseases. When plastics decompose they release chemicals that are hazardous to health, the environment and wildlife. Some of the chemicals released when plastic-containing waste is burned are carcinogenic.**

**Mismanaged plastic waste ranges from 60 percent in East Asia and Pacific to one percent in North America. Something needs to be done to stop plastic pollution. Just a century ago, there was no plastic and no pollution problem. Now it's everywhere - in the ocean, on every coastline, on the sea floor and blowing in the wind to eventually wind up on city streets, parks, trees, fences and farmland.**

**In this review article, dependency on plastics and their *ecological, economic and eco-toxicological effects are* explained.**

*Keywords: Plastiphilia, Plastimania, Plasticimea, Plastidicted, Thermoplastics, Thermosets, Polyethylene Terephthalate, Polycarbonate,Polypropylene, Low-Density Polyethylene, High-Density Polyethylene, Polystyrene, Polypropylene, Polyvinyl-chloride*

## I. INTRODUCTION

EARTH with a present age of 4.543 billion years faced several changes in its exterior as well as interior and one of those is the industrial revolution. In the 19th century, the aftermath of industrial revolution saw a demand for new materials, at first as substitutes for rare or expensive materials like ivory- and the scientific and manufacturing know-how to make them mass commodities.

For this option, industrialists chose a new invention as a substitute for each and everything of our earth and named it 'Plastic'. The first widely available plastic, celluloid, was plant-derived, made from a nitrocellulose and camphor resin. Patented in 1869 by an American Inventor, John Wesley Hyatt, celluloid was designed to win a prize offered by a billiard-table manufacturer seeking a synthetic replacement for ivory billiard balls.

Plastic is a material consisting of any of the wide range of synthetic or semi-synthetic organic compounds that are malleable and so can be moulded into solid objects and this makes it a wonderful material as different forms can be made according to the need and choice. Plastics are typically organic polymers of high molecular mass and often contain other substances. They are usually synthetic, most commonly derived from petrochemicals, however, an array of variants are made from renewable materials such as polylactic acid from corn or cellulosics from cotton linters. Due to their low cost, ease of manufacture, versatility, and imperviousness to water, plastics are used in a multitude of products of different scale, including paper clips and spacecraft. They have prevailed over traditional material, such as wood, stone, horn and bone, leather, metal, glass, and ceramic, in some products previously left to natural materials.

In developed economies, about a third of plastic is used in packaging and roughly the same in buildings in applications such as piping, plumbing or vinyl siding. Other uses include automobiles (up to 20% plastic), furniture, and toys. In the developing world, the applications of plastic may differ—42% of India's consumption is used in packaging. Plastics have many uses in the medical field as well, with the introduction of polymer implants and other medical devices derived at least partially from plastic. The field of plastic surgery is not named for use of plastic materials, but rather the meaning of the word plasticity, about the reshaping of flesh.

People make a lot of things out of plastic because it is cheap and versatile. Plastic things also last a long time. This can be

very useful for people but it's one of the biggest problems for the environment. Most plastics last just about forever because no life form has yet evolved which can eat plastic. Almost everything else made by humans gets broken down, either by microbes which can use waste as food or by the natural decay of metals like steel. The sun or the pounding of waves on the seashores of the world does break up plastic into little bits but the little bits don't vanish… and that is one of the biggest problems with this human-made stuff.

## II. PLASTIC TYPES

Two main categories of plastics and their single-use applications are Thermoplastics and Thermosets (Table 1).

TABLE 1—TYPES OF PLASTICS

| Thermoplastics | Thermosets |
|---|---|
| The most common Thermoplastics are:<br>Polyethylene Terephthalate(PET),<br>Polypropylene (PE),<br>Low-Density Polyethylene(LDPE),<br>High-Density Polyethylene(HDPE),<br>Polystyrene (PS),<br>Expanded polystyrene (EPS),<br>Polyvinyl-chloride (PVC),<br>Polycarbonate,<br>Polypropylene (PP);<br>Polylactic acid (PLA)<br>and Polyhydroxyalkanoates (PHA). | The most common Thermosets are:<br>Polyurethane (PUR),<br>Phenolic resins,<br>Epoxy resins,<br>Silicone,<br>Vinyl ester,<br>Acrylic resins,<br>Urea-formaldehyde (UF) resins |
| Thermoplastics are a family of plastics that can be melted when heated and hardened when cooled. These characteristics, which lend the material its name, are reversible. That is, it can be reheated, reshaped and frozen repeatedly. | Thermosets are a family of plastics that undergo a chemical change when heated, creating a three dimensional network. After they are heated and formed, these plastics cannot be re-melted and reformed. |

TABLE 2 --MAIN POLYMERS USED IN THE PRODUCTION OF SINGLE-USE PLASTICS

| Type | Use | Type | Use |
|---|---|---|---|
| LDPE | Bags, trays, containers, food packaging film | PS | Cutlery, plates and cups |
| HDPE | Milk bottles, freezer bags, shampoo bottles, ice cream containers | EPS | Hot drink cups, insulated food packaging, protective packaging for fragile items |
| PET | Bottles for water and other drinks, dispensing containers for cleaning fluids, biscuit trays | PP | Microwave dishes, ice cream tubs, potato chip bags, bottle caps |

TABLE 3 --PLASTICS REPLACING THE TRADITIONALLY USED MATERIALS

| Product | Previous typical packaging material | Current typical packaging material |
|---|---|---|
| Milk, edible oil | Glass, Metal | 3 or 5 layer film pouches |
| Toiletries (Soap/ Shampoos) | Paper, Glass | Plastic pouches or films |
| Cement, Fertilizer | Jute | PP/HDPE woven sack |
| Tothpaste | Metal | Plastic lamitube |

Source:- UNEP (2018). SINGLE-USE PLASTICS:A Roadmap for Sustainability

Each plastic type is different from the other. Some of them are reusable; the others produce hazardous material after several uses. Some are easily recyclable; others need a more sophisticated and intricate handling in their recycling process.

