

ASSESSMENT OF ENVIRONMENTAL STATUS OF LUCKNOW CITY

(PRE-MONSOON)

FINDINGS OF A RANDOM SURVEY



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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	: 22.45 lakhs as per 2001 Census
❖ Projected Population	: 45 lakhs as per <i>Master Plan 2021</i>
❖ Climate	: Subtropical climate, cool dry winter (Dec. - Feb.) & summer (Mar - Jun). Temperature about 45 ⁰ C in summer to 3 ⁰ C in winter. Average annual rainfall about 100 cm.
❖ Total Vehicle Population In the Lucknow city as on 31/03/2009	: 10,50,834
❖ Growth of Vehicle over 2008-2009	: 8.34%
❖ Total Number of Petrol Pumps	: 89
❖ Consumption of Petrol	: 96,982 KL
❖ Consumption of Diesel	: 99,353 KL
❖ Major Source of Pollution	: Automobiles, D. G. sets, Civil Constructions
❖ Parameters Monitored	: SPM, RSPM, SO ₂ , NO _x , and Noise
❖ Study Conducted by	: Environmental Monitoring Section IITR, Lucknow

1.0 INTRODUCTION

Over the past several decades, the rapid growth in travel has increased traffic congestion, especially in the major metropolitan areas which leads to significant increase in air pollutants. However, current facilities have not kept pace with increased travel demands. Traffic congestion has caused significant increase in vehicular emissions. The air quality in urban area depends on the number of vehicles plying on the road, types of fuel (diesel or gasoline), vehicle speed, the meteorological condition (wind speed, wind direction, temperature, relative humidity, etc.). Air pollution has been aggravated due to increasing traffic, rapid economic development, industrialization and higher level of energy consumption. Currently in India, air pollution is widespread in urban areas where vehicles, industries and thermal power plant are the major contributors. Recent literature revealed that urban people are developing symptoms of respiratory problems, both of upper respiratory tract (runny nose, sinusitis, sore throat, wet cough, hay-fever and burning eyes) and lower respiratory tract (wheezing, dry cough, phlegm, shortness of breath, chest discomfort and pain). Generally it is found that in most of cities the ambient air is highly polluted due to suspended particulate matter.

The quality of ambient air in the Lucknow city has improved significantly after the introduction of Compressed Natural Gas (CNG) for running public transport around a year ago. Generally the use of CNG as a fuel reduces vehicular exhaust emissions significantly. Carbon Monoxide emissions are reduced by 70 to 90% and Hydrocarbon emissions by 40 to 60% as compared to vehicles that use the conventional fuel - Petrol. Carbon Dioxide emissions, a cause for global warming, are also reduced significantly by 10%.

In view of above facts, it is need of the hour to look in to the air quality of our city Lucknow, the capital of Uttar Pradesh which has a population of 22,45,509 (Municipal corporation + Cantonment) as per 2001 census and an area of 310 sq. km. Total vehicle of different categories registered with RTO, Lucknow during 2008-2009 were 10,50,834 as against 9,69,915 during 2007-2008. The overall growth registered is 8.34% during 2008-2009 (Table 1).

Table 1: Registered Vehicle with R.T.O. Lucknow during 2007- 08 and 2008- 09

Sl. No.	Type of Vehicle	Number of Registered Vehicles On 31 st March		% increase in the number of vehicles
		2008	2009	
1	Commercial vehicles	34,906	40,229	15.25%
2	Three Wheelers and Auto Rickshaw	13,224	19,963	50.96%
3	Two wheelers	7,71,846	8,26,083	7.03%
4	Four Wheeler	1,46,654	1,60,489	9.43%
5	Others	3,285	4,070	23.89%
Total		9,69,915	10,50,834	8.34%

Source: RTO, Lucknow

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 31.03.2009 are given in Table 2.

Table 2: Details of Lucknow city bus service, 2009

Sl. No.	Route No.	To and Fro	No. of Buses
1	11	Chinhat-Gomti Nagar-Alambagh	31
	11 A	Chinhat-Gomtinagar-Dalibagh-Charbagh	
	11B	Chinhat-Gomtinagar-Charbagh-SGPGI	
	11C	Charbagh-Uttaria-Sardar Patel Dental college	
	11D	Charbagh-Babasaheb Bhimrao Ambedkar-BB	
	11E	Charbagh-Telibagh-Ganesh Kunj	
2	12	Chinhat-Scooter India	6
3	23	Rajinikhand-Gudamba thana	13
4	24	Charbagh - Engineering College	14
5	25	Charbagh-Bijnor	02
6	31	Alambagh – IIM	02
7	33	Alambagh- Engineering College	15
8	34	Alambagh-Charbagh-Hazratganj-Kapporthala-Keshavnagar	01
9	44	Charbagh-Andhi Chowki	09
10	45	Parag Dairy – Polytechnic Chowraha	10
11	66	GPO- Hazratganj-Rajajipuram	02
12	Shuttle service	Charbagh-Alambagh	03
		Total	108

Source: UPSRTC, Lucknow

Monitoring of Environmental Status of Lucknow city with respect to air and noise is being conducted by IITR, since 1997 twice in a year (pre monsoon and post monsoon in the month of May and October respectively) to assess the environmental quality and its trends. The study was conducted with the following aims and objectives.

- ✓ To assess the ambient air quality with respect to SPM, RSPM, SO₂ and NO_x.
- ✓ 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.

The present study is conducted during the month of March to May, 2009 representing the pre monsoon (summer) period.

In Lucknow city there are 89 petrol pumps operated by four oil companies. The break-up of these petrol pumps are given in Table 3.

Table 3: Petrol Pumps in Lucknow City

Sl. No.	Agency	Number of outlet
		31 st March 2009
1	Indian Oil Corporation. (IOC)	45
2	Bharat Petroleum Corporation Ltd. (BPCL)	19
3	Hindustan Petroleum Corporation Ltd. (HPCL)	22
4	Compressed Natural Gas Stations.(CNG)	3
Total		89

Source: Indian Oil Corporation (IOC), Lucknow

The sales figure of oil companies for the year (2008-09) has been compared with sale figure of 2007-08 (Table 4). It is observed that petroleum sale have been increased marginally by 7.53% whereas sale of diesel has increased by 18.81%.

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

Sl. No.	Agency	Petrol (Unleaded)			High Speed Diesel		
		Apr. 07 to Mar. 08	Apr. 08 to Mar. 09	% increase in consumption	Apr. 07 to Mar. 08	Apr. 08 to Mar. 09	% increase in consumption
1	IOC	49410	53325	7.92	52248	61231	17.19
2	BPCL	25524	26728	4.71	16318	18889	15.75
3	HPCL	15253	16929	10.99	15052	19233	27.78
Total		90187	96982	7.53	83618	99353	18.81

Source: Indian Oil Corporation (IOC), Lucknow

1.1 MONITORING LOCATIONS AND METHODOLOGY

1.1.1 AIR QUALITY

Ten air quality monitoring locations representing different activities/areas i.e., four in residential, five in commercial cum traffic and one industrial area were selected for the study as summarized in Table 5 and methodology is given in Table 6.

Table 5: Air Quality Monitoring Locations

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

The brief description of each sampling site is given below:-

I. Aliganj

Earlier, Aliganj was a residential area, now it has become a semi commercial area. In this locality, the main source of air pollution is vehicular emission. Most of the people are using LPG gas for cooking. Aliganj has a traffic route from Engineering College to Power House LDA Colony Kanpur Road via Charbagh railway station. In this route means of mass public transportation is by jeep, city buses, three wheeler (Vikram and tempo) which are run by diesel and CNG. Monitoring location was at CSIR Scientist Apartments; sector K, near main road.

