

# A PLASTIC ROAD FROM A GARBAGE PATCH: THE MODERN WORLD OF PLASTICS

**Author:** *Oluwawemimo Oluwagbemiga Ogunmoyela.*

## ABSTRACT

In every industry in the world, over various areas of application, plastics have become one of the most relevant raw materials. They are used in everything from construction pipes and mobile phones to planes, consumer utensils and clothing, as well as being the primary material used for food packaging. Plastics are everywhere these days, and exist in some form in every industry, but when were modern forms of these polymer-derived materials first invented, and why have they become so popular?

The prevalence of plastics has had unintended effects on the environment, as a significant amount of human-caused land and water pollution results from plastic waste while the effects of microplastics have become a global health concern. Despite this, the amount of plastic produced annually is only expected to increase in the future.

In the coastal and riverine regions of Nigeria such as Lagos, ineffective waste control systems and limited recycling procedures mean that many gutters and canals created for water drainage have been filled with plastic waste which impedes water flow, causing floods within communities during rainy seasons.

This study examines the relevance of plastics as a key pillar of the world's economic and manufacturing climate as well as the concerns and problems associated with what has become one of the most important socio-economic challenges facing the world today. More importantly, it also introduces and discusses potential solutions to these problems.

**Keywords:** *plastic; microplastic; pollution; polymer; recycling.*

## 1.2 INTRODUCTION:

What we call plastic refers to a range of thousands of different, mostly synthetic materials made from polymers, which are very large molecules comprised of simpler chemical units called monomers. Polymers exist in different forms in nature and cellulose, silk, cotton, wool, and other naturally occurring materials are comprised of natural polymers.

However, the most popular types of plastic today are the kinds made from synthetic polymers. These plastics are typically based on hydrocarbons and can be derived from natural materials found in nature such as natural gas, oil and plant matter.

While it was in 1907 that the first modern plastic, '**Bakelite**' was invented by **Leo Baekeland** (whom himself coined the term 'plastic'), it wasn't until between the late 1950s and early 1960s that improvements in manufacturing processes brought the costs for plastic production low enough for cheap mass production to be possible.

Plastic was extremely durable, lightweight, transparent, waterproof, resistant to biodegradation, versatile enough that it could be custom made with characteristic preferences manufacturers required, and could even be coloured with pigments. It was a revolutionary creation in every sense of the word.

When it then became cheap enough to be mass-produced, it was universally adopted as no available materials could compete with the advantages it offered and in 1964, 15 million tonnes of plastic was produced. This number grew to about 311 million tonnes in 2014, stands at about 400 million tonnes today and is expected to have doubled by 2034.

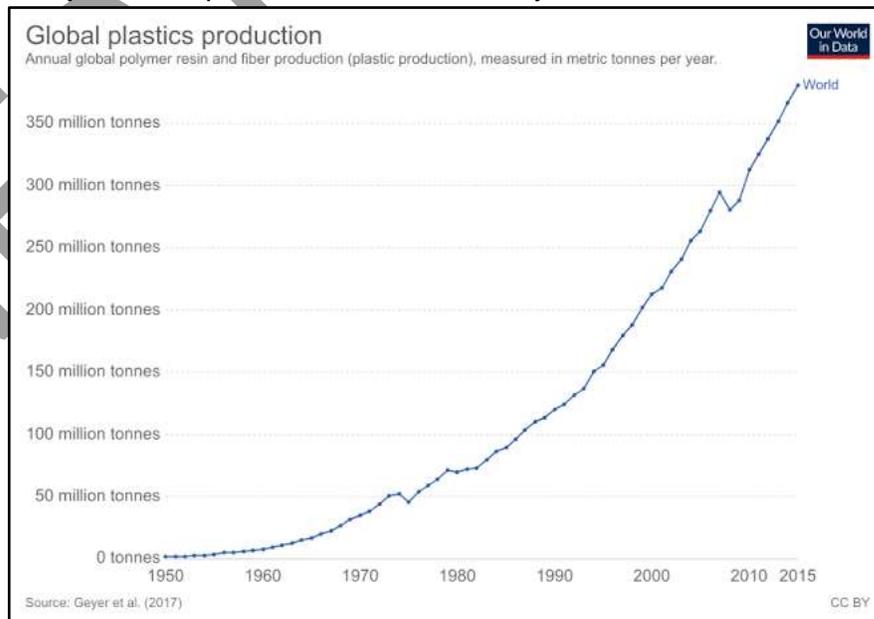


Figure 1: Annual global plastic production in tones.

That plastic is ubiquitous today, should, therefore, be no surprise as even to date, any alternatives would not only be more expensive to use but may cause more greenhouse gas emissions over their lifetimes.

### 1.3 WHAT'S WRONG WITH PLASTICS?

The problems with plastic that weren't foreseen during the early days of its adoption were its cumulative effects on our environment and how that inevitably affects us.

From pollution and global warming to concerns about medical problems associated with microplastics (which are very small plastic fragments less than 5mm in size), plastics have become an important challenge for the world.



