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Occurrence, potential sources and ecological risk estimation of microplastic towards coastal and estuarine zones in Malaysia

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ABSTRACT

Extensive global plastic production has led to microplastic (MP) pollution of marine ecosystems. This study analysed the abundance of MPs in the surface water of tropical coastal and estuarine zones in Malaysia affected by rapid urbanisation and intense human activity. It also estimated the risk posed by MPs to the marine environment. Mean MP abundance ranged from 2.10 to 6.80 particles/L. Fourier-transform infrared spectroscopic analysis found that the MP polymers were dominated by cellophane (54%), followed by polyester (33%) and polyethylene (2%). The risk posed by MPs was estimated with the risk quotient (RQ) method which found no potential ecological risk to both coastal and estuarine areas (RQ < 1). This study will serve as a baseline for future monitoring of MP pollution of marine water to assess the impact of heavily urbanised coastal and estuarine zones.

The rise in plastic pollution around the world warns of the possibility that these pollutants may persist in the environment and adversely affect ecosystems and human health. The total plastic production is currently 360 million metric tonnes, with the waste being recycled, incinerated, or deposited in landfills and the environment (Plastic Europe, 2018). The global plastic waste reached 60–90 million tonnes in 2015 and is projected to increase up to 155–265 million tonnes by 2060 (Lebreton and Andrady, 2019). The main concern about the fate of plastic waste is the formation of microplastics (MPs) from either primary plastic or secondary plastic. Various MP shapes are known. Fibres are regarded as one the most common MP shapes identified in marine ecosystems due to their prevalence and generation by human activities (Desforges et al., 2014; Zhu et al., 2019a, 2019b; Zhang et al., 2020a: Zaki et al., 2021). Laundry washing, fishing activities, and effluent from waste-water treatment plants are among the main origins of MP fibres released into marine ecosystems (Zhao et al., 2015; Xu et al., 2021). Although MPs predominantly originated in land-based areas, they are eventually transported and loaded into marine ecosystems (Kershaw and Rochman, 2015). Plastic food packaging, cosmetic products, personal hygiene, and sanitary products are among the sources of MPs that can be introduced into the marine ecosystem (Fadare et al., 2020; Briain et al., 2020). Microbeads from the personal care and cosmetic products that always had an intensive demand from consumers, are not efficiently removed from treated wastewater treatment and eventually released into the aquatic environment (Xanthos and Walker, 2017; Guerranti et al., 2019). Storm and surface runoff, atmospheric emission, and wind deposition may cause MPs originating from industrial activities and urbanisation to enter river water bodies (Constant et al., 2020; de Jesus Piñon-Colin et al., 2020; Wang et al., 2020). Rivers account for 80% of the enormous amount of mismanaged plastic waste loaded into the marine environment, with an estimated annual release of around 0.8–2.7 million metric tonnes (Meijer et al., 2021). Both river discharge and population density are regarded as influential factors in regression models of MP input from rivers into marine ecosystems, with R^2 up to 0.80 (Weiss et al., 2021). The enormous amount of MPs loaded into the marine ecosystem is mainly influenced by seasonal deposition and the density of the nearest urban population (Mai et al., 2019).

The occurrences of MPs in various marine compartment matrices – the water column (Frias et al., 2020; Jiang et al., 2020), sediment (Zhang et al., 2020a; Khoironi et al., 2020), and aquatic organisms (Ding et al.,

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