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Seasonal Variability in Microplastic Distribution and Associated Ecological Risk in a Semi-Arid Freshwater Ecosystem

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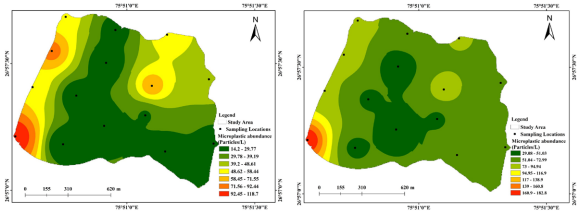
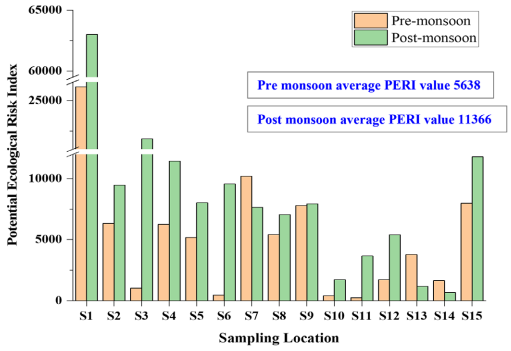
Microplastics have emerged as a prevalent pollutant across diverse environmental matrices. Although their presence has been extensively studied in various ecosystems, semi-arid freshwater ecosystems remain relatively underexplored. This study explored the seasonal variation in the distribution and characteristics of microplastics in water samples collected from Man Sagar Lake, a culturally and ecologically significant semi-arid freshwater lake in northwestern India. The results revealed that the average abundance of microplastics in water samples was significantly lower during the pre-monsoon season (42.93 ± 29.72 particles/L) than the post-monsoon season (70.54 ± 36.53 particles/L). The abundance of microplastics varied significantly between the two seasons at various sample sites ($F = 7.82$, $p < 0.0001$). Most of the microplastics found in the samples from both seasons were less than 500 µm, and the most frequent color was transparent. The most prevalent morphologies of microplastics were fibers and fragments, while polyethylene, polypropylene, and polystyrene were the most prevalent polymer types found in water samples. All of the sampling sites in both seasons showed moderate to high levels of microplastic pollution, according to the Microplastic Contamination Factor and Pollution Load Index (PLI 5.14 to 6.96). Additionally, according to the potential ecological risk index, about 70% of the lake's area is classified as being at very high ecological risk during both seasons. Furthermore, principal component analysis (PCA) revealed distinct seasonal patterns in the origins of microplastics; during the pre-monsoon period, the primary contributors were packaging materials, whereas in the post-monsoon period, urban runoff and wastewater emerged as significant sources. The results of this investigation may assist in formulating region-specific targeted remediation and prevention approaches by identifying areas at high risk and potential contributors to microplastic pollution.



Spatial distribution of MPs abundance during pre-monsoon and post-monsoon season



Potential Ecological Risk Index (PERI) of Man Sagar Lake