II. Vikas Nagar

Like Aliganj, Vikas Nagar was earlier a purely residential area and now it has become a semi commercial area. On the main route public transport is by Vikram tempo, minibuses and buses. In Vikas Nagar, vehicular emission is mainly dominated by two wheelers, passenger cars and public transport. The monitoring location was at a residential area, which is about 500 meter away from the Vikas Nagar main road.

III. Indira Nagar

Indira Nagar is now a semi commercial area. In this area the means of public transport is by Jeep and buses running on diesel. In day time, main source of vehicular emission is public transport, two wheelers and passenger cars. The main Ring Road pass through Indira Nagar is carrying high volume of mixed vehicular traffic. During night time large volume of different capacity of commercial trucks pass through this route, generating high level of air and noise pollution. Monitoring was carried out 30 m away from the main Ring Road.

IV. Gomti Nagar

Gomti Nagar is a residential area, dominated by middle and upper class families, using LPG gas for cooking. Source of air pollution is public transport (tempo, jeep and mini buses), two wheeler and passenger car. Night time traffic flow is low. The monitoring location was in Vinay Khand, near Jaipuria crossing about 25 meter away from the main road

V. Hussainganj

In Hussainganj, the monitoring location was 40 meter away from the main road. It is a purely commercial place and during day time traffic flow are city buses, jeeps, two wheelers and passenger cars. Night time commercial vehicles were the main source of pollution.

VI. Charbagh

The place is congested with roadside make shift shops/hawkers and having a high traffic flow. The major source of pollution is auto exhaust from mixed type of vehicles including buses and trucks during night hours. One of the important sources is diesel locomotive. It is one of the busiest places in Lucknow city. The monitoring location was near the main traffic junction.

VII. Alambagh

In Alambagh, monitoring location was 100 m away from the Alambagh crossing on the main Lucknow – Kanpur road. The main source of pollution is vehicular exhaust. In day time, source of pollution is from city as well as from intercity buses, tempos, two wheelers and passenger cars. In night time trucks and long distance buses are the main sources of pollution. Major source of pollution in the area is diesel engine driven vehicular traffic.

VIII. Aminabad

The monitoring location was situated in the central place of Aminabad. This is purely commercial area mainly consisting mainly of shopping complexes. Aminabad serves as major shopping area for upper middle class and middle class family. The whole area is congested having narrow lanes and mixed traffic ranging from bicycles, rickshaws to two wheeler and passenger cars. Sampling site was located adjacent to the Jhandewala Park.

IX. Chowk

The monitoring location was 100 m away from the main road. Area is residential cum commercial. Source of pollution is mainly from tempo, two wheeler and passenger car. During night time commercial vehicles passes through the main road.

X. Amausi

Amausi is an industrial area. There are a number of small-scale industries. In this area, main source of pollution is from vehicular as well as industrial. The monitoring location was about 300 meter away from the main Lucknow - Kanpur road.

Table 6: Methodology for Air Quality Monitoring

Particulars	SPM	RSPM	SO ₂	NO _x
Sampling equipment	HVS	RDS	HVS/RDS with gaseous sampling attachment	
Collection media	Glass Fibre		Sodium Tetra Chloro-Mercurate	NaOH
Flow rate	1.0-1.3 m ³ /min		0.5 L/min	
Analytical method	Gravimetric		Spectrophotometric	
Frequency	24 hourly		8 hourly	
Sampling duration	Continuous for 24 hours			
No. of days of sampling at each location	8 days (Once a week)			

HVS: High Volume Sampler, RDS: Respirable Dust Sampler

1.1.2 NOISE LEVEL MEASUREMENTS

The measurement of noise level was carried out at twelve locations for 30 minutes at each location during the day time (6 AM to 10 PM) and night time (10 PM to 6 AM). All measurements were made with the "A" weighing filter at a height of receptor organ, i.e., ~1.5 metres above the ground level. The location for the noise level measurement is given in Table 7.

Table 7: Noise Monitoring Locations

Sl. No.	Locations	Activity
1	Aliganj	Residential
2	Vikas Nagar	
3	Indira Nagar	
4	Gomti Nagar	
5	Hussainganj	Commercial cum traffic
6	Hazratganj	
7	Charbagh	
8	Alambagh	
9	Aminabad	
10	Chowk	
11	Amausi	Industrial
12	Talkatora	

1.2 RESULTS

1.2.1 AIR QUALITY

The detailed results of air quality monitoring are presented in Table 8 & 9 and Fig. 1.

1.2.1.1 PARTICULATE MATTER (RSPM and SPM)

In residential areas (Aliganj, Vikas Nagar, Indira Nagar and Gomti Nagar) the average concentration of RSPM and SPM were in the range of 133.2 to 193.7 and 280.1 to 379.7 $\mu\text{g}/\text{m}^3$ respectively.

In commercial areas (Hussainganj, Charbagh, Alambagh, Aminabad and Chowk) the average concentration of RSPM and SPM were in the range of 160.9 to 235.1 and 355.3 to 420.8 $\mu\text{g}/\text{m}^3$ respectively.

In industrial area (Amausi), the average concentration of RSPM and SPM were found to be 182.3 and 374.7 $\mu\text{g}/\text{m}^3$ respectively.

All the values of RSPM were above the prescribed National Ambient Air Quality Standard (NAAQS) of 100 and 150 $\mu\text{g}/\text{m}^3$ for residential/commercial and industrial area respectively. All the values of SPM were above the NAAQS of 200 $\mu\text{g}/\text{m}^3$ in residential, rural and other areas whereas it was less than 500 $\mu\text{g}/\text{m}^3$ (NAAQS for industrial area) at Amausi.

Table: 8 Concentration ($\mu\text{g}/\text{m}^3$) of SPM, RSPM, SO_2 , and NO_x , during pre monsoon 2009