A lunch box, a water bottle, an instant noodle cup would have a number at its back or bottom. The number indicates the type of plastic used to make the product. But what number one should

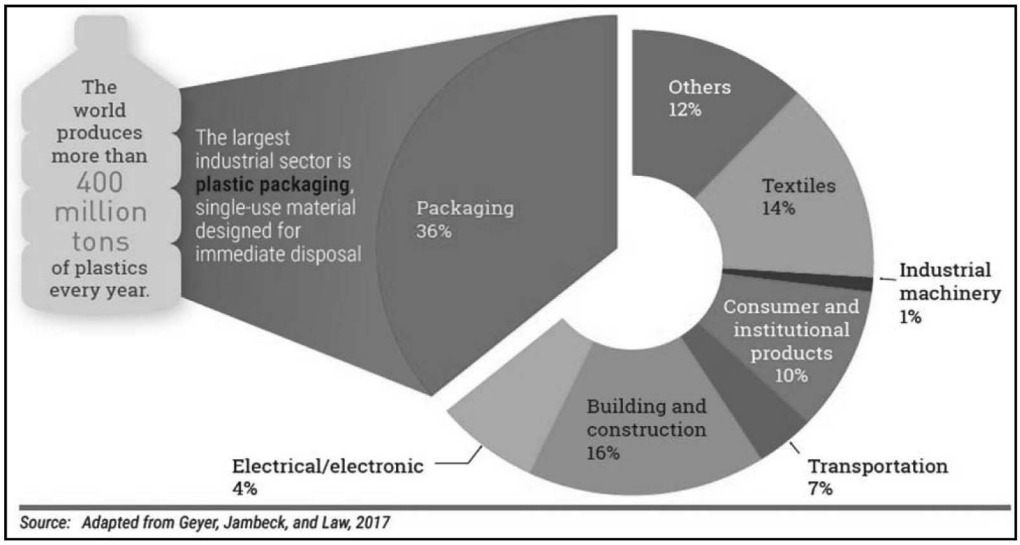


Figure 1. Global plastic production by industrial sector, 2015.


Figure 2. Plastic types and their end-use.
Source: Plastic Waste Management, Issues, Solutions and Case Studies, Ministry of Housing and Urban Affairs, March 2019

avoid and what number holds the biggest chance of damaging the environment?

*Type 1 – Polyethylene Terephthalate (PET or PETE or Polyester):* PET is also known as a wrinkle-free fiber. It's different from the plastic bag that we commonly see at the supermarket. PET is mostly used for food and drink packaging purposes due to its strong ability to prevent oxygen from getting in and spoiling the product inside. It also helps to keep the carbon dioxide in carbonated drinks from getting out. Though PET is most likely to be picked up by recycling programs, this type of plastic contains antimony trioxide—a matter that is considered as a carcinogen—capable of causing cancer in living tissue. The longer a liquid is left in a PET container, the greater the potential for the release of the antimony. Warm temperatures inside cars, garages, and enclosed storage could also increase the release of the hazardous matter.

*Type 2 – High-Density Polyethylene (HDPE):* Quite special compared to the other types, HDPE has long virtually unbranched polymer chains which makes them really dense and thus, stronger and thicker than PET. HDPE is commonly used as the grocery bag, opaque milk, juice container, shampoo bottles, and medicine bottle. Not only recyclable, HDPE is relatively more stable than PET. It is considered as a safer option for food and drink use, though some studies have shown that it can leach estrogen-mimicking additive chemicals that could disrupt the hormonal system when exposed to ultraviolet light.

*Type 3 – Polyvinyl Chloride (PVC):* PVC is typically used in toys, blister wrap, cling wrap, detergent bottles, loose-leaf binders, blood bags and medical tubing. PVC or vinyl used to be the second most widely used plastic resin in the world (after polyethylene), before the manufacture and disposal process of PVC has been declared as the cause of serious health risks and environmental pollution issues.

In terms of toxicity, PVC is considered as the most hazardous plastic. The use of it may leach a variety of toxic chemicals such as bisphenol A (BPA), phthalates, lead, dioxins, mercury, and cadmium. Several of the chemicals mentioned may cause cancer; it could also cause allergic symptoms in children and disrupt the hormonal system. PVC is also rarely accepted by recycling programs. This is why PVC is better to be avoided at all costs.

*Type 4 – Low-Density Polyethylene (LDPE):* This type of plastic has the simplest plastic polymer chemical structure, making it easy and cheap to process. LDPE polymers have significant chain branching including long side chains making it less dense and less crystalline (structurally ordered) and thus a generally thinner more flexible form of polyethylene. LDPE is mostly used for bags (grocery, dry cleaning, bread, frozen food bags, newspapers, garbage), plastic wraps; coatings for paper milk cartons and hot & cold beverage cups; some squeezable bottles (honey, mustard), food storage containers, container lids. Also used for wire and cable covering. Though some studies have shown that LDPE could also cause unhealthy hormonal effects in humans, LDPE is considered a safer plastic option for food and drink use. Unfortunately, this type of plastic is quite difficult to be recycled.

