

**ASSESSMENT OF AMBIENT AIR QUALITY OF LUCKNOW
CITY DURING PRE-MONSOON, 2014**

FINDINGS OF A RANDOM SURVEY

Presented on
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Salient Features of the Study

- ❖ **Geographical Position** : 26° 52' N Latitude
80° 56' E Longitude
128 m above Sea Level
- ❖ **Area** : 310 sq. km.
- ❖ **Population** : 28,15033 as per 2011 Census
- ❖ **Projected Population** : 45 lakhs as per *Master Plan 2021*
- ❖ **Climate** : Subtropical climate, cool dry winter (Dec.- Feb.) & summer (Mar - Jun.). Temperature about 45⁰C in summer to 3⁰C in winter. Average annual rainfall about 100 cm.
- ❖ **Total Vehicular Population in Lucknow city as on 31/03/2014** : 15,52,695
- ❖ **Growth of Vehicle over 2012-2014** : 9.0%
- ❖ **Total No. of Filling Stations (Petrol/Diesel/CNG)** : 100
- ❖ **Consumption of Petrol** : 1,38,755 KL
- ❖ **Consumption of Diesel** : 1,55,226 KL
- ❖ **Consumption of CNG** : 2,62,55,742 Kg
- ❖ **Major Source of Pollution** : Automobiles, D. G. sets, Civil Constructions
- ❖ **Parameters Monitored** : PM₁₀, SO₂, NO_x, Trace metals and Noise Level
- ❖ **Study Conducted by** : Environmental Monitoring Division CSIR- IITR, Lucknow

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Environmental Monitoring Division
CSIR- Indian Institute of Toxicology Research
M.G. Marg, Lucknow

1.0 SUMMARY

The study was carried out during the months of April-May, 2014 to assess the status of air quality by monitoring and assessment of some selected air pollutants namely Respirable Particulate Matter (RSPM or PM_{10}), Sulphur dioxide (SO_2), Oxides of Nitrogen (NO_x) and Trace metals-Lead (Pb) and Nickel (Ni) and noise level at 9 representative locations, categorized as residential (four), commercial (four) and industrial (one) areas in Lucknow city. The results revealed the 24 hours concentration of PM_{10} to be in the range of 120.5 to 341.6 $\mu\text{g}/\text{m}^3$ with an average of 214.7 $\mu\text{g}/\text{m}^3$. The average values of PM_{10} irrespective of locations were found to be above the permissible limit (100 $\mu\text{g}/\text{m}^3$ prescribed by MoEF). 24 hours concentration of SO_2 and NO_x were found in the range of 10.2 to 28.4 and 19.8 to 72.6 $\mu\text{g}/\text{m}^3$ with an average concentration of 19.7 and 44.7 $\mu\text{g}/\text{m}^3$ respectively and all the values were below the permissible limits (80 $\mu\text{g}/\text{m}^3$). The mean level of trace metals were found Ni = 43.2 and Pb = 154.3 ng/m^3 . Noise levels during day and night time were found in the range of 68.4 to 73.2 dB (A) and 53.8 to 68.5 dB (A) which were above the respective permissible limits except in industrial area.

1.1 INTRODUCTION

The increased levels of urban air pollution are a major environmental problem in the developing countries of the world. In India, pollution has become a great topic of debate at all levels and especially the air pollution because of the enhanced anthropogenic activities. Among the harmful chemical compounds entering into the atmosphere as a result of fossils fuels burning, are carbon dioxide (CO₂), Carbon monoxide (CO), Nitrogen oxide (NO_x), Sulfur Dioxide (SO₂) and tiny solid particles –including lead from gasoline additive. The reported studies on air pollution in large cities of India showed that ambient air pollution concentrations are at such levels where serious health effects are possible. Continuous rise of population due to urban activities along with the lack of suitable measures for air pollution control means that there is a great potential that conditions may worsen in Indian cities in future. Lucknow, one of the fast growing metropolises in India has been suffering from air pollution for the last two decades. In the last two decades the rapid urbanization and industrialization has been catalyzing this problem. The air quality in the urban area is affected adversely due to emission and accumulation of SPM, RSPM, SO₂, and NO_x. These pollutants may pose detrimental effect on human health, as exposure of these are associated with cardiovascular and respiratory disease, neurological impairments, increased risk of preterm birth and even mortality and morbidity.

Lucknow Metropolis, the state capital of Uttar Pradesh, traditionally known for its rich cultural heritage and distinct etiquette is now emerging as one of the fastest growing non-metropolitan cities. Shedding its old image of a city famous only for its unique styles of embroidery like 'Chikan' and 'Lakhnawi Zardozi', it is today a centre of modern technology, with a high level of investment, institutional development and progressive outlook. It is witnessing an economic boom which is reflected in the pace of real estate development in the city. Today, Lucknow is an amalgamation of cultured grace and newly acquired pace. According to the data given by the Census of India, approximately 310 km² of the land in Lucknow accommodated more than 2.8 million people as per 2011 census. City has a number of small industries located in different parts of the city. Also the territory has approximately 15.52 Lakhs registered vehicles traveling on roads (as on 31-03-2014).

The latest mark of expansion of the city is Shahid Path connecting Faizabad road to Kanpur road. The road has connected residential areas of Indira Nagar and Gomtinagar to Airport and Kanpur road. This development has also paved way for the development of land along with this road for residential, institutional, and commercial activities. A number of residential complexes and townships are being developed in this area by LDA and many private developers. In coming years huge population will be residing in this area. The earlier constructed ring road in the city has become part of main city. Recently a plan to construct an outer ring road of 170 km length was proposed by the state government authorities. This activity in the periphery of city will lead to developmental activities along this road. Construction of Metro rail is also on the cards, which will initially connect major locations through its North-South and East- West corridors. In the next phase Metro rail will be extended to the outer areas of the city.

People will migrate to the newly developed areas of the city in search of opportunities and comfortable life. The population residing in the newly developed areas will also have to commute to the central part of the city. Also the movement of the people from old city to the newly developed area will increase. This will result in more vehicular population on all the city roads. Even now traffic congestion and jams are common features on most of the city roads. An increased traffic condition in the city is likely to deteriorate further and result in more air pollution. High traffic densities and abnormal meteorological factors adversely influence the ambient air quality of Lucknow.

In view of the above facts, it is need of the hour to look into the air quality of our city Lucknow, the capital of Uttar Pradesh which has a population of 28.15 Lakh (Municipal corporation + Cantonment) as per 2011 census. Vehicular traffic is the main source of particulate air pollution in Lucknow city. The number of different categories of vehicles registered with RTO (Regional Transport Office) Lucknow is 15,52,695 as on 31.03.2014 which is 9.0% higher over the last year (Table 1). Uttar Pradesh State Road Transport Corporation (UPSRTC) introduced bus services under the banner “Lucknow Mahanagar Parivahan Sewa” on different routes of Lucknow city. The details of bus routes and number of buses plying as on 31.03.2014 are given in Table 2. In Lucknow city there are 100 filling stations for petrol, diesel and CNG operated by different oil companies (Table 3).