Location	Days	SPM	RSPM	SO_2				NO_x			
				A	B	C	Mean	A	B	C	Mean
Aliganj	I	280.5	131.0	19.4	18.9	16.7	18.3	22.1	22.9	21.6	22.2
	II	265.9	129.0	16.8	15.0	13.6	15.1	27.3	36.4	22.1	28.6
	III	281.1	140.0	18.3	21.4	15.0	18.2	25.9	28.9	28.5	27.8
	IV	293.0	132.8	17.3	18.6	14.6	16.8	24.6	30.2	23.7	26.2
	Avg	280.1	133.2				17.1				26.2
Vikas Nagar	I	347.0	156.5	16.0	20.3	12.1	16.2	29.3	24.8	23.0	25.6
	II	345.0	163.5	8.1	19.7	12.4	13.4	26.9	28.0	22.6	25.1
	III	299.7	148.0	15.9	18.9	11.1	15.3	25.9	33.8	20.8	26.8
	IV	325.5	154.9	19.2	15.6	15.5	16.8	25.0	22.1	25.2	24.1
	Avg	329.3	155.7				15.4				25.6
Indira Nagar	I	390.6	228.1	19.4	16.0	17.4	17.6	31.5	29.1	22.7	27.8
	II	342.8	185.6	15.8	22.1	22.0	20.0	28.7	23.9	23.8	25.5
	III	352.4	168.4	11.7	23.3	18.7	18.0	25.2	28.4	21.3	25.0
	IV	299.0	163.9	13.2	20.2	16.8	16.8	21.5	26.2	23.9	23.9
	Avg	346.2	186.5				16.7				25.5
Gomti Nagar	I	395.6	211.3	18.0	16.2	13.1	15.7	23.3	23.1	23.9	23.4
	II	430.6	205.6	22.1	18.9	17.5	19.5	29.9	24.5	25.6	26.7
	III	374.6	186.7	18.6	17.1	16.4	17.4	30.2	31.2	23.2	28.2
	IV	317.9	171.3	20.3	16.8	12.9	16.7	26.3	30.7	27.9	28.3
	Avg	379.7	193.7				17.3				26.7
Hussainganj	I	369.3	150.6	18.3	15.4	17.0	16.9	22.2	28.1	33.1	27.8
	II	393.1	153.4	21.1	24.5	20.4	22.0	23.9	31.8	27.7	27.8
	III	338.9	178.2	17.8	21.0	12.3	17.0	26.0	27.3	26.5	26.6
	IV	347.3	161.2	14.6	18.1	18.4	17.0	26.6	33.1	26.0	28.6
	Avg	362.2	160.9				18.2				27.8
Charbagh	I	401.2	171.2	22.4	17.1	20.5	20.0	30.3	25.0	26.6	27.3
	II	329.6	171.2	21.0	21.1	19.7	20.7	25.6	22.8	28.7	25.7
	III	327.7	184.6	17.2	19.3	15.8	17.5	25.2	31.4	25.6	27.6
	IV	352.6	183.5	13.8	21.0	18.5	18.0	27.0	27.2	30.0	28.0
	Avg	355.3	177.6				19.1				27.2
Alambagh	I	411.2	243.6	21.6	27.0	18.1	22.2	23.3	28.1	27.4	26.3
	II	425.6	251.3	21.0	18.0	19.8	19.8	22.8	26.1	25.7	24.9
	III	456.5	249.8	17.8	21.6	19.4	19.6	28.9	31.5	23.6	28.0
	IV	389.8	195.8	18.6	19.3	18.2	18.7	27.2	21.9	22.1	23.8
	Avg	420.8	235.1				20.1				25.8

Table 8 continued....

Table: 8 Concentration ($\mu\text{g}/\text{m}^3$) of SPM, RSPM, SO_2 , and NO_x , during pre monsoon 2009

		SPM	RSPM	SO_2				NO_x			
				A	B	C	Mean	A	B	C	Mean
Aminabad	I	495.2	188.7	20.7	23.8	18.3	21.0	30.2	25.7	20.8	25.6
	II	318.9	154.6	24.8	29.1	21.7	25.2	30.1	26.9	17.6	24.9
	III	321.3	162.6	18.4	23.3	8.5	16.8	26.8	28.4	20.5	25.3
	IV	330.4	173.2	13.7	21.0	20.4	18.3	25.0	30.5	20.6	25.4
	Avg	366.5	169.7				20.3				
Chowk	I	437.7	192.3	21.0	21.0	14.5	18.8	30.7	27.1	23.5	27.1
	II	345.9	169.2	22.1	18.0	18.2	19.4	26.9	29.2	23.7	26.6
	III	309.5	170.5	19.8	17.4	11.8	16.4	32.2	31.8	25.5	29.8
	IV	353.2	167.7	14.8	15.1	15.2	15.0	21.0	27.6	28.8	25.8
	Avg	361.1	174.9				17.4				
Amausi	I	394.5	169.3	17.3	15.2	16.1	16.2	25.2	24.6	29.4	26.4
	II	412.3	195.0	19.5	16.4	19.3	18.4	25.2	26.6	25.0	25.7
	III	329.5	179.5	20.3	13.5	14.4	16.0	29.6	21.8	27.2	26.2
	IV	362.4	185.3	15.0	11.5	12.8	13.1	27.4	24.9	27.8	26.7
	Avg	374.7	182.3				15.9				

*Once a week during 24 March-24 April 2009.

A = 06:00-14:00 hr., B = 14:00-22:00 hr, C = 22:00-06:00 hr

Table 9: Average Concentration ($\mu\text{g}/\text{m}^3$) of SPM, RSPM, SO_2 and NO_x

Area	Location	SPM	RSPM	SO_2	NO_x
Residential	Aliganj	280.1	133.2	17.1	26.2
	Vikas nagar	329.3	155.7	15.4	25.6
	Indiranagar	346.2	186.5	16.7	25.5
	Gomti nagar	379.7	193.7	17.3	26.7
	Average	333.8 \pm 41.3	167.3 \pm 28.0	16.6 \pm 0.9	26.0 \pm 0.6
	NAAQS	200	100	80	80
Commercial	Hussainganj	362.2	160.9	18.2	27.8
	Charbagh	355.3	177.6	19.1	27.2
	Alambagh	420.8	235.1	20.1	25.8
	Aminabad	366.5	169.7	20.3	25.3
	Chowk	361.6	175.0	17.4	27.3
	Average	373.3 \pm 26.9	183.7 \pm 29.5	19.0 \pm 1.2	26.7 \pm 1.0
	NAAQS	200	100	80	80
Industrial	Amausi	374.7	182.3	15.9	26.3
	NAAQS	500	150	120	120

NAAQS=National Ambient Air Quality Standards

1.2.1.2 SULPHUR DIOXIDE (SO₂)

In residential area (Aliganj, Vikas Nagar, Indira Nagar and Gomti Nagar) the average concentrations of SO₂ were in the range of 15.4 to 17.3 µg/m³.

In commercial area (Hussainganj, Charbagh, Alambagh, Aminabad and Chowk) the average concentrations of SO₂ were in the range of 17.4 to 20.3 µg/m³.

In industrial area (Amausi) the average concentrations of SO₂ was found to be 15.9 µg/m³.

All the values are within the prescribed limit of the NAAQS of 80 µg/m³ for residential, rural and other areas and 120 µg/m³ for industrial area.

1.2.1.3 OXIDES OF NITROGEN (NO_x)

In residential areas (Aliganj, Vikas Nagar, Indira Nagar and Gomti Nagar) the average concentrations of NO_x were found in the range of 25.5 to 26.7 µg/m³.

In commercial areas (Hussainganj, Charbagh, Alambagh, Aminabad and Chowk) the average concentrations of NO_x were found in the range of 25.3 to 27.8 µg/m³.

In industrial areas (Amausi) the average concentrations of NO_x was 26.3 µg/m³.

All the values of NO_x were within the prescribed NAAQS of 80 µg/m³ for residential, rural and other areas and 120 µg/m³ for industrial area.

