Environmental Engineering and Management Journal

August 2025, Vol. 24, No. 8, 1657-1665
http://www.eemj.icpm.tuiasi.ro/; http://www.eemj.eu
http://doi.org/10.30638/eemj.2025.129

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PREDICTING AIR POLLUTANTS IN URBAN ENVIRONMENTS USING ARTIFICIAL NEURAL NETWORK MODELS

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Abstract

Air quality monitoring plays a vital role in protecting human health and supporting environmental sustainability, especially in densely populated urban areas where anthropogenic activities intensify pollutant emissions. In this study, the concentrations of key air pollutants: PM_{10}, CO, CO_2, SO_2, NO_2, and O_3 were assessed under diverse environmental and social conditions through the application of Artificial Neural Networks (ANN). Data were obtained from three major cities in Jordan, incorporating meteorological factors (wind speed, temperature, humidity) as well as socio-economic variables (population density and vehicular traffic). The ANN model was trained to predict pollutant concentrations based on these inputs, and its performance was evaluated using statistical indices. Among the analyzed pollutants, CO exhibited the strongest correlation with environmental parameters, achieving a mean squared error (MSE) of 7.2×10^{-3} and a correlation coefficient (R^2) approaching unity, thereby confirming the robustness of the model's predictive capacity. In contrast, pollutants such as NO_2, O_3, and PM_{10} demonstrated variable prediction accuracy, with PM_{10} presenting the weakest correlation, likely due to the complex and heterogeneous nature of particulate matter sources. The ANN-derived equations provide a computationally efficient tool for forecasting pollutant levels in urban areas where conventional monitoring networks are limited or resource-intensive. These findings underline the potential of ANN-based approaches to complement existing air quality management strategies and to serve as cost-effective predictive systems for real-time urban air pollution assessment. Future research should aim to refine the predictive capacity for pollutants with lower correlations by integrating additional explanatory variables, expanding the temporal and spatial datasets, and exploring hybrid modeling frameworks that combine ANN with other machine learning techniques.

Key words: air pollution monitoring, ANN, CO_2 concentration, environmental parameters, PM_{10}, urban air quality prediction

Received: February, 2023; Revised final: October, 2024; Accepted: December, 2024; Published in final edited form: August, 2025

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