As per Indian Oil Corporation (IOC), the consumption/sale of petrol and diesel was 1,38,755 and 1,55,226 KL as on 31-03-2014. It is observed that petroleum sale has increased by 8.03% whereas sale of diesel has increased by 13.41%. (Table 4). In Lucknow there are six CNG filling stations and consumption of CNG in the last year was approximately 2,62,55,742 Kg (2013-14) which was 10.26% higher than the previous year (2012-13) (Green Gas Limited, Lucknow). Distribution and number of CNG vehicles in Lucknow is summarized in Table 5. Considering the above, assessment of ambient air quality of Lucknow city was carried out at 9 locations during pre monsoon (April-May), 2014 with respect to PM₁₀, SO₂, NO_x, Trace metals and Noise level with the following aims and objectives.

- *To assess the ambient air quality with respect to PM₁₀, SO₂, NO_x, and trace metals (Ni and Pb) associated with PM₁₀.*
- *To study trends of pollutants over a period of time.*
- *To assess day and night time noise to ensure compliance of permissible noise levels*
- *To create a database for future use.*
- *To create public awareness about environmental pollution*

Table 1. Vehicles registered with R.T.O. Lucknow during 2012-13 and 2013-14

Sl. No.	Type of Vehicle	Number of Registered Vehicles on 31 st March		% Change
		2012-13	2013-14	
1	Multi Articulated	2770	2974	7.36
2	Light, Medium and Heavy weight Vehicles (Four wheeler)	17142	18430	7.51
3	Light commercial vehicles (Three wheeler)	3170	3225	1.73
4	Buses	3181	3249	2.13
5	Taxi	7089	7797	9.98
6	Light Motor Vehicles (Passenger)	7246	7743	6.85
7	Two wheelers	1136822	1238691	8.96
8	Car	201628	221019	9.61
9	Jeep	19612	22175	13.06
10	Tractor	20417	22010	7.80
11	Trailors	1421	1469	3.37
12	Others	3980	3913	-1.68
Total		1424478	1552695	9.0

Source: RTO, Lucknow

Table 2. Details of Lucknow City Bus Service, 2014

Sl. No.	Route No.	To and From	No. of Buses	Frequency
1	11	BBD -Chinhat-Gomti Nagar-Lohiya Park- Tikonia park- Dainik Jagara – Sikendrabagh Jaharbhavan – GPO- Hussainganj- KKC-Charbagh	19	10 minutes interval
2	12	BBD- Chinhat- Polytechnic-Bhoothnath –Badshanagar- Nioshatganj- Sikendrabagh- G.P.O- Hussainganj- Charbagh- Alambagh- Avadh hospital.	9	15 minutes interval
3	13	Charbagh –Mobaiya-Alambagh thana-Teriphulia- Alambagh-bus stand-Awadth Hospital-Krishnagarthana- Natherganj –Sccoter India-Koti Bagia.	10	12 minutes interval
4	23	Behta- Integral University-Gudamba – Vikasnagar- Nishatganj-Sikendrabagh-G.P.O.-Hussaingaj-Chargbagh Alambagh- Avadh hospital-Rajnikhand	21	10 minutes interval
5	24	Munshiphulia-BhoothnathpIndiranagar – Nishatganj- Hazratganj-Hussainganj –Charbagh-Alambagh- Krisnagagar-Parag diary- Paasi Kila	10	15 minutes interval
6	31	IIM - P &T - Purania- Kapoorthala - Goal Market- Nishatganj_ Sikendrabagh-Shakti Bhavan - Hussainganj- Charbagh-Alambagh	2	60 minutes interval
7	33	Engineering College- Purania- Kapoorthala - Goal Market-Nishatganj-Sikendrabagh-Shakti Bhavan - Hussainganj-Charbagh-Alambagh-Avadh hospital.	20	10 minutes interval
8	45	Virajkhand-Gomtinagar- Lohiya hospital-Polytechnic – Lekraj-Nishatganj- Sikendrabagh-Shakti Bhavan - Hussainganj-Charbagh-Alambagh-Avadh hospital Krishnagar –Parag diary- Passi Kila-Shahid path	16	15 minutes interval
		Total	107	

Source: UPSRTC, Lucknow

Table 3. Fuel Outlets in Lucknow City

Sl. No.	Agency	Number of outlets
		31 st March 2014
1	Indian Oil Corporation (IOC)	47
2	Bharat Petroleum Corporation Ltd. (BPCL)	22
3	Hindustan Petroleum Corporation Ltd. (HPCL)	25
4	Compressed Natural Gas Stations (CNG)	6
	Total	100

Source: Indian Oil Corporation (IOC), Lucknow

Table 4. Consumption of Fuel (in KL) in Lucknow

Sl. No.	Agency	Petrol (Unleaded)			High Speed Diesel			*CNG		% Change
		Apr. 12 to Mar. 13	Apr. 13 to Mar. 14	% Change	Apr. 12 to Mar. 13	Apr. 13 to Mar. 14	% Change	Apr. 12 to Mar. 13	Apr. 13 to Mar. 14	
1	IOC	71217	77693	9.09	75456	88234	16.93	--	---	
2	BPCL	33172	34178	3.03	28234	31497	11.56	--	---	
3	HPCL	24051	26884	11.77	33180	35495	6.97	--	---	
4	Green Gas	--	--	--	--	--	--	2,38,11,473	2,62,55,742	10.26
Total		128440	138755	8.03	136870	155226	13.41	23811473	26255742	10.26

Source: Indian Oil Corporation (IOC), Lucknow, * CNG in Kg, CNG Source: Green Gas Limited, Lucknow

Table 5. Distribution of CNG vehicles

Sl. No.	Vehicles	Number		% of change
		2012-2013	2013-14	
1	Auto Rickshaws	4343	4343	0.0
2	Tempo Taxi	2534	2575	1.61
3	Buses (UPSRTC)	260	260	0.0
4	Buses (Private)	36	36	0.0
5	School Buses	878	985	12.18
6	School Van	753	962	27.75
7	Private Vehicles	83	205	146.98
8	Private Cars	5788	7943	37.23
	Total	14675	17309	17.94

Source: Green Gas Limited, Lucknow

1.2 MONITORING LOCATIONS AND METHODOLOGY

Nine air quality monitoring locations representing different activities/areas i.e., four in residential, four in commercial cum traffic and one industrial area were selected for the study as summarized in Table 6 (brief description of each location is given in our earlier reports Pre and Post monsoon, 2010) and parameters along with methodology is given in Table 7.