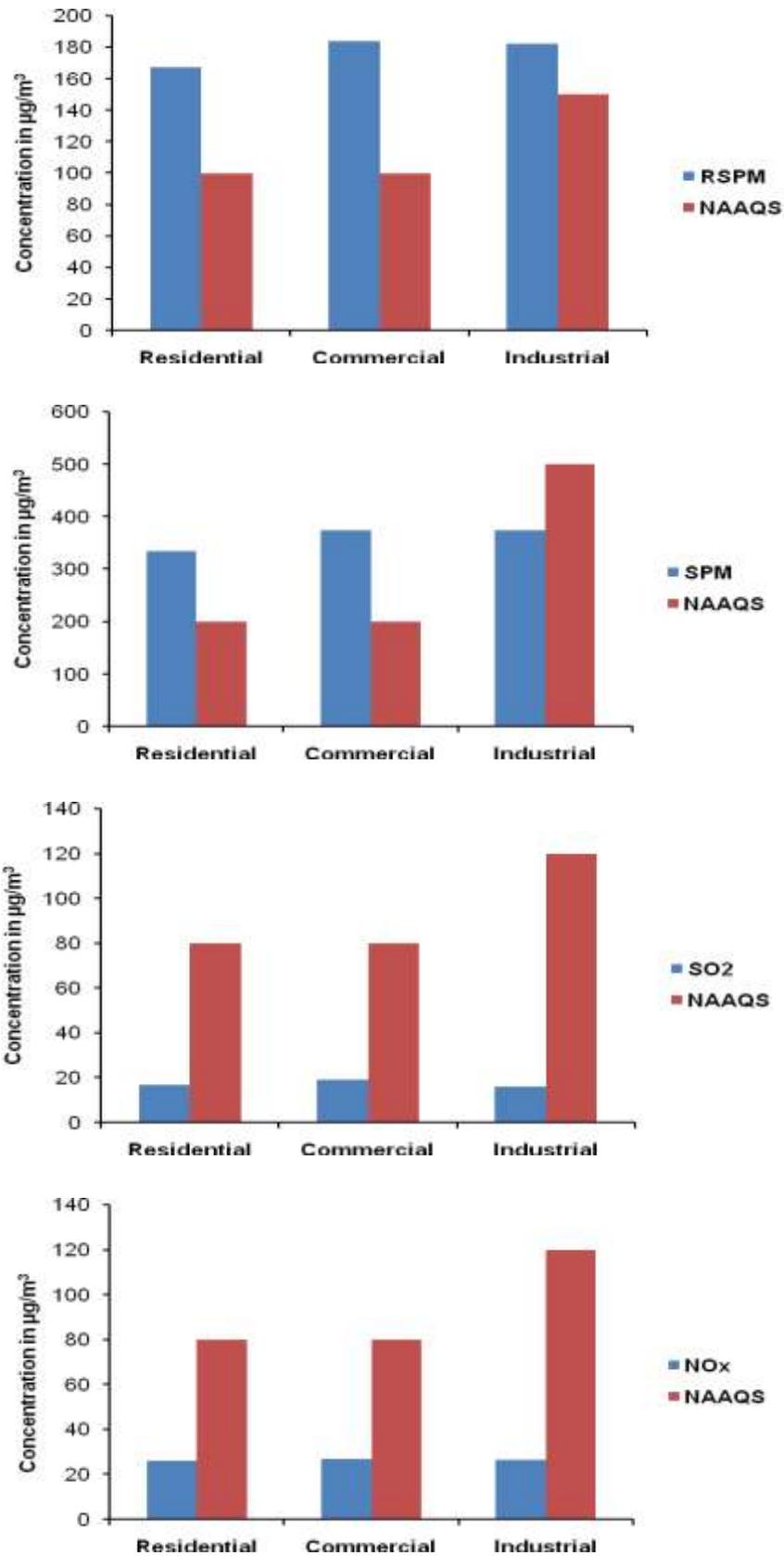


Fig. 1: Concentration ($\mu\text{g}/\text{m}^3$) of SPM, RSPM, SO₂ and NO_x in different areas of Lucknow city during pre monsoon season (2009) and compared with prescribed National Ambient Air Quality Standard (NAAQS).

1.2.2 NOISE

Elevated noise levels have been associated with adverse impact on human health, ranging from minor annoyance to physiological damage. As such, traffic noise has become a major environmental concern and a source of an ever-increasing level of discomfort particularly in urban areas with high traffic congestion. The sources of noise in the urban settings are primarily vehicular engines, exhaust systems, aerodynamic friction, and tyre-pavement interaction. Traffic noise is affected by factors such as traffic volume and speed, vehicle mix, pavement type, and vehicle conditions. The monitoring data recorded during the pre monsoon period (May, 2009) is presented in Table 10.

In residential areas, the day and night time noise level were recorded between 65.2 to 76.2 and 52.8 to 68.1 dB(A) respectively. All the values are 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 69.2 to 72.1 and 55.6 to 69.5 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 areas, Amausi and Talkatora the day and night time noise level were recorded between 68.2 to 72.5 and 61.8 to 65.8 dB(A) respectively. Noise level at both 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 (May, 2009)

Sl. No.	Area	Location	Noise level dB(A)	
			Day	Night
1	Residential	Aliganj	65.2	53.1
		Vikas Nagar	68.5	52.8
		Indira Nagar	76.2	61.0
		Gomti Nagar	65.4	68.1
		Standard	55.0	45.0
2	Commercial	Hazratganj	69.2	61.2
		Hussainganj	72.1	65.6
		Charbagh	71.8	69.5
		Alambagh	70.5	66.8
		Aminabad	70.8	55.6
		Chowk	69.5	60.2
		Standard	65.0	55.0
3	Industrial	Amausi	68.2	61.8
		Talkatora	72.5	65.8
		Standard	75.0	70.0

1.3 TRENDS

1.3.1 AMBIENT AIR QUALITY

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

1.3.1.1 Suspended Particulate Matter (SPM)

At all the locations except Gomti Nagar in residential areas, slight decrease was recorded over last year but all the values are higher than the NAAQS (Fig. 2).

Among the commercial areas, SPM values showed decreasing trend except Alambagh at all the locations than the last year and all values are higher than the NAAQS (Fig 2).

Amausi under industrial area showed lower value over the last year and also lower than the NAAQS (Fig. 2).

1.3.1.2 Respirable Suspended Particulate Matter (RSPM)

In all the locations in residential areas, slight decrease was recorded over last year except Gomti Nagar and all the values are higher than the NAAQS (Fig. 3).

Among the commercial areas, RSPM values showed decreasing trend at all the locations except only in Alambagh which showed significantly higher value than the last year. All the values are higher than the NAAQS (Fig 3).

Amausi under industrial area showed increasing trend over the last year and marginally higher than the NAAQS (Fig. 3).

1.3.1.3 Sulphur Dioxide (SO₂)

SO₂ level in residential areas namely Gomti Nagar showed slightly increasing trend in comparison to last year. (Fig.4).

In the commercial areas, SO₂ showed decreasing trend at all the locations when compared with the last year values (Fig. 4).

The industrial area Amausi showed decreasing trend with the last year. (Fig.4).

1.3.1.4 Oxides of Nitrogen (NO_x)

Among the Residential areas all the locations showed slightly decreasing trend except Gomti Nagar (Fig.5).

Among commercial areas, NO_x registered decreasing trend at all the locations when compared with the last year data. (Fig.5).

The industrial area Amausi showed slightly decreasing trend when compared with the last year data (Fig.5).