*Type 5 – Polypropylene (PP):* Stiffer and more resistant to heat, PP is widely used for hot food containers. Its strength quality is somewhere between LDPE and HDPE. Besides in thermal vests, and car parts, PP is also included in disposable diaper and sanitary pad liners. Same as LDPE, PP is considered a safer plastic option for food and drink use. Though it bears all those amazing qualities, PP isn't quite recyclable and could also cause asthma and hormone disruption.

*Type 6 – Polystyrene (PS):* Polystyrene is the Styrofoam we all commonly used for food containers, egg cartons, disposable

cups and bowls, packaging, and also bike helmet. When exposed with hot and oily food, PS could leach styrene that is considered as brain and nervous system toxicant, it could also affect genes, lungs, liver, and immune system. On top of all of those risks, PS has a low recycling rate.

*Type 7 – Other:* Number 7 is for all plastics other than those identified by number 1-6 and also plastics that may be layered or mixed with other types of plastics, such as bioplastics. Polycarbonate (PC) is the most common plastic in this category, isn't used as much in recent years due to it being associated with bisphenol A (BPA). PC is also known by various names: Lexan, Makrolon, and Makroclear. Ironically, PC is typically used for baby bottles, sippy cups, water bottles, water gallon, metal food can liner, ketchup container, and dental sealants. Due to its toxicity, several countries have banned the use of PC for baby bottles and infant formula packaging.

The BPA contained inside PC has been linked to numerous health problems including chromosome damage in female ovaries, decreased sperm production in males, early onset of puberty, various behavioral changes, altered immune function, sex reversal in frogs, impaired brain and neurological functions, cardiovascular system damage, adult-onset (Type II) diabetes, obesity, resistance to chemotherapy, increased risk of breast cancer, prostate cancer, infertility, and metabolic disorders. Added with its very low recycle rate quality, PC is to be avoided at all cost.

- Though it varies between types, every single category of plastic could leach hazardous materials if put in an extreme situation such as extreme heat.
- 3 types of plastic that are considered as safer options among the others are Polyethylene Terephthalate (PET), High-Density Polyethylene (2-HDPE), and Polypropylene (5-PP).
- Though experts are currently working on inventing the best method and strategy to recycle all types of plastic, the 2 types of plastic that are mostly picked up by the recycling programs are Polyethylene Terephthalate (1-PET) and High-Density Polyethylene (2-HDPE).

## III. PLASTICS ON LAND, WATER, SOIL AND AIR

*Effects of plastic on land:* Plastic pollution on land poses a threat to the plants and animals - including humans who are based on the land. Estimates of the amount of plastic concentration on land are between four and twenty three times that of the ocean. The amount of plastic poised on the land is greater and more concentrated than that in the water. Mismanaged plastic waste ranges from 60 percent in East Asia and Pacific to one percent in North America. The percentage of mismanaged plastic waste reaching the ocean annually and thus becoming plastic marine debris is between one third and one half the total mismanaged waste for that year.

Chlorinated plastic can release harmful chemicals into the surrounding soil, which can then seep into groundwater or other surrounding water sources and also the ecosystem of the world. This can cause serious harm to the species that drink the water.

*Plastic pollution in tap water:* A 2017 study found that 83% of tap water samples taken around the world contained plastic pollutants. This was the first study to focus on global drinking water pollution with plastics, and showed that with a contamination rate of 94%, tap water in the United States was the most polluted, followed by Lebanon and India. European countries such as the United Kingdom, Germany and France had the lowest contamination rate, though still as high as 72%. This means that people may be ingesting between 3,000 and 4,000 micro-particles of plastic from tap water per year. The analysis found particles of more than 2.5 microns in size, which is 2500 times bigger than a nanometer. It is currently unclear if this contamination is affecting human health, but if the water is also found to contain nano-particle pollutants, there could be adverse impacts on human well-being, according to scientists associated with the study. However, plastic tap water pollution remains under-studied, as are the links to how pollution transfers between humans, air, water, and soil.

A. *Effects of plastic on oceans:* In 2012, it was estimated that there were approximately 165 million tons of plastic pollution in the world's oceans. The Ocean Conservancy reported that China, Indonesia, Philippines, Thailand, and Vietnam dump more plastic in the sea than all other countries combined. One study estimated that there are more than 5 trillion plastic pieces (defined into the four classes of small micro-plastics, large micro-plastics, meso-and macro-plastics) afloat at sea.

The litter that is being delivered into the oceans is toxic to marine life, and humans. The toxins that are components of plastic include diethylhexyl phthalate, which is a toxic carcinogen, as well as lead, cadmium, and mercury. Plankton, fish, and ultimately the human race, through the food chain, ingest these highly toxic carcinogens and chemicals. Consuming the fish that contain these toxins can cause an increase in cancer, immune disorders, and birth defects.

The majority of the litter near and in the ocean is made up of plastics and is a persistent pervasive source of marine pollution. According to the Gyres Institute, there are 5.25 trillion particles of plastic pollution that weigh as much as 270,000 tons (2016). This plastic is taken by the ocean currents and accumulates in large vortexes known as ocean gyres. The majority of the gyres become pollution dumps filled with plastic.