Table 6. Monitoring Locations

Sl. No.	Locations	Activities
1	Aliganj	Residential
2	Vikas Nagar	Residential
3	Indira Nagar	Residential
4	Gomti Nagar	Residential
5	Charbagh	Commercial cum traffic
6	Alambagh	Commercial cum traffic
7	Aminabad	Commercial cum traffic
8	Chowk	Commercial cum traffic
9	Amausi	Industrial

Table 7. Parameters and Methodology for Air Quality Monitoring

Sl. No.	Parameters	Time Weighted average	Methods of Measurement
1	Particulate Matter-PM ₁₀	24 hours	Gravimetric
2	Sulphur dioxide (SO ₂)	24 hours	Improved West Gaeke
3	Nitrogen Dioxide(NO ₂)	24 hours	Modified Jacob & Hochhesier (Na-Arsenite)
4.	Trace Metals - (Pb & Ni)	24 hour	AAS method after sampling on EPM 2000.
5	Noise Level	1 hour	The measurement of noise level was carried out during the day (6 AM to 10 PM) and night time (10 PM to 6 AM) by Noise level Meter.

1.3 RESULTS

The detailed results of air quality monitoring are presented in Table 8 and Fig. 1.

1.3.1 Respirable Suspended Particulate Matter (RSPM or PM₁₀)

In residential areas (Aliganj, Vikas Nagar, Indira Nagar and Gomti Nagar), the 24 hours average concentrations of PM₁₀ were in the range of 176.7 to 259.5 µg/m³ with an average of 209.1 µg/m³. In commercial areas (Charbagh, Alambagh, Aminabad and Chowk) the average concentrations of PM₁₀ were in the range of 181.7

to 274.5 $\mu\text{g}/\text{m}^3$ with an average of 219.7 $\mu\text{g}/\text{m}^3$ respectively. In industrial area (Amausi), the average concentrations of PM_{10} was 217.3 $\mu\text{g}/\text{m}^3$.

The maximum 24 hours mean concentration of PM_{10} was observed in Gomti Nagar (259.5 $\mu\text{g}/\text{m}^3$) in residential area and Charbagh (274.9 $\mu\text{g}/\text{m}^3$) in commercial area.

All the values of PM_{10} were above the prescribed National Ambient Air Quality Standard (NAAQS) of 100 $\mu\text{g}/\text{m}^3$ for industrial, residential, rural and other area respectively.

1.3.2 Sulphur dioxide (SO_2)

In residential area (Aliganj, Vikas Nagar, Indira Nagar and Gomti Nagar) the mean levels of SO_2 were in the range of 14.6 to 21.0 $\mu\text{g}/\text{m}^3$ with an average of 17.9 $\mu\text{g}/\text{m}^3$. In commercial area (Charbagh, Alambagh, Aminabad and Chowk) the average concentrations of SO_2 were in the range of 16.4 to 25.1 $\mu\text{g}/\text{m}^3$ with an average of 20.3 $\mu\text{g}/\text{m}^3$. In industrial area (Amausi) the average concentration of SO_2 was 23.5 $\mu\text{g}/\text{m}^3$.

All the values of SO_2 were well below the prescribed NAAQS of 80 $\mu\text{g}/\text{m}^3$ for all the locations.

1.3.3 Oxides of Nitrogen (NO_x)

In residential areas (Aliganj, Vikas Nagar, Indira Nagar and Gomti Nagar) the 24 hours average concentrations of NO_x were found to be in the range of 29.2 to 44.3 $\mu\text{g}/\text{m}^3$ with an average of 36.4 $\mu\text{g}/\text{m}^3$. In commercial areas (Charbagh, Alambagh, Aminabad and Chowk) the average concentrations of NO_x were found in the range of 42.4 to 61.5 $\mu\text{g}/\text{m}^3$ with an average of 54.4 $\mu\text{g}/\text{m}^3$. In industrial areas (Amausi) the average concentration was 39.6 $\mu\text{g}/\text{m}^3$.

All the values of NO_x were within the prescribed NAAQS of 80 $\mu\text{g}/\text{m}^3$ for all the monitoring locations.

Table 8: Concentration ($\mu\text{g}/\text{m}^3$) of PM_{10} , SO_2 and NO_x during Pre monsoon 2014

Location	RSPM			SO_2			NO_x		
	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Aliganj	132.3	231.4	176.7	11.6	17.2	14.6	25.3	33.6	29.2
Vikas Nagar	120.5	238.3	188.8	10.6	19.8	15.6	19.8	41.2	31.1
Indira Nagar	155.9	268.9	211.5	13.8	25.4	21.0	35.7	46.2	40.8
Gomti Nagar	181.7	292.7	259.5	16.5	23.8	20.6	33.9	54.6	44.3
Commercial									
Charbagh	187.6	341.6	274.5	15.8	28.12	21.9	41.5	72.6	61.5
Alambagh	173.1	284.9	207.2	14.5	23.7	25.1	37.8	68.7	56.8
Aminabad	141.3	249.2	181.7	12.1	19.2	16.4	38.4	58.7	42.4
Chowk	149.2	290.3	215.3	12.4	23.6	17.8	41.3	71.2	57.0
Industrial									
Amausi	187.3	298.3	217.3	10.2	28.4	23.5	29.8	55.6	39.6
NAAQS	100			80			80		
WHO Guidelines	50			20			40*		