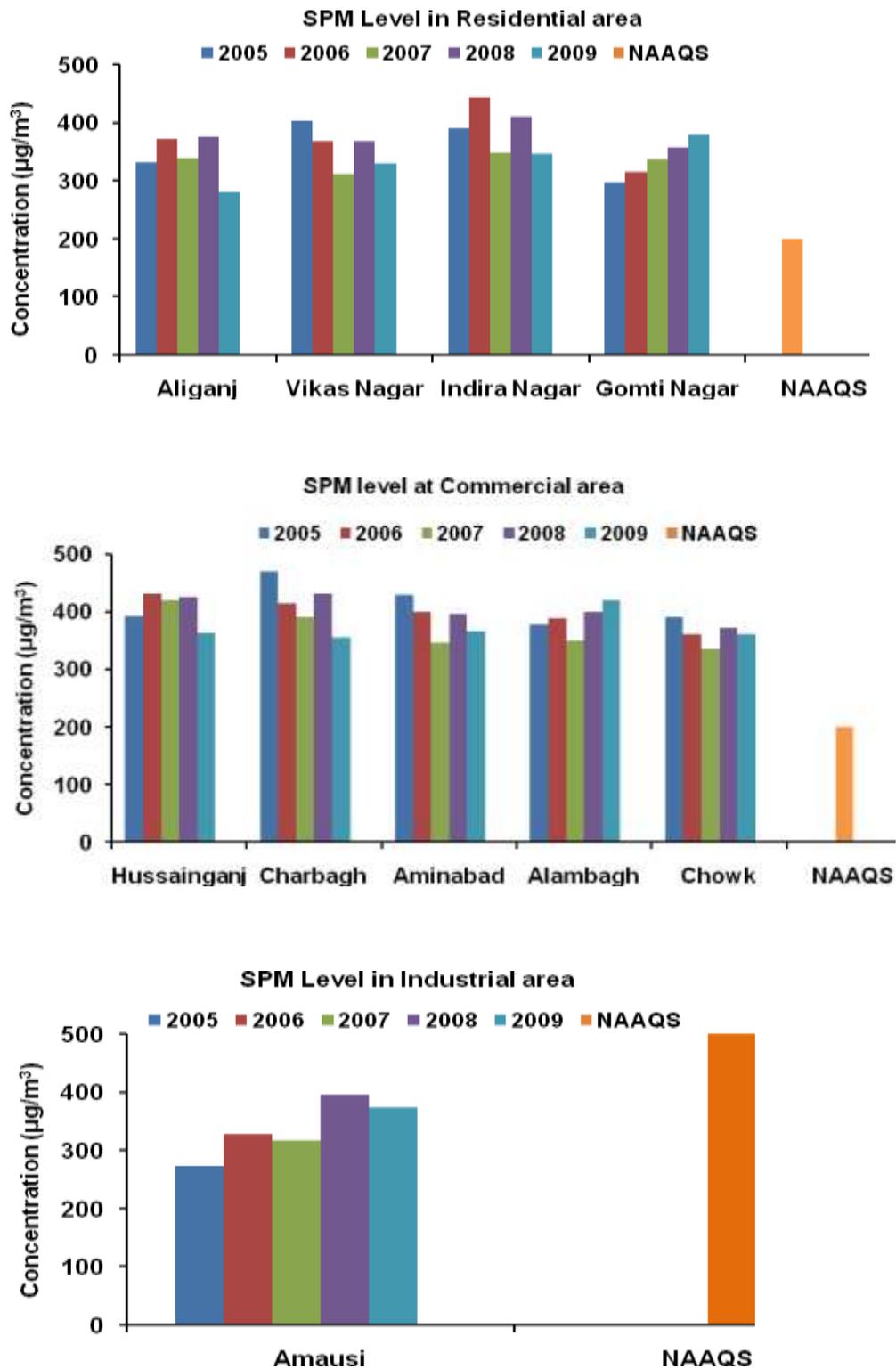


Fig. 2: Concentration ($\mu\text{g}/\text{m}^3$) of SPM in Residential, Commercial and Industrial areas of Lucknow city during 2005 to 2009 and compared with prescribed National Ambient Air Quality Standard (NAAQS).

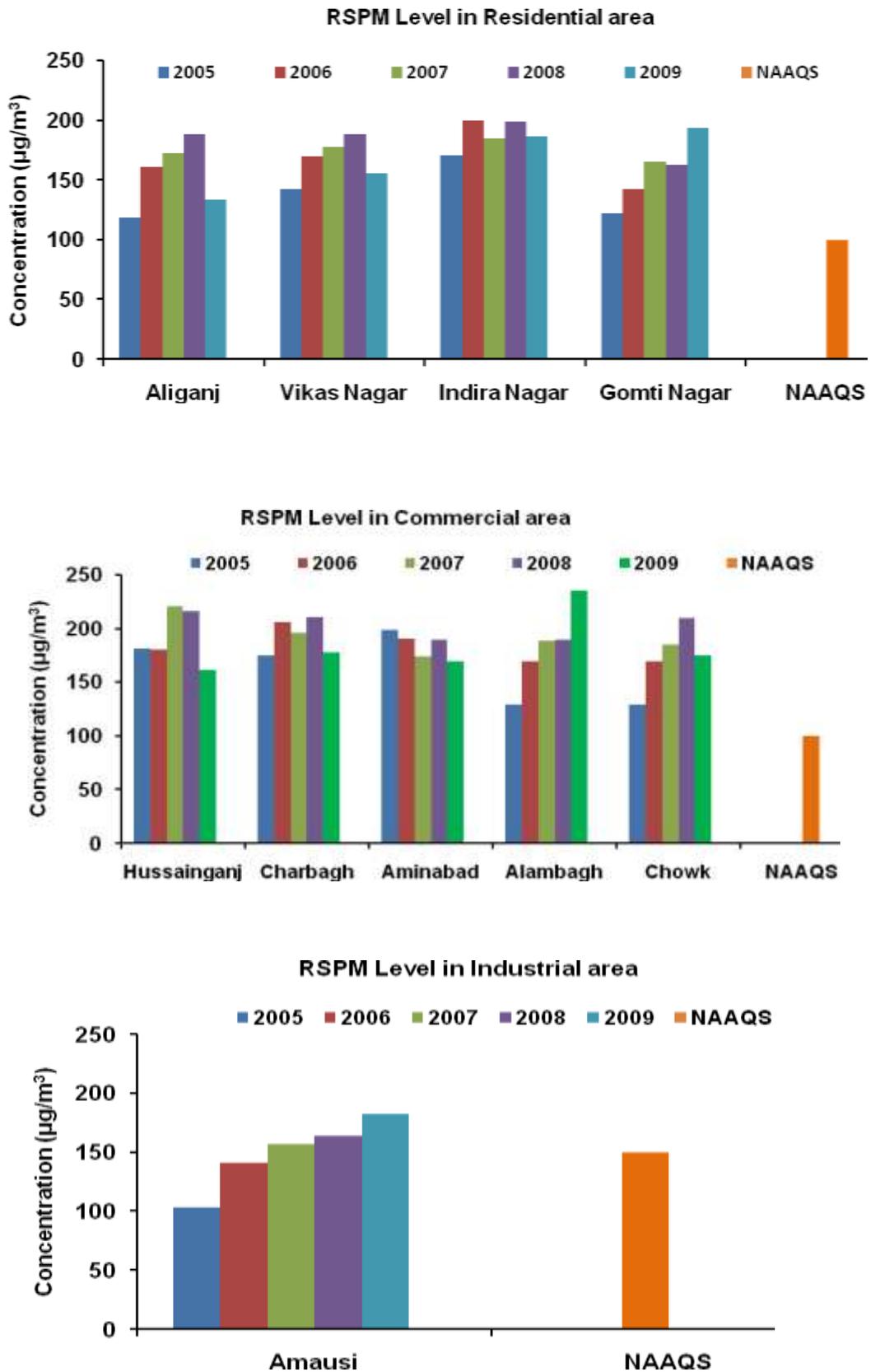


Fig. 3: Concentration ($\mu\text{g}/\text{m}^3$) of RSPM in Residential, Commercial and Industrial areas of Lucknow city during 2005 to 2009 and compared with prescribed National Ambient Air Quality Standard (NAAQS).

