© 2017 IJSRST | Volume 3 | Issue 4 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Science and Technology

Comparative Assessment of Air Quality of Major Cities of Uttar Pradesh, India

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ABSTRACT

In Indian urban cities, air pollution is mostly visible now days due to rapid increase in urbanization, commercialization and industrialization. In the last few decades, the human behaviours have changed the global atmospheric condition, the present study deals with the quantitative effect of vehicular emission on ambient air quality during Feb 2017-April 2017 in the monitoring at 6 locations viz: three in Lucknow and three in Kanpur city. The Assessment of ambient air quality was undertaken on the basis of following air pollutants which were Particulate Matter ($PM_{2.5}$ & PM_{10}), sulphur dioxide (SO_2), nitrogen dioxide (NO_2). The $PM_{2.5}$ & PM_{10} level at all the locations were higher than the NAAQS limits. The SO_2 & NO_2 levels at all the locations below than the NAAQS limits. Overall, it is indicating an alarm on the substantial level of air pollution impacting Lucknow city environment and ultimately affecting its human health. It is suggested that major steps be initiated immediately to control the ambient air pollution for the safe future of the citizens of the Lucknow city and Kanpur city.

Keywords: Urbanization, Air Pollution, Air Pollutants, NAAQS

I. INTRODUCTION

Urban air pollution, In now days is one of the serious issues, because of the elevated levels of air pollutants in the ambient air causing environmental impacts and severe health effects on human beings. In developing countries, the large numbers of urban population in worldwide are exposed to high levels of air pollutants. Since motor vehicle emission are major sources of air pollution (Fujita et.al.2002).

There are several sources of air pollutants in urban areas such as tail pipe emission from vehicles, industrial operations, burning of solid wastes from urban kitchen, re-suspension of soil, etc. These sources generally generate a number of pollutants in the air namely particulate matter (PMs), sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and other inorganic (trace elements) and organic pollutants poly aromatic hydrocarbon (PAHs) etc. are released in significant quantity associated with serious health hazards (Ravindra et.al.2003; Pachauri et.al. 2013) . Major sources of these pollutants are arising due to burning of fossil fuels [petrol, diesel, compressed natural gas (CNG), liquefied petroleum gas (LPG), coal, etc. they considerably affect human health through long-term adverse effect (Bapna et.al. 2013; Bhuyan et.al. 2014)

Due to change of technologies and change of fuel consumption patterns, the composition ratio of each pollutant is changing over time. The changing scenario demands continuous assessment of air quality as well as its health effects (Costabile et.al.2008). Pollutants released in the ambient environment interact with other existing pollutants and micrometeorological factors may form more intricate pollutants and that are more harmful to human health. A large number of urban people are at the edge of health risk due to adverse air quality (Tiwari et. al 2014). So it is necessary to identify the pollutants, their source of transformation as well as levels of each pollutants and their impact on environment including living beings.

Air pollution is defined as the presence in the external atmosphere of one or several substances introduced by man to such as extent as to affect health and welfare of human system and the life in atmosphere. The pollutants in air may be in the form of solids, gases and liquids. They may have a periodicity which is especially manifested in the biological pollutants, including the

airborne spores (Sharma, 2013). It found considerable evidence that SO_2 aggregates existing respiratory disease in humans and contributes to their development. Even healthy individuals experience broncoconstriction when exposed for a few minutes to levels of 1.6 ppm.

This condition is accompanied by shallow breathing and an increased respiratory rate. The acute irritant effects of the gas are confined to the upper respiratory tract where more than 95% of inhaled SO_2 is absorbed (Kiely et.al.2007). The chronic effects resulting from extended exposure to low concentrations include incidence of respiratory infection in children. SO_2 level is on humans and plants. Impaired bronchial functioning is noted at ambient levels of approximately 25 mg/m^3 for 10 minutes exposures. Nitrous oxide is a colourless, odourless nontoxic gas present in the natural atmosphere in relatively large concentrations (0.25 ppm).

The major source of N_2O in the atmosphere is the biological activity of the soil and there are no significant anthropogenic sources. It has a low reactivity in the lower atmosphere and is generally not considered an air pollutant (C.S. Rao et al.2008). Air pollution can cause several adverse effects health and building. Pollutants may cause several diseases such as respiratory diseases, including asthma, bronchitis, eye- irritation etc, to human being living in the surrounding of the industries. They adversely affect the air quality of surrounding area. The air pollutants can be classified as primary or secondary pollutants. The primary air pollutants are harmful chemicals which directly enter the air due to natural events of human activities.

