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Amazonia: the new frontier for plastic pollution

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Brazil's Amazon region is currently experiencing increasing deforestation as well as hydropower development, mining, and other environmental impacts (Fearnside 2016). Now an insidious new threat has emerged – discarded plastic.

Figure 1. Dense carpet of garbage floating in one of the poorest regions of the city of Manaus (Middle Amazon basin, Brazil). Credit: B Kelly

Brazilian government policies to promote economic growth in Amazonia triggered an increase in the region's population from 1.4 to 15.9 million inhabitants in less than a century (IBGE 2018). These people are distributed among more than 450 municipalities (counties), 70% of which lack urban planning and efficient waste management (Becker 2005). Few communities have adequate landfills, and much of their trash ends up in rivers. Plastic comprises 15.7% of the waste produced in Amazonia, a percentage more than double the national average (MMA 2015). It has been estimated that each person in Brazil generates more than 1 kg of solid waste every day (Jambeck et al. 2015), and 19.4% of this waste is not collected (ABRELPE 2015). Based on data from the latest solid-waste management statistics for the Amazon region (MMA 2015), the population census

estimates (IBGE 2018) and literature (Jambeck et al. 2015), we conservatively estimate that the amount of plastic being discarded into the Brazil's Amazonian environment each year is 182,085 metric tons. Even though an unknown fraction of this mismanaged plastic waste is retained within the river system (e.g., trapped in the flooded forest), our study provides a new estimate of annual plastic waste transport by the Amazon River to the Atlantic Ocean that is five times higher than previously estimated by Lebreton et al. (2017). This result ranks the Amazon as the world's second most polluted river in terms of plastic, only behind Yangtze River in China (Lebreton et al. 2017). The Amazon Basin, which covers 4.7% of the world's land area and represents only 0.4% of the global population, contributed 10% of the world's plastic emission to the oceans. The Amazon River, with the world's largest freshwater discharge-- ranging between ~80,000 m^3/s (in October–November) and ~250,000 m^3/s (in May–June) -- produces a 1.3×10^6 km^2 plume extending into the Atlantic Ocean for more than 1500 km (Coles et al. 2013). The Amazon plume carries with it large amounts of sediments and nutrients, as well as plastic debris. Driven by seasonal winds and currents, the plume can flow northward into the Caribbean and eastward toward the subtropical gyre and toward Africa. Plastic loads from the Amazon Basin can therefore impact much of Western Atlantic Ocean and requires immediate international attention.

With more than 80,000 km of navigable waters, the human occupation in the Amazon is concentrated along the rivers. From the largest cities, such as Manaus and Belém, to the smallest and most remote indigenous villages, the region's torrential rains coupled with increasingly frequent and severe floods wash plastic waste into Amazonian streams and rivers.

Our preliminary surveys in the Amazon estuary have revealed accumulations of solid waste range from 27 to 113 items/m of vegetated bank, of which 96% is plastic, predominantly disposable bottles and shopping bags. The documented densities are comparable to those described for wind-exposed mangroves on the Caribbean island of Bonaire (Debrot et al. 2013).

This mountain of plastic waste, much of it trapped within flooded forests, eventually degrades into microplastics that can be incorporated into the soil and/or carried back into the water, thus posing a new threat to the Amazonian biota. Recent studies in the lower Xingu River and the Amazon estuary revealed microplastic particles in the digestive tracts of 13 freshwater and 14 marine fishes, including 20 species commonly consumed by humans (Andrade et al. 2019; Pegado et al. 2018). Microplastics ingested by fish may be transported to muscle or other tissues where the plastic particles may be retained for the entire lifespan of the fish (Karami et al. 2017). The effects of human consumption of microplastics are largely unknown, but evidence of immunotoxic responses has been reported (Seltenrich 2015). In addition, microplastics may have toxic or endocrine effects due to the presence of polymers that often contain plastic additives and/or chemical pollutants adhering to plastic particles, including persistent organic pollutants (POPs) (Rochman et al. 2015). This may represent a public-health concern in the Amazon region, which has the world's highest per-capita fish consumption (Isaac et al. 2015).

Dumping trash, including plastics, into rivers in the Amazon Basin results from poor public policies and general lack of environmental awareness. There is an urgent need for environmental education, investments by state and municipal governments in sanitary and waste treatment infrastructure, reduction of single-use items that are not necessary for the local people, as well as research on types of microplastics in the environment and their bioaccumulation and toxicity. Residents of Amazonia can try to influence their state and municipality governments to address pollution by plastics. However, federal influence is essential to reach many of these far-flung decision points. Federal influence is substantial because state and municipal governments are heavily dependent on financial transfers from the federal government. Increased federal regulation is not likely at present (Fearnside 2018).

Consequences of continued failure to address plastic pollution are far-reaching, given that much of this plastic eventually reaches the Atlantic Ocean. The plastic-pollution problem has been documented and well publicized for the marine realm, as well as for rivers in Asia. New evidence for the magnitude of this problem in the vast Amazon Basin makes it clear that we confront a complex global challenge.

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