Poor air quality as an important predictor of climate change in Delhi

GAURAV YADAV, GEETA SINGH and S. D. ATTRI*

Department of Environmental Engineering, Delhi Technological University, New Delhi – 110 042, India

*India Meteorological Department, MoES, New Delhi – 110 003, India

(*Received 23 May 2022, Accepted 24 January 2023*)

e mail : geeta.singh@dce.ac.in

सार —जलवायवी परिस्थितियों में निरंतर परिवर्तन ने दुनिया भर के लोगों के लिए एक चुनौतीपूर्ण स्थिति पैदा कर दी है। बढ़ते तापमान और आर्द्रता का अधिक आबादी वाले शहरों पर सबसे बुरा प्रभाव पड़ता है, और शहरी वातावरण में खराब वायु गुणवत्ता जलवायवी परिवर्तन को मुख्य रूप से प्रभावित करती है। दुनिया भर के सबसे अधिक प्रदूषित शहरों में वायु प्रदूषण हॉटस्पॉट की सूची में दिल्ली सबसे ऊपर है, जिसे इस अध्ययन के लिए चुना गया है। इस अध्ययन में मानदंड वायु प्रदूषकों और मौसम संबंधी मापदंडों के बीच संबंध का आकलन किया गया। यह परिकल्पना की गई थी कि मानदंड वायु प्रदूषक दिल्ली में दैनिक डेटासेट (01 जनवरी, 2015 - 31 दिसंबर, 2021) और औसत वार्षिक डेटासेट (2000 से 2021) के दौरान तापमान और सापेक्ष आर्द्रता (जलवायु परिवर्तन के स्तंभ) में परिवर्तन का सकारात्मक पूर्वानुमान करेंगे। यह अध्ययन EVIEWS 12 का उपयोग करके मॉडल अन्वेषण और गुणांक अनुमान में इलास्टिक नेट-एप्लाइड नियमितीकरण का उपयोग करता है। यह देखा गया कि चयनित अध्ययन अवधि के दौरान, अधिकांश मानदंड वायु प्रदूषकों ने दिल्ली की जलवायवी परिस्थितियों में परिवर्तन को बढ़ाने में महत्वपूर्ण भूमिका निभाई। यह शोध उपलब्ध साहित्य की मदद से वायु प्रदूषण और जलवायु परिवर्तन के बीच अंतर संबंध को और स्पष्ट करता है।

ABSTRACT. The continuous change in climatic conditions has created a challenging situation for people living all over the World. The rising temperature and humidity have the worst impacts on the cities with high populations, and poor air quality in an urban environment significantly affects climatic variables. Delhi, which tops the list of air pollution hotspots among the top polluted cities around the World, is selected for this study. This study assessed a correlation between criteria air pollutants and meteorological parameters. It was hypothesized that criteria air pollutants would positively predict the change in temperature and relative humidity (pillars of climate change) during the daily dataset (January 01, 2015 - December 31, 2021) and average annual dataset (2000 to 2021) in Delhi. This study uses elastic net-applied regularization in model exploration and coefficient estimation using EVIEWS 12. It was observed that during the selected study period, most of the criteria air pollutants played an important part in increasing the changes in the climatic conditions of Delhi. This research further explains the interlinkage between air pollution and climate change with the help of available literature.

Key words –   Air Pollutants, Climate Change, Temperature, Relative humidity, Elastic Net Regression.

1. Introduction

Due to population increase, growing numbers of automobiles, fuel use, inadequate transportation networks, poor land use patterns, industrialization, and insufficient environmental legislation, India has been particularly vulnerable to air pollution and climate change over the previous two decades (Ravindra *et al.*, 2016; Sharma & Mauzerall, 2022; Yarlagadda *et al.*, 2022). New Delhi, India's capital, is one of the worst-affected cities. It has the country's highest level of particulate matter pollution and very abnormal meteorological conditions (Biswas *et al.*,

