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*Editorial corner – a personal view*

# Environmental PET litter is a resource not to be wasted

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Nowadays, most people have heard of the enormous garbage patches floating on the ocean's surface. However, these patches do not form a continuous layer of waste. Instead, they are vast regions with a higher-than-average concentration of plastic debris (typically around 10 kilograms per square kilometre) dispersed across millions of square kilometres (https://doi.org/10.1038/s41598-018-22939-w).
Most of this waste consists of tiny microplastics suspended just below the ocean surface, creating what scientists describe as 'plastic smog' rather than a visible floating island. These patches are formed by circulating ocean currents but represent only around 15% of all marine plastic pollution. Approximately 70% of household and industrial plastic waste that enters the oceans sinks to the seabed, while another portion is washed ashore and accumulates along coastlines (https://doi.org/10.3390/su16125040). Current research suggests that nearly 80% of marine plastic pollution originates from land-based sources, with rivers transporting an estimated 0.8 to 2.7 million tonnes of plastic waste into the oceans annually (https://doi.org/10.1080/00908328409545757, https://doi.org/10.1126/sciadv.aaz5803). A considerable proportion of this waste comes from illegal landfills located in river floodplains, where the waterflow can carry the debris downstream and eventually into the seas. This phenomenon may cause multiple environmental risks. Foreign substances disturb native wildlife and disrupt local ecosystems, threatening biodiversity and the balance of aquatic habitats (https://doi.org/10.1002/wat2.1398).
A substantial portion of the plastic waste carried by water is composed of packaging materials, including poly(ethylene terephthalate) (PET) bottles. These plastics can remain stranded on coastlines for years until high tides or storms transport them further along their journey. According to reports from the European Union (https://doi.org/10.1007/s12237-025-01497-1), approximately 80–85% of beach litter is plastic, with nearly half consisting of single-use items (https://doi.org/10.2495/EI-V5-N2-105-115). Existing studies have shown that plastic products left in natural environments undergo degradation due to thermal, photochemical, and hydrolytic effects, and these processes start nearly immediately upon exposure (https://doi.org/10.1186/s43591-022-00042-2, https://doi.org/10.1016/j.polymdegradstab.2021.109794), leading to the gradual fragmentation of plastics into micro- and nanoplastics that can persist in ecosystems for decades. The most severe material breakdown typically occurs when both light and moisture are present (https://doi.org/ 10.1016/j.wasman.2020.09.029), highlighting the critical importance of early-stage waste collection in aquatic environments. Numerous international initiatives and non-governmental organizations are actively engaged in improving the health of water systems. Among them is The Ocean Cleanup (https://doi.org/10.5194/oos2025-1155), a global project focused on developing and deploying technologies to remove plastic from oceans and reduce input from rivers. One of their key innovations, the Interceptor Original, is the world's first scalable solution designed to prevent river

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debris from entering the ocean (https://doi.org/10.1016/j.clwas.2025.100262). The Plastic Cup Society (https://doi.org/10.3390/su16125040) is a prominent civil initiative combatting riverine plastic pollution, with a special emphasis on the Tisza River, a major waterway in Eastern Europe.

Since 2016, the Plastic Cup Society has monitored the composition of litter in the Tisza and found that plastic waste accounts for approximately 15–37% by weight. Notably, PET bottles for single-use beverages constitute the largest fraction. Data from the Felső-Tisza Water Treatment Administration indicates that flood events in the region can carry up to 500 plastic bottles per minute. This recurring phenomenon, which occurs multiple times a year, has been termed a 'plastic flood'. Fortunately, PET bottles are visually easy to recognize and can be relatively easily separated from other litter by volunteers, making targeted collection efforts feasible and effective. In natural areas like floodplains and riverbanks, these bottles are among the most prevalent plastic items. Volunteer teams remove an average of 12.4 tonnes of PET waste annually from the Tisza catchment alone (https://doi.org/10.1038/s41598-025-94925-y).

In contrast to oceanic waste, plastic collected from rivers is less degraded and easier to recover, making river cleanup efforts both more efficient and more practical (https://doi.org/10.3390/w16020248). Marine plastic undergoes more severe degradation due to prolonged exposure to UV radiation, saltwater, and mechanical abrasion. This significantly complicates mechanical recycling and reduces the quality of materials produced. Nevertheless, recent research study has demonstrated that recycling marine PET is technically feasible using common plastic processing techniques such as filament and sheet extrusion, injection moulding, 3D printing, and thermoforming. Although products made from weathered PET exhibit some decline in mechanical and optical properties, such as reduced impact strength and transparency, core properties like stiffness and tensile strength often remain adequate for use (https://doi.org/10.1016/j.wasman.2020.09.029).

Given these differences, the selective collection and recycling of less degraded riverine PET is strongly recommended. Recent studies confirm that even unseparated PET waste collected from rivers can yield recycled materials with reliable mechanical performance. Despite some reduction due to environmental exposure and reprocessing, key properties, such as tensile strength, modulus, and impact resistance, typically decline by less than 10% compared to virgin PET. The most significant reduction is observed in elongation at break, which is highly sensitive to reductions in molecular weight (https://doi.org/10.1038/s41598-025-94925-y). Even so, the performance of recycled PET can be significantly enhanced using standard industry techniques such as toughening or reinforcement, making it suitable for durable, high-performance applications (https://doi.org/10.1016/j.polymdegradstab.2021.109505, https://doi.org/10.1007/s10924-023-02945-4, https://doi.org/10.3390/polym11020233).

Several commercial products already incorporate recycled PET sourced from marine or riverine environments. For example, Adidas manufactures shoes and apparel using Parley Ocean Plastic®, Coca-Cola has released bottles made from ocean-bound plastic under its 'World Without Waste' initiative, and Patagonia incorporates recycled coastal plastic into jackets and fleece products.

Despite the promising technological solutions and the efforts of civil society and environmental professionals, long-term success in tackling plastic pollution ultimately depends on systemic change. Establishing effective waste management systems, improving environmental education, and raising public awareness are critical steps. Until such structural goals are achieved, river cleanup remains a cost-effective and preventive strategy to mitigate marine pollution. Moreover, plastic waste collected from rivers serves as a valuable secondary raw material that can be recycled into useful and sustainable products.