5 Conclusion

Data on air pollution showed a high prevalence of seasonal trends, multiple periodicities, and stochastic components. We have proposed a hybrid deep learning model by integrating ConvLSTM, 3DCNN, and BLSTM network to address various complexities found in the air pollution data. Its forecasting effectiveness was then evaluated throughout India using a univariate $PM_{2.5}$ time series data. Since every data series in the $PM_{2.5}$ data sets in India rejected the null hypothesis of a normal distribution, thereby exhibit universality. With the exception of Patna in the MGP and Shillong in the EH region, which follow log normal distribution, they mostly follow either the beta or gamma distribution. 8-hour ahead sequential prediction result shows notable regional variations, with the maximum (53.81) and minimum (7.09) RMSE values found at Patna in MGP and Shillong in EH, respectively. Comparable results were also evident for the MAE values at Patna and Shillong, respectively (maximum: 34.09 and minimum: 5.41). The MAPE values at Hyderabad and Chennai were found to be 18.6 for the minimum and 52.7 for the maximum. The slight differences in model error estimation for 8-hour and 1-hour ahead sequential forecasts demonstrated the model's robustness. When the results (MAE) were further examined in relation to SNR, a strong correlation was observed between the error level and SNR values. The model performance tends to decrease when SNR value decreases. Man-made activities in the area could be the cause of the variations in SNR. The findings indicate that, in relation to the rest of India, performance in and around IGP are weak. Planning and policy for pollution control could be benefited from the application of this model. It might be a helpful tool to forewarn of impending events involving air pollution.

Future Scope:

I. The model architecture could be examined for other Geographical regions in the global scale irrespective of the climatic dissimilarities.
II. The modeling framework may be used for multiple input and single output mode by incorporating different cofactors responsible for $PM_{2.5}$ concentration in ambient atmosphere.
III. The model architecture could also be explored for other pollutants.

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5.1 List of Publications

Peer Reviewed Journal Publications:

[1] Goswami P, Prakash M, Ranjan RK, Prakash A. A Hybrid Deep Learning Model for Multi-step Ahead Prediction of PM2.5 Concentration Across India. Environ Model Assess. 2023;28(5):803-816. doi:10.1007/s10666-023-09902-4

Conference Proceedings:

[1] "Multi step ahead prediction of PM2.5 value using independent value prediction method; a deep learning approach" - Published on peer reviewed proceedings of the National Seminar on "Current Perspectives in Environmental Pollution: Challenges and opportunities (2019)".

[2] "Estimation of loss of visibility due to pollution events; a neural network approach" – Published on peer reviewed proceedings of the National Seminar on "Climate Chang and Society (2017)".

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