N=6, *= Annual Average, NAAQS=National Ambient Air Quality Standards

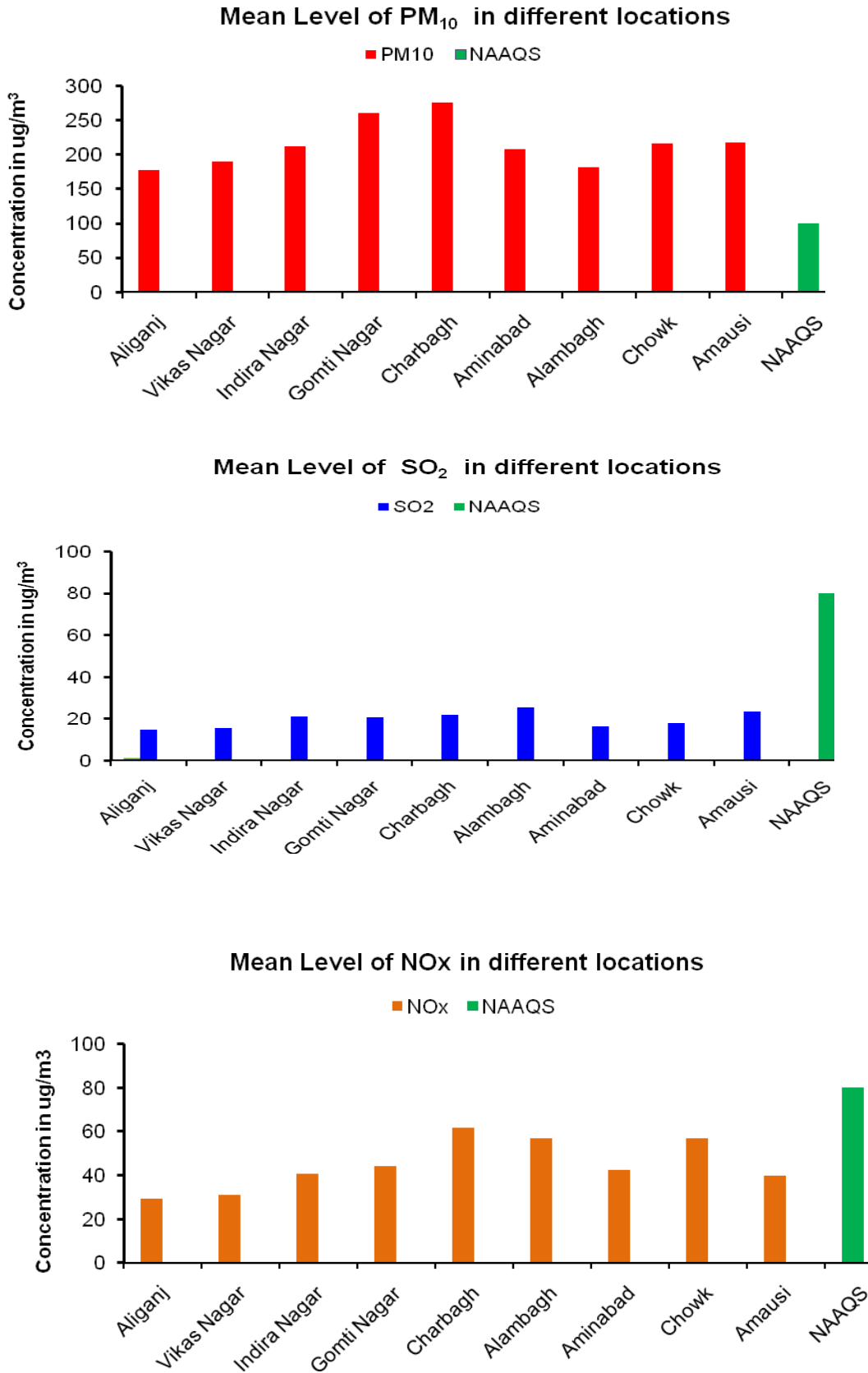


Fig 1: Concentration ($\mu\text{g}/\text{m}^3$) of PM₁₀, SO₂ and NO_x in different areas of Lucknow city during pre monsoon season (2014) and compared with prescribed National Ambient Air Quality Standard (NAAQS)

1.3.4 Trace Metals in Ambient Air (RSPM)

The trace metals (Pb and Ni) were estimated in ambient air associated with PM₁₀ at 9 monitoring locations. The results are present in Table 9.

The 24 hr mean concentration of metals were found to be Pb = 154.3 (83 -260) and Ni = 43.2 (30 -64) ng/m³.

Table -9 : Metal Concentration in ng/m³ associated with PM₁₀

Sl. No.	Location	Lead	Nickel
1	Aliganj	117	34
2	Vikas Nagar	105	39
3	Indira Nagar	260	63
4	Gomti Nagar	148	47
5	Charbagh	128	36
6	Alambagh	188	35
7	Aminabad	130	64
8	Chowk	83	30
9	Amausi	230	41
Mean		154.3	43.2
NAAQS		1000	20*

N= 1, *=Annual Average

1.3.5 Noise

The monitoring data recorded during the pre monsoon period (May, 2014) is presented in Table 10.

In residential areas, the day and night time noise levels were recorded between 67.4 to 69.5 and 57.2 to 61.7 dB(A) respectively. All the values were higher than the prescribed limit of 55 and 45 dB (A) for day and night time respectively.

In commercial and traffic area, the day and night time noise level were recorded between 68.4 to 71.8 and 53.8 to 68.5 dB(A) respectively. Noise level at all the commercial sites during day and night time were found above the prescribed limit of 65 and 55 dB (A) respectively.

In industrial area Amausi the day and night time noise levels were recorded 73.2 and 67.5 dB (A) respectively. Noise levels at all industrial locations in the day and night time was found below the prescribed limit of 75.0 and 70.0 dB(A) respectively.

Table 10. Noise Level dB (A) during Day and Night Time

Sl. No.	Area	Location	Noise level dB(A)	
			Day	Night
1	Residential	Aliganj	68.6	58.3
		Vikas Nagar	67.8	57.6
		Indira Nagar	69.5	61.7
		Gomti Nagar	67.4	57.2
		Standard	55.0	45.0
2	Commercial	Charbagh	71.8	68.5
		Alambagh	68.9	65.4
		Aminabad	70.4	53.8
		Chowk	68.4	61.5
		Standard	65.0	55.0
3	Industrial	Amausi	73.2	67.5
		Standard	75.0	70.0

N=1

1.4 TRENDS OF AMBIENT AIR QUALITY IN LUCKNOW CITY

The observed PM₁₀, SO₂ and NO_x for 3 years data have been compared to find out the prevailing trend of air pollution in Lucknow city (Fig. 2-4). A slight change in the values may be attributed to some local environmental and climatic factors.

1.4.1 Respirable Suspended Particulate Matter (RSPM or PM₁₀)

In the residential areas, higher values were found in Indira Nagar and Gomti Nagar whereas lower values were observed in Aliganj and Vikas Nagar when compared to the data of the previous year. Among the commercial areas, PM₁₀ values showed decreasing trend except at Charbagh as compared to the last year. Amausi, under industrial area showed slightly lower value over that of the last year. All the values are higher than the NAAQS (Fig. 2).

1.4.2 Sulphur dioxide (SO₂)

The level of SO₂ during pre monsoon since 2011 is presented in Fig. 3 for all the locations.

In residential areas, higher concentration of SO₂ was found only in Gomti Nagar compared to that of the previous year at all the locations. Among the commercial areas, SO₂ values showed decreasing trend except at Alambagh than the last year. Amausi, industrial area showed increasing trend over the last year. All the values of the present study were found to be lower than the NAAQS (Fig. 3).

1.4.3 Oxides of Nitrogen (NO_x)

The level of NO_x during pre monsoon since 2011 is presented in Fig. 4 for all the locations. Among the residential all the locations showed decreasing trend except Gomti Nagar where in commercial area all the locations showed increasing trend and the only industrial area Amausi showed lower value when compared with the previous year data. All the values of the present study were found to be lower than the NAAQS (Fig. 4).