2011; Krishan *et al.*, 2019; Marlier *et al.*, 2016; Sharma *et al.*, 2018). Before the outbreak of SARS-COV-2 infection in 2020, the average annual $PM_{2.5}$ concentration in India was 58.1 µg/m^3 in 2019, with Delhi's average $PM_{2.5}$ concentration being 98.6 µg/m^3, which lowered down to 93.23 in 2020 (due to lockdown) and which again increased to 103.33 in 2021. Similarly, the average annual relative humidity in 2019 was 48.69%, which increased to 53.25% in 2021 (Krishan *et al.*, 2019). All of these above stats indicate that the situations are getting worse yearly. The weather has a significant impact on air quality in Delhi, *i.e.*, meteorological variables such as temperature,
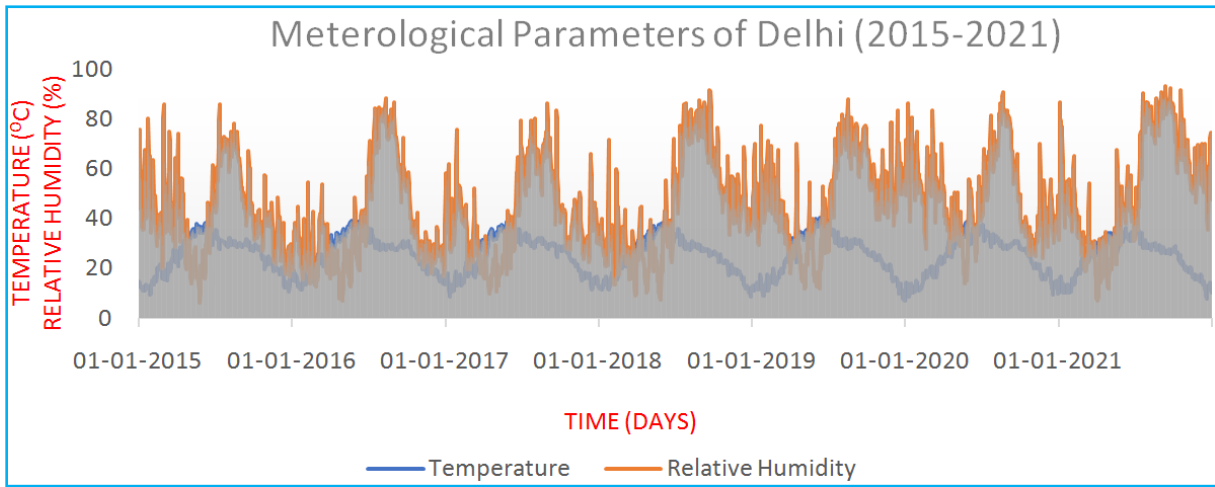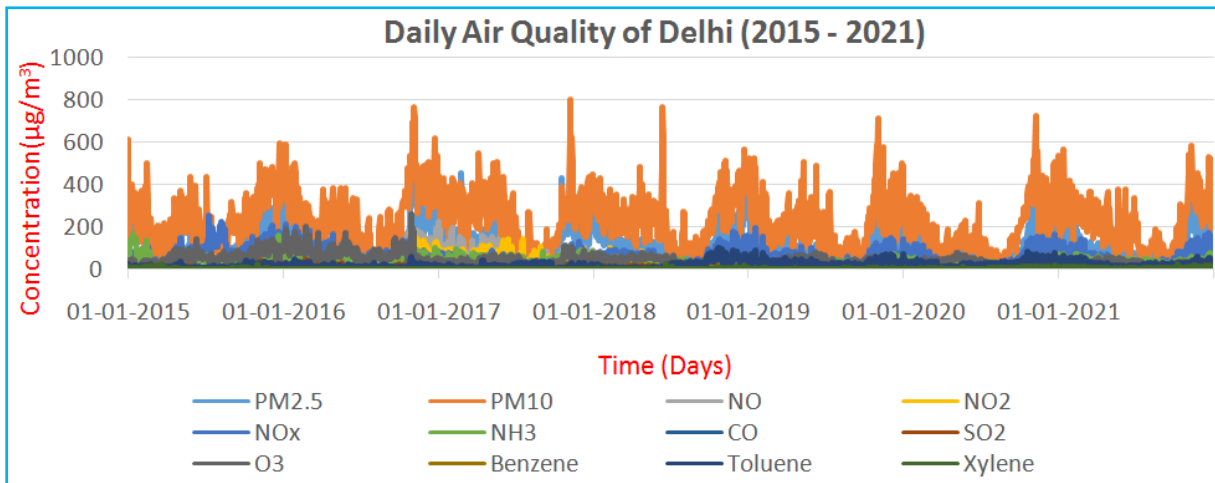
Fig. 1. Daily meteorological conditions in Delhi
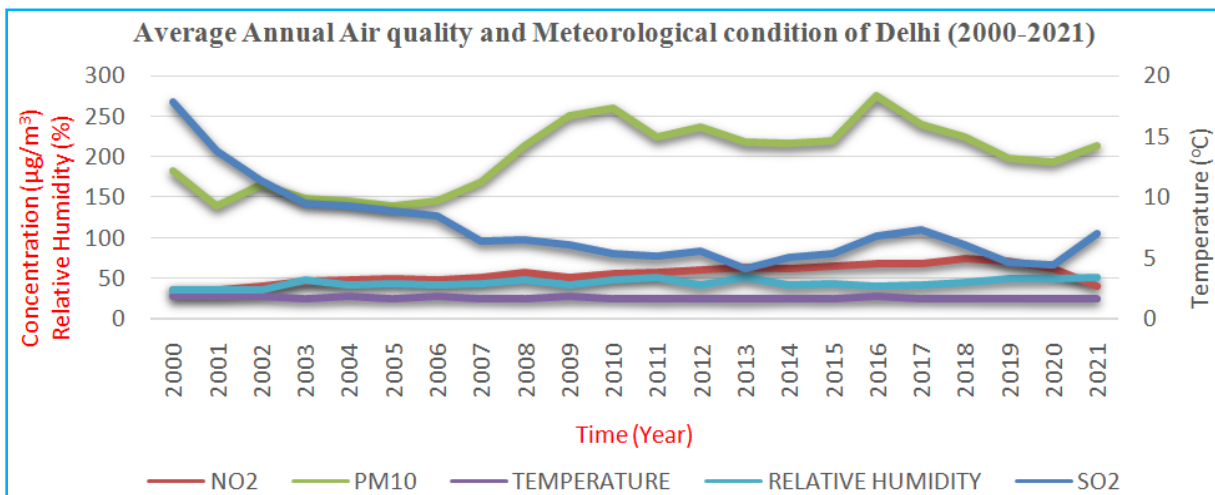

Fig. 2. Daily Air quality in Delhi

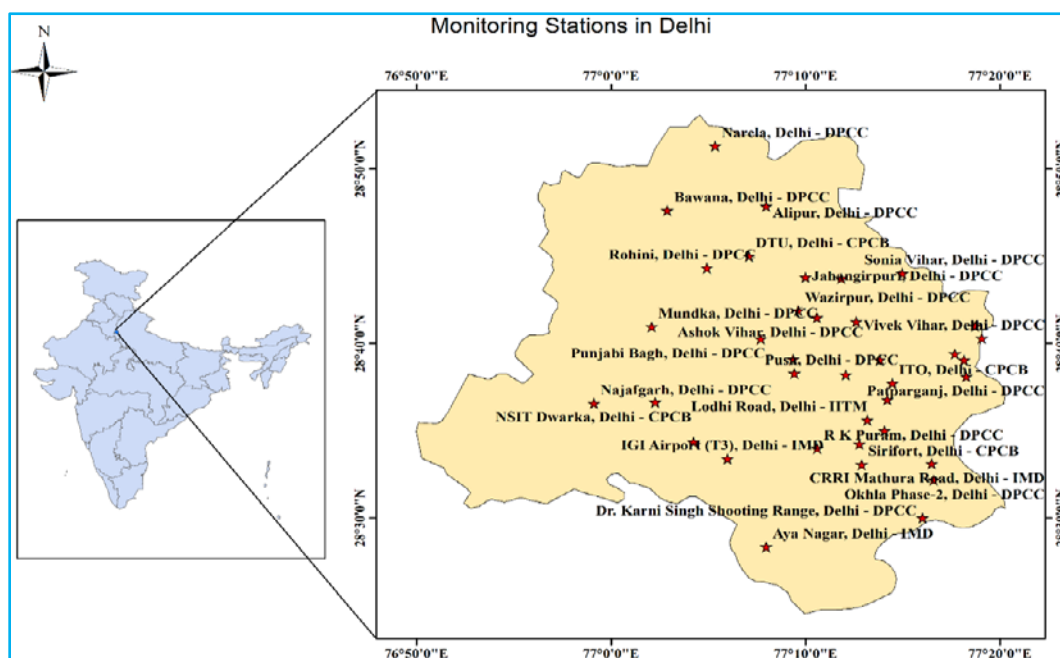**Fig. 3.** Annual Concentration of Ecological Conditions in Delhi

