ASSESSMENT OF ENVIRONMENTAL STATUS OF LUCKNOW CITY

(PRE-MONSOON)

FINDINGS OF A RANDOM SURVEY

WORLD ENVIRONMENT DAY

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Post Box 80, Mahatma Gandhi Marg,
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Salient Features of the Study

❖ **Geographical Position**	**:**	26^{o} 52' N Latitude 80^{o} 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 *Master Plan 2021*
❖ **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 31/03/2010**	**:**	11,07,455
❖ **Growth of Vehicle over 2009-2010**	**:**	8.02%
❖ **Total Number of Petrol Pumps**	**:**	93
❖ **Consumption of Petrol**	**:**	10,89,59 KL
❖ **Consumption of Diesel**	**:**	1,13,779 KL
❖ **Major Source of Pollution**	**:**	Automobiles, D. G. sets, Civil Constructions
❖ **Parameters Monitored**	**:**	RSPM, SO_2, NO_X, Pb, Ni and Noise
❖ **Study Conducted by**	**:**	Environmental Monitoring Section IITR, Lucknow

1.1 INTRODUCTION

Exposure of air pollution is an inescapable part of our urban life. Air pollution has adverse impact on living organisms including human beings. Particulate and gaseous emission of the pollutants from the industries and auto-exhaust is responsible for the rising discomfort, increasing airways diseases, decreasing productivity and deterioration of artistic and cultural patrimony in urban centres [1]. Over the past 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. The presence of air pollutants over prescribed limits in the lower atmosphere is not only injurious to humans, but also to animals, foliage, fruits, vegetables and microbial life and may even damage to property [2]. 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 are the major contributor. Vehicular emission is responsible for higher level of air pollutants like RSPM, SO_2, NOx and other organic and inorganic pollutants including trace metals which have adverse effects on human and environmental health [3 – 8]. Motor vehicles are also the main source of noise pollution in urban area. Inhabitants of the major cities subjected to continuous to high level of air and noise pollution, run the risk of losing their working ability.

The quality of ambient air in the Lucknow city has improved comparatively after the introduction of Compressed Natural Gas (CNG) for running public transport around four year ago especially for gaseous pollutants. In view of 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 22.45 Lakhs (Municipal corporation + Cantonment) as per 2001 census and an area of 310 sq. km. Total vehicle of different categories registered with RTO, Lucknow during 2009-2010 were 11,07,455 which is 8.02% higher than last year (2008-2009). The details are given in Table 1.

Table 1: Registered Vehicle with R.T.O. Lucknow during 2008- 09 and 2009-10

Sl. No.	Type of Vehicle	Number of Registered Vehicles On 31st March		% Change
		2009	2010	
1	Multi Axial	1808	2134	18.03
2	Light, Medium and Heavy weight Vehicles (Four wheeler)	7957	8631	8.47
3	Light Commercial Vehicles (Three wheeler)	3776	3702	-1.95
4	Light Commercial Vehicles (Four wheeler)	4434	4532	2.21
5	Buses	2794	2930	4.87
6	Taxi	4361	5055	15.91
7	Three wheelers and Auto Rickshaw	11649	7410	-36.3
8	Two wheelers	825088	890442	7.92
9	Car	129234	145996	0.74
10	Jeep	13627	14910	9.41
11	Tractor	15477	16464	6.38
12	Trailers	1110	1182	6.49
13	Others	3927	4067	3.57
	Total	10,25,242	11,07,455	8.02

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 31.03.2010 are given in Table 2.

