

Modeling the life cycle of plastic: from marine debris to the source

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Plastic Lifecycle

The Problem

The overuse of synthetic thermoplastics in modern society is an untenable practice and is severely damaging to the health of various ecosystems around the world and may have unforeseen impacts (beyond the obvious physical obstruction of airways and digestive tracts) on the health of many organisms around the world, including humans. The production of synthetic plastics on an industrial scale has existed for less than 100 years and has already changed the face of much of everyday life. Plastics are easily created and shaped, cheaply produced, and extremely durable compared to many natural materials. While these qualities make plastic ideal for the production of many consumer goods, the durability of plastics mean that goods that are designed for a few minutes of use before they are discarded can last for hundreds of years before they begin to degrade, and the ease of production means that the volume and mass of plastic waste in the world has increased by 160,000% since 1950 and is projected to increase by another 400% in the next 30 years.

ESTIMATED PLASTIC PRODUCTION AND DESTINATIONS

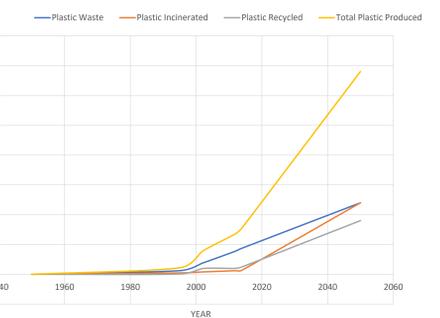


Figure: A graph of the new plastic generated in the last few decades, as well as a projection of the plastic production for the next few decades

Figure: Plastic trash washing up on the beach in County Cork, Ireland, showcasing some of the examples of single use plastic waste

Around 75% of the plastic produced annually leaves its usefulness within one year of being produced. The majority of resin-based plastic products (41%) are used for packaging, which typically has a use span of a few days. Only around 9% of the plastics produced have been recycled. Around 12% have been incinerated, which removes the physical burden of the plastic on the environment but potentially releases harmful chemicals that lay benign as additives within the structure of the plastic. This leaves around 79% of plastic produced ending its life as waste in landfills or in the environment.

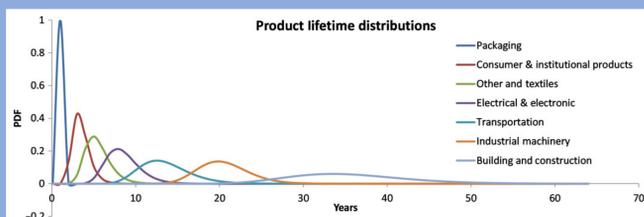


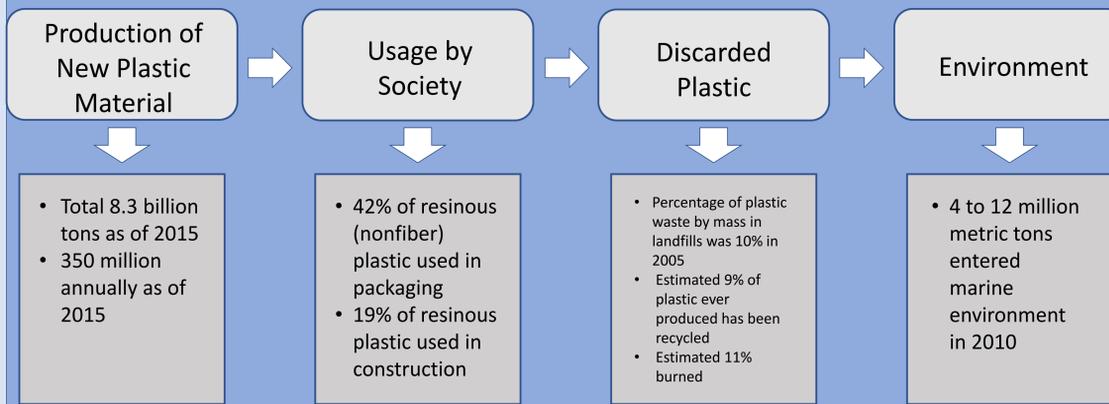
Figure: A graph of the average life cycle of plastics based on its usage

The Project

The goal of this project will be to use modeling to discover the origin of plastic marine debris by tracking it back to its source. This information will allow policymakers to better inform decisions on how to arrest the flow of plastic into the marine environment so that any efforts to remove the mass of plastic in the ocean will not be hampered by fluxes that outweigh removal efforts. By combining percentages of plastic produced by type with quantities of plastic produced, populations in coastal areas, properties of plastic such as density, geological maps of watersheds, and ocean circulation models, this project will be able to determine the ultimate origins of various sinks of marine plastic debris, and identify potential hot spots of plastic flux where policymakers will best be able to employ mitigation efforts.