Fig. 4. Study area with 38 CAAQMS stations

humidity, wind characteristics and vertical mixing can influence pollutant emission, transport, dispersion, chemical change and deposition (Das *et al*., 2021; Deswal & Chandna, 2010; Guttikunda, 2010; Guttikunda & Gurjar, 2012; Krishan *et al*., 2019; Ramsey *et al*., 2014; Sonwani *et al*., 2021; Tiwari *et al*., 2014; Trivedi *et al*., 2014; Verma & Desai, 2008). Further, if the weather is significantly associated with air pollutants, the fluctuating concentrations of pollutants will also show some impact on the change in weather and climate (Saha *et al*., 2014). Fig. 1 represents the daily change in the temperature and relative humidity of Delhi during (2015- 2021); Fig. 2 represents the concentration of air pollutants on a daily 24-hour mean basis and, Fig. 3 shows the perfect example of a change in criteria air pollutants concentration and meteorological conditions in Delhi over past 22 years on an annual basis. All these figures showed that the change in the temperature and relative humidity trend is very similar to the transformation of some air pollutants. This indicates that both meteorological variables and air pollutants influence each other and share a positive association. Temperature and Relative humidity are the pillars of climate change which further is projected to exacerbate air pollution in numerous densely populated areas by altering atmospheric ventilation and dilution, precipitation and other removal mechanisms and atmospheric chemistry (Depietri *et al*., 2012; Godde *et al*., 2021). The bad air quality will have a direct influence on human health and the change of climate. Climate change affects air quality and hence impacts human health.

So far, researchers have considered only meteorological parameters to conclude the association between meteorological parameters and air pollutants. (Barzeghar *et al*., 2022; Dandotiya *et al*., 2019; Deswal & Chandna, 2010; Ding *et al*., 2021; Ghosh *et al*., 2017; Guo *et al*., 2022; Gupta *et al*., 2004; Guttikunda & Gurjar, 2012; Heydarzadeh *et al*., 2022; Ilten & Selici, 2008; Jayamurugan *et al*., 2013; Khedairia & Khadir, 2012; Kucbel *et al*., 2017; Kuzu & Saral, 2017; Li *et al*., 2017; Mahanta *et al*., 2021; Mahapatra *et al*., 2014; Ramsey *et al*., 2014; Sati & Mohan, 2018; Trivedi *et al*., 2014; Verma & Desai, 2008; Xue & Liu, 2014; Yadav *et al*., 2015). At the same time, most of the studies were done at the bivariate level, which has the drawback of not considering the presence or effect of other independent variables between the two being investigated. This study examined the impact of criteria air pollutants on climate change in the Delhi region. It was hypothesized that all the criteria air pollutants (PM_{10}, $PM_{2.5}$, NO, NO_2, NO_X, NH_3, O_3, CO, SO_2, C_6H_6, C_7H_8, C_8H_{10}) would positively predict the change in temperature and relative humidity. Elastic net regression analysis was used to test this hypothesis because it is a model with minimal crucial independent variables. Additionally, it punishes the fitting of unwanted independent variables. However, none of the studies which used elastic-net has been published for finding an association between air pollutants and meteorological conditions in Delhi. Many statisticians proved that elastic-net produces accurate results with reference to the lucidity and precision of regression models (Edouard Grave,

2011). Elastic-net regression provides the most uncompromising model with perfect prediction when predicting a dependent variable with numerous predictors (Kim *et al*., 2016). Through cross-validation, it was also discovered that a model founded by elastic-net regression predicts accurate results out of the bounds of data required for regression analysis. (McNeish, 2015).

2.   Materials and methods

2.1. *Study area*

The study analyzedthe eleven most polluted districts in the Delhi (28.7041° N, 77.1025° E) region, as shown in Fig. 4. These districts have emerged as important hubs for the commercial, industrial, medical and educational sectors, attracting people from all over the country. These districts are struggling to handle air pollution and its impacts due to the increase in population. In all these districts, the effect of change in meteorological conditions over a significant period has been highly observed.

2.2. *Data collection*

(*i*)   For model 1, daily 24-hour mean concentration data of criteria air pollutants, temperature and relative humidity (of 38 CAAQMS sites) was collected from (https://app.cpcbccr.com/ccr) operated by CPCB (https://cpcb.nic.in) as shown in Fig. 4. The daily dataset was collected between (January 01, 2015 - December 31, 2021) by using the above-mentioned sites.

(*ii*)   For model 2, the dataset for the past 22 years was collected from (http://www.cpcbenvis.nic.in/air_quality _data.html), where annual average data was stored under NAMP (National Air Quality Monitoring Programme). For this study,annualaverage data for the year 2000 to 2021 was collected from seven monitoring sites. (*i.e*., ITO, Janakpuri, Nizamuddin, Pitampura, Shahdara, Shahazada Bagh, and Siri Fort).

2.3. *Data analysis*

The hypothesis tests were conducted to find whether the criteria air pollutants carry an essential influence on the change in Temperature and relative humidity in the eleven most polluted districts lying under the Delhi region.

(*i*)   For Model 1, the daily 24-hour mean Temperature and relative humidity in all eleven districts of Delhi were used as the dependent variables, and 24-hour mean air quality was taken as predictors to find how much variance each parameter was created on the change in the climate.

(*ii*)   For Model 2, the annual average temperature and relative humidity were used as dependent variables and

the yearly average concentration of (SO_2, NO_2 and PM_{10}) was taken as predictors to find how much variance each parameter was created on the change in the climate.

(*iii*)   This study's statistical analyses were performed using EVIEWS 12 (www.eviews.com).

2.3.1. *Elastic Net Regression*

Elastic net-applied regularization has been used in model exploration and coefficient estimation (Zou & Hastie, 2005) as shown in equation (1), where α is the mixing parameter between ridge ($\alpha = 0$) and lasso ($\alpha = 1$).

$$L_{\text{enet}}\left(\hat{\beta}\right)= \frac{\sum_{i-1}^{n}\left(y_i - x_i'\hat{\beta}\right)^2}{2n} + \lambda\left(\frac{1-\alpha}{2}\sum_{j=1}^{m}\hat{\beta}_j^2 + \alpha\sum_{j=1}^{m}\left|\hat{\beta}_j\right|\right) \tag{1}$$

By minimizing regression coefficients to zero, the L1-norm (lasso) of penalty creates a sparse model. The L2-norm (ridge) of penalty removes the constraint on the number of selected variables, stimulates grouping, and stabilizes the L1 regularization route (Kuang *et al*., 2015). Elastic net reduces the regression coefficients by combining the L1-norm (lasso) and L2-norm (ridge) penalties; $\alpha = 0.5$ was utilized, which is a midpoint among L1 and L2. Additionally, to reduce the threat of overfitting, elastic net regression was done with K-Fold cross-validation to measure the mean square error. The complete dataset was randomly split into ten folds. For every test, one block of split datasets (90% of the entire dataset) was used to calculate coefficients.

