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Розділ 1

КОМПОЗИЦІЙНІ МАТЕРІАЛИ НА ОСНОВІ ПОЛІМЕРІВ (МАТЕРІАЛИ, ТЕХНОЛОГІЇ, ОБЛАДНАННЯ, ВИБОРИ)

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OCCURRENCE OF MICROPLASTICS IN SOIL IN RECREATIONAL, RESIDENTIAL, AND INDUSTRIAL AREAS INFLUENCED BY HUMAN ACTIVITIES

Tunali Mehmet Meric[1], Ph. D. student,
Oleksiy Myronyuk[2], Ph. D., As. Prof.
1 Institute of Environmental Sciences, Boğaziçi University,
Bebek, Istanbul, Turkey2 Igor Sikorsky Kyiv Polytechnic Institute

Abstract. Plastic pollution affects ecosystems worldwide, with microplastics (MPs) being a major concern. This study evaluates MP abundance in soils impacted by human activities in different areas in Istanbul. Results indicate recreational areas have the highest MP content, while residential areas have the lowest. Industrial areas have intermediate levels. Particle shapes vary by category, with fibers most prevalent in recreational areas. FT-IR spectrometry analysis identified the types of MPs present, with the recreational areas containing polymers undergoing hydrolysis. The industrial zone's MP contamination was recent and relatively clean, while the PE plastic in Dilovası showed little weathering.

Key words: microplastic, land use, soil, humanimpact, residential, industrial, recreational.

Plastic pollution is a global issue that affects various ecosystems including terrestrial, marine, and freshwater. Microplastics (MPs), small plastic particles measuring less than 5 mm, are a major concern and can come from primary and secondary sources. In terrestrial ecosystems, the abundance and movement of MPs are expected to be higher than in aquatic systems. This study aims to evaluate the abundance of microplastics in soils influenced by human activities in different areas, namely industrial, residential, and recreational, to determine their impact on soil contamination. Soil samples were collected from Istanbul, Turkey, from various land-use types for each category. Results showed that recreational areas had the highest MP content (mean=7,956 items/kg), while residential areas had the lowest (mean=3,378 items/kg). The abundance of MPs in industrial areas was between these two groups with a mean value of 4,488 items/kg. The lowest concentration was observed in one of the residential zones with 1,868 items/kg, while the highest content was found in a forested recreational area (Belgrad forest) with 9,332 items/kg. The shape ratios of particles varied for each category, with round/spherical particles having the highest share in industrial and residential areas (34% and 32%, respectively) and fibers in recreational areas (36%).

FT-IR spectrometry analysis with diamond ATR accessory (32 scans per spectrum) was used to identify the types of microplastics present in the sampled areas. For one of the recreational areas, the spectrum showed two bands of asymmetric and symmetric C–H stretching (2,916 and 2,849 cm^{-1}) that were not overlapping. The bending of CH (1,453 cm^{-1}) with other minor bands up to 1,375 cm^{-1}, along with the carbonyl area between 1,700 and 1,800 cm^{-1}, contained minor peaks inside it [1]. Although major peaks were absent, it was determined that the originating type of plastic was not polyester or polyamide, but probably of polyolefin type (closest to polypropylene). However, due to contamination with cellulose paper filter residue, the spectrum also contained a wide 1,027 cm^{-1} artifact band.

In the Dilovası sample, the PE plastic remained almost unchanged by weathering. The peaks at 2,914 cm^{-1} and 2,949 cm^{-1} corresponded to asymmetrical and symmetrical stretching of C–H bond in CH_2, CH_3, and CH groups, while the doublet at 1,462–1,440 cm^{-1} was related to bending vibrations of the respective CH bond, which is typical for polyethylene.

The spectra obtained from the sample from the university campus showed the same configuration of aliphatic C–H bond stretching peaks (2,917 and 2,850 cm^{-1}), a sharp PE-like band at 1,468 cm^{-1}, but significant carbonyl C=O stretching band at 1,740 cm^{-1} with a noticeable shoulder. Minor bands at 1,316 cm^{-1} and nearby can be associated with the ether bond and be a product of the polymer transformations in contact with the environment [2].

Recreational areas #2 and #3 showed similar attributions in terms of their spectra; the presence of organic matter could be detected by the bands of aliphatic CH groups at 2,918 cm^{-1} and 2,849 cm^{-1} for both samples. There were no signs of the carboxylic band, indicating that the material destruction had just started. However, two bands at 3,675 and 3,620 cm^{-1}, attributed to O–H bond stretching in material structure, may possibly point out the hydrolytic way of material destruction, which is usual for plastics such as polyacetal, nylons, and polyethers [3].

In summary, the recreational areas contained small particles of the polymer at the beginning of destruction. The presence of OH groups, even after drying, indicated that this polymer underwent hydrolysis instead of UV or oxygen / ozone-driven oxidation. Hence, it could be considered either as the initially C=O-containing polymer (such as acrylate) that is frequently used in packaging or oxidized polyolefin (PE or PP). The material found in the industrial zone was PE-based MP with a still well-defined structure and was relatively clean, suggesting that the MP contamination was recent.

CONCLUSIONS

MP particles or fibers were present in all of the sam-ples evaluated in this study. Soil samples from Belgrad forest (recreational area #2) had the highest amount of MP among all locations, and the other two rec-reational areas (Yıldız Park and university campus) having higher MP content compared to industrial andresidential areas further support the accumulation scenario of MPs in soil. The lowest

average MP contentwas found in recreational areas, and the results havebeen consistent for that aspect. It can also be arguedthat size and shape distribution of MPs can be differ-ent due to the location of contamination and variousother factors. Specifics of the size distribution on eachand every location can be further studied to obtainmore information on fragmentation, and the findingsthat support the land use affect the distribution of MPsin soil. For recreational areas including forested area;microfibers were the most common type with an aver-age of 36.92%, while industrial areas had more shareon round/spherical MP particles with 32.85% and residential areas with 34.26%, respectively.

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