ASSESSMENT OF AIR QUALITY OF LUCKNOW CITY AND PROPOSING A MODEL USING MATLAB: A REVIEW

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Abstract : Air quality is one of the major ecological issues of Lucknow city. This is a result of increase of vehicular outflows and gradual escalating private vehicles on street, Rapid urbanization, Industries encompassing the city, Unconsciousness of government and public toward this issue, burning of woods for fuel purposes and burning of the garbage leads to excessive pollution load. The objective of this review article is to analyze the ambient air pollution status of city by using soft computing in data interpretation. The study relates to the application of MATLAB toolbox technique in evaluating contamination status in city of Lucknow, India. The point of this investigation was to address air quality assessment utilizing MATLAB toolbox assessment model and to predict the best possible approach on assessment of air quality parameters. In point of view of the rapid development of Lucknow city in term of area, inhabitants and number of enrolled vehicles, arranging and usage of appropriate air contamination control measures are important to ensure the strength of its residents. A systematic review on the existing MATLAB toolbox and turn out to be a good option for predicting and analyzing the future impact of air pollution on various zones of Lucknow.

KEYWORDS: Air quality, MATLAB toolbox, Lucknow

1. INTRODUCTION:

The Pollution means the contamination of the air. As per section 2(a) of Air (Prevention and Control of Pollution) Act, 1981 air pollution has been defined as, " any solid, liquid or gaseous substance (including noise) present in atmosphere in such concentration as may be or tend to be injurious to human being or other living creatures or plants or property of environment" .The composition of the atmosphere has been gradually changing over the past millions of years. Rapid urbanization and industrialization has added other elements/ compounds to the pure air and thus caused the increase in pollution.

As per CSIR-IITR report 2018 The most extreme 24 hours mean grouping of PM2.5 was seen in Indira Nagar (99.6 µg/m^3) local location and Charbagh (105.4 µg/m^3) in business territory. The estimations of PM2.5 was over the endorsed National Ambient Air Quality Standard (NAAQS) of 60 µg/m^3 for residential, commercial, industrial and different zones. The level of the pollutants has been found increasing from the last year records. The reason found were the increase of the deforestation rate for the construction of highways and for widening roads; increase of the automobiles on road, casual nature of the citizens of Lucknow and expansion of the industrial sector in the outskirts of Lucknow [Saluja G. 2017]. The examination goes for assessing the air contamination in Lucknow with the attention on the Particulate Matter (PM_{10} and $PM_{2.5}$), Sulphur Dioxide and Nitrogen Dioxide.

Vehicular traffic was identified the major source of air pollution in the city. Air pollution level at control site (village or low traffic density area) was lower than other urban sites. Particulates and associated toxic chemicals (metals and PAHs) and gaseous pollutants have found to be toxic to human and plants in Lucknow. The exposure of these pollutants is associated with cardiovascular and respiratory diseases, neurological impairments, increased risk of preterm birth and even mortality and morbidity. Various studies focusing roadside air contamination have demonstrated high air contamination and in addition to adverse effect on chlorophyll content of roadside plants [Verma et al.2015]. The uncovered drivers, sellers and

activity policemen are at high danger of eye-related issues because of release of auto exhaust and contaminated air at the breathing zone [Kisku et al.2012]. The utilization of alternative fuel is thought to be a successful measure to enhance the urban air quality [Khillare et al. 2008]. Technological upgradation and scientific know how has reduced the pollution level, especially of the gaseous pollutants, but increase in number of vehicles causes more emission of pollutants and also changes the composition ratio of the pollutants especially the particulate matter [Zanini et al., 2006], which includes the fine and ultrafine particles.

Vehicular exhaust is one of the most important source of fine particles (Nolte et al., 2002; Fang et al., 2005; Barman et al., 2008). Li et al. (2008) proposed an integrated fuzzy-stochastic modelling approach for quantifying uncertainties associated with both source/medium conditions and evaluation criteria and thus assessing air pollution risks. Hajek and Olej (2009) presented an approach for design of AQIs based on tree/cascade hierarchical fuzzy inference systems.

Mandal et al. (2012), Sowlat et al. (2011) used rule-based fuzzy techniques for air quality assessment. Fisher (2003) illustrated that the use of fuzzy sets formalizes the underlying uncertainty and therefore leads to better decision-making.

Considering various research outputs it can be concluded that fuzzy logic is a promising and well suited approach for air quality assessment modelling.

2. STUDY AREA:

Lucknow is popularly known as the City of Nawabs. It is also known as the Golden City of East. Lucknow, which has a population of 3.47 million (Municipal corporation and cantonment), area of 310 sq.km and its graphical position is 26◦52'N latitude to 80◦56'E longitude; 128m above the sea level. City has a number of small industries located in different parts of city**.**

The main causes of air pollution in Lucknow are:

- Vehicular emissions and day by day increasing private vehicles on road.
- Rapid urbanization on the expenditure of greenery.
- Industries surrounding the city.
- Unconsciousness of government and public toward this problem.
- Burning of woods for fuel purposes.
- Burning of the garbages.