*Sources of ocean-based plastic pollution:* Almost 20% of plastic debris that pollutes ocean water, which translates to 5.6 million tons, comes from ocean-based sources. MARPOL, an international treaty, "imposes a complete ban on the at-sea disposal of plastics". Merchant ships expel cargo, sewage, used medical equipment, and other types of waste that contain plastic into the ocean. Pleasure crafts release fishing gear and other types of waste, either accidentally or through negligent handling. The largest ocean-based source of plastic pollution is discarded fishing gear (including traps and nets), estimated to be up to 90% of plastic debris in some areas.

Continental plastic litter enters the ocean largely through storm-water runoff, flowing into watercourses or directly discharged into coastal waters. Plastic in the ocean has been shown to follow ocean currents which eventually form into what is known as Great Garbage Patches.

B. *Land-based sources of ocean plastic pollution:* Estimates for the contribution of land-based plastic vary widely. One study estimated that a little over 80% of plastic debris in ocean water comes from land-based sources, responsible for 0.8 million tons (790,000 long tons; 880,000 short tons) every year. In 2015, Jambeck *et al.* calculated that 275 million tons (271,000,000 long tons; 303,000,000 short tons) of plastic waste was generated in 192 coastal countries in 2010, with 4.8 to 12.7 million tons (12,500,000 long tons; 14,000,000 short tons) entering the ocean - a percentage of only up to 5%.

In a study published by *Science*, Jambeck *et al.* (2015) estimated that the ten largest emitters of oceanic plastic pollution worldwide are, from the most to the least, China, Indonesia, Philippines, Vietnam, Sri Lanka, Thailand, Egypt, Malaysia, Nigeria, and Bangladesh.

*The Great Pacific Garbage Patch:* Imagine you're sailing across the Pacific Ocean, way out of sight of land? So you don't expect your boat to be pushing through great rafts of floating plastic for mile after mile. Welcome to the great Pacific garbage patch... and to a modern myth because there aren't "great rafts of floating plastic". The "garbage patch" certainly exists — and there are several others — but the plastic is mostly small bits the size of confetti or smaller. It floats in the surface layers of the ocean forming a sort of thin 'soup'. This plastic garbage is caught in the best known of 5 giant rotating ocean currents called gyres. These floating patches of plastic debris have become worrying about new ecosystems that scientists call the "Plastisphere".

*What harm do floating plastics do?* Unfortunately, many marine animals mistake some types of plastic for food and eat them. Turtles often die because the plastic they eat blocks their digestive system so they starve. Marine mammals (like dolphins) often get trapped by plastic nets or ropes and either drown or starve to death: "ghost fishing". Great and rare sea birds like albatrosses also get tangled up in old fishing gear and die. Around 400,000 marine mammals die every year due to plastic pollution in oceans. Plastics also poison the animals that eat them. Eventually, much of the floating ocean plastic sinks to the sea floor or ends up on beaches all around the world. People don't see the rubbish on the sea floor but the animals (filter feeders like worms) accidentally eat it.

*Choking the food chain: micro-plastics and nurdles:* This is the scary stuff. You don't notice it because it's very small (less than a small pea) but it gets everywhere. Micro-plastics form in the same way sand on beaches forms: by the endless crashing and pounding of the waves which can turn big rocks and stones into sand over time. This is called mechanical erosion and it affects anything that's on the world's coasts, including the gazillions of pieces of plastic waste that end up on every beach everywhere - even on the shores of large lakes. Because very few plastics can be broken down by biological or chemical means, it is only pounding waves bashing bits of plastic against rocks and twisting it about that can actually break plastic down into very

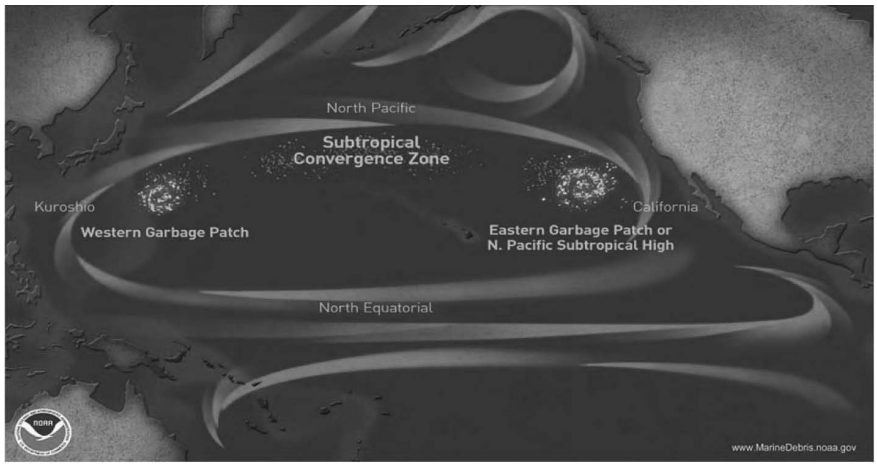


Figure 3. Plastics in oceans.

small pieces — about the size of sand grains. On the land, ultraviolet rays from the sun also play a role in breaking down plastics into small pieces (photo degradation).

Another big source of micro-plastics is waste water from washing machines. Tiny fibres from clothes made of synthetic materials get broken off the clothing by the pounding action of the machine and end up in sewage outflows into rivers and seas. And then there are personal care products like scrubs and peels many of which contain plastic particles which also end up in the sea.