Furthermore, the predictive performance of our prediction model was calculated with the remaining data block (10% of the entire dataset). For each test, a separate set of coefficients quantity was calculated while changing λ. Lambda (λ) at minimum error is used to calculate the simplest model with high prediction accuracy and regularized beta coefficients. To estimate accurate algorithm OLS with 500 maximum iterations and 0.0001 convergence was used.

3.   Results and discussion

3.1.   *Analysis output of daily data model (2015-2021), including all twelve air pollutants*

3.1.1.   *Association among criteria air pollutants and temperature*

The stepwise procedure of elastic net regression was performed to find an association between predictors and
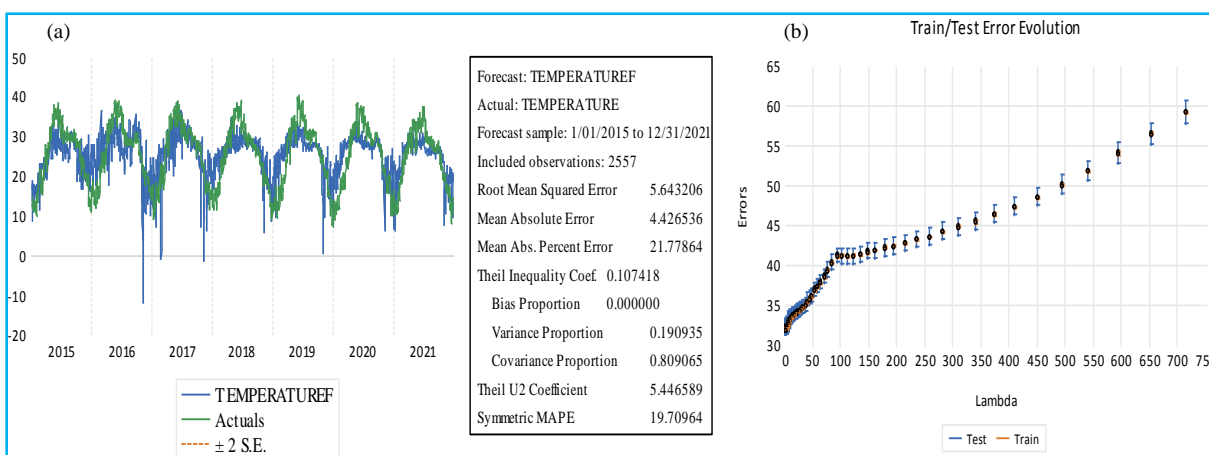
Figs. 5(a&b). Temperature model output after testing {graph (a), X – axis denotes Time (Years) and (b) Y - axis denotes temperature (°C)}
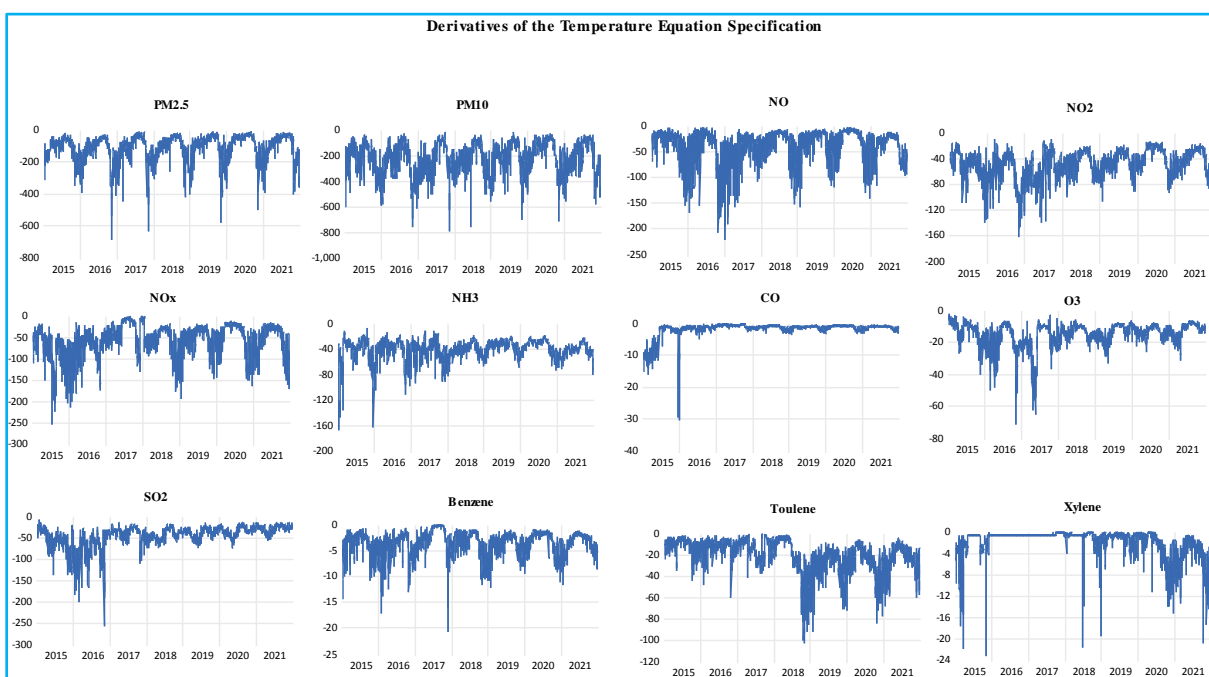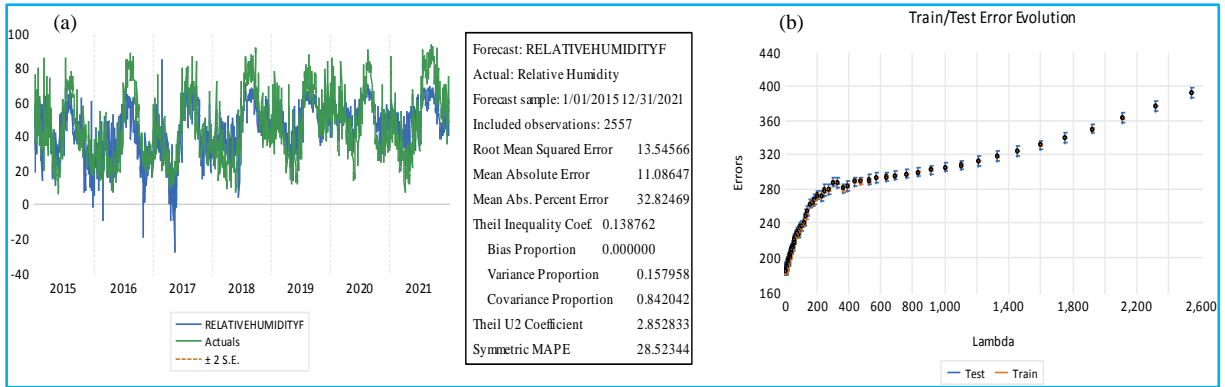