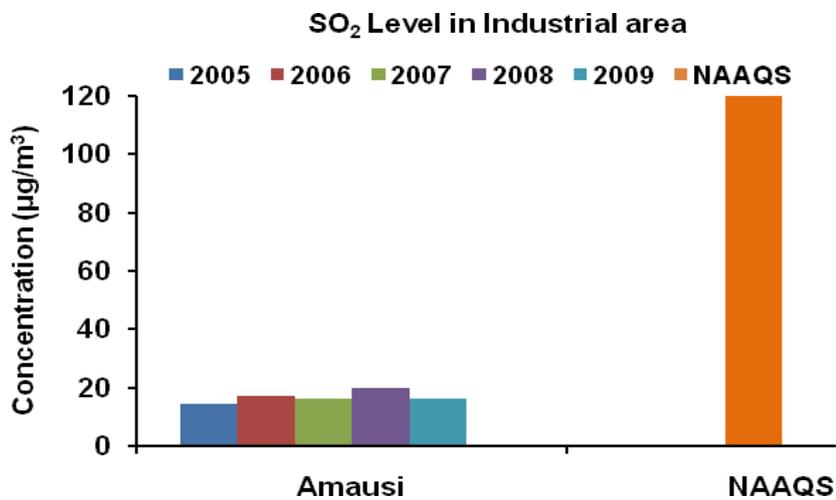
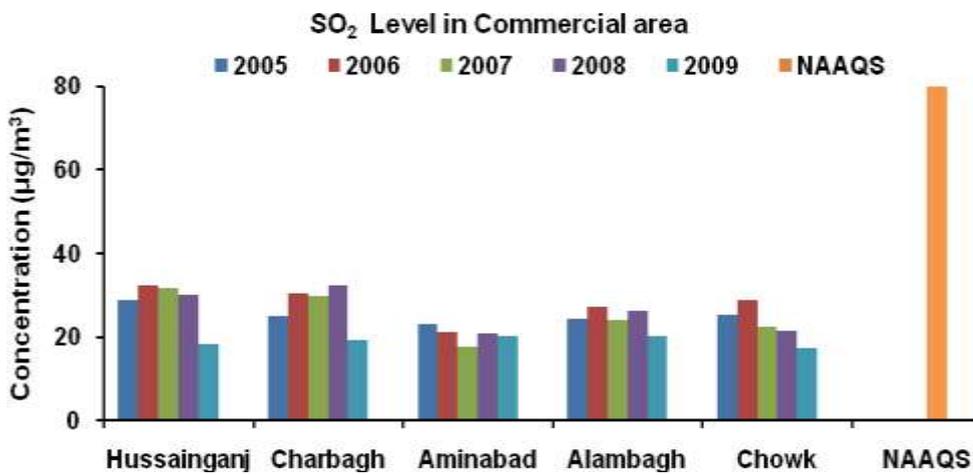
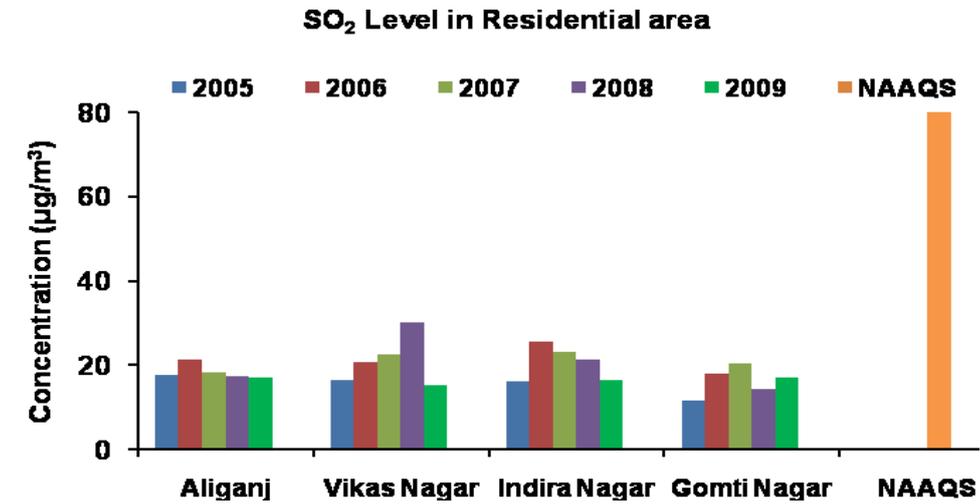


Fig. 4: Concentration ($\mu\text{g}/\text{m}^3$) of SO₂ in Residential, Commercial and Industrial areas of Lucknow city during 2005 to 2009 and compared with prescribed National Ambient Air Quality Standard (NAAQS).

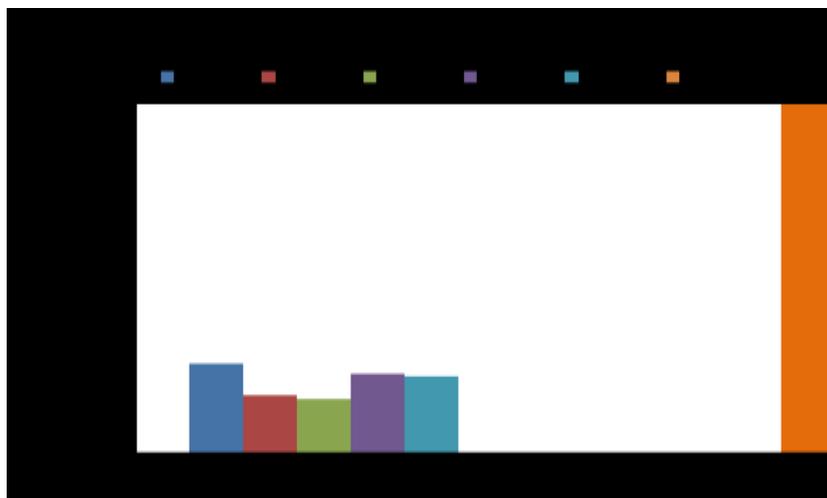
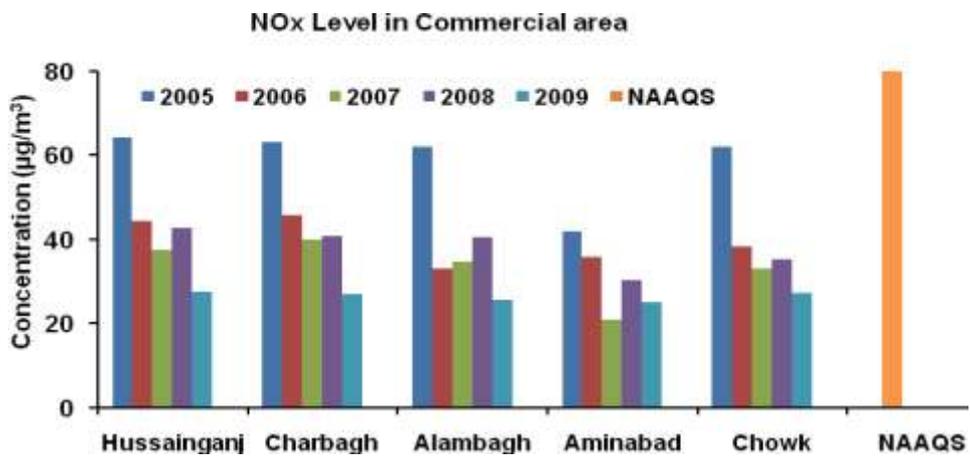
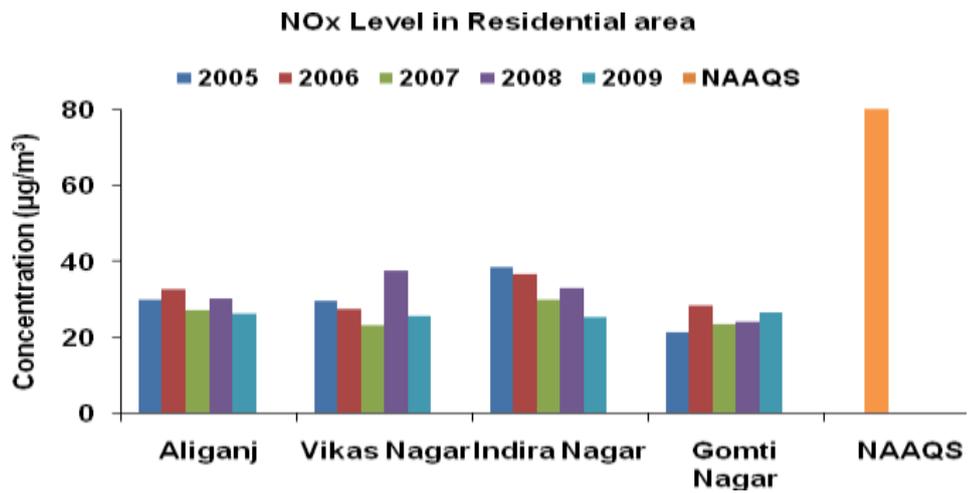


Fig. 5: Concentration ($\mu\text{g}/\text{m}^3$) of NO_x in Residential, Commercial and Industrial areas of Lucknow city during 2005 to 2009 and compared with prescribed National Ambient Air Quality Standard (NAAQS).