The level of Particulate Matter (PM2.5 & PM10) and gaseous pollutant (SO2 & NO2) was measured to check the ambient air quality at three different activity areas of the Lucknow city and Kanpur city. To The objectives of the present study are to assess the ambient air quality with respect to Particulate Matter (PM2.5 & PM10) and gaseous pollutant (SO2 & NO2): To the preliminary information of the study area and principal source of pollution. To study trends of pollutants over a period of time, to create a database for future use and space.

II. STUDY AREA

Lucknow is fast growing city. Lucknow is the capital city of Uttar Pradesh in India. Lucknow is an administrative headquarters of Lucknow District and Lucknow Division. It is historically known as the Awadh region, Lucknow has always been a multicultural city. Lucknow is popularly known as the City of Nawabs. It is also known as the Golden City of the East and is rapidly emerging as a manufacturing, commercial and retailing hub. This unique combination of rich cultural traditions and brisk economic growth provides Lucknow with an aura that refuses to fade away. Lucknow has developed as a metro city of Uttar Pradesh and is second largest city in the state Kanpur is the 11th most populous city in India and the largest city in the state of Uttar Pradesh followed by Lucknow. It is the administrative headquarters of Kanpur Nagar district and Kanpur division. The name is believed to have derived from Karnapur (meaning "town of Karna", one of the heroes of the Mahabharata). Another theory is that it came from the nearby town of Makanpur, earlier known as Khairabad, where the Sufi saint of the Madariya Sufi order, Badiuddin Zinda Shah Madar, settled. City is facing problem of intercity vehicular traffic passing through its internal roads that contribute to a great extent to the existing air and noise pollution levels in the city. Therefore, to avoid the entry of these vehicles into the city a proposal for 108 km long outer ring road has been initiated in 2015. This outer ring road will join Sitapur road, Faizabad road, Sultanpur road, Raibareli road and Kanpur road. Therefore for better traffic management all the connecting roads including Arjunganj-Cantt area (Sultanpur highway), Deva road, Kursi road, Faizabad road, Mohan road, Bijnaur road will be widened as per the requirements from a width of 60 to 76 m.

Sampling was done at six different locations of the Lucknow city and kanpur city. Three selected monitoring locations of Lucknow were Vikas Nagar (residential area), Aminabad (commercial area), Chowk (commercial area) and three locations of kanpur city were Govind nagar (residential area), Vikas nagar (commercial area) and Colonelganj (commercial area). Sampling was done in Feb 2017 – April 2017.

III. MATERIALS AND METHODS

The rate of emission and concentration of these gases in the ambient air is studied by the following laboratory methods – (a) Modified West and Geake method for determination of sulphur dioxide in ambient air, (b) Modified Jacob and Hochheiser method for determination of nitrogen oxides in ambient air, (c) RDS technique for the measurement of PM10. All parameters were analyzed as per standard methods of National Ambient Air Quality Standard (NAAQS) prescribed by CPCB 17 Research Expo International Multidisciplinary Research Journal ISSN : 2250 – 1630 Volume - IV, Issue - II ● June - 2014 ● Section - I (Central Pollution Control Board, 2009).The Statistical Programming System Software (SPSS) used for the statistical analysis.

A. Monitoring and Analysis

Monitoring of Particulate Matter ($PM_{2.5}$ & PM_{10}) was carried out using Respirable Dust Sampler (Model Envirotech) at a flow rate of 1.0-1.2 m^3/ min for 24 hour (6:00Am to 6:00Am). The respirable Dust Sampler (RDS) has been provided with a cyclone for the separation of $PM_{2.5}$. The suspended particles enters the cyclone, coarse, non-respirable dust is separated from the Air steam by centrifugal forces. The suspended particulate matter falls through the cyclone's conical hopper and gets collected in the cyclonic-cup. This fine dust comprising the respirable fraction of Particulate Matter ($PM_{2.5}$) passes through the cyclone and gets collected on filter paper (CPCB 2009).

Preweighted cellulose filters, Whatman (EPM- 2000) of 20x 25 cm size were used and reweighted after sampling in order to determine the mass of the particles collected $PM_{2.5}$. The concentration of the particulate matter in the ambient air was then computed on the net mass collected divided by the volume of air sampled. The amount of non- respirable suspended particulate matter (NRSPM) was summed up with Respirable Particulate Matter $PM_{2.5}$ for calculation of PM_{10}. The sampling instrument was fixed at a breathing height of 1.5 m above the ground level (CPCB 2009).

The analysis of SO_2 and NO_2 was done by Bureau of Indian Standard (BIS) methods Indian standard (2001): IS: 5182 (Part II) and Indian Standard (1975): IS: 5182 (Part VI), respectively. A known quantity of air was passed through the impinger containing known volume of absorbing solution; SO_2 is absorbed in absorbing solution, sodium tetracholoromercurate. A dichlorsulphitomercurate complex is formed which made to react with para rosaniline and methysulphonic acid. The absorbance of the solution was measured at a wavelength of 560nm on spectrophotometer. Whereas, Nitrogen dioxides was absorbed in absorbing solution, sodium hydroxide which formed a stable solution, sodium hydroxide which formed a stable solution, sodium nitrite. The nitrite ion produced was determined colorimetrically at a wavelength 540 nm by reacting the exposed absorbing reagent with phosphoric acid, sulphanilamide and N (1 – naphthyl) ethylenediamine dihydrochloride.

