Time series forecasting for ground level ozone in Kota city

Shikha Saxena[1*], A.K Dwivedi[2] Anil K Mathur[3],
[1]Rajasthan technical University, Department of Civil Engineering, Kota, India
[2]Rajasthan technical University, Department of Civil Engineering, Kota, India
[3]Rajasthan technical University, Department of Civil Engineering, Kota, India.

ABSTRACT

Urbanization of the cities and exponentially increasing population led global warming climate change and health problems related to environment. In this regard many studies have been conducted that are concerned about the prediction of pollutants using supervised learning methods to model the pollutant concentrations as well as to control the activities as per alerts signalized by future predictions. As per the Data shown by pollution control board the concentrations of ground level ozone is under control. To encapsulate the trend of ground level ozone promotes the study and future predictions In Kota city. The trend of pollutants is rising every day. For precise trend determination the continuous historical data are of utmost importance. In this paper time series forecasting approach is used for predicting future data by analyzing historical data and as a trend analyzer. Nonlinear Autoregressive (NAR) of time series tool of neural network have been used in this paper to predict series from past series values. Time series forecasting Predictor model is developed for the prediction of prime pollutant from i.e. Ground level ozone.

Keywords: Time series forecasting, O_3, Health effects.

1. Introduction

Ground-level ozone is a colorless and highly irritating gas that forms just above the earth's surface. It is produced when two primary pollutants react in sunlight and stagnant air. The two primary pollutants are nitrogen oxides (NOx) and volatile organic compounds (VOCs).

Environmental impact of ozone gas varies with height. Stratospheric ozone is good as it protects living being from ultraviolet radiation from the sun. Ground-level ozone is bad as it can trigger a variety of health problems, particularly for children, the elderly, and people of all ages who have lung diseases such as asthma. Long term exposure leads to pre-mature mortality. In addition to its effects on human health, ozone can significantly impact vegetation and decrease the productivity of some crops .Ozone can also damage synthetic materials, causes cracks in rubber, accelerate fading of dyes, and speed deterioration of some paints and coatings. As well, it damages cotton, acetate, nylon, polyester and other textiles.

Ozone at ground-level is emitted by cars, power plants, refineries, and other sources. It is found that the prime component of smog is ozone. Its values substantially increases with temperature in summer season hence weather plays an important role in the pollutant concentrations.

2. Area of study

Kota city is well known as education hub with over 16 lakhs habitants. It is situated on the bank of Chambal River in the southern part of Rajasthan. It is the third largest city after Jaipur and Jodhpur. Area of city is 527 sq km and the cartographic coordinates are 25.18º N 75.83º E. It has semiarid climate with high temperature throughout the year. Maximum temperature reaches up to 48 degrees which subside in monsoon season. The average rainfall in Kota is 660.6 mm. Majority of region is rural in character. The population of the district has increased by more than four times in the present century. Kota is one of the three most polluted city as reported in Times of India. Here population is growing day by day due to coaching centers. It also comes under non- attainment cities in terms of PM10.

3. Methodology:

The parameters monitored include O_3, Solar radiation, relative humidity, wind speed from one the monitoring station situated at Shreenath puram stadium taken into account for statistical studies and prediction of pollutant at particular location has been done through dynamic time series model. .The primary goal of the paper was the prediction of trend of ground level ozone in Kota City with the ground data set.

4. Neural network time series model

Prediction is kind of dynamic filtering in which past values are used to predict future values. Nonlinear autoregressive (NAR) have been used to predict future series from past series values. The database was generated through one of the continuous air quality monitoring station situated at shreenathpuram stadium official site. Time period is the only predictor variable and O_3 concentrations are the output variable. Daily data of O_3 from May 2018 to 14 Feb 2019 have been used in this study. As the O_3 values (variables) showed a wide range of numerical values, the data set was normalized within a range of (0.1,0.9)) to avoid the overflow of network due to large or small weights produced for the data set considered and to eliminate the influence of dimensions of data on the network. Fig 2 shows the daily variation of Ground level ozone concentration from date 16 May 2018 to 14 Feb 2019.

5. Results and Discussion

In this work time series model architecture is proposed to evaluate the ground level ozone concentrations in Kota city. The data taken over here is from one of the monitoring station i.e.

Shreenathpuram stadium. The observation shows the trend of ground level ozone and their correlation with other meteorological parameters. It can be concluded that ground level ozone has increasing trend in Kota city. Descriptive statistical parameters for various meteorological parameter and ground level ozone are shown in the **Table 1** below. **Fig.**1 shows the Output response for time series and Fig.2 depicts the Regression analysis for time series.

Table 1: Statistical parameters for G.L Ozone and meteorological parameters

	O3	WS	RH	SR	NOX	TEMP
Mean	22.45543796	1.925292	55.32934	184.9591	35.78296	27.2079
Standard Error	0.57279132	0.382697	1.451253	4.654629	1.248433	0.433181
Median	20.685	1.24	52.055	197.13	35.44	28.375
Mode	21.84	0.73	52.87	241.74	16.79	18.11
Standard Deviation	9.481383417	6.334758	24.02252	77.04782	20.66525	7.144197
Sample Variance	89.89663149	40.12915	577.0814	5936.366	427.0526	51.03955
Kurtosis	8.421357584	152.0816	12.19644	-0.25388	-0.87989	-0.65486
Skewness	2.432820608	12.13355	2.000926	-0.47979	0.231059	-0.16248
Range	75.37	87.77	219.68	406.3	85.7	34.67
Minimum	5.19	0.53	8.01	6.11	1.76	8.34
Maximum	80.56	88.3	227.69	412.41	87.46	43.01
Sum	6152.79	527.53	15160.24	50678.8	9804.53	7400.55
Count	274	274	274	274	274	274