Figure 2: A Nigerian woman sorts through plastic bottles at a recycling operation on the outskirts of Lagos.

The durability of plastics means that they are very resistant to natural degradation and decompose very slowly over centuries and some may last for up to a thousand years. Most of the plastic produced 50 years ago are still present in the environment today in different forms.

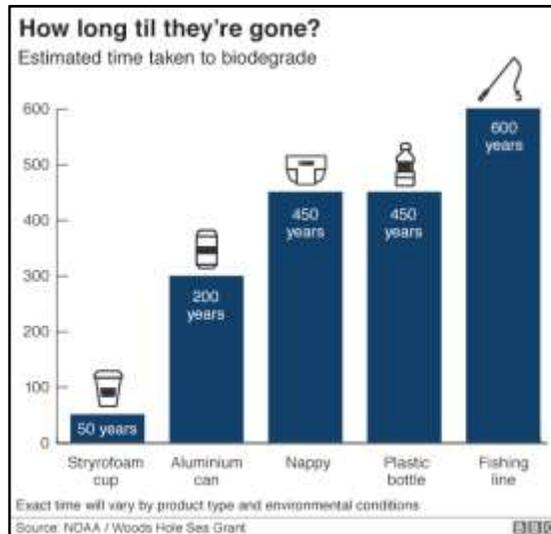


Figure 3: Estimated biodegradation times for some items commonly found as litter.

About half of all plastic produced is designed to be used once and then thrown away. With an average of 400 million tonnes of plastic produced annually, you might be tempted to ask where all the waste plastic goes.

In December 2016, a man walking strolling across a beach in France one morning watched as a yoghurt cup was brought to shore by the waves - not an unusual occurrence these days. What was shocking was that the yoghurt cup was commemorating the 1976 Montréal Olympics in Canada and was still in excellent condition after being carried thousands of kilometres from the waters of Canada. For 40 years, that cup was floating on the surface of the ocean.

On average, about 1 million plastic bottles are bought every minute. Less than half of these recycled after use, while only about 7 percent is retained for further use. The rest of these plastic bottles, about 400,000 on average every minute become waste.

A study by the British Broadcasting Corporation states that of the 8.3 billion tonnes of plastic that has been produced, 6.3 billion tonnes has become plastic waste. Of that, only nine percent has been recycled. The vast majority—79 percent—is left accumulating in landfills or sloughing off in the natural environment as litter.

In Nigeria for instance, while recycling exists in limited areas, the majority of plastic litter clogs up canals and gutters and are partially responsible for temporary floods in low lying communities during rainy seasons.



**Figure 4: A gutter in Southwestern Nigeria that had been recently dredged of plastic waste.**

The effects of massive amounts of these plastics being dumped into the world's oceans have been the creation of garbage patches. These are islands of floating plastic collected at areas where ocean currents interact. The largest of these patches, called The Great Pacific Garbage Patch is an island of floating plastic in the Pacific Ocean spread out over an area about 1.6 million kilometres, which makes it almost twice as large as Nigeria. The amount of plastics in the oceans is rising so quickly that it could outweigh all the fish by 2050.



Figure 5: The Great Pacific Garbage Patch.

These garbage patches threaten aquatic ecosystems as they are full of microplastics which birds and fish consume. In 2015, the majority of seabirds and fish had eaten plastic.



Figure 6: A dead albatross chick found off the coast of the Pacific Ocean with plastic debris in its stomach.

This has led to some concerns regarding some of the chemicals used in the production of plastics. **BPA** (Bisphenol A) for example, makes plastics transparent, but there is also evidence that it interferes with our body's hormonal systems. **DEHP (Bis 2-ethylhexyl phthalate)** makes plastic more flexible, but studies have shown that it may cause cancer. These chemicals do not affect our normal use of plastics, but when getting into the oceans and are broken down into

microplastics by **photocatalytic oxidation** (which is a process by which plastics slowly break down into smaller pieces upon exposure to sunlight), they are eaten by fish or birds. They accumulate in the stomachs of these animals as they cannot be digested, and these chemicals may be absorbed into their bodies. When animals that have experienced this are consumed by people, they may pose a health risk.

In 2018, a sperm whale found washed up on a beach was discovered to have consumed almost 30kg of plastic substances. Experts found plastic bags, as well as nets and ropes in its stomach. These materials blocked its digestive tract and were what led to its death.

## **1.4 CAN WE SOLVE THE PLASTIC PROBLEM?**

Despite the numerous problems and concerns associated with the unregulated use of plastics, the reality is that plastic has too many economic and characteristic advantages for its use to be discontinued. Because of this, proper regulation of plastic usage has become more important than ever.

Scientists around the world are currently working on new types of plastic that would bring less harm to the environment by decomposing more quickly, while some countries have moved towards banning the use of plastics altogether for uses where alternatives are feasible.

Rwanda, for instance, banned single-use plastic bags in 2008, and Rwandan law since prohibits the manufacture, use, importation, and sale of the bags.

Owners of businesses that violate this ban face up to a year in prison, while people caught with plastic bags face stiff fines.



