

Unpredictable Plastics

How the production and use of plastic is a great example of unintended consequences in sustainability.

Unintended consequences are just that, the outcomes or result of an action that is unpredictable and unavoidable, beneficial or otherwise. The impacts of these outcomes are imperceptible and occasionally catastrophic. Situations like these arise due to the chaotic nature of a system, and this is no truer than in the environmental science and sustainability.

Plastics have been one of the greatest achievements of mankind, the ability to artificially manufacture materials that do not exist naturally or modified from raw materials by simple processing. Plastics are one of the most versatile materials we have, have led to rapid technological advancement and now exist in every part of our lives, from automotive transport, electronics, clothing and household items, plastics surround us and have become the undeniable foundation of our comfort and convenience. In every sense of the notion, plastics have drastically improved our quality of life, but that has led to the degradation of our environmental systems and threaten our health.

Plastics

Plastics are polymers, complex molecules made of hundred to millions of smaller repeating units, conveniently called monomers. They are combined in an infinite number of configurations and lengths through a process called polymerisation. Polymers are found naturally in the environment, from the cell walls of plants and carbohydrates, to our hair and DNA, polymers play a key role in our natural environment. However, in 1907, Leo Baekeland artificially replicated polymerisation and invented the world's first fully synthetic plastic called Bakelite (Clegg, 2014). Bakelite was a flexible, yet firm plastics, used in electronics and automotive throughout World War I, but by the late 1940's, newer materials superseded Bakelite as understanding and manipulation of synthetic polymerisation and the global demand for plastics rapidly increased and still does today (Meikle, 1995).

Traditionally, plastics are made petrochemically from the polymerisation of crude oil. The hydrocarbon molecules ethylene and propylene prominent in crude oil are

wildly available, easily stored and easily manipulated to achieve polymerisation. The diverse range of configurations and lengths achievable by this method is responsible for the range of physical and chemical properties, malleability and uniquely plasticity, the quality associated with plastics of being easily shaped or moulded. Today, plastics can be made from many materials, including cellulose, coal, natural gas and even salt.

The Role of Consumerism in Plastic Production and Waste Trends

Plastics have extraordinary traits, they are lightweight, durable and can be manipulated into any shape. They are also easily mass-produced, inexpensive and their raw materials are vastly available, as a result, plastic use surpassed general material uses and became disposable trash. Specifically, single-use plastics (such as straws, cups, shopping bags and packaging) which make up 35.9% of primary plastic production which, globally, has totalled 7.82 billion tonnes of plastic waste has been produced since its invention (Geyer et al., 2017). The vast majority of these products were made from high- and low-density polyethylene, the most available plastic in the world, a malleable and durable thermoplastic that takes between 20 and 500 years to decompose naturally. Fortunately, both high- and low-density polyethylene are readily recyclable the only problem with this is that plastic waste infrastructure and plastic recycling and collection is grossly mismanaged, as only 9% of plastics are recycled (O'Farrel, 2019), 88% is collected and disposed of in a landfill or incinerated and 3% of global plastic waste ends up in our oceans (Jambeck et al., 2015).

The pathway by which plastic enters the world's oceans

Our World
in Data

Estimates of global plastics entering the oceans from land-based sources in 2010 based on the pathway from primary production through to marine plastic inputs.

Global primary plastic production:
270 million tonnes per year

Global plastic waste:
275 million tonnes per year

It can exceed primary production in a given year since it can incorporate production from previous years.

Coastal plastic waste:
99.5 million tonnes per

This is the total of plastic waste generated by all populations within 50 kilometres of a coastline (therefore at risk of entering the ocean).

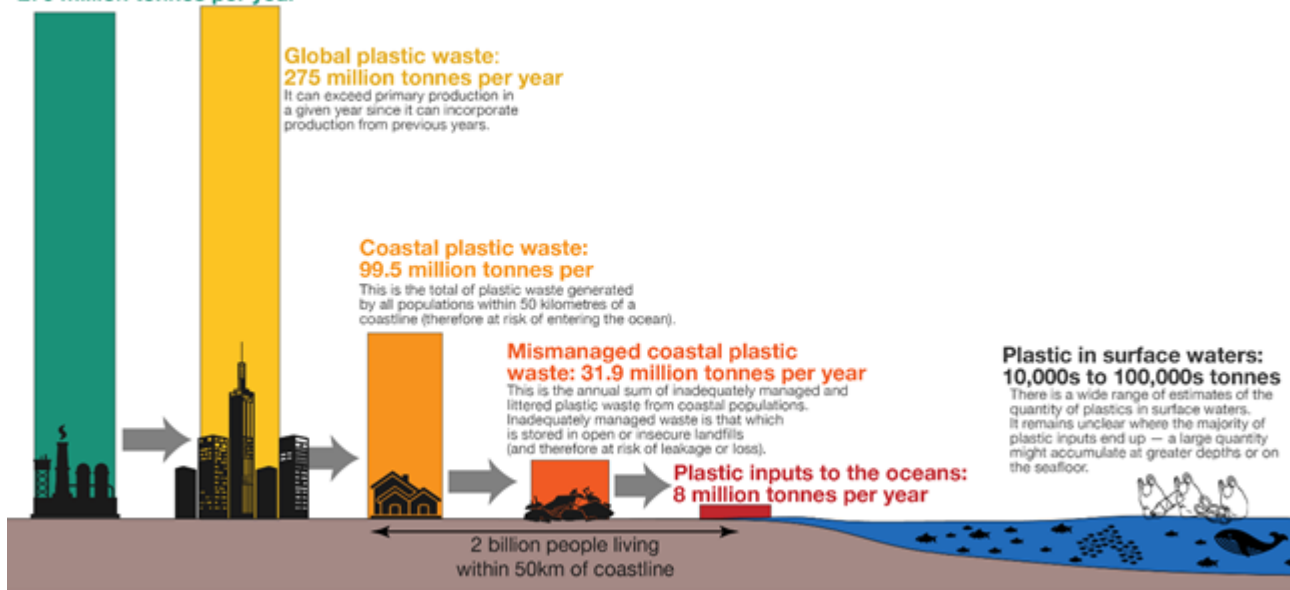
Mismanaged coastal plastic waste: 31.9 million tonnes per year

