IJBPAS, January, Special Issue, 2022, 11(1): 102-105
ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)
'A Bridge Between Laboratory and Reader'

www.ijbpas.com

STATISTICAL TREND ANALYSIS AND FORECAST MODELING OF AIR POLLUTION IN CITY AGRA

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Received 10th June 2021; Revised 11th July 2021; Accepted 20th Aug. 2021; Available online 15th Jan. 2022

https://doi.org/10.31032/IJBPAS/2022/11.1.1011

ABSTRACT

The study provides a statistical trends analysis of air pollutant sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and SPM using Air Pollution Index (API) and Moving average method. Data from 1996 to 2000 and 2001 to 2005 was calculated to find the effect of Supreme Court ruling, 1996 and public awareness about air pollution control. The Moving average method forecast was applied to check out the environmental air quality forecast in city Agra India. The API Trend indicated a decrease in pollutant level.

Keywords: Air quality, Statistical forecasting model. Mathematical modeling, Moving Average, SPM, SO_2

INTRODUCTION

Industrial growth of a city has increased the problem of pollution. There is an urgent requirement of an effective measurement of Urban environmental forecast to control the air quality of cities (Urban) and to protect people's health. It is a public welfare work to improve people's quality of life and reflect the image of the people's government[1]. The scientific basis is required for environmental management and decision-making departments which can be possible by releasing timely and accurate environmental air quality forecast to provide strong grip on observing the future change trend of urban environmental air quality[2].

METHODOLOGY AND OBSERVATIONS

An 'air pollution index' can be defined as a scheme that transforms (weighted) values of individual air pollution related parameters, e.g.. NO_2. SO_2 & Suspended paniculate matter (SPM) into single number or set of numbers. Air pollution index is calculated by the following formula

Air pollution index (API) = $\frac{1}{n}\sum_{i=1}^{n}(Ai)$

Here $A_i = \frac{C_i}{S_i} \times 100$

Where C_i = concentration of pollutant i

S_i = Air quality standard for pollutant i

API = air pollution Index

The concentration of SO_2, NO_2 and SPM **(Table 1)** was recorded at Tajgnj. Dayalbagh, St. John's Crossing, Manas Nagar, Sadar Bazar and Foundry Nagar parts of Agra, India.

Table 2 shown the National air quality standard presented by Central Pollution Control Board (CPCB, Government of India) New Delhi. India (CPCB report 2000)[3].

On putting the values from **Table 1** and table 2 in calculating Air Pollution Index (API) was obtained **(Table 3)**.

Table 1: Concentration of SO_2, NO_2 and SPM

Site	Location	SO_2	NO_2	SPM
1	Tajganj	18	15	519
2	Dayalbagh	14	12	516
3	St. John's Crossing	21	19	751
4	Manas Nagar	15	14	653
5	Sadar Bazar	16	14	656
6	Foundry Nagar	22	20	742

Table 2: Ambient air quality standard for SO_2, NO_2 and SPM

Pollutant	Time weighted average	Industrial	Residential or Rural	Sensitive
SO_2	Annual Average	80	60	15
	24Hrs	120	80	30
NO_2	Annual Average	80	60	15
	24Hrs	120	80	30
SPM	Annual Averag	360	140	70
	24Hrs	500	200	100

Table 3: API of Agra at various selected sites

S. No.	Location/Sites	API
1	Tajganj	320.48
2	Dayalbagh	161.11
3	St. John's Crossing	446.51
4	Manas Nagar	498.09
5	Sadar Bazar	378.82
6	Foundry Nagar	86.203

As per the obtained data, it can be concluded that the minimum air pollution is in the Foundary Nagar. The air pollution index of Taj Ganj St. John's, Manas Nagar and Sadat Bazar is Hazardous. Air Pollution in Dayal Bagh is also

unhealthful.

Further, to check the trends of pollution level and Forecasting after effect of Supreme Court's ruling 1996, the Moving average model was implemented to analyzed SO_2, NO_2 and SPM level in the city between year 1996 - 2000 and 2001-2005.

The chain index and API were calculated for SO_2, NO_2 and SPM using formula-

Index No. = $\frac{P_1^i}{P_0^i} \times 100$; i = 1,2,3.....10

Where P_1^i is value of i^{th} commodity in the base year and P_0^i is i^{th} commodity in current year.

Chain index = *index no. x* $\frac{P_1^i}{P_0^i}$

Normalization of given value was also done using formula

Norm Y = $\sqrt{x_1^2 + x_2^2 + x_3^2}$

Where normalized values = $\frac{x_1}{y}, \frac{x_2}{y}, \frac{x_3}{y}$

here x_1, x_2 and x_3 are mean values of SO_2. NO_2 and SPM respectively.

Average of SO_2. NO_2 and SPM was $\frac{\left[\frac{x_1}{y} + \frac{x_2}{y} + \frac{x_3}{y}\right]}{3}$

Table 4 has demonstrated the API and chain Index of SO_2. NO_2 and SPM between 1996 - 2000 and thereafter a forecast was calculated by Moving average method.

Table 4 : Average mean API and chain index number of SO_2, NO_2 and SPM during 1996-2000

Year	NO_2			SO_2			SPM		
	Average	*Index No.*	*Chain Index No.*	*Average*	*Index No.*	*Chain Index No.*	*Average*	*Index No.*	*Chain Index No.*
1996	**13.0**	**102.36**	**83.02**	**17.0**	**76.58**	**62.09**	**480**	**109.84**	**106.32**
1997	**12.3**	**94.49**	**96.72**	**13.7**	**61.71**	**47.26**	**380**	**86.96**	**95.52**
1998	**108**	**85.04**	**80.35**	**12.1**	**54.50**	**33.63**	**507**	**116.02**	**134.60**
1999	**9.7**	**76.38**	**64.95**	**10.7**	**48.20**	**26.27**	**418**	**95.65**	**91.49**
2000	**9.2**	**72.44**	**55.23**	**10.3**	**46.20**	**22.36**	**330**	**76.20**	**58.07**

The moving average model is a part of Box-Jenkins method of forecasting in Period t on the basis on its past values. There is a simple, rather a naive, yet a useful method of using average to forecast. This simple method assumes that forecast in future year equals the average of forecast in the past years. The formula of simple moving average method is expressed as

$$f_t = \frac{1}{N}(X_{t-1} + X_{t-2} + X_{t-3} + ... + X_{t-n})$$

where f_t = forecast in period t; X_{t-1}, $_{t-2}$, $_{t-3}$, ... $_{t-n}$ is forecast in previous years, N = number of preceding years.

Table 5: Forecast calculated by moving average method for SO_2, NO_2 and SPM

Year	SO_2	NO,	SPM	$\frac{[SO_2 + NO_2 + SPM]}{3}$
2001	**11.43**	**17.83**	**431.45**	**150.59**
2002	**11.13**	**17.32**	**430.86**	**149.86**
2003	**9.95**	**15.26**	**391.08**	**135.48**
2004	**8.77**	**12.71**	**340.28**	**117.46**
2005	**7.63**	**10.51**	**295.39**	**92.12**

Based on these calculations the moving average model of air represents a decreasing trends after 1996 which may be due to Supreme Court's ruling.

CONCLUSION:

The present study concluded that a legal and social awareness should be imposed on industrial units, transportation means and other activities, which are responsible for creating air pollution problems. The steps should be taken to educate persons to each other regarding pollution control. The Moving Average Model is a potential method to find the trend of a public awareness and legal ruling in any situation like air pollution.

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