1.3.2 TRENDS OF NOISE LEVEL

Current year's noise data has been compared with the corresponding data of previous four years and are presented in Fig. 6 and 7. The comparative noise level in residential, commercial and Industrial areas is described below:

1.3.2.1 Day Time Noise Level

In residential areas all the locations shows slightly increasing trend over the last year level. (Fig. 6).

In commercial cum traffic areas slightly lower levels were recorded except Hazratganj which showed slightly increasing value was recorded over the last year (Fig.6).

In industrial area, in both the locations the noise level was recorded lower over last year data. The comparative data are presented in (Fig. 6).

1.4.3.2 Night Time Noise Level

All four residential areas showed slightly lower trend except Gomti Nagar was recorded over the last year level (Fig. 7).

Among commercial areas, all the locations showed almost showed slightly lower values except Hazratganj than the last year (Fig. 7).

In both the locations of industrial area, registered a slight decrease in the noise level during nighttime over last year data (Fig. 7).

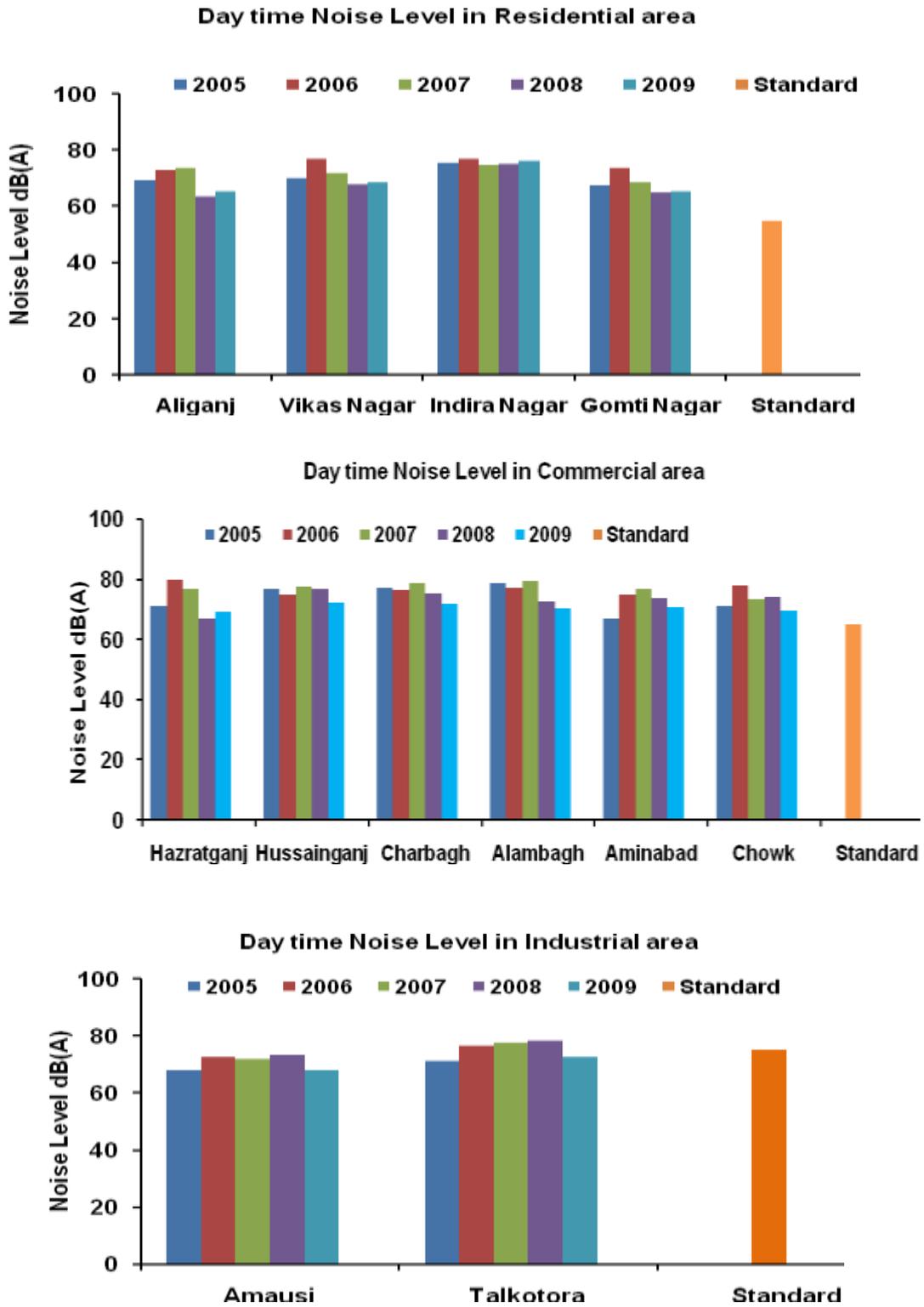


Fig. 6: Comparison of day time Noise Level dB(A) in different areas of Lucknow city (2005-2009)