Fig. 6. Daily temperature equation derivatives

dependent variables. After running the model, the predicted results demonstrate that air pollutants account for 46.29% of the variance in change in daily temperature. Similarly, Lambda (λ) at minimum error comes out to be 0.0716, RMSE (Root Mean Square Error) came as 5.64, and MAE is 4.42, as shown in Fig. 5. The results indicate that the air pollutants influencing Delhi's temperature change are portrayed in equation (2). The equation derivatives of temperature are displayed in Fig. 6.

$$\begin{aligned}
\text{Daily Temperature}_{\text{Delhi}} = {}& 25.6 + 0.027 \\
& *PM_{10} + 0.025*NO_2 + 0.085 \\
& *O_3 - 0.17*CO + 0.084*SO_2 \\
& + 0.025*NO_2 - 0.076 PM_{2.5} \\
& - 0.014*NO_x - 0.03*NO \\
& - 0.013*NH_3 - 0.74*C_6H_6 \\
& + 0.064*C_7H_8 + 0.082 \\
& *C_8 H_{10}
\end{aligned}$$

(2)

Figs. 7(a&b). Relative humidity model output after testing {graph (a), X- axisdenotes Time (Years) and (b) Y- axis denotes relative humidity}
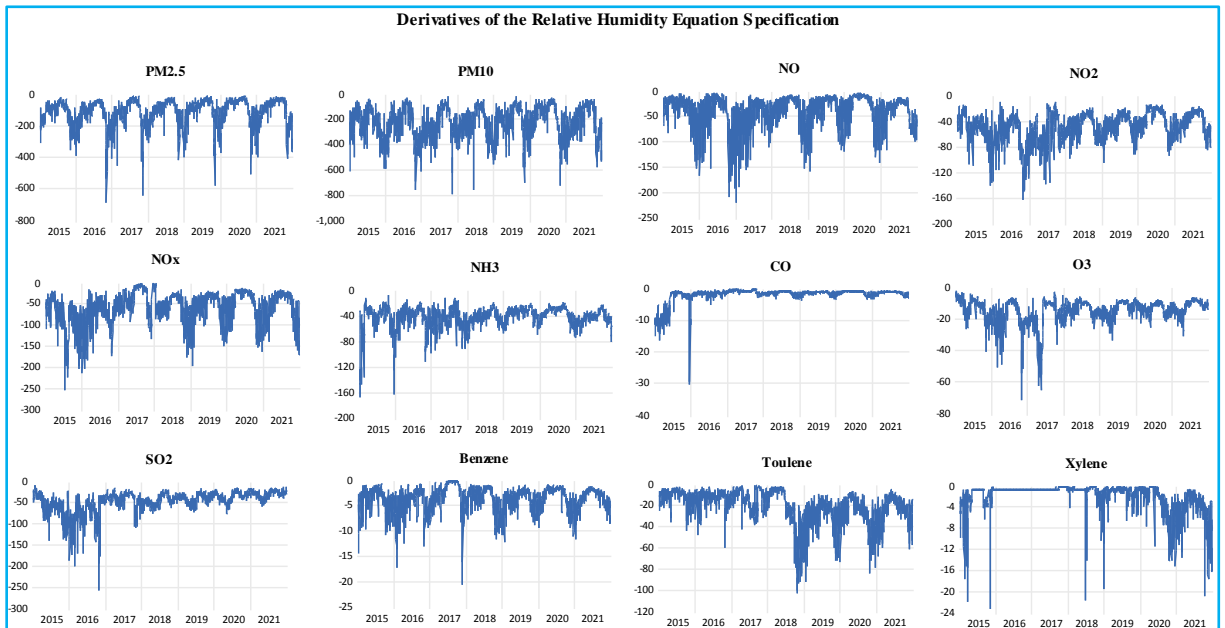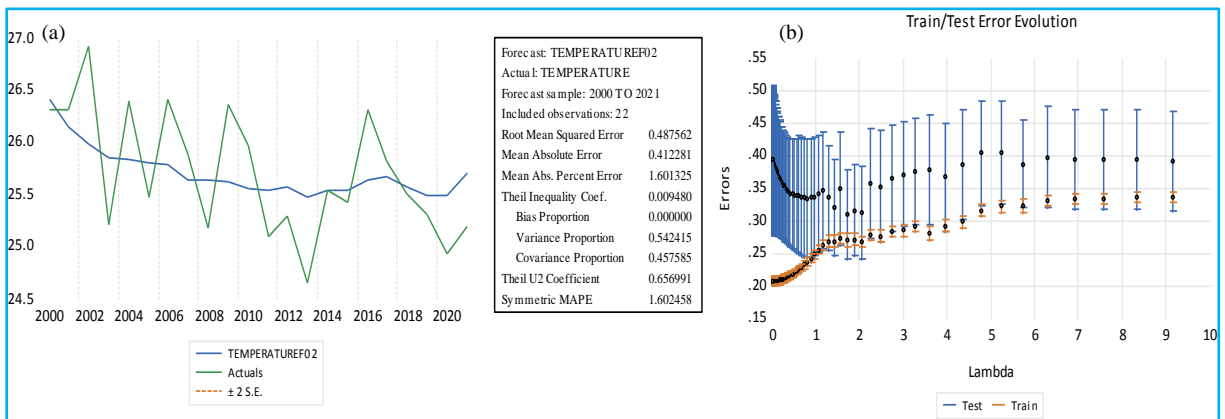