*Nurdles* are another type of tiny plastic that cause serious problems. They sound vaguely cute, like cartoon characters, but they are not imaginary. They are tiny beads — smaller than a soybean — which is the raw materials of plastic production, ready to be molded into anything from bags to toys. Accidents happen and many nurdles escape, typically from container ships carrying them around the world. And so nurdles are now a significant source of ocean and beach pollution and share all the unpleasant properties of other micro plastics.

Micro-plastics are made of all the main types of plastics used by people: polyethylene (polythene), polyethylene terephthalate (PET), PVC or polystyrene. They don't get removed by wastewater treatment plants and so — they end up in the ocean. Plastic is here to stay: Nearly every piece of plastic ever made — and thrown away — still exists today because there is no organism that can break it down completely.

Like other types of plastic, these micro-plastics don't go away. They build up in the sand and mud of coastlines and on the sea floor. Where there are sand dunes, the wind will blow them inland so they become part of the soil. They don't decay because plastics don't do that. But they do enter the food chain. Because micro-plastics (including nurdles) seem like food to the myriad little animals, that normally filter-feed in sand and mud, they get eaten by them. But they are not food and can block up the animals' digestive systems so they starve to death.

These tiny sea creatures (like worms, mollusks and crustaceans at the bottom of the food chain are very sensitive to toxic substances (like plasticizers) and these toxins then pass up the food chain… and humans are at the top of the chain! Scientists don't yet know much about the damage was done by these 'invisible' microplastics but suspect that they will turn out to be serious. They already know that microplastics can 'suck up' and carry with them toxic chemicals (*e.g*. persistent organic pollutants, POPs). These man-made chemicals already pollute the oceans.

So humans have to do something to stop plastic pollution. Just a century ago, there was no plastic and no pollution problem. Now it's everywhere — in the ocean, on every coastline, on the sea floor and blowing in the wind to eventually wind up on city streets, parks, trees, fences and farmland.

*Effects of plastic on humans:* Due to the use of chemical additives during plastic production, plastics have potentially harmful effects that could prove to be carcinogenic or promote endocrine disruption. Humans can be exposed to these chemicals through the nose, mouth, or skin. Though the level of exposure varies depending on age and geography, most humans experience simultaneous exposure to many of these chemicals.

Average levels of daily exposure are below the levels deemed to be unsafe, but more research needs to be done on the effects of low dose exposure on humans. A lot is unknown on about how severely humans are physically affected by these chemicals. Some of the chemicals used in plastic production can cause dermatitis upon contact with human skin.

In many plastics, these toxic chemicals are only used in trace amounts, but significant testing is often required to ensure that the toxic elements are contained within the plastic by inert material or polymer. It can also affect humans because it may create an eyesore that interferes with the enjoyment of the natural environment.

*Plastic, in short, is poison:* Hailed as a wonder material when the first synthetic polymer, Bakelite, was developed using fossil fuels in 1907, plastic had made so much possible, from the way we manufacture to making our lives faster and more convenient. However its usage as a single-use product and our reliance on it, as well as our failure to recycle or reuse it properly has made it a nightmare material. This is because plastic is persistent. It does not biodegrade and disappear. It becomes brittle over time and degrades into smaller and smaller pieces, known as microplastic. Every piece of plastic ever made is still around, and may well be for the next few thousand years, either in the ocean or as a toxic time bomb in the landfill.

Plastic leaches chemicals, such as BPA, which mimics estrogens, and has been linked to low sperm counts and infertility in men, as well as breast and prostate cancer. In the ocean, plastic also attracts persistent organic pollutants, which are naturally occurring toxins. These accumulate over time, meaning that any ingested pieces pass the toxins on the creature that has eaten them. This can travel up the food chain to us.

Clinical significance: Due to the pervasiveness of plastic products, most of the human population is constantly exposed to the chemical components of plastics. 95% of adults in the United States have had detectable levels of BPA in their urine. Exposure to chemicals such as Bisphenol A (BPA) has been correlated with disruptions in fertility, reproduction, sexual maturation, and other health effects.

*Thyroid hormone axis:* Bisphenol A affects gene expression related to the thyroid hormone axis, which affects biological functions such as metabolism and development. BPA can decrease thyroid hormone receptor (TR) activity by increasing TR transcriptional core pressor activity. This then decreases the level of thyroid hormone binding proteins that bind to triiodothyronine. By affecting the thyroid hormone axis, BPA exposure can lead to hypothyroidism.

*Sex hormones:* BPA can disrupt normal, physiological levels of sex hormones. It does this by binding to globulins that normally bind to sex hormones such as androgens and estrogens, leading to the disruption of the balance between the two. BPA can also affect the metabolism or the catabolism of sex hormones. It often acts as an anti androgen or as estrogen, which can cause disruptions in gonadal development and sperm production.

*Impacts of Styrofoam on health:* Styrofoam items contain toxic chemicals such as styrene and benzene. Both are considered carcinogenic and can lead to additional health complications, including adverse effects on the nervous, respiratory and reproductive systems, and possibly on the kidneys and liver. Several studies have shown that the toxins in Styrofoam containers can transfer to food and drinks, and this risk seems to be accentuated when people reheat the food while still in the container. In low-income regions, domestic waste - including plastics - is often burnt for heating and/or cooking purposes, exposing largely women and children to prolonged toxic emissions. Illegal disposal practices of plastics often take the form of open burning, accentuating the release of toxic gases that include furans and dioxins.