IV. RESULTS AND DISCUSSION

The results of ambient air quality parameters of Lucknow and Kanpur city were compared with their reference range prescribed by CPCB, 2009. Their comparison of different parameters such as Particulate Matter ($PM_{2.5}$ & PM_{10}) and gaseous pollutant SO_2 & NO_2 are presented in table 1.

Table 1. Concentration of $PM_{2.5}$, PM_{10}, SO_2, NO_2

S No.	Location	Parameter	Minimum (µg/ m^3)	Maximum (µg/ m^3)	Average(µg/m^3)
1	Vikas nagar (lko)	$PM_{2.5}$	38.8	134.5	87.5
		PM_{10}	60.1	302.7	175.4
		SO_2	8.6	19.8	16.9
		NO_2	22.7	61.6	46.8
2	Aminabad (lko)	$PM_{2.5}$	41.1	105.5	78.5
		PM_{10}	76.3	252.4	179.7
		SO_2	9.7	18.2	17.8
		NO_2	36.2	65.8	53.4
3	Chowk (lko)	$PM_{2.5}$	51.3	162.1	108.9
		PM_{10}	137.	398.	264.

			3	2	8
		SO_2	10.8	24.6	21.4
		NO_2	39.8	89.4	72.6
4	Vikas nagar (kanpur)	$PM_{2.5}$	184.6	210.4	89.2
		PM_{10}	198.3	232.8	96.4
		SO_2	7.5	18.6	12.4
		NO_2	38.9	52.6	19.2
5	Govind nagar(kanpur)	$PM_{2.5}$	165.2	188.5	115.7
		PM_{10}	165.2	188.5	115.7
		SO_2	5.8	12.6	8.7
		NO_2	25.4	42.8	32.7
6	Colonelganj(kanpur)	$PM_{2.5}$	172.6	228.4	74.8
		PM_{10}	186.2	295.4	92.8
		SO_2	6.9	16.2	10.4
		NO_2	28.5	48.2	36.4

A. Respirable particulate matter ($PM_{2.5}$)

- The graph shows (as shown in fig 1) that the minimum concentration of $PM_{2.5}$ in the Lucknow is low as compare to the Kanpur city is above the permissible limit 60µg/m^3 of the NAAQS standards.
- The graph shows (as shown in fig 1) that the maximum concentration of $PM_{2.5}$ in the Lucknow is low as compare to the Kanpur city is above the permissible limit 60µg/m^3 of the NAAQS standards.
- The graph shows (as shown in fig 1) that the average concentration of $PM_{2.5}$ in the Lucknow is low as compare to the Kanpur city.

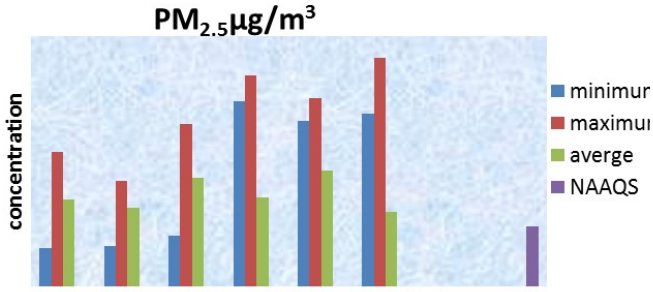

Figure 1. Concentration Of $Pm_{2.5}$ In Different Location of Lucknow City And Kanpur City

B. Suspended particulate matter (PM_{10})

- The graph shows (as shown in fig 2) that the minimum concentration of PM_{10} in the Lucknow is low as compare to the Kanpur city is above the permissible limit 100µg/m^3 of the NAAQS standards.
- The graph shows (as shown in fig 2) that the maximum concentration of PM_{10} in the Lucknow is low as compare to the Kanpur city is above the permissible limit 100µg/m^3 of the NAAQS standards.

