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Machine Learning Algorithms for Predicting Microplastic Levels in Aquatic Environments

Fateme Barari, Ziaeddin Bonyadi*

Department of Environmental Health Engineering, School of Health,
Mashhad University of Medical Sciences, Mashhad, Iran

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***Corresponding Author:**
Dept. of Environmental Health Engineering, School of Health, Mashhad University of Medical Sciences, Mashhad, Iran

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ABSTRACT

Introduction: Microplastics (MPs), encompassing both primary plastic particles and secondary fragments of degraded plastics, represent emerging pollutants generally smaller than 5 mm. These tiny particles can absorb toxins and are ingested by organisms, posing significant global health and environmental risks. Machine learning holds promise in collecting environmental data and predicting pollutant levels. This study aimed to assess the role of machine learning in forecasting the distribution, classification, and detection of MPs within aquatic ecosystems.

Search Strategy: In this research, an initial search was performed using the terms "microplastics," "machine learning (ML)," "artificial intelligence (AI)," and "aquatic environments" from 2015 to 2024. From databases like "ScienceDirect," "Scopus," "Web of Science," and "Google Scholar," 366 relevant publications were initially identified. After eliminating duplicates, the remaining papers were evaluated for relevance, narrowing down to 55 journal articles for a thorough and concentrated analysis.

Results: This research indicates that fibers and fragments were the predominant types of MPs, constituting 28% and 31% of the studies examined. Moreover, Polyethylene (PE) and Polypropylene (PP) are identified as the primary sources of MPs, contributing to 29% and 17% of cases, respectively. The YOLOv5 model was employed in 30% of the studies to identify MPs, achieving a detection accuracy rate of 95%. Additionally, the Convolutional Neural Network (CNN) was utilized in 40% of the research to identify the types of MPs, including PE, PP, and Polyvinyl Chloride (PVC), by processing Fourier Transform Infrared Spectroscopy (FTIR) data. This model had an overall prediction accuracy above 93%. The results demonstrated that the U-Net model was employed in 54% of the articles to ascertain the morphology of MPs by examining scanning electron microscope (SEM) images. Consequently, MPs in pellet form constituted the most significant proportion, accounting for 93.6%.

Conclusion and Discussion: In conclusion, ML models have become integral in MP research, boosting predictions, evaluating contaminant adsorption, categorizing shapes, and discerning types. These models provide deep insights into MPs interactions and facilitate the identification of weathered MPs. This research emphasizes ML's influence across numerous studies.

Keywords: Artificial intelligence, Machine learning, Microplastics