Research has shown that in developed as well as in developing countries, littering of plastic bags and Styrofoam containers can lead to perceived 'welfare losses' associated for instance to the visual disamenity of a park being contaminated with litter. This increases the indirect social costs of plastic pollution.

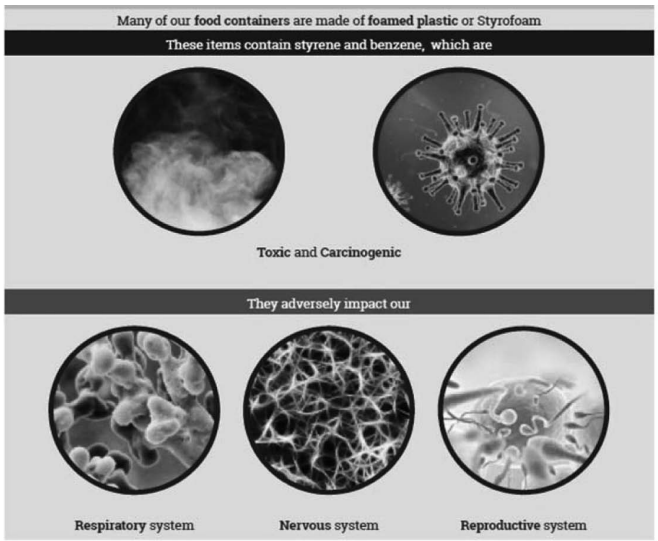


Figure 4. Negative impact of Styrofoam.

In developing countries with inadequate solid waste management regulations, plastic bag litter can aggravate pandemics. By blocking sewage systems and providing breeding grounds for mosquitoes and other pests, plastic bags raise the risk of transmission of vector-borne diseases such as malaria.

World Health Organization (WHO), United Nations sister agencies and thousands of communities and organizations celebrated World Environment Day with theme "Beat plastic pollution" in 2018 – a call for action for the world to work together to address one of the great environmental challenges of our time and raise global awareness of the need to reduce the heavy burden of plastic pollution on people's health and the threat it poses to the environment and wildlife.

While the world has derived great benefit from the use of plastics, which have transformed people's everyday lives, the negative ecological effects and adverse impact on health from their misuse and overuse cannot be overlooked. Plastic remains in the environment for a long time, it cannot biodegrade, only break down into smaller and smaller pieces.

When plastics decompose they release chemicals that are hazardous to health, the environment and wildlife. Some of the chemicals released when plastic-containing waste is burned are carcinogenic, such as dioxin – the common name for a group of toxic chemicals. Dioxin is toxic to humans and when inhaled through exposure to fumes can accumulate in the human body and transmitted from mothers to babies via the placenta. Dioxin attached to dust also falls onto waterways and crops.

*Effects of plastic on animals:* Plastic pollution has the potential to poison animals, which can then adversely affect human food supplies. Plastic pollution has been described as being highly detrimental to large marine mammals, described in the book *Introduction to Marine Biology* as posing the 'single greatest threat' to them. Some marine species, such as sea turtles, have been found to contain large proportions of plastics in their stomach. When this occurs, the animal typically starves, because the plastic blocks the animal's digestive tract. Sometimes marine mammals are entangled in plastic products such as nets, which can harm or kill them.

*Holy Cow or Plastic Cow?* Since plastic bags and other plastic items have invaded our lives, almost all garbage and food waste are disposed off in plastic bags. These bags spill out either on the road or from municipality dustbins. Since the plastic bags are knotted at the mouth, cows, unable to undo the knot, eat food leftovers including the plastic.

India has an open garbage system, which means open garbage bins on the roads overflowing with stinking waste. Dogs, monkeys, pigs, rats and cows eat whatever they can find to survive. In cities and towns, large numbers of cows on the roads eat from garbage bins, foraging for fruit, vegetable leftovers, anything edible and anything smelling like food.

## IV. THE UGLY FACE OF PLASTIC POLLUTION

Plastic is lightweight, durable — and widly popular. We've produced 8.3 billion metric tons of the material since mass production began in the 1950s. Because it doesn't easily biodegrade, much of what we've made now lives in landfills. Rubbish pickers there hunt for recyclable plastics to earn a living. But a lot of plastic also ends up in the ocean.

Some 90 percent of plastic enters marine habitats via just 10 rivers: The Yangtze, the Indus, Yellow River, Hai River, the Nile, the Ganges, Pearl River, Amur River, the Niger, and the Mekong. These rivers run through highly populated areas with a lack of adequate waste disposal infrastructure.

Though plastic is highly durable and can be used for products with a long lifespan, such as furniture and piping, about 50 percent goes to disposable products, including single-use cutlery and six pack rings that end up in the natural environment. Animals, like penguin, are in danger of becoming entangled and dying as a result.

Other animals mistake the material for food. According to one study of 34 seabird species in northern Europe, Russia, Iceland, Svalbard, the Faroe Islands, Scandinavia and Greenland, 74 percent had ingested plastic. Eating the material can lead to organ damage and blockages in the gut.

*Visible and invisible plastic*: Trillions of tiny particles less than 5 mm in diameter are found floating around in seas. These particles end up in the food chain. Sea plankton, which are an important source of food for fish and other marine animals, have been filmed eating them.