Fig. 8. Daily relative humidity equation derivatives

Figs. 9(a&b). Annual average temperature model output {graph (a), X-axis denotes Time (Years) and (b) Y- axis denotes temperature (°C)}
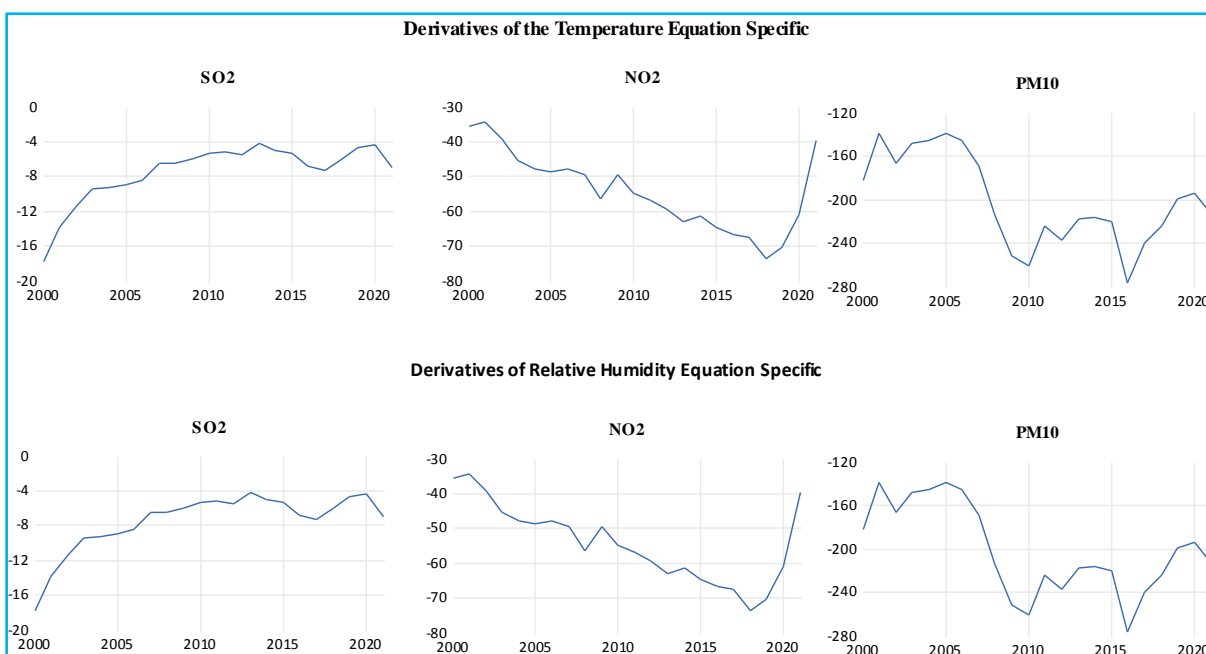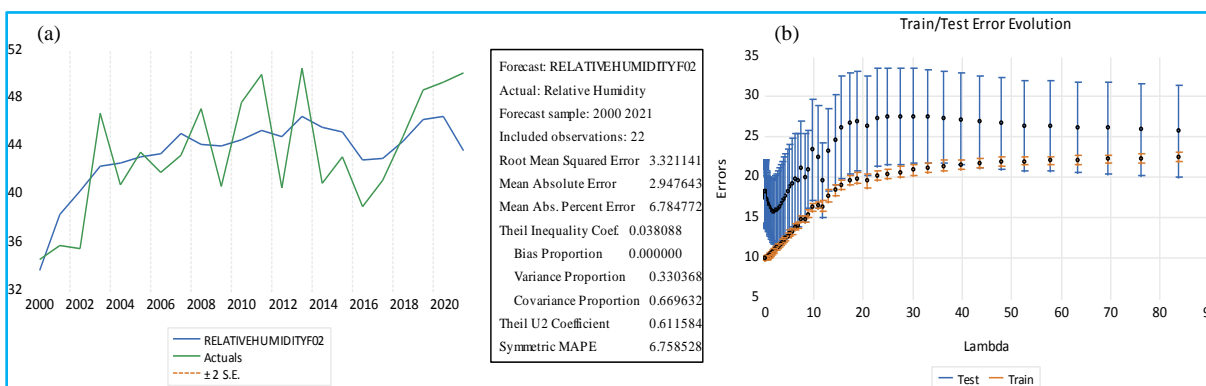
Fig. 10. Annual average temperature and relative humidity equation derivatives

Figs. 11(a&b). Annual average relative humidity output {graph (a), X -denotes Time (Years) (b) Y-axis denotes relative humidity}

3.1.2. *Association among criteria air pollutants and relative humidity*

The stepwise procedure of elastic net regression was performed to find an association between predictors and dependent variables. After running the model, the predicted results demonstrate that air pollutants account for 53.36% of the variance in change in daily relative humidity. Similarly, Lambda (λ) at minimum error comes out to be 0.2544, RMSE (Root Mean Square Error) came as 13.54 and MAE is 11.08, as shown in Fig. 7. The results indicate that the air pollutants influencing Delhi's humidity change are portrayed in Equation(3). The equation derivatives of relative humidity are displayed in Fig. 8.

$$\text{Daily Relative Humidity}_{Delhi} = 78.58 + 0.072*PM_{2.5} + 0.056*NO_x - 0.133*NO_2 - 0.11*O_3 - 0.621*CO - 0.97*SO_2 + 0.025*NO_2 - 0.102PM_{10} + 0.11*NO - 0.028*NH_3 - 0.58*C_6\,H_6 + 0.27*C_7\,H_8 - 0.35*C_8\,H_{10}$$
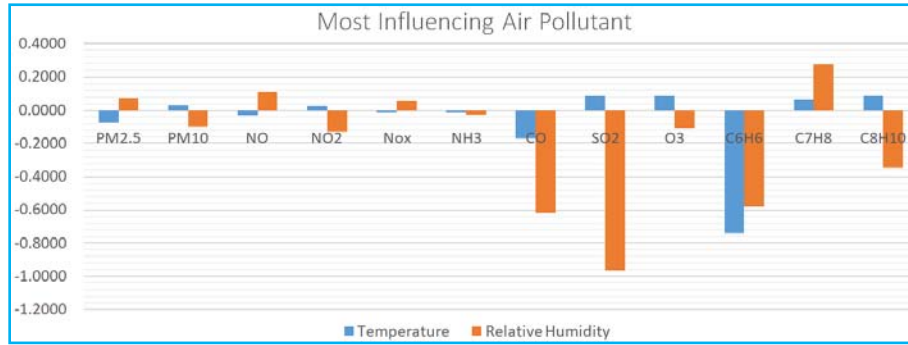
$$(3)$$