3. SALIENT FEATURES OF THE STUDY AREA (LUCKNOW):

Table 1:

AREA	310 sq.km
GEOGRAPHICAL POSITION	26°52' N LATITUDE 80°56' E LONGITUDE 128 m above sea level
POPULATION	28,15,033 as per 2011 censes 34,70,400 estimated population 2018
TOTAL VEHICULAR POPULATION IN LUCKNOW AS ON 31/03/2018	20,08,190
CLIMATE	Subtropical climate, cool dry winter (Dec.- Feb.) & summer (Mar. - Jun.). Temperature about 45◦C in summer to 3◦C in winter.
TOTAL NO. OF FILLING STATIONS	110
CONSUMPTION OF PETROL	2,08,736 KL
CONSUMPTION OF DIESEL	2,09,801 KL
CONSUMPTION OF CNG	4,24,37,108 KG

4. AIR POLLUTION STATUS

The ambient air quality studies of Lucknow reported in literature since the last many years have been summarized in this section. In this study, SPM, RSPM, SO2, NOx and 7 trace metals associated with RSPM

were estimated at 10 representative locations in urban area and one village area for control. Beside this, air quality index (AQI), health effects of different metals and mortality were assessed. The 24 hr average concentration of SPM, RSPM, SO_2 and NOx was found to be 382.3, 171.5, 24.3 and 33.8 µ g m-3 respectively in urban area and these concentrations were found to be significantly ($p<0.01$) higher by 94.8, 134.8, 107.4 and 129.6% than control site respectively. The 24 hr mean of SPM and RSPM at each location of urban area were found to be higher than prescribed limit of National Ambient Air Quality Standard (NAAQS) except SPM for industrial area. The 24 hr mean concentration of metals associated with RSPM was found to be higher than the control site by 52.3, 271.8, 408.9, 75.81, 62.7, 487.54 and 189.5 % for Fe, Cu, Pb, Zn, Ni, Mn and Cr respectively. The inter correlation of metals Pb with Mn, Fe and Cr; Zn with Ni and Cr; Ni with Cr; Mn with Fe and Cu with Cr showed significant positive relation either at $p<0.05$ or $p<0.01$ level. Metals Pb, Mn and Cr ($p<0.01$) and Cu ($p<0.05$) showed significant positive correlation with RSPM. These results indicate that ambient air quality in the urban area is affected adversely due to emission and accumulation of SPM, RSPM, SO_2 , NOx and trace metals. (S.C.Barman et.al. 2010).

The PM10 concentration (lg/m3) in Lucknow city at 4 locations in three different seasons ranged between 148.6–210.8 (avg. 187.2 ± 17.1) during summer, 111.8– 187.6 (avg. 155.7 ± 22.7) during monsoon and 199.3– 308.8 (avg. 269.3 ± 42.9) during winter while PM2.5 ranged between 32.4–67.2 (avg. 45.6 ± 10.9), 25.6–68.9 (avg. 39.8 ± 4.6) and 99.3–299.3 (avg. 212.4 ± 55.0) during respective seasons. The mass fraction ratio of PM2.5 ranged between 0.22–0.92 (avg. 0.42 ± 0.26) and was significantly high during winter season indicating their composition.(P. Pandey et.al. 2011).

The average concentration of PM10 during winters of 2002, 2003 and 2004 was 196.5, 266.8 and 166.3 µg/m3 in residential, 258.2, 321.7, 211.2 µg/m3 in commercial and 205.0, 231.5, 198.5 µg/m3 in industrial area respectively, were above their respective NAAQS of 100 µg/m3 for residential/ commercial, rural and other areas and 150 µg/m3 for industrial areas. The Pb concentration in this study ranged 0.07-0.89 µg/m3. Introduction of CNG buses for public transport in place of diesel-operated three wheelers on the trunk route resulted in lower PM10 levels in 2004 (G. C Kisku et.al. 2013).

Particulate fractions viz.; PM2.5, PM10 and SPM were reported to be exceeded the National Ambient Air Quality Standards (NAAQS) limits in most of the studies but oxides of sulphur and nitrogen (SO2 and NOx) were within the limit of 80 µg/m3. Lack of dispersion of pollutants in winter season was reported to be the main reason for highest air pollution during this season and minimum in monsoon due to washout by rains. Commercial areas with high traffic volume recorded higher air pollution levels than residential and industrial areas with low traffic density. Vehicular traffic was identified the major source of air pollution in the city. Air pollution level at control site (village or low traffic density area) was lower than other urban sites. Particulates and associated toxic chemicals (metals and PAHs) and gaseous pollutants have found to be toxic to human and plants in Lucknow (A.K. Verma et.al. 2015).

In a study conducted at four locations of the city during 2007–09, the average value of PM10 and PM2.5 was 168.1 (1.7 times) and 87.3 (1.5 times) µg/m3 higher than their respective NAAQS limits of 100 and 60 µg/m3. Amongst the metals associated with PM10, maximum Fe and minimum Cd was observed. Concentration of Pb, 40.6 was less than 1000 ng/m3, while Ni, 35.1 exceeded 20 ng/m3 limits prescribed by NAAQS-2009. The maximum values of metals were observed during winter. The average level of benzo(a)pyrene (51.96 ng/m3) was about 50 times higher than the standard value of 1 ng/m3 (NAAQS-2009, India: annual average). Author suggested that the higher prevalence of diseases viz.; asthma, tuberculosis, pneumoconiosis, chronic bronchitis and lung cancer among Lucknow population can be linked to the high concentration of fine particulates, toxic metals and PAHs found in urban atmosphere (D. Patel et. al. 2013).

