Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.26116

Subsurface Transport and Environmental Risks of Microplastic Pollution: Influence of Land Use and Seasonal Hydrological Variability

JASWANT SINGH AND BRIJESH KUMAR YADAV
Indian Institute of Technology Roorkee

Microplastic (MP) contamination is an emerging environmental concern with significant implications for soil health, hydrological processes, and aquatic ecosystems. However, the mechanisms governing MP transport across different land-use types remain inadequately understood [1]. This study systematically investigates the vertical migration and seasonal variability of MPs across diverse land-use settings, including riverbanks, dumpsites, agricultural lands, residential areas, and woodlands. A comprehensive field sampling campaign was conducted during the pre-monsoon (May) and post-monsoon (October) seasons. Soil and sediment samples were collected from five depth intervals (0–20 cm, 20–40 cm, 40–60 cm, 60–80 cm, and 80–100 cm) and analyzed for MP abundance, morphology, size distribution, polymer composition, and environmental risk using density separation, FTIR spectroscopy, and SEM-EDX analysis.

Results indicate that woodlands exhibited the highest vertical transport efficiency due to macropore flow and preferential pathways such as root channels. Monsoonal hydrology played a crucial role in MP redistribution, particularly in riverbanks, where lateral transport dominated over vertical movement. Dumpsites recorded the highest MP concentrations, with surface concentrations decreasing from 39,113 ± 4,750 particles/kg (pre-monsoon) to 30,920 ± 1,712 particles/kg (post-monsoon), while deeper layers (80–100 cm) showed an increase from 8,156 ± 869 particles/kg to 14,926 ± 869 particles/kg post-monsoon, indicating leachate-driven transport. Fragmented MPs dominated all land-use types, accounting for 40% of MPs in riverbanks and 37.73% in dumpsites, whereas fibers were most prevalent in residential areas. Polymer characterization classified all samples under Polymer Hazard Index (PHI) Level V (>1000), signifying high chemical risk across seasons. Principal Component Analysis (PCA) identified MP hotspots and their association with shape and size distributions. These findings underscore the complex interactions between hydrological processes and land-use dynamics in shaping MP fate in soil and aquatic systems. Given the increasing reliance on plastics in agriculture, urban infrastructure, and industry, targeted waste management strategies, stricter regulations, and long-term monitoring are essential to mitigate the environmental risks associated with MP contamination.

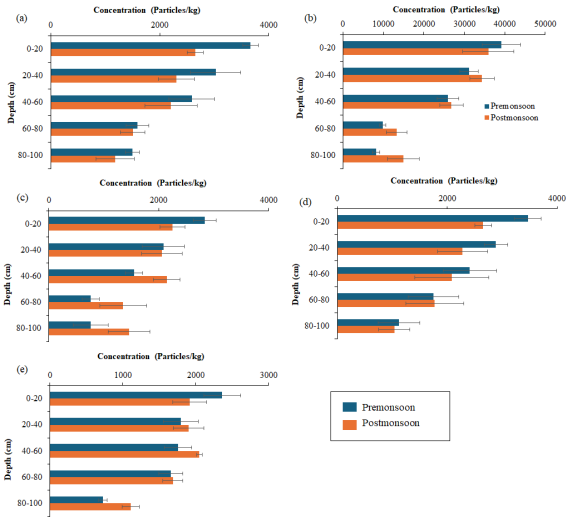

Fig. 1. Seasonal variation in microplastic (MP) concentrations across different land use types: (a) river banks, (b) dumpsites, (c) agricultural lands, (d) residential areas, and (e) woodlands.

Reference

[1] Hu et al., 2025,*Journal of Hazardous Materials* 477 (2024): 135253.