Chapter 4
The Presence and Impacts of Microplastics in Drinking Water: Their Occurrence, Detection, Removal, and Implications

Alice Liddell
Queen's University Belfast, UK

Marco Geron
Queen's University Belfast, UK

Eoin Cunningham
Queen's University Belfast, UK

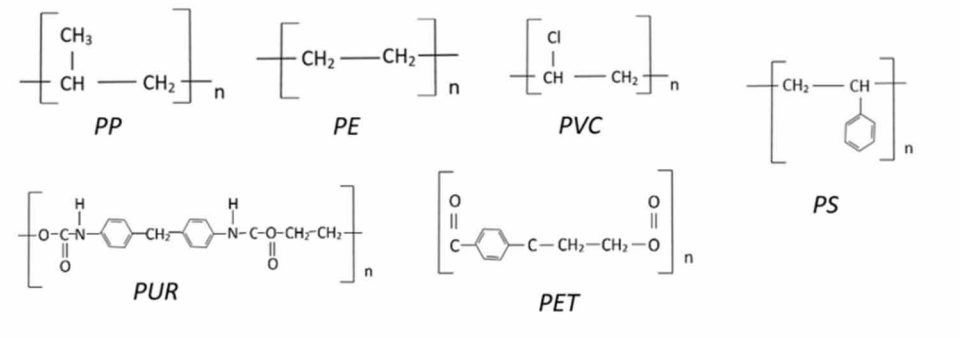
Beatrice M. Smyth
https://orcid.org/0000-0002-2983-2404
Queen's University Belfast, UK

ABSTRACT

This chapter discusses the issues of plastic, primarily microplastic pollution in freshwater and drinking water, with a focus on developing nations. Microplastics, generally defined as plastic particles with a size less than 5 mm, are beginning to gain attention as an emerging contaminant of concern. Whilst testing has recently begun on the contamination of freshwater and treated drinking water by microplastics in a number of developed regions, literature regarding microplastic pollution in the water of less economically developed countries is lacking. Microplastics pose a threat to human health, and therefore, it is important that cost-effective methods for the testing, detection, and removal of these plastic items from drinking water globally is considered with a higher level of urgency. It is argued that by achieving the aims laid out by the Sustainable Development Goals, particularly Goals 6 and 12, the threats from microplastic pollution will subside.

DOI: 10.4018/978-1-7998-9190-1.ch004

Figure 1. Chemical structure of high demand plastics
PP: polypropylene, PE: polyethylene, PVC: polyvinylchloride, PUR: polyurethane, PET: polyethylene terephthalate, PS: polystyrene



INTRODUCTION

The attractiveness of plastic, defined by its mechanical properties, inexpensiveness, and relative ease of production, has led to a continual rise in its manufacture, with an increase of 9 Mt plastic produced between 2018 and 2019 alone (Plastics Europe, 2020). The popularity of plastic items follows from the development of the first fossil fuel derived plastic, Bakelite, in 1907, encouraging the rapid development of similar plastics in the following years (polyester, nylon, polythene etc.) (Wagner & Lambert, 2018). The durability of plastic products, albeit seen as an attractive attribute to producers across all sectors, has recently led to concerns regarding plastic accumulation in the environment. Out of all the plastic ever produced, it is estimated that only 9% has been recycled, with 60% either being sent to landfill or released directly into the natural environment (Geyer et al., 2017).

Plastics are a branch of synthetic polymers, which are monomers that are specifically arranged in repeating units to deliver desirable properties. Polymers are long chains of molecules (monomers) and can be synthetic or naturally occurring. Polymers are derived from various hydrocarbon and petroleum materials, usually have a high molecular weight, and are connected by strong chemical bonds. Thermoplastics (which may be moulded at elevated temperatures) and thermosets (irreversibly hardened by curing) are the two main groups of plastics. Typical plastics (Figure 1) are made up of carbon and hydrogen with an extension to nitrogen, oxygen and chlorine groups.

The irresponsible disposal of plastic items is often evident adjacent to, or within, rivers and lakes. The result of this is the accumulation of plastic in freshwater waterways, either by direct dumping or their migration to water bodies through water run-off from the land. Currently when discussing the issue of plastic pollution in aquatic environments, the focus is on the quantity of plastic in the marine environment, with freshwater plastic pollution largely overlooked and understudied. A study published in 2021 (Meijer et al., 2021) showed that more than one thousand rivers were responsible for 80% of global riverine plastic emissions to the ocean, indicating the widespread contamination of rivers on a worldwide scale. Asian rivers were the most significant contributors to plastic pollution in the oceans, particularly those in areas with high population densities (Meijer et al., 2021). Although Asia has experienced rapid growth in terms of human development, the Asia and Pacific region accounts for almost half of the multidimensional poor worldwide, with South Asia home to more than 41% of the total (Conceição,