*An end in sight?* Tentative measures to cut down on disposable plastic have already been taken in some African countries with bans on plastic bags, while the European Union is looking into prohibiting single-use plastic products. But if current trends continue, scientists believe there will be 12 billion metric tons of plastic on the planet by 2050.

## V. CONCLUSION

The world with almost more than 200 countries is suffering from the curse of plastic pollution. The world is waking up to a crisis of ocean plastic. The world has a plastic pollution problem and it's snowballing—but so is public awareness and action. Not long ago, shopping bags, cartons, bottles, cutlery, crockery, clothes, shoes and millions of other items of daily use were not made of that amazing range of synthetics usually referred to as plastic. From polystyrene celluloid, viscose rayon and cellophane to PVC, acrylics, polyurethane, Teflon, nylon and neoprene, the world appears terminally addicted to plastic.

Most of India's states have banned plastic use. As on date, twenty five Indian states/ UTs (complete ban in 20 states/ UTs, a partial ban in five states) now have some forms of a ban polythene carry bags, but implantation is often lax, and plastic which takes hundreds of years to decompose-continues to be used.

In the last decade, dozens of national and local governments around the world have adopted policies to reduce the use of disposable plastic. And the number continues to grow. Africa stands out as the continent where most countries have adopted a total ban on the production and use of plastic bags. Of the 25 African countries that have banned the bags, more than half have done so in the last four years alone.

To curb the use of plastic in countries around the world, various initiatives have been taken in different countries. United Nations Environment Program has issued "Single-Use Plastics: A Roadmap for Sustainability".

In this paper, the love for the plastics and also its ecological, economic and eco-toxicological effects was explained with the following points: An overview of plastic, Plastic population on earth, Categories of plastics (Thermoplastics and Thermosets) and their single-use applications, Seven different types of plastics, End of plastic life, The Journey of products at end-of-life, Plastics on land, water, soil, and air, Effects of plastic on humans, health, and animals, etc.

Recently, authors published their book, *Let's move towards Being Plastic Free: One Thought Solution to Beat Plastic Pollution",* Inkart Publishing, ISBN: 978-93-89808-15-5.

## REFERENCES


[1] Plastic Waste Management (Issues, Solutions and Case Studies), Swachh Bharat Mission (Urban), Ministry of Housing and Urban Affairs, www.mohua.gov.in, March 2019

[2] Single-Use Plastics: A Roadmap for Sustainability, United Nations Environment Program, 2018

[3] Fact Sheet on plastic waste in India, http://www.teriin.org/event/tericelebrates-world-environment-day-2018.

[4] The Plastic Waste Management Rules, 2016 Published in the Gazette of India, Part-II, Section-3, Sub-section (i), Ministry of Environment, Forest and Climate Change, Govt. of India.

[5] Discussion paper: Challenges and opportunities - plastic waste management In India, TERI with MOEFCC and UNEP. This Discussion Paper, released by the Ministry of Environment, Forests and Climate Change on World Environment day 2018.

[6] Pratibha Singh and a talk on plastic became life on Lok Sabha TVviahttps://www.youtube.com/watch?v=TGbqkDVMsBs&t=29s.

[7] Alexander Paul, 'New York City Tries to Ban Styrofoam: It's Déjà Vu All Over Again'. Huffington Post, 25 October. https://www.huffingtonpost.com/entry/new-york-city-tries-to-ban-styrofoam-its-%C3%A9j%C3%A0-vu_us_59f08cefe4b02ace788ca8ea, 2017.