Figure 7: A Public poster in Kigali, the Rwandan capital.

While the Rwandan ban might have seemed harsh at first considering the stiff punishments attached, it seems to have been effective and numerous international organizations have praised the prohibition for helping to clean up the streets of the country, especially the capital city, Kigali, which is now undoubtedly one of the cleanest cities in the world.

Single-use plastics such as plastic bags and straws are materials that can be substituted for environmentally friendly alternatives without negative economic effects and have already been banned in countries like Italy, India, Kenya and Sweden.

Australia has installed filter nets at sections of their water drainage systems that lead to oceans, rivers or lakes. These filters prevent plastics and other pollutants from gaining entry into these aquatic ecosystems.



**Figure 8: Filter nets at canal exits in Australia.**

Despite knowledge of all the problems accompanying widespread use of plastic, a complete plastic ban is unlikely. This is not just because of plastic's advantages but because any alternatives to plastic may cause more harm to the environment in other ways.

For example, a study by the Danish government in 2018 discovered that single use plastic bag costs so little in energy required for production and in CO<sub>2</sub> emissions produced that an equivalent cotton bag would need to be used 7,100 times to have a lower global warming impact.

## **1.5 CAN WASTE PLASTICS STILL BE USEFUL?**

While strict regulations on plastic production and application, as well as more efficient recycling systems, would undoubtedly be helpful, an alternative and convenient solution would be to find useful applications for waste plastic.

Because it exists in such abundance, any useful, environmentally friendly uses would have access to a lot of inexpensive raw materials. After all, if you can't be rid of plastic pollutants, why not use them?

One important application that Nigeria could immensely benefit from would be the use of waste plastic in road construction.

## **1.6 WHAT ARE PLASTIC ROADS? HOW CAN THEY HELP?**

Standard roads are usually made of asphalt concrete, which consists of mineral aggregates and asphalt. Plastic roads however have been made from a plastic-asphalt mixture with treated plastic waste, and even entirely from compressed single-use plastics.

Plastic composite roads have demonstrated superior characteristics to regular asphalt roads such as improved wear resistance and shock absorption.

A Green Zine paper explained that studies have shown that using plastic waste in road construction can lead to roads that last three times more than normal. This would lower transportation and labour costs because roads would need to be fixed less and plastic-made roads have shown excellent resistance to potholes.

**MacRebur**, a company which uses plastic waste to surface roads already has factories operating in the United Kingdom. They explained that a one-kilometre stretch of road made with their composite would use about 684,000 recycled plastic bottles or the equivalent of 1.8 million recycled plastic bags.



Figure 9: A road made from waste plastic by MacRebur in the United Kingdom.

This means they have managed to greatly reduce the amount of bitumen required for road construction while replacing the deficit with cheap, readily available waste plastic and are even creating more superior roads in the process.

In Zwolle, a city a few hundred kilometres west of Amsterdam in the Netherlands, a plastic road prototype was constructed using only recycled single-use plastic and trialed in 2016. For over a year, cars and trucks used this road without any difficulty.

The material used for the construction of this road (unceremonially referred to as the '**PlasticRoad**'), was conceived by **KWS (Koninklijke VolkerWessels)**, one of the largest road construction companies in the Netherlands, and is a result of a partnership with **Wavin**, a leader in recycled plastic pipe systems, and oil and gas company **Total**.

PlasticRoad has been made from recycled ocean plastics and made into prefabricated road parts of determined lengths in a factory and can then be installed in pieces directly into prepared paths. Not only would this greatly reduce the time required to for road construction, but it would also make potential repairs a convenience as damaged road segments can simply be unlatched and replaced.

Wavin says that PlasticRoad:

- Comes prefabricated with hollow space for drainage pipes, cabling and floodwater attenuation.
- Is 70% faster to install than traditional road surfaces?
- Is expected to last 3 times longer than asphalt paved roads.
- About halves construction costs.

Plastic roads have already been trialed and used in varying forms in Ghana, The United Kingdom, USA, Indonesia and the Netherlands. While the benefits about reducing pollution are obvious, the potential applications of this technology are more important because of Nigeria's history with roads.

A World Bank compilation indicated that only about 15% of Nigerian roads are paved. A significant portion of this 15% however, consists of paved roads that are already in poor conditions.

Poor roads impede in-state and inter-state transportation and can turn highways into death traps under low lighting conditions like during nighttime.

Infrastructural development is a key component of economic growth. And with the argument overwhelmingly in favour of plastic roads, it would be beneficial for governments to commit efforts to research to perfect potential methods of adaptation of this technology.

## **1.7 CONCLUSION:**

Because plastic manufacturing levels are currently unsustainable for the long term health of the Earth's ecosystems, adequate regulations and sanctions on its production and usage are required.

Also, perfecting potential applications for the plastic waste that already exists in abundance would undoubtedly go some way towards addressing what has become a very important problem.

If people can make cheaper, stronger roads that can be constructed more quickly and are even easier to repair, while helping to alleviate a pollution epidemic, then much progress would have been made in pollution management for Nigeria and the world at large.

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