Modeling

Conceptual Model of Plastic Life Cycle



A simplified conceptual model of the life cycle of plastic from production to pollution.

Plastic Usage Pathways

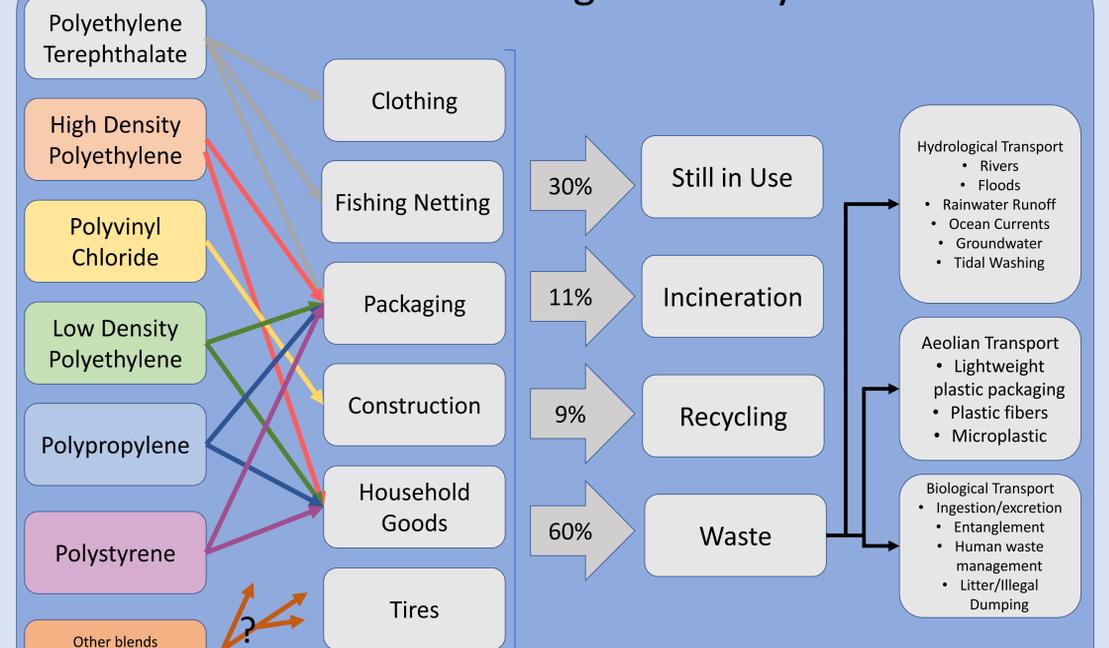


Figure: A conceptual model illustrating the types of plastic, their potential use, their destination with percentages, and the various transport methods by which they enter and traverse the environment

Modeling Approach

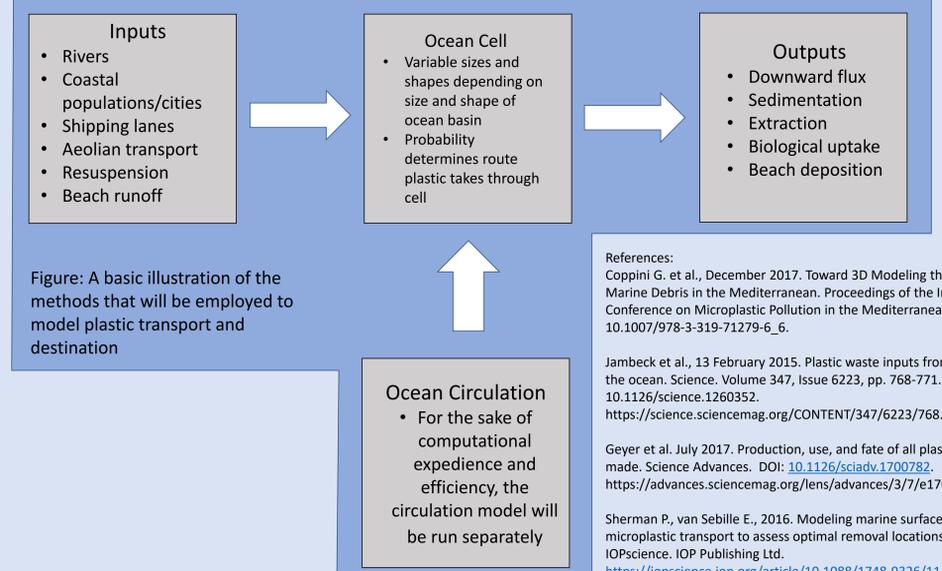


Figure: A basic illustration of the methods that will be employed to model plastic transport and destination

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