[8] 'Costa Rica wants to become world's first country to eliminate single-use plastics', EcoWatch, 7 August. https://www.ecowatch.com/costa-rica-ban-single-use-plastics-2470233949.html, 2017b.
[9] Convery, Frank, Simon McDonnell, and Susana Ferreira, "The most popular tax in Europe? Lessons from the Irish plastic bags levy", Environmental Resource Economy, vol. 38, pp 1-11, 2007.
[10] Dikgang, Johane, Anthony Leiman and Martine Visser, "Analysis of the plastic-bag levy in South Africa", Resources, Conservation and Recycling, Vol. 66, pp 59-65, 2012a.
[11] Earth Policy Institute (2014). http://www.earth-policy.org/press_room/C68/ plastic_bags_fact_sheet
[12] Hasson, Retviva, Anthony Leiman, and Martine Visser, "The economics of plastic bag legislation in South Africa", South African Journal of Economics, vol. 75, no.1, 2007.
[13] 'Non-Biodegradable Garbage (Control) Act, 1995', No. STE-A(3)-4/2003, Himachal Pradesh, India,1995, p. 819. http://www.hpforest.nic.in/files/THE%20HIMACHAL%20PRADESH%20NON-BIODEGRADABLE%20GARBAGE.pdf
[14] 'Notification on Plastic Waste Management Rules', Gazette of India, Part-II, Section-3, Sub-section (i), March 18', Ministry of Environment, Forest and Climate Change, India, 2016 http://www.indiaenvironmentportal.org.in/files/file/ Plastic%20Waste%20Management%20Rules%20 2016.pdf.
[15] 'Plastic Bags', Department of Communications, Climate Action & Environment, Ireland, https:// www.dccae.gov.ie/en-ie/environment/topics/ waste/litter/plastic-bags/Pages/default.aspx.
[16] J.R. Jambeck, A. Andrady, R. Geyer, R. Narayan, M. Perryman, T. Siegler, C. Wilcox and K. Lavender Law , "Plastic waste inputs from land into the ocean", Science, vol 347, p. 768-771, 2015.
[17] "Kenya brings in world's toughest plastic bag ban: four years jail or $40,000 fine" The Guardian, 28 August 2017, https://www.theguardian.com/environment/2017/aug/28/kenya-brings-in-worlds-toughest-plastic-bag-ban-four-years-jail-or-40000-fine.
[18] Viktor Kiprop, "Finally, Kenya effects ban on plastic bags", The East African, 7 September 2017. http:// www.theeastafrican.co.ke/business/Kenya-effects-ban-on-plastic-bags-/2560-4086512-10oy0x4/index. html
[19] Martin Dorey, Founder of the #2minutesolution. "No.More. Plastic." what you can do to make a difference
[20] Marine Conservation Society (Luca Bonaccorsi, Richard Harrington and Clare Fischer). "How to Live Plastic Free, A day in the life of a plastic detox".
[21] 'Mauritius bans the use of plastic bags', 4 January 2016. http://www.govmu.org/English/ News/Pages/Mauritius-bans-the-use-of-plastic-bags.aspx
[22] Sophie Pilgrim, "Smugglers work on the dark side of Rwanda's plastic bag ban", Al JazeeraAmerica, 25 February. http://america.aljazeera.com/articles/2016/2/25/rwanda-plastic-bag-ban.html.
[23] "Plastic bags on the way out in Austria's supermarkets", The Local, January 16, 2017. https://www.thelocal.at/20170116/plastic-bags-on-the-way-out-in-austrias-shops-and-supermarkets.
[24] 'Malawi introduces ban on thin plastic', United Nations Development Programme, 8 September 2015. http://www.mw.undp.org/content/malawi/en/ home/presscenter/articles/2015/09/08/malawi-introduces-ban-on-thin-plastic.html.
[25] 'Burkina Faso endorses law on sustainable development and bans non-biodegradable plastic bags', United Nations Development Programme – United Nations Environment Programme Poverty –Environment Initiative 2015, http://www. unpei.org/latest-news/burkina-faso-endorses-law-on-sustainable-development-and-bans-non-biodegradable-plastic-bags.
[26] 'Selection, design and implementation of economic instruments in the Kenyan solid waste management sector', United Nations Environment Programme 2005, Geneva, Switzerland.
[27] Overview of Plastic Waste Management by CPCB.
[28] Research Study by Dr. R. Vasudevan, Dr. A. Ramalinga Chandra Sekar and Mr B. Sundarakannan from Thiagarajar College of Engineering (TCE), Madurai on 'Plastone Block – A Precast Structure Made With Waste Plastics And Stone Aggregate And Its Use In Toilet Construction'
[29] Toolkit on Plastic Waste Management Rules 2016
[30] Plastic Waste Management Rules, 2016
[31] Plastic Waste Management (Amendment ) Rules, 2018
[32] https://saferenvironment.wordpress.com/2008/10/06/plastic-wastes-%E2%80%93-reduce-reuse-and-recycle-of-plastics-are-essential-to-make-environment-greener-and-safer/
[33] UNIDO 2018 Report by CIPET on 'Recycling of Plastics in Indian Perspective' by Dr. Smita Mohanty.
[34] UN Environment: Single Use Plastics- A Roadmap for Sustainability.

**Pratibha Singh**, an Environmental Engineer by education mainly working on the mission 'Beat Plastic Pollution'. Engaged in inculcating environmental awareness in the students/people of different streams/backgrounds and make holistic development of students/people and their capacity building through socially committed, intellectually inclined, culturally delivered and future oriented paradigm of learning.

She is almost completing her Ph.D. in Environmental Science and was UPTU MTech topper in Environmental Engineering. Graduated in Botany, Chemistry & Education and post graduate in Environmental Science & Chemistry as well. Obtained PG Diploma in Environment Health and Safety Management from Indian Institute of Environment Health & Safety Management, New Delhi

She has vast experience as faculty of Environment & Ecology in an engineering and management college of a reputed group of professional institution and industry experience of Environmental Impact Assessment. Published and presented many technical and research papers and contributed chapters in books.

Participated as environmental expert in TV programs on Environment and Plastic Pollution. Authored book *Paryavaran, Pradushan aur Ham***.** Working as All India General Secretary of the Ssheetal Prathom Aahaar Society**.**

**Om Pal Singh**, is Assistant Director, Bharat Sanchar Nigam Limited. Holds honours degree in Electronics & Communication Engineering; completed MBA in Human Resource Management and is an International Trainer.

Presently, working as Sr. Trainer (Assistant Director) at Advanced Level Telecommunication Training Centre, Ghaziabad for over 15 years. Joined telecom department in 2003 and has experience in telecom of over 15 years. Worked with different technologies in telecom and rich experience of Training/Research & Development in telecom and non-telecom areas including regulation, green telecom technologies etc.

Conducted international training courses in India and Mauritius, Ghana and Nigeria. He has been associated through the Organisations like International Telecom Union, Commonwealth Telecom Organisation, ASEAN etc. Organised ITU-supported program on 'Deployment of Broadband through Next Generation Network', at ALTTC, Ghaziabad in Nov'17. Published paper on 'ICT Regulatory Environment: India and the World Next Generation Technologies & Their Regulations'.