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Conference Abstract

Distribution of large microplastic particles along the Bulgarian Black Sea coast during the pre-tourist season: patterns and environmental drivers

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Abstract

Our study aimed to describe microplastic pollution on Bulgarian Black Sea coast beaches outside the tourist season, as a baseline for assessing the role of locally based pollution sources and for further quantifying seasonal touristic contributions. To avoid misidentification and enable precise chemical analysis of the collected material, we focused on the large microplastic (LMPP) fraction (1–5 mm). Sampling was conducted in late April–early May 2021 at five Bulgarian Black Sea beach areas, each represented by three stations. Three sand samples (0–5 cm depth, 50 × 50 cm quadrat) were collected, and LMPPs were separated by density flotation using pre-filtered seawater. Chemical composition was determined for every particle by ATR-FTIR using the S.T. Japan–Europe GmbH L30605 Polymer Starter library. Matches >70% were accepted, yielding 1,528 confidently identified particles (94.5% of those collected).

LMPP abundance ranged from 32 to 1768 particles·m^{-2} (mean 428), and mass from 0.04 to 3.4 g·m^{-2} (mean 1.28). The highest contamination was recorded near the mouth of the Kamchia River, whereas the lowest occurred at Chernomorets Beach, a resort area

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without a permanent resident population. At most stations, white foam fragment particles predominated. Polystyrene (PS) prevailed (58%), followed by polypropylene (PP, 19%) and polyethylene (PE, 11%). LMPP abundance showed only a weak correlation with macroplastic at the same samples, suggesting that beach microplastics are transported and deposited largely independently of local fragmentation of larger debris.

Integrating ATR-FTIR spectroscopy with the specialised library enabled the identification of 42 polymers associated with diverse consumer and industrial products: water distribution piping, ion-exchange resins, automotive components, café/greenhouse sheeting, industrial packaging films, woven shipping sacks, and roofing membranes. Thus, the problem of microplastic beach pollution requires multifaceted regional management rather than targeted single-use plastic bans.

Multiple regression models at both regional and station levels indicated that riverine input was the main contributor to LMPP contamination outside the tourist season, whereas direct anthropogenic input and wastewater treatment plant (WWTP) discharge had comparatively weaker effects. Wind- and wave-protective structures were associated with reduced LMPP abundance. Canonical correlation and regression analyses further revealed source-specific relationships among polymer types: PS was primarily associated with riverine input ($p < 0.01$), whereas PP showed a moderate association with direct anthropogenic input and WWTP discharge. Although some model coefficients were not statistically significant, the consistency of predictor rankings across different modelling approaches suggests that the environmental factors studied exert systematic influences on LMPP distribution.

Keywords

beach sand, riverine input, wastewater treatment plants, direct anthropogenic pollution, polymer composition

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Ethics and security

Ethical approval was not required for the study in accordance with the local legislation and institutional requirements.

Author contributions

Maria Grandova: Writing – original draft, Visualization, Investigation, Formal analysis, Conceptualization, Validation. **Svetlana Mihova:** Writing – review & editing, Validation, Methodology, Conceptualization, Formal analysis, Investigation. **Valentina Doncheva:** Writing – review & editing, Visualization, Supervision. **Kremena Stefanova:** Writing – review & editing, Supervision, Funding acquisition, Project administration. **Aleksandar Ivanov:** Investigation, Formal analysis, Methodology. **Oleksandr Umanov:** Investigation, Formal analysis, Visualization.

Conflicts of interest

The authors have declared that no competing interests exist.