Fig. 12. Most influencing pollutant during 2015 to 2021

3.2. *Analysis output of the annual average model (2000-2021), including three criteria air pollutants*

3.2.1. *Association among criteria air pollutants and temperature*

The stepwise procedure of elastic net regression was performed to find an association between predictors and dependent variables. After running the model, the predicted results demonstrate that air pollutants account for 30.51% of the variance in change in average annual temperature. Similarly, Lambda (λ) at minimum error comes out to be 1.715, RMSE (Root Mean Square Error) came as 0.487, and MAE is 0.412, as shown in Fig. 9.Looking at the unique individual contributions of the predictors (pollutants), the results show that the air pollutants which influenced the temperature change in Delhi are portrayed in Equation 4. The equation derivatives of temperature are displayed in Fig. 10.

$$\text{AnnualTemperature}_{\text{Delhi}} = 25.31 + 0.0649 * SO_2 + 0.0023 * PM_{10} - 0.0016 * NO_2$$

(4)

3.2.2. *Association among criteria air pollutants and relative humidity*

The stepwise procedure of elastic net regression was performed to find an association between predictors and dependent variables. After running the model, the predicted results demonstrate that air pollutants account for 51.7% of the variance in change in daily relative humidity. Similarly, Lambda (λ) at minimum error comes out to be 1.847, RMSE (Root Mean Square Error) came as 3.321, and MAE is 2.94, as shown in Fig. 11. Looking at the unique individual contributions of the predictors (pollutants), the results indicate that the air pollutants

influencing the humidity change in Delhi are portrayed in Equation 5. The equation derivatives of relative humidity are displayed in Fig. 10.

$$\text{Annual Relative Humidity}_{\text{Delhi}} = 54.122 + 0.00042 * NO_2 - 0.977 * SO_2 - 0.016 * PM_{10}$$

(5)

3.3. *Impact of air pollutants on climate change*

3.3.1. *Based on the daily dataset*

Findings that appeared after running the best available method are portrayed in Fig. 12 showing the footprint of air pollutants on temperature and relative humidityfrom 2015 to 2021. The results from this study indicate that $PM_{2.5}$, PM_{10}, NO, NO_2, NO_x, SO_2, and O_3 showed a high correlation with the meteorological variables.Through all these findings of this study, it is seen that most of the pollutants in our atmosphere have significantly positive impacts on temperature and relative humidity. It is well known that both temperature and relative humidity are inversely proportional. Hence, the pollutants showing a positive association with Temperature and negative association with relative humidity work as an influencer for the climate change and *vice versa* (Khan *et al*., 2022; Sein *et al*., 2022; Uzuazor *et al*., 2021). Table 1 indicates the beta values that came out from this study. In the third column, indications are given. Green indication means the pollutant has significantly influenced climate change, and red indicates that there is no role that particular pollutant has played.

3.3.2. *Based on the annual average dataset*

Findings that appeared after running the best available method show the influences of air pollutants on the temperature and relative humidity change from 2000 to 2021. The results appeared after running the model with

TABLE 1

Climate change indication on daily basis

Pollutants	Temperature	Relative Humidity	Association
$PM_{2.5}$	-0.0763	0.0719	
PM_{10}	0.0274	-0.1029	
NO	-0.0302	0.1111	
NO_2	0.0259	-0.1335	
NOx	-0.0150	0.0562	
NH_3	-0.0134	-0.0281	
CO	-0.1697	-0.6212	
SO_2	0.0844	-0.9672	
O_3	0.0860	-0.1112	
C_6H_6	-0.7397	-0.5823	
C_7H_8	0.0641	0.2737	
C_8H_{10}	0.0826	-0.3490	

TABLE 2

Climate change indication on an annual basis

Pollutants	Temperature	Relative Humidity	Association
SO_2	0.0649	-0.977	
NO_2	-0.0016	0.00042	
PM_{10}	0.0023	-0.016	

the average annual dataset it was observed that all three criteria air pollutants whose data has been collected are showing significant association in enhancing the process of climatic change in Delhi over the past 22 years. It was found that SO_2, NO_2 and PM_{10} have demonstrated positive and negative associations with temperature and relative humidity, satisfying the condition of both being inversely proportional and the role of each pollutant in increasing the impact of change in the weather of Delhi. Table 2 indicates the beta values that came out from this study. In the third column, green indicates that the pollutant has significantly influenced climate change, and red indicates no role that particular pollutant has played.

3.4. *Association among pollutants and climatic variables*

In the below sections, a comparison between the findings with the results of previously available literature will be discussed, the effects of the combination of pollutants and climate change on human health.

3.4.1. *Particulate Matters (PM$_{2.5}$ and PM$_{10}$) and Meteorological Variables (Temp, RH)*

Particulate matter (PM) is currently one of the most severe urban pollutants due to its known adverse effects on human health, climate change, ecosystem damage, and its role in impaired visibility. It has been observed from previous studies that long- and short-term exposure to particulate matters can lead to premature death, non-fatal cardiovascular events, and respiratory effects (Hassan *et al*., 2022; Jain & Barthwal, 2022; Liao *et al*., 2022; Priyan *et al*., 2022; Sasmita *et al*., 2022; Sharma *et al*., 2022; Sisani *et al*., 2022). In this study, both $PM_{2.5}$ [with temperature (β = -0.076, R^2 = 46.29%) and relative humidity (β = 0.0719, R^2 = 53.36%)] and PM_{10} [with temperature (β = 0.0274, R^2 = 46.29%) and relative humidity (β = -0.1029, R^2 = 53.36%)] shown significant association in influencing the climate change process. Additionally, PM_{10}, when assessed with the yearly dataset of the past 22 years, showed a significant association with climate change, which further indicates that particulate

matter is playing a vital role in enhancing the process of climatic change in Delhi. Previous studies also observed a high association between particulate matter and meteorological parameters, *i.e.*, (Chithra & Shiva Nagendra, 2014; Goyal & Jaiswal, 2010; "IMPACT OF METEOROLOGICAL FACTORS ON $PM_{2.5}$ IN CHENNAI," 2017; Li *et al*., 2017; Maleki & Molaei, 2022; Sharma & Sharma, 2016. The government has to take additional preventive measures to stop particulate matter emissions from controlling the high pollution levels and even climate change.