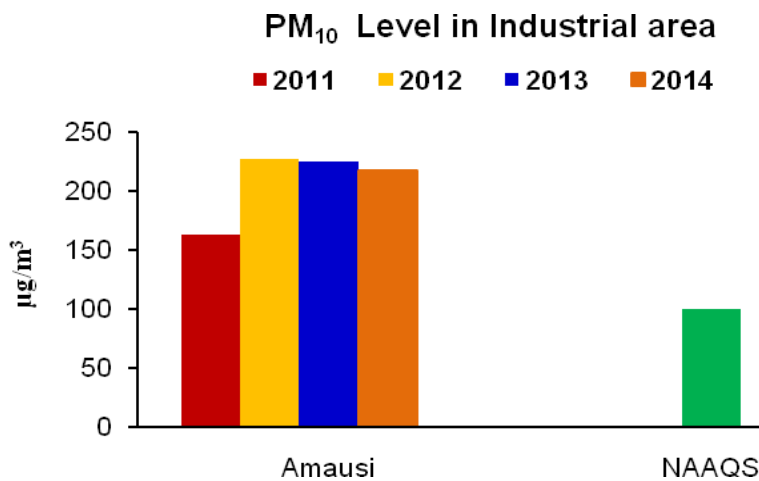
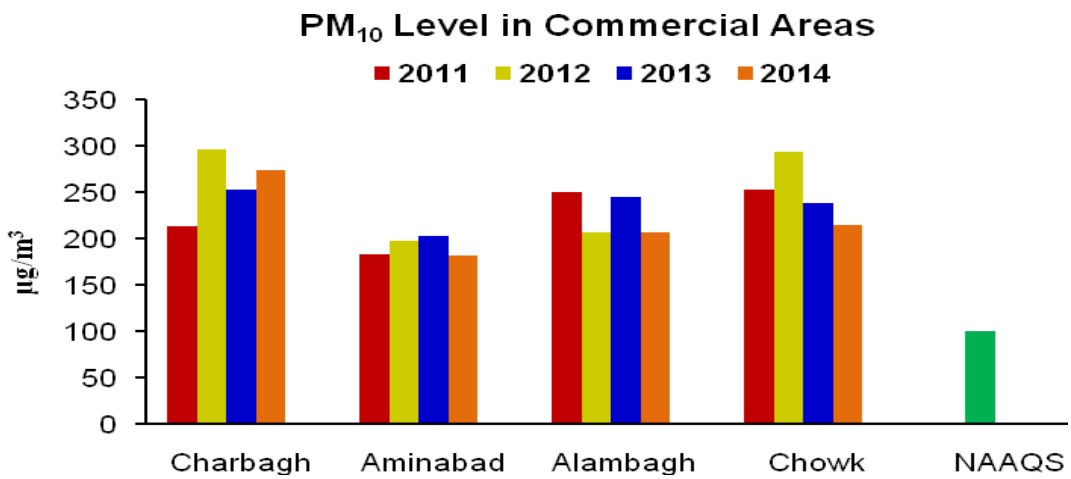
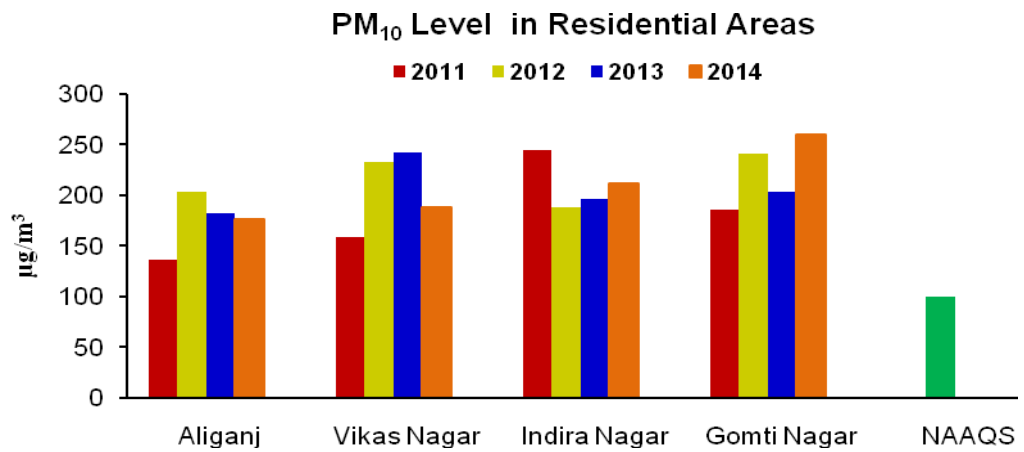


Fig 2: Concentration ($\mu\text{g}/\text{m}^3$) of PM₁₀ (RSPM) in Residential, Commercial and Industrial areas of Lucknow city during 2011 to 2014 and compared with prescribed National Ambient Air Quality Standard (NAAQS)

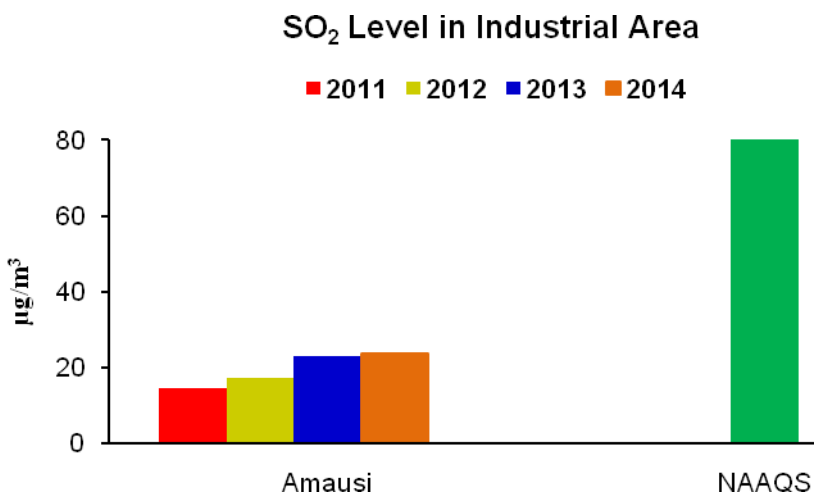
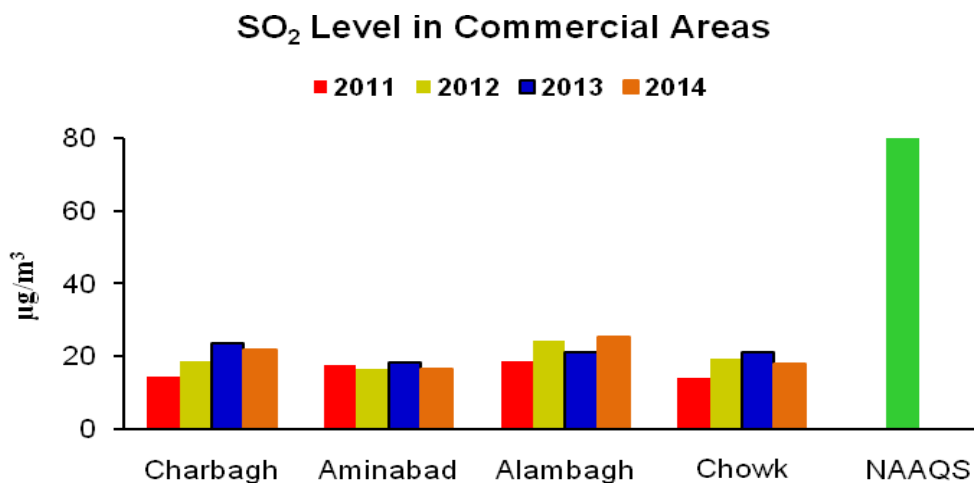
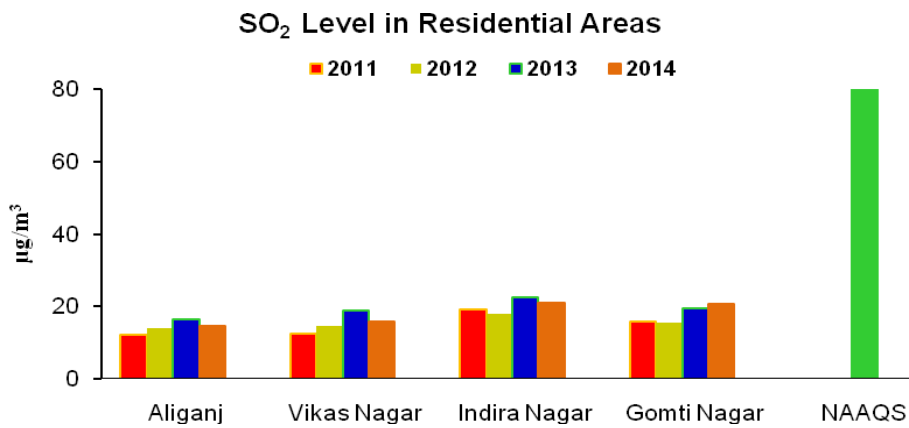