This is the annual sum of inadequately managed and littered plastic waste from coastal populations. Inadequately managed waste is that which is stored in open or insecure landfills (and therefore at risk of leakage or loss).

Plastic inputs to the oceans:
8 million tonnes per year

Plastic in surface waters:
10,000s to 100,000s tonnes

There is a wide range of estimates of the quantity of plastics in surface waters. It remains unclear where the majority of plastic inputs end up — a large quantity might accumulate at greater depths or on the seafloor.



Source: based on Jambeck et al. (2015) and Eriksen et al. (2014). Icon graphics from Noun Project.

Data is based on global estimates from Jambeck et al. (2015) based on plastic waste generation rates, coastal population sizes, and waste management practices by country.

This is a visualization from [OurWorldinData.org](https://www.ourworldindata.org), where you will find data and research on how the world is changing.

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The Missing Plastic Problem

The majority of plastic wastes are less dense than water and should float on the oceans surface. This is supported by the existence of the Great Pacific Garbage Patch, a floating patch of anthropogenic waste (over 99.99% plastics) that spans 1.6 million square kilometres (Lebreton et al., 2018).

However, of the 8 million tonnes of plastic waste that is recorded to have entered the ocean the best estimates and measurement of surface plastic are only 250,000 tonnes (Eriksen, 2018). This discrepancy, or “Missing Plastic” is often justified by the following explanations;

- Inaccurate measurement of plastic production or floating waste volumes that lead to over- or under-estimations of the issue. This is reasonable as finding mass estimates from surface coverage and density distributions is not easy as such as scale; or
- Plastic actually breaks down slower than expected so most of the “missing” plastics has been buried in on shore after being washed up (Lebreton et al., 2019); or
- Significantly, the UV accelerated degradation of plastics, leading to the production and dispersal of “microplastics”, a worryingly popular scientific trend whose existence and impact are largely unknown yet

concerning (Woodall et al., 2014).

Microplastics are immeasurable by standard surveillance methods, they continue to persist for decades, build up in ocean floor sediment and are ingested by organisms (Ceurstemont, 2015). As these organisms move up the food chain so does this plastic in abundance volumes. This process is called bioaccumulation (Nelms, Galloway, Godley, Jarvis, & Lindeque, 2018) and the presence of microplastics have been tracked in a variety of tap water samples, aquatic organisms (including the fish we consume), beer and even household dust, so much so, one of the most common components of commercial plastics, phthalates, are found by measurable amounts in 8 out of 10 babies and nearly all adults (Meeker, Sathyanarayana, & Swan, 2009). Ongoing scientific research is yet to identify severe risks or chemical threats to human life but as this accumulation of plastic in our life begins to rapidly grow, serious efforts need to be taken to ensure that possible threats do not materialise.

The Verdict

Plastics are one of the most valuable and versatile materials ever invented, however, ongoing misuse of this material's abundance, mismanagement of its waste infrastructure and underestimation of its environmental impacts have led to unforeseen and unexpected consequences. The consequences have largely arisen from our commercial and personal greed and may lead to catastrophic impacts on our health and environment. Fortunately, measures are already being taken, consider the:

- Increase in renewable and compostable plastic production made from alternative and biodegradable materials;
- Efforts such as the nationwide plastic bag ban in 2018 that saw the end of single use plastic bags in our supermarkets; or
- The future plastic product ban in Queensland from July of 2012 that includes all cutlery, straw and single-use plastics; and
- Larger international and non-for-profit efforts like The Ocean Cleanup Project.

You can also do your part! The “mismanagement of plastic waste” includes everything from commercial and industrial emissions to littering and poor household waste systems and you can combat this by following the “Three R’s” in

plastics and waste management:

- **Reduce**, your consumption of single-use and commercial plastics, opt for non-plastic solutions or at the very least prefer recyclable and biodegradable options;
- **Reuse**, plastic material as often as possible. This may include investing in reuseable food containers and water bottles, to refilling single use bottles and Ziplock bags; and
- **Recycle**, as much plastic as possible.

10 WAYS TO UNPACKAGE YOUR LIFE!



Tip 1
Bring your own shopping bag.



Tip 2
Reduce the use of plastic bags for produce & bulk items.



Tip 3
Bring your own food container and utensils.



Tip 4
Carry a reusable water bottle.



Tip 5
Pack a waste-free lunch.



Tip 6
Bring your own cup.



Tip 7
Slow down and dine in.



Tip 8
Say no to disposable straws.



Tip 9
Avoid heavily packaged foods.



Tip 10
Share these tips with friends!

For future publication on plastics in our ocean, recycling and international initiatives stay tuned to the [THRIVE Project](#), designed to guide you and the world towards sustainable prosperity. Also, check our recent THRIVE article on the [Ocean Cleanup's Interceptor](#) and their ongoing innovation in scalable and affordable ocean clean up.

Written in collaboration with THRIVE Tribe member Thomas Jackson.

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