Migration and aggregation of foamed plastic debris in the urban river of Mongolia

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Foamed plastic material is one of the most commonly produced and consumed anthropogenic products in the world. An extensive use of foamed plastic materials produces their debris followed by scattering of these plastic waste as marine and freshwater debris. Their transport by rivers accompanied by degradation and fragmentation of the plastic foams in the river environment is considered as the important processes in order to understand their distribution and fate. Regarding to the various processes affecting to the migration of environmental plastics, current study aimed to investigate the distribution, degradation, and fragmentation of foamed plastic debris and their potential to form plastic aggregates in the urban river environment in Mongolia. Foamed debris particularly polystyrene foams (PSFs) are collected from the six sampling sites along the shore of Tuul River in Ulaanbaatar, capital of Mongolia. The triplicate quadrats with 100 m^2 were set on the shore and collected all visible PSF samples. In terms of chemical structural properties, PSF samples and adhered microplastics (MPs) were evaluated using a digital microscope and a micro-Fourier transform infrared (FTIR) spectroscopy after the separation of the aggregates.

Various sized PSF particles are recorded with an average of 741 pieces in the transect. Micro-sized PSF which has <5mm length was the dominant piece of plastics at all sites in Tuul River. This study adopted the carbonyl index (CI) to figure out surface oxidation of PSFs through photodegradation. The CI of PSFs ranging between 0.00 and 1.09 indicates diverse stages of photooxidation status in the environment. Furthermore, the linear relationships between mega- and macro-sized ($p < 0.01$ and $r^2 = 0.80$), macro- and meso-sized ($p < 0.01$ and $r^2 = 0.94$), and meso- and micro-sized ($p < 0.01$ and $r^2 = 0.52$) PSFs were a proof of on-site fragmentation at the field. The results of predominance of micro-sized PSFs illustrate that solar radiation and freeze-thaw cycles are probably the major reason of degradation and fragmentation of PSFs. The abundance of adhered MPs which extracted from the surface of PSFs varied from 5 to 141 items on a piece of PSF. The aggregates of PSFs and MPs were common status of PSFs based on surface morphological changes of PSFs in the environment.

PSFs actively interact with a variety of secondary sourced MPs and travel together. Regarding migration and aggregation, plastic items have the potential to aggregate with other plastic particles and contaminants, and hotspots were determined in the downstream of the river. More detail mechanisms, the interaction between plastic-plastic aggregates and effects from hydrodynamic processes are necessary to focus on further research in the river environment.

Keywords: Foamed plastic, Tuul River, Mongolia, Degradation, Aggregates, Adhered microplastics

