

# Hourly Urban Air Pollution Level Prediction Using Numerical Modelling and Deep Learning Techniques

Niveditha GC, Lakshmi K, Narendra KN

Department of CSE  
Sri Sairam College of Engineering,  
Bengaluru, India

<https://orcid.org/0009-0005-7003-3769>

<https://orcid.org/0009-0006-7302-4435>

<https://orcid.org/0009-0004-2409-4336>



## Publication History

Manuscript Reference No: IJIRIS/RS/Vol.11/Issue11/NVISXI10095

Research Article Open Access| Double-Blind Peer-Reviewed| Article ID: IJIRIS/RS/Vol.11/Issue11/NVISXI10095 Received: 28, October 2025, Revised: 05, November 2025, Accepted: 12, November 2025, Published Online: 21, November 2025.

<https://www.ijiris.com/volumes/Vol11/iss-11/16.NVISXI10095.pdf>

**Citation:** Niveditha, Lakshmi, Narendra (2025), Hourly Urban Air Pollution Level Prediction Using Numerical Modelling and Deep Learning Techniques, IJIRIS: International Journal of Innovative Research in Information Security, Volume 11, Issue 11 of 2025 pages 808-809 **Doi:** <https://doi.org/10.26562/ijiris.2025.v1111.16>

**BibTeX Key:** Niveditha@Hourly

IJIRIS papers should be cited as IJIRIS (International Journal of Innovative Research in Information Security, AM Publications, India 2025, ISSN 2349-7017, <https://doi.org/10.26562/ijiris.2025.v1111.16> The journal's official abbreviation is IJIRIS.

Orcid: <https://orcid.org/0009-0004-9398-7488>

Copyright © 2025 copyright by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

**Abstract:** Rapidly growing and urbanizing countries like India need forecasting of pollutants in the air to manage air quality. Traditional Artificial Neural Networks (ANN) have limited representation capacity for prediction, especially for complex, non-linear interactions among parameters in environmental data. To forecast hourly concentrations of PM<sub>2.5</sub>, this study presents an advanced deep learning model that combines Long Short-Term Memory (LSTM), Convolutional Neural Networks (CNN), and a numerical-based ANN. The study measures impact factors such as PM<sub>10</sub>, NO<sub>2</sub>, SO<sub>2</sub>, and O<sub>3</sub> in a few chosen cities of India, influencing air pollution and determines the transition from traditional ANN to deep learning models. The result shows that the hybrid CNN-LSTM models reduce Root Mean Squared Error by 22-35% across pollutants, giving better results than classical ANN models.

## I. INTRODUCTION

Indian cities, particularly metropolitan areas, are vulnerable to declining air quality due to urbanization, industrialization, and rising vehicle density. Predicting pollutant levels makes it easy for the concerned authorities to take necessary actions, like health advisories and environmental planning. Conventional models like regression, ANN, and numerical models fail to capture nonlinear interactions among pollutants. Models like CNN, LSTM, and GRU gave better results for forecasting air pollution. This study looks at air pollution prediction using various numerical, ANN, and deep learning models.

## II. LITERATURE REVIEW

Early studies used multilayer perceptron (MLP) architectures to predict PM and NO<sub>x</sub>, but their accuracy was limited due to shallow learning. Temporal memory was absent from meteorology-coupled ANNs, despite their superior performance. Later research recorded sequential dependencies in the dispersion of pollutants using LSTM networks. Hybrid CNN-LSTM models showed promise by combining spatial and temporal features. Numerical pollution models such as CMAQ and WRF-Chem provided physical insights despite being computationally expensive. Deep learning and numerical-mode analysis are still not fully integrated in Indian urban areas. To bridge this gap, this paper suggests a hybrid numerical ANN-deep learning framework. For Indian urban areas, there is still a gap in the integration of deep learning with numerical-mode analysis. This paper proposes a hybrid numerical ANN-deep learning framework to close this gap.

## III. METHODOLOGY

(A). Data Collection: IMD stations in Bengaluru, Kolkata, Mumbai and Delhi; furthermore, time series data (2018–2023) from the Central Pollution Control Board are used. PM<sub>2.5</sub>, or air pollutants, was one of the variables. <sup>1</sup>, PM<sub>10</sub>, SO<sub>2</sub>, NO<sub>2</sub>, CO, O<sub>3</sub>; meteorological parameters: temperature, humidity, wind direction, wind speed, and solar radiation; traffic density index; boundary layer height (numerical model input) B. Pre-processing; KNN imputation for missing values; Min-Max scaling for normalisation; temporal windowing (last 24 hours → next 1-hour prediction); and rolling averages for stationarization. Result components were set up operating the ANNA quantitative system decay system, which is based on a quantitative system. The beginning is to apply Principal Component Analysis (PCA) to the matrix of climatic and contaminants. Establishing which quantitative system supply greater than 90% of the variance. ANN feed system. Find the using SHAP analysis.

### CONCLUSION:

This study conveys that machine learning, particularly cross-bred CNN-LSTM systems, importantly amplifies hourly air pollution prediction in urban Indian fields. By combining quantitative system analysis with ANN, the results parts and pollutant dynamics can be understanding in better. environmental organisations, smart-city air quality management systems and Policymakers can use the recommended model as a reliable tool. Additionally, work will require combining chemical transport models for hybrid physical–AI forecasting, deploying, and extending coverage to tier-2 cities' real-time IoT sensor networks.

### REFERENCES:

1. S. Kumar and R. Singh, "Numerical model based artificial neural network model and its application for quantifying impact factors of urban air quality," *Environmental Modelling Review*, 2021.
2. A. Sharma and P. Agarwal, "Transport and Urban Air Pollution in India," *Journal of Urban Environmental Engineering*, vol. 15, no. 2, pp. 120–135, 2020.
3. V. Prakash, M. Rao, and K. Reddy, "Evolution of neural network to deep learning in prediction of air and water pollution and its Indian context," *International Journal of Intelligent Systems*, vol. 33, no. 11, pp. 5600–5615, 2021.
4. T. Chen and Y. Zhang, "Predicting hourly air pollutant levels using artificial neural networks coupled with uncertainty analysis by Monte Carlo simulations," *Atmospheric Pollution Research*, vol. 12, no. 3, pp. 450–462, 2021.
5. Central Pollution Control Board (CPCB), "National Air Quality Monitoring Programme (NAMP) Report," Govt. of India, 2020.
6. World Health Organization, "Ambient Air Pollution Database: Global Update," WHO Press, Geneva, 2022.