Fig 3: Concentration ($\mu\text{g}/\text{m}^3$) of SO₂ in Residential, Commercial and Industrial areas of Lucknow city during 2011 to 2014 and compared with prescribed National Ambient Air Quality Standard (NAAQS)

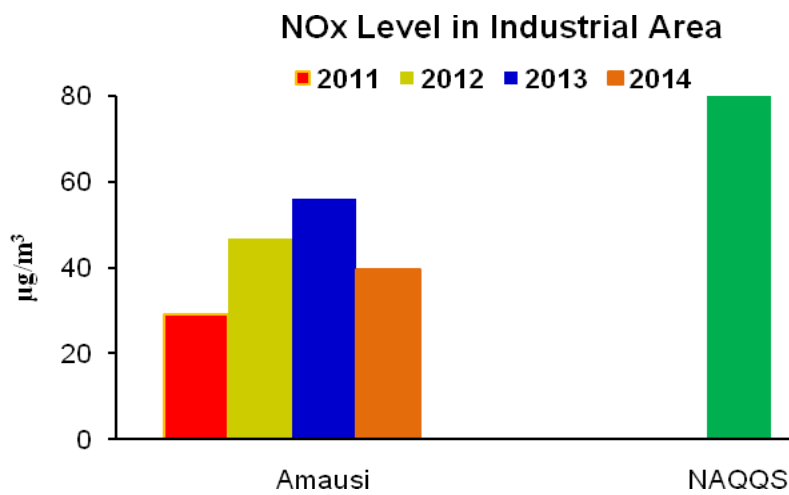
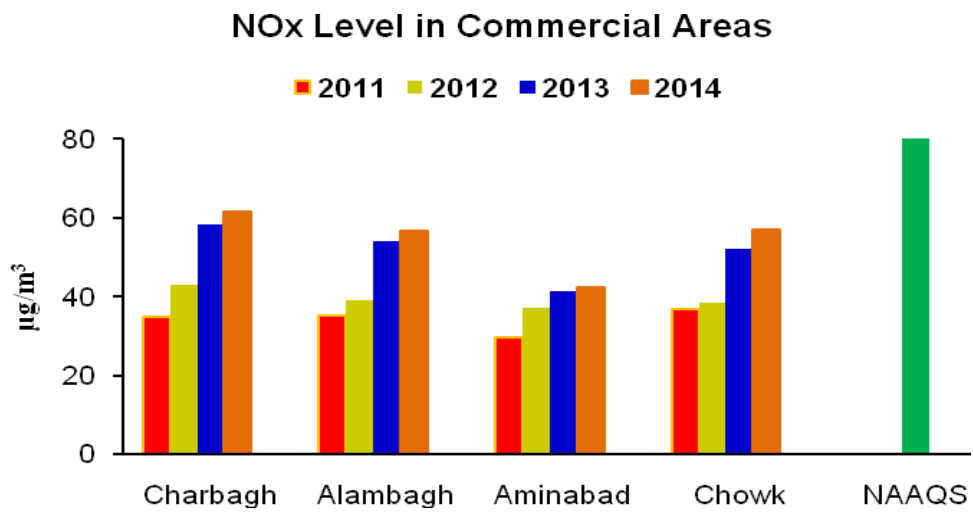
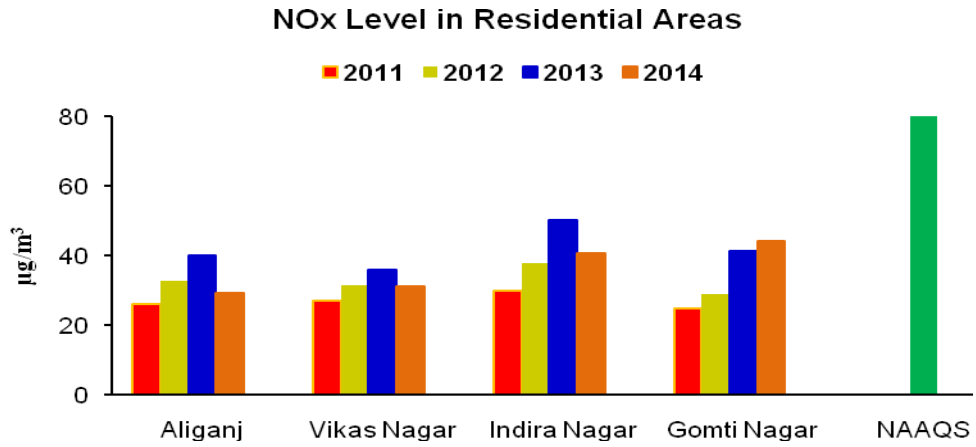


Fig 4: Concentration ($\mu\text{g}/\text{m}^3$) of NO_x in Residential, Commercial and Industrial areas of Lucknow city during 2011 to 2014 and compared with prescribed National Ambient Air Quality Standard (NAAQS)

1.4.4 Noise Level

Current year's noise data has been compared with the corresponding data of the previous three years (2011 to 2014) and are presented in Fig. 5 and 6. The comparative noise level in residential, commercial and industrial areas are described below:

1.4.4.1 Day time Noise Level

In residential areas all the locations showed slightly increasing trend over that of the previous year. In commercial cum traffic areas noise level was found to be on the higher side at all the locations were recorded compared to the previous year. In industrial area, Amausi the noise level was slightly higher than the previous year. The comparative data are presented in (Fig.5).

1.4.4.2 Night time Noise Level

Residential areas showed slightly higher level than the last year level except Vikas Nagar. In commercial areas showed little variations and the only industrial areas showed slightly higher value than the previous year. The comparative data are presented in (Fig. 6).