According to the UPPCB (UTTAR PRADESH POLLUTION CONTROL BOARD) analysis of air quality parameters of different locations such as residential, commercial, for industrial areas Lucknow in year 2018 as shown in table.

Table 2: CONCENTRATION OF PM_{10}

MONTHS	HAZRATGANJ	MAHANAGAR	ALIGANJ	TALKATORA	GOMTINAGAR
Jan-18	429.35	259.32	363.72	415.76	337.35
Feb-18	370	185.49	188.8	311.36	308.08
Mar-18	255.44	169.94	200.93	307.07	237.26
Apr-18	250.26	232.26	165.6	244.12	207.33
May-18	216.29	220.11	190.48	216.05	220.84
Jun-18	233.01	201.03	127	214.12	178.68
Jul-18	171.31	189.01	87.24	111.97	129.89
Aug-18	155.06	105.16	78.04	74.15	83.25
Sep-18	166.22	156.35	82.06	173.02	120.85
Oct-18	187.08	207.37	154.27	183.99	212.06
Nov-18	278.12	291.42	236.58	276.37	281.66

Table 3: CONCENTRATION OF SO_2

MONTHS	HAZRATGANJ	MAHANAGAR	ALIGANJ	TALKATORA	GOMTINAGAR
Jan-18	9.45	9.24	9.21	10.28	10
Feb-18	8.83	8.37	7.08	9.03	8.31
Mar-18	8.88	7.48	7.04	8.86	8.34
Apr-18	8.3	8.04	7.16	8.39	8.68
May-18	9.01	8.08	7.92	8.64	8.21
Jun-18	8.29	7.38	6.53	7.94	7.67
Jul-18	7.16	6.47	6.01	6.67	6.65
Aug-18	6.03	5.76	5.77	6.36	5.94
Sep-18	6.49	6.94	5.7	6.76	6.7
Oct-18	8.04	7.68	7.55	8.62	8.44
Nov-18	10.08	9.93	8.91	4.28	9.66

Table 4: CONCENTRATION OF NO_2

MONTHS	HAZRATGANJ	MAHANAGAR	ALIGANJ	TALKATORA	GOMTINAGAR
Jan-18	29.62	29.23	26.75	27.6	29.93
Feb-18	28.4	35.5	24.36	29.91	24.79
Mar-18	28.08	24.78	24.83	28.05	25.12
Apr-18	27.68	29.2	24.29	28.58	27.75
May-18	31.07	29.58	29.19	29.88	28.99
Jun-18	30.14	27.9	27.31	29.83	29.84
Jul-18	27.44	26	22.16	26.57	24.88
Aug-18	23.18	23.29	21.6	23.92	22.64
Sep-18	27.2	23.68	20.74	28.72	24
Oct-18	32.13	27.69	27.51	32.83	31.2
Nov-18	38.18	34.92	31.65	38.81	34.48

Table 5 : AQI LEVEL

MONTHS	HAZRATGANJ	MAHANAGAR	ALIGANJ	TALKATORA	GOMTINAGAR
Jan-18	399	209	317	382	287
Feb-18	325	157	159	261	258
Mar-18	201	147	167	257	192
Apr-18	200	188	144	196	172
May-18	178	180	160	177	181
Jun-18	189	169	118	176	152
Jul-18	148	159	87	108	120
Aug-18	137	103	78	74	83
Sep-18	144	138	82	109	114
Oct-18	158	172	136	156	175
Nov-18	228	241	191	226	232

5. CONCLUSION

Lucknow has witnessed significant growth during the last one and half decades and recorded similar trends of air pollution to other cities located in northern Indo Gangetic plains of India. Lucknow has a complex mix of air pollution like any other urban centers. The present review, based on the studies conducted in Lucknow,

identified particulate matter as the main air pollutant in the city. Most of the time particulate fractions (PM2.5, PM10, SPM) exceeded the NAAQS limits. Gaseous pollutants sulphur dioxide and nitrogen dioxide although remained within the NAAQS limits, but were high enough to cause substantial damage to human and plant health.

This is a result of increase of vehicular outflows and gradual escalating private vehicles on street, Rapid urbanization, Industries encompassing the city, Unconsciousness of government and public toward this issue, burning of woods for fuel purposes and burning of the garbage leads to excessive pollution load.

6. RECOMMENDATIONS

These are some recommendation for improvement of the ambient air quality:

- Public mass transport must be strengthened to minimize use of personal vehicle.
- Improvement in the traffic management.
- Check on fuel adulteration.
- Regular sweeping of roads to avoid re- suspension of soil dust.
- Increase use of alternative fuel e.g. CNG
- Stop cutting of plants and trees.
- Automobiles must be designed with emission control system.
- Public awareness

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