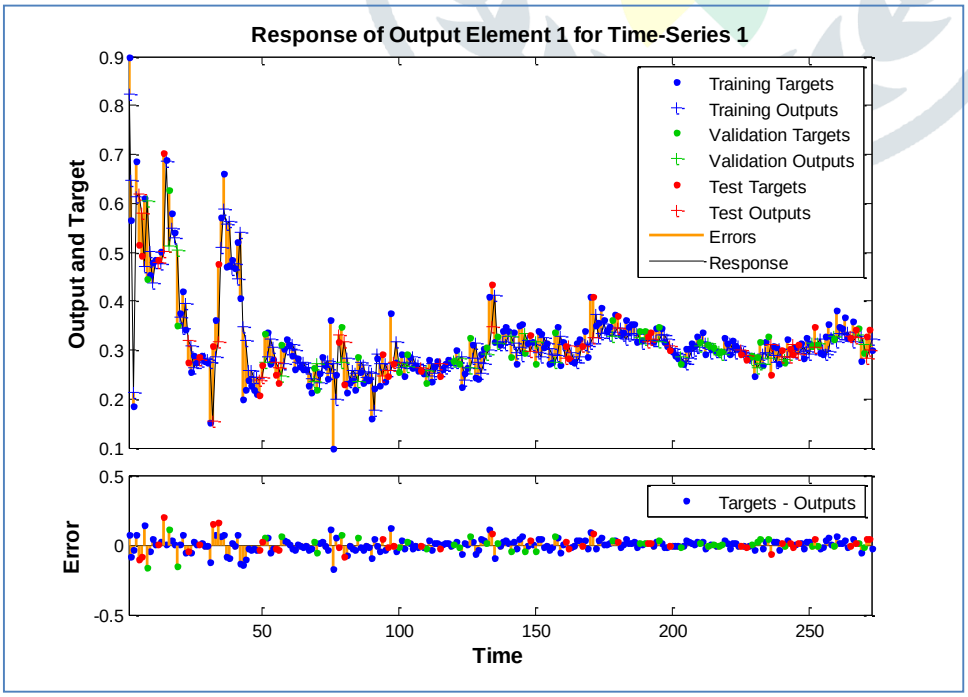

Fig.1 **Output response for time series.**

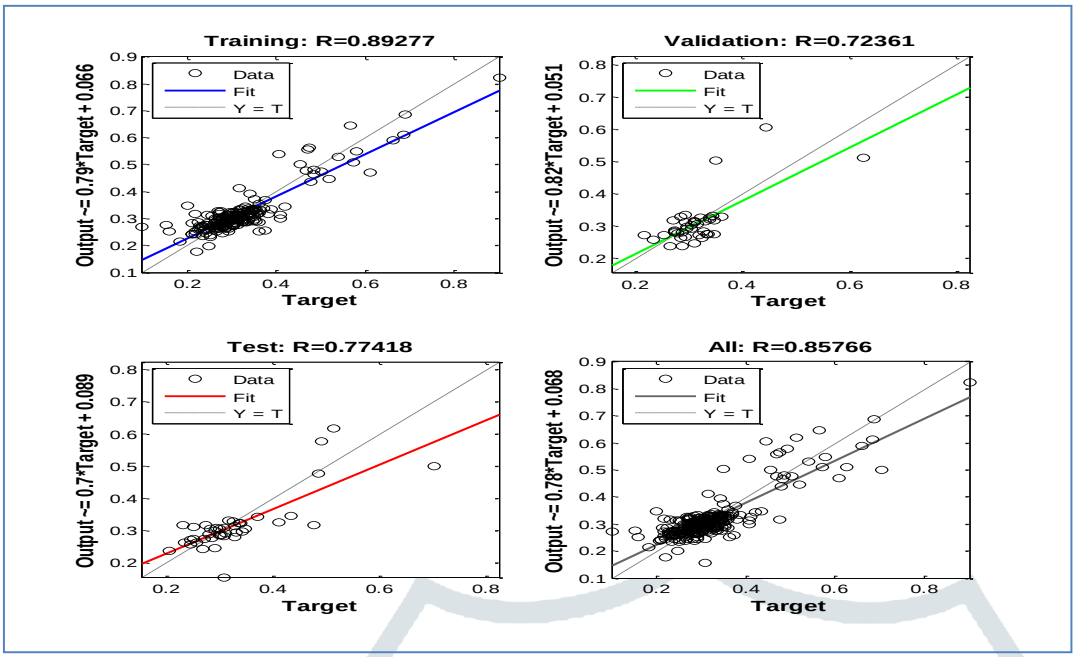

Fig.2 Regression analysis for time series.

Conclusion

Although the Ground level ozone concentrations are found to be within limits prescribed by W.H.O and NAAQS but occasionally gets high in summer season. The maximum concentration found 80.56 µg/m^3 which is lesser than 100 µg/m^3, 8 hour mean and minimum was 5.19 µg/m^3. As weather plays an important role, weather parameters need to employ in analysis to understand the real time scenario. It can be concluded that time series dynamic model of neural network can be applied successfully as tool used for making decisions in case of alarming situations and problem solving for better atmospheric management. The pollutant Ground level-ozone (O_3) concentrations are used for AQI calculation. Keeping its health impacts in view it is necessary to keep an eye on the trend of particular pollutant as well.

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