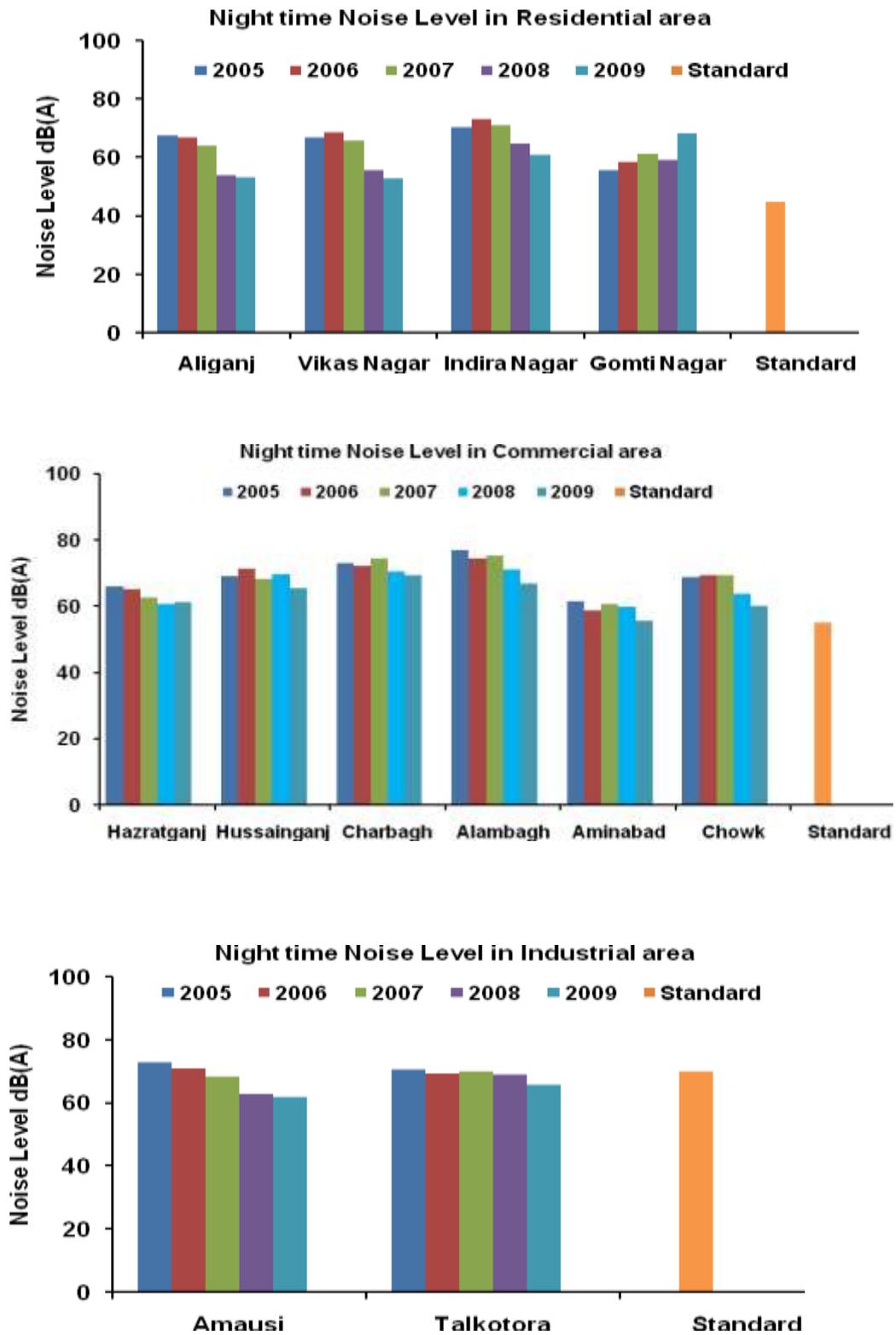


Fig. 7: Comparison of night time Noise Level dB(A) in different areas of Lucknow city (2005-2009)

1.4 HEALTH HAZARDS OF POLLUTANTS

1.4.1 Particulate Matter

The respirable particles known as PM₁₀ have a diameter ≤ 10 μm and when inhaled would penetrate beyond the larynx.

- Small particles penetrate deeply into the lung and can cause respiratory disease such as emphysema and bronchitis, and aggravate existing heart disease.
- Ultra fine particles ranging from 0.001 to 0.1 micron in diameter are able to penetrate deep into the lung and to the alveolar sacs where gaseous exchange occurs.
- Further these particles increase the rates of blood flow and vascular permeability to white blood cells, elevating clotting activity, constriction of the airways and fever induction.

1.4.2 Sulfur Dioxide (SO₂)

Elevated level of SO₂ may cause-

- Irritation of the eyes, nose and throat, choking and coughing.
- Reflex cough, irritation, and a feeling of chest tightness, which may lead to narrowing of the airways, particularly likely to occur in people suffering from asthma and chronic lung disease, whose airways are often inflamed and easily irritated.
- Oral inhalation of larger volumes may reach the segmental bronchi and damage the organ.
- Exposure of the eyes (eg. In an industrial accident) can cause severe burns, resulting in the loss of vision.
- Repeated or prolonged exposure to moderate concentrations may cause inflammation of the respiratory tract, wheezing and lung damage
- Other health effects include headache, general discomfort and anxiety.

1.4.3 Oxides of Nitrogen (NO_x)

NO_x causes a wide variety of health and environmental impacts because of various compounds and derivatives in the family of nitrogen oxides, including nitrogen dioxide, nitric acid, nitrous oxide, nitrates, and nitric oxide.

- Long term exposure to NO₂ may affect lung function
- May increase the level of respiratory infections in children
- Enhance the response to allergens in sensitised individuals.
- Lowering the resistance to diseases such as pneumonia and influenza.

- Extremely high-dose exposure (as in a building fire) to NO₂ may result in pulmonary edema and diffuse lung injury.
- Continued exposure to high NO₂ levels can contribute to the development of acute or chronic bronchitis.
- Industrial exposure to nitric oxide can cause unconsciousness, vomiting, mental confusion, and damage to the teeth.
- Exposure to low levels of nitrogen oxides in smog can irritate the eyes, nose, throat, and lungs and can cause coughing, shortness of breath, fatigue, and nausea.

1.4.4 Noise

Elevated levels of noise may have

- Adverse effects varying from hearing loss to annoyance.
- Noise produces both temporary and permanent hearing loss. Noise can range from the bursting of the eardrum to permanent hearing loss,
- Cardiac and cardiovascular changes, stress, fatigue, dizziness, lack of concentration,
- Cause of accident, irritation, inefficiency, deterioration in motor and psychomotor functions, nausea, interference with work tasks and speech communication, headaches, insomnia and loss of appetite and many others.
- Continuous noise causes an increase in cholesterol level resulting in constriction of blood vessels making prone to heart attack and stress.

1.5 DISCUSSION

The level and effect of emissions from vehicles exhaust are usually an outcome of several factors: population density, congestion, weather, type of fuel and vehicle used, driving habits, road conditions and maintenance schedule.

Similarly, weather, climate and topography of a region determine the ambient conditions. However, exposure to emissions is mainly a function of socio-economic status of an individual and the location-both house and office.

The automobile exhaust directly influences ambient air quality in urban area. Overall the pollution levels are a major concern respect to SPM and RSPM, at most of the locations and which are higher than the prescribed limit, whereas SO₂ and NO_x also showed decreasing trend as compared with previous year results except few locations

in residential area of Gomti Nagar but well below the prescribed limit recommended by MoEF, New Delhi.

The study revealed that concentration of the pollutants in residential, commercial and industrial area showed little variations indicates that pollutants are well dispersed within the urban area. The major concern is the particulate matter which is much higher than the permissible limit and affects the human health. The effect of pollutant especially the particulate matter in urban areas depends on several factors like number of concentration, size composition, time of exposure, and lastly the receptor (in case of humans these factors depend on age, health conditions etc.).

Thus it is necessary to monitor the air quality as well as the health effects on regular interval 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 data base since 1997 will help the planners for sustainable development of the city.

1.6 CONCLUSIONS

Monitoring of air pollutants such as SPM, RSPM, SO₂ and NO_x at 10 locations during pre monsoon, 2009 revealed that-

- The SPM and RSPM level at all the monitoring locations of residential and commercial areas were higher than the NAAQS.
- The concentration of gaseous pollutants, SO₂ & NO_x were within the prescribed NAAQS at all the locations.
- Decreasing trend for the RSPM was found at all the locations over the 2005 data except at Gomti Nagar and Alambagh. It may be due to local construction activity.
- The noise level at all the locations except in industrial areas during day and night time showed slightly higher level than the respective permissible limits.
- Overall results indicate that RSPM and SPM is one of the major causes for deterioration of ambient air quality.

1.7 RECOMMENDATIONS

- 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.
- Check on fuel adulteration.

- Regular sweeping of roads to avoid re-suspension of soil dust.
- Increase use of alternative fuel e.g., CNG.
- Public awareness programme for automobile pollution.
- Pressure horns to be removed from all vehicles.