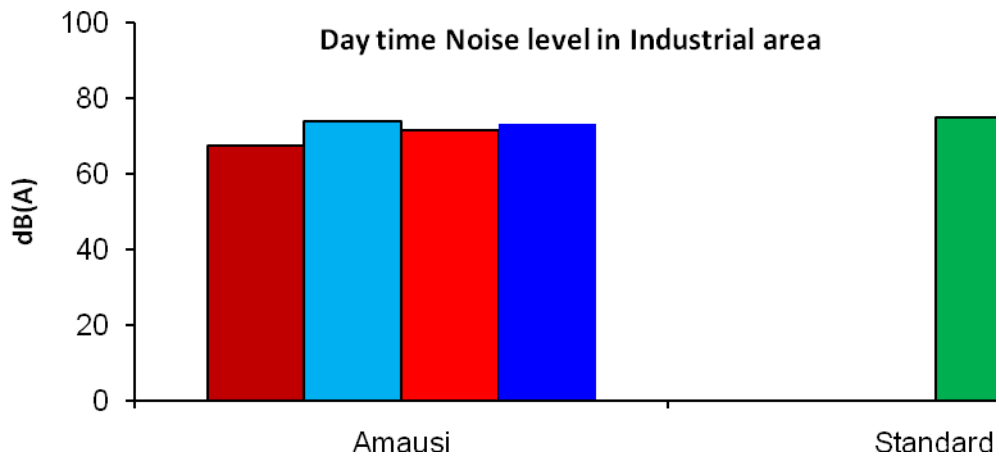
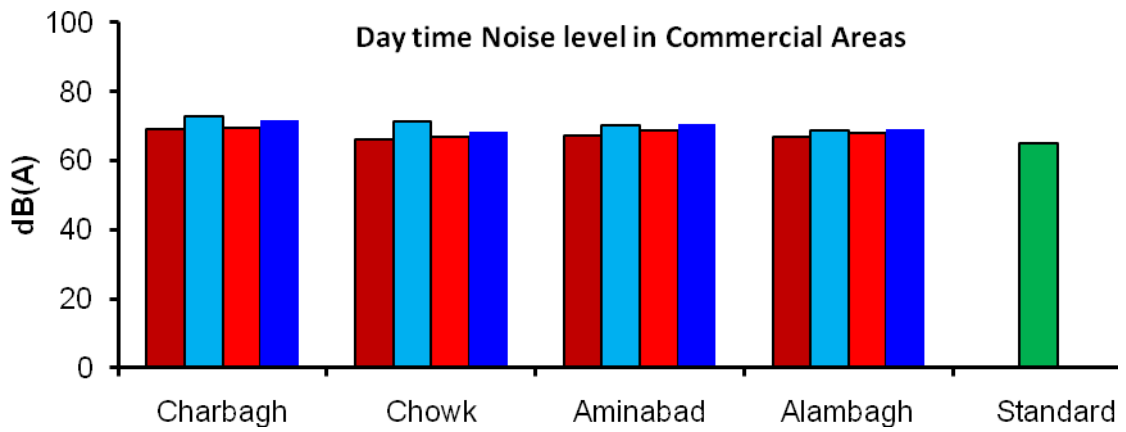
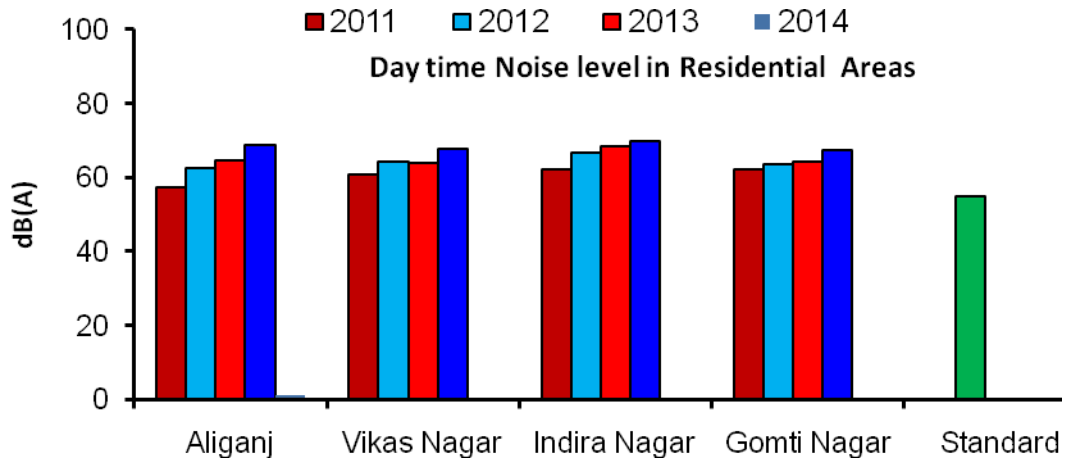


Fig 5: Comparison of day time Noise Level dB(A) in different areas of Lucknow city (2011-2014)