The graph shows (as shown in fig 2) that the average concentration of PM_{10} in the Lucknow is low as compare to the Kanpur city

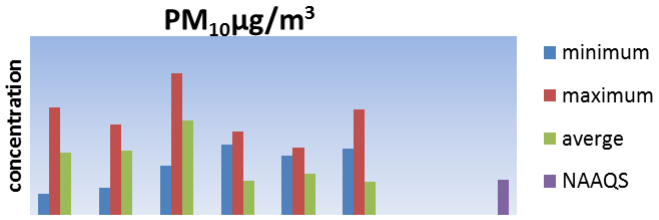

Figure 2. Concentration of Pm10 In Different Location of Lucknow City And Kanpur City

C. Sulphur dioxide (SO_2)

- The graph shows (as shown in fig 3) that the minimum concentration of SO_2 in the Lucknow is high as compare to the Kanpur city is below the permissible limit 80µg/m^3 of the NAAQS standards.
- The graph shows (as shown in fig 3) that the maximum concentration of SO_2 in the Lucknow is low as compare to the Kanpur city is below the permissible limit 80µg/m^3 of the NAAQS standards.
- The graph shows (as shown in fig 3) that the average concentration of SO_2 in the Lucknow is low as compare to the Kanpur city.

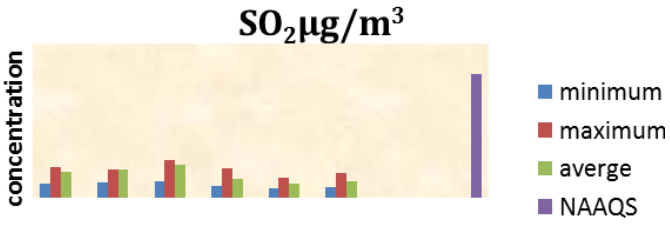

Figure 3. Concentration of So_2 In Different Location Of Lucknow City And Kanpur City

D. Nitrogen dioxide (NO_2)

- The graph shows (as shown in fig 4) that the minimum concentration of NO_2 in the Lucknow is high as compare to the Kanpur city is below the permissible limit 60µg/m^3 of the NAAQS standards.
- The graph shows (as shown in fig 4) that the maximum concentration of NO_2 in the Lucknow is high as compare to the Kanpur city is below the permissible limit 60µg/m^3 of the NAAQS standards.
- The graph shows (as shown in fig 4) that the average concentration of NO_2 in the Lucknow is high as compare to the Kanpur city.

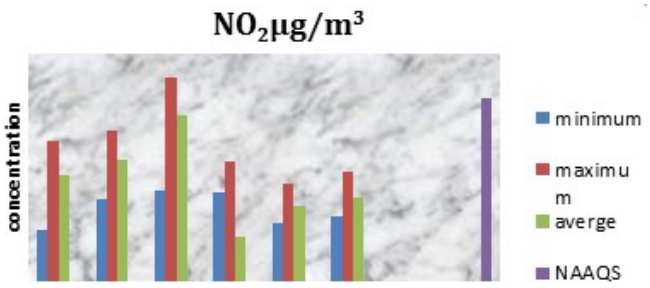

Figure 3. Concentration of No_2 In Different Location Of Lucknow City And Kanpur City

V. CONCLUSION

Lucknow is not an industrial town but scattered industries in the industrial areas of the city and small workshops are also adding to the air pollution to some extent. At present, metro rail section in luck now is under process. This activity may affect air quality of the area due to construction activities as well as traffic congestion.

In Kanpur city, spatial variations in emission quantity suggest that for PM_{10}, CO and NOx, it is the central down town area of the city where emissions are the highest. It suggests that air quality will be worst in the central part of city for all the pollutants with the exception of SO2 which has highest emission in the industrial areas.

The monitoring at 6 locations viz: three in Lucknow and three in Kanpur city Feb 2017-April 2017). The Assessment of ambient air quality was undertaken on the basis of following air pollutants which were Particulate Matter ($PM_{2.5}$ & PM_{10}), sulphur dioxide (SO_2), nitrogen dioxide (NO_2).

The RSPM ($PM_{2.5}$) & SPM (PM_{10}) is above NAAQS limits standard at all locations of the city. The SO_2 & NO_2 level is below the NAAQS limits standards at all the locations of the city. The concentration of the particulate matter is more in Kanpur city as compare to Lucknow city and the SO_2 & NO_2 concentration is more in Lucknow AS Kanpur city. Overall results indicate that $PM_{2.5}$ and PM_{10} are one of the major causes for deterioration of ambient air quality in Lucknow city.

Heavy vehicular density and construction activity at road side, unpaved road is the causes of increase particulate matter in atmosphere.

Overall, continuous accumulation of different types of pollutants and their exposure to human beings need immediate attention of the policy maker and regulatory agencies.

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

- Subsidized public mass transport (Metro, Monorail etc.) must be introduced/ strengthened to minimize use of personal vehicles.
- Public mass transport must be strengthened to minimize use of personal vehicle.
- Improvement in the traffic management.
- Encroachment should be removed for smooth flow of traffic.
- Restore foot path for pedestrians.
- Regular sweeping of roads to avoid re- suspension of soil dust.
- Increase use of fuel e.g. CNG.

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