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WASTEWATER TREATMENT PLANTS AS A BARRIER AND SOURCE OF MICROPLASTICS

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Wastewater treatment plants (WWTPs) play a dual role in the environmental fate of microplastics (MPs), acting both as an effective barrier and a significant source of MP emissions to environment[1]. This study reports evidence on MPs dynamics in WWTPs, focusing on treated effluents, sewage sludge, and combined sewer overflows (CSOs). Long-term monitoring data from a full-scale WWTP highlighted that conventional treatment processes can achieve high MP removal efficiencies under dry weather conditions. However, large MP loads are retained in sludge, confirming WWTPs as important sinks of microplastics and raising concerns about their subsequent release through sludge handling and reuse practices[2]. In tis context, the adoption of more advanced treatment technologies, such as membrane bioreactors (MBRs), also encouraged by the new European Directive 2024/3019, can further increase microplastic removal from treated effluents. However, this improvement comes with a trade-off, as a larger fraction of MPs is retained in sewage sludge. Conversely, extreme rainfall events leading to CSO activation substantially alter this mitigation role. CSO discharges were found to contain MP concentrations up to an order of magnitude higher than treated effluents, driven by stormwater runoff, sewer sediment resuspension, and the bypass of treatment units[3]. These findings demonstrate that, although WWTPs effectively reduce continuous MPs emissions from treated wastewater, episodic CSO events represent critical pollution pulses with potentially high ecological relevance, especially in regions increasingly affected by climate-change-driven extreme rainfall. Overall, WWTPs should be considered dynamic systems whose role as barriers or sources of microplastics strongly depends on hydraulic conditions, treatment configuration, and climate. Mitigation strategies should therefore integrate advanced treatment technologies, improved stormwater and sewer management, and long-term monitoring frameworks to adequately control microplastic emissions under both normal and extreme operating conditions.

References

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