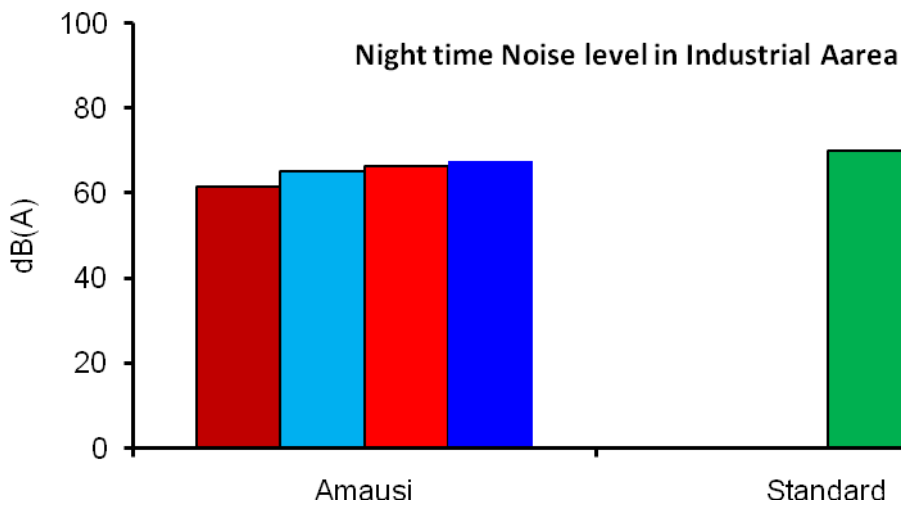
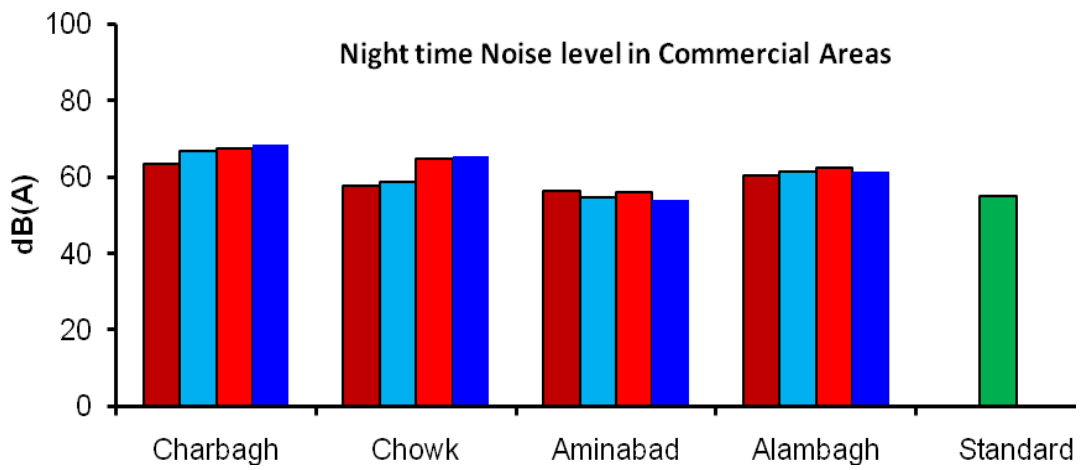
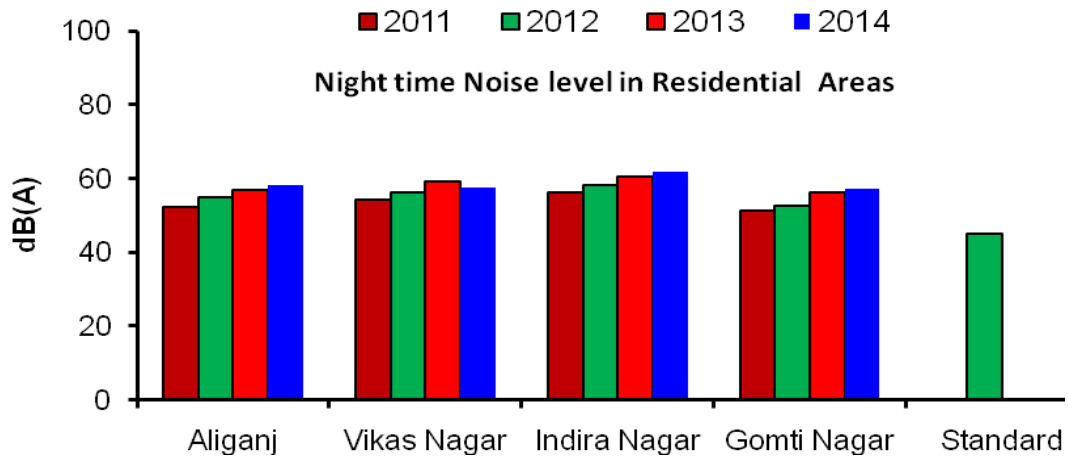


Fig 6: Comparison of night time Noise Level dB(A) in different areas of Lucknow city (2011-2014)

1.5 HEALTH EFFECTS

At elevated levels, all the pollutants including metals have adverse effects on human and environmental health. Accumulation of pollutants in the human body through inhalation of air is an important route. Results of the present study revealed that higher level of particulate matter (PM₁₀) at all the monitoring locations are responsible for cardiovascular and respiratory diseases such as asthma, bronchitis, reproductive development, increased risk of preterm birth and even mortality and morbidity rate.

Human exposure to particulate air pollution has been identified as a risk factor for human mortality and morbidity related to respiratory and cardiovascular diseases especially among susceptible individual and people with pre-existing heart and lung diseases and many countries have revised the limits for PM₁₀. Nevertheless, PM threshold levels to which exposure does not lead to adverse effects on human health have not yet been clearly identified and there is a substantial inter-individual variability in exposure and in the response and it difficult to establish a standard or guideline value that will lead to a complete protection of every individual against all possible adverse health effects of particulate matter.

The effect of PM depends on the mass and number concentration, shape and size and the composition and concentration of other inorganic and organic pollutants associated with it. We also estimated the trace metals associated with PM₁₀. The inorganic components constitute a small portion by mass of the particulates; however, it contains some trace elements such as As, Cd, Ni, Pb, etc. which are known human or animal carcinogens, even in trace amounts. The high level of Pb can induce severe neurological and hematological effects on the exposed population especially children, whereas Cd and Ni are known for inducing carcinogenic effects in humans through inhalation. Occupational exposure to Cd is a risk factor for chronic lung diseases.

In the present study, the concentration of SO₂ and NO_x were found to be below permissible limit (80 µg/m³) of NAAQS (MoEF 2009), but there are several reports that gaseous pollutants are related with respiratory diseases and reproductive and

developmental effect even at low concentration. Vehicular traffic and NO₂ are associated with significantly higher risk of lung cancer.

1.6 CONCLUSIONS

Air pollutants such as PM₁₀, SO₂, NO_x trace metals and noise level were monitored for the assessment of ambient air quality. Besides, noise level during day and night time at 9 locations were also monitored during pre monsoon (March-May), 2013 and the data revealed following salient points-

- The RSPM (PM₁₀) level at all the monitoring locations of residential, commercial and industrial areas were higher than the NAAQS.
- The concentration of gaseous pollutants, SO₂ and NO_x were below the prescribed NAAQS (80 µg/m³) at all the locations but showed increasing trend.
- The noise level at all the locations except in industrial area during day and night time showed higher level than their respective permissible limits.
- Overall results indicate that RSPM and associated metals are one of the major causes for deterioration of ambient air quality. One time estimation Ni concentration showed that all the values of nine monitoring locations were found to be higher than the prescribed standard of annual average level (20 ng/m³) which is one of the major concern.

Unlimited growth of number of vehicles, their technological development and release of invisible tailpipe pollutants emission are serious debatable issues even for the policy makers. Use of different types of fuels namely gasoline, diesel, LPG and CNG make the environment more complex regarding the air quality and their synergistic effects on the human health. Overall, continuous accumulation of different types of pollutants and their exposure to human beings needs urgent attention of the policy makers, researchers and regulatory agencies.

The present study suggests that it is necessary to monitor the air quality as well as the health effects at regular intervals at strategic locations. Our pre monsoon monitoring survey might be of help to focus on the pollution level in Lucknow city and its probable consequences. Our database since 1997 will help the planners for sustainable development of the city.

1.7 RECOMMENDATIONS

- Subsidized public mass transport (Metro, Monorail etc.) must be introduced/strengthened to minimize use of personal vehicles.
- Improvement in the traffic management.
- Encroachment should be removed for the smooth flow of traffic.
- Public awareness programme for reduction of automobile pollution.
- Pressure horns to be removed from all vehicles and avoid use of horn.
- Government should increase the parking charges on hourly basis to discourage the use of personal vehicles.
- Restore foot path for pedestrian

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