3.4.2. *Oxides of Nitrogen (NO, NO_2 and NO_X) and Meteorological Variables (Temp, RH)*

Nitrogen dioxide (NO_2) forms when nitrogen oxide (NO) and other nitrogen oxides (NO_x) react with other chemicals in the air to form nitrogen dioxide, which means they are associated with each other (Kumar *et al*., 2015; Tiwari *et al*., 2015).

(*i*) Delhi has recorded an increase of 125% in NO2 pollution in the past year (https://www.greenpeace. org/india/en/). NO_2 is also an indirect greenhouse gas. It forms photochemical reactions in the atmosphere and produces tropospheric ozone. NO_2 exposure can have a negative influence on people's health at any age, damaging the respiratory, circulatory, and neural impulses, as well as the brain, leading to a rise in hospital admissions and mortality (Boningari & Smirniotis, 2016; Erickson *et al*., 2020; Kjellstrom *et al*., 2002). In this study, NO_2 [with temperature (β = 0.0259, R^2 = 46.29%), and relative humidity (β = -0.1335, R^2 = 53.36%)] showed significant association in influencing the climate change process. Additionally, the annual study of the past 22 years also states that NO_2 plays a vital role in the temperature change in Delhi. The most significant sources of NO_2 pollution in Delhi are motor vehicles and fossil fuel industries. Governments, local governments and city planners must begin the transition from privately owned automobiles to an efficient, clean, and safe public transportation system powered by renewable energy, which will not only assist in reducing pollution but also to decrease the rate of climate change.

(*ii*) Both NO (with temperature (β = -0.032, R^2 = 46.29%) and relative humidity (β = 0.111, R^2 = 53.36%) and NO_x [with temperature (β = -0.0150, R^2 = 46.29%), and relative humidity (β = 0.0562, R^2 = 53.36%)] shown significant association in influencing the climate change process. Previous studies indicating association among these both including NO_2, *i.e.*, (Cheng & Lam, 2000; Ghosh *et al*., 2017; Jiang *et al*., 2005; Khiem *et al*., 2010; Lin *et al*., 2021; Mahapatra *et al*., 2014; Sharma & Sharma, 2016).

3.4.3. *Ammonia (NH_3), Carbon Monoxide (CO), and Meteorological Variables (Temp, RH)*

(*i*) Ammonia presents for a shorter period in the atmosphere. Hence it has a global warming potential of zero which even matches with the findings of this study NH_3 [with temperature (β = -0.0134, R^2 = 46.29%) and relative humidity (β = -0.0281, R^2 = 53.36%)], had not shown any significant association in influencing the climate change process (Majeed *et al*., 2020).

(*ii*) On the other hand, CO does not absorb terrestrial thermal IR energy strongly enough, which indicates that it is not a greenhouse gas. In this study, CO [with temperature (β = -0.1679, R^2 = 46.29%) and relative humidity (β = -0.6212, R^2 = 53.36%)] had not shown significant association in influencing the climate change process (Majeed *et al*., 2020).

3.4.4. *Ground-level Ozone (O_3), Sulphur dioxide (SO_2) and Meteorological Variables (Temp, RH)*

(*i*) Ground-level ozone levels tend to high in summer due to the elevated heat and sunlight. With the help of the available dataset, the link between ground-level ozone and temperature was assessed, and it was found that the Pearson Correlation came out as (r = 0.12). Recently, in many studies, it has been found that ground-level ozone is highly associated with heat waves on hot days. It also indicates that ozone also helps with climatic change.

(*ii*) On the other hand, SO_2 is not a direct greenhouse gas. It is considered an indirect greenhouse gas because it forms aerosols that contribute to the planet's cooling and warming when coupled with elemental carbon. From this study, it is observed that SO_2 [with temperature (β = 0.0844, R^2 = 46.29%) and relative humidity (β = -0.9672, R^2 = 53.36%)] showed significant association in influencing the climate change process after forming aerosols in Delhi region. These have also been justified with the second model in which 22 years of annual average data was assessed (Abdul-Wahab, 2006; Calkins *et al*., 2016; Ghosh *et al*., 2017; Gvozdić *et al*., 2011; Kim & Lim, 2005; Sezer Turalıoğlu *et al*., 2005; Unnikrishnan & Madhu, 2019; Xue & Yin, 2014; Yang *et al*., 2022).

3.4.5. *Benzene, Toluene, Xylene, and Meteorological Variables (Temp, RH)*

In this study, both C_6H_6 [with temperature (β = -0.7397, R^2 = 46.29%) and relative humidity (β = -0.5823, R^2 = 53.36%)] and C_7H_8 [with temperature

(β = 0.0641, R^2 = 46.29%) and relative humidity (β = 0.2737, R^2 = 53.36%)], has not shown positive association on the climate change process. Only C_8H_{10} [with temperature (β = 0.0826, R^2 = 46.29%) and relative humidity (β = -0.3490, R^2 = 53.36%)] are shown to have a significant association in influencing the climate change process, making it an indirect greenhouse gas. Additionally, this study has observed that Toluene positively affects both temperature and relative humidity, indicating it is a strong predictor in influencing temperature and relative humidity.

4. Conclusion

A daily dataset of twelve air pollutants (2015-2021), an average annual dataset with three criteria air pollutants (2000-2021), and the best regression model were used to assess the impact of air pollutants on the temperature and relative humidity. The results were obtained in which $PM_{2.5}$, PM_{10}, NO, NO_2, NO_x, SO_2, O_3 and C_8H_{10} showed a significant positive association in enhancing the process of climatic change in the Delhi region. Additionally, NH_3, CO, C_6H_6 and C_7H_8 showed a negative association with climatic change. Toluene, in this study, appeared as a pollutant that has shown a positive relationship with both temperature and relative humidity. It can be studied whether it shows the same behavior in other regions. From all these findings, it has been concluded most of the pollutants were showing significant association in enhancing the rate of climate change in Delhi. The Government of Delhi has to make effective policies to control the emission of pollutants in this region, which will further help minimize air pollution's influence on climate change and human health.

Disclaimer : The contents and views expressed in this study are the views of the authors and do not necessarily reflect the views of the organizations they belong to.

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