Table 2: Details of Lucknow city bus service, 2010

Sl. No.	Route No.	To and Fro	No. of Buses
1	11	Chinhat-Gomti Nagar-Alambagh	37
	11 A	Chinhat-Gomtinagar-Dalibagh-Charbagh	
	11B	Chinhat-Gomtinagar-Charbagh-SGPGI	
	11C	Charbagh-Uttaratia-Sardar Patel Dental college	
	11D	Charbagh-Babasaheb Bhimrao Ambedkar-BB	
	11E	Charbagh-Telibagh-Ganesh Kunj	
2	12	Chinhat-Scooter India	14
3	23	Rajinikhand-Gudamba thana	20
4	24	Charbagh - Engineering College	41
5	25	Charbagh-Bijnor	4
6	31	Alambagh – IIM	2
7	33	Alambagh- Engineering College	20
8	34	Alambagh-Charbagh-Hazratganj-Kapporthala-Keshavnagar	2
9	44	Charbagh-Andhi Chowki	6
10	45	Parag Dairy – Polytechnic Chowraha	11
11	66	GPO- Hazratganj-Rajajipuram	5
		Total	162

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 present study was conducted with the following aims and objectives.

- ✓ *To assess the ambient air quality with respect to RSPM, SO_2, NOx and trace metals (lead and nickel).*
- ✓ *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, 2010 representing the pre monsoon (summer) period.

In Lucknow city there are 93 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 31st March 2010
1	Indian Oil Corporation. (IOC)	45
2	Bharat Petroleum Corporation Ltd. (BPCL)	20
3	Hindustan Petroleum Corporation Ltd. (HPCL)	22
4	Compressed Natural Gas Stations.(CNG)	6
	Total	93

Source: Indian Oil Corporation (IOC), Lucknow

For consumption of Fuel in Lucknow, the sales figure of oil companies for the year (2009-10) has been compared with sale figure of 2008-09 (Table 4). It is observed that petroleum sale have been increased marginally by 12.07% whereas sale of diesel has increased by 13.99%.

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

Sl. No.	Agency	Petrol (Unleaded)			High Speed Diesel		
		Apr. 08 to Mar. 09	Apr. 09 to Mar. 10	% increase in consumption	Apr. 08 to Mar. 09	Apr. 09 to Mar. 10	% increase in consumption
1	IOC	53345	60163	12.78	61267	66719	8.90
2	BPCL	26734	28828	7.83	18964	22252	17.34
3	HPCL	17142	19968	16.49	19583	24808	26.68
Total		97221	108959	12.07	99814	113779	13.99

Source: Indian Oil Corporation (IOC), Lucknow

Green Gas Limited (GGL) is a Joint Venture of GAIL (India) Limited and Indian Oil Corporation Limited [IOCL]. It has been incorporated for the implementation of City Gas Projects for supply of Piped Natural Gas (PNG) to domestic, commercial and industrial Consumers and Compressed Natural Gas (CNG) to automobile consumers in the cities of Lucknow and Agra. In Lucknow there are five CNG filling stations which are located at Ashiana, Gomti Nagar, Kanpur Hardoi bypass and Madion (Sitapur Road). Consumption of CNG on daily basis in last year was 50,000 Kg. On average 7500 vehicles fill CNG fuel daily. Distribution and number of CNG vehicles in Lucknow is summarized in Table-5.

Table-5 Distribution of CNG vehicles

Sl. No.	Vehicles	Number
1	Auto	4080
2	Taxi	2514
3	Buses (UPSRTC)	137
4	Buses (Private)	26
5	School Buses	246
6	Private Service Vehicles	77
7	Cars	410
	Total	7490

1.2 MONITORING LOCATIONS AND METHODOLOGY

1.2.1 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 mentioned in Table 6. The methodology for air quality monitoring is given in Table 7.

Table 6: 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 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, mini buses and CNG 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 CNG buses. 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 though 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 and mini buses), two wheelers and passenger cars. 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 (CNG), jeeps, two wheelers and passenger cars. In night 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 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 wheelers 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 wheelers and passenger cars. 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 7: Methodology for Air Quality Monitoring

Particulars	RSPM	SO_2	NOx	Metal
Sampling equipment	RDS	RDS with gaseous sampling attachment		
Collection media	Glass Fibre	Sodium Tetra Chloro-Mercurate	NaOH	EPAM 2000
Flow rate	1.0-1.3 m^3/min	0.5 L/min		1.0-1.3 m^3/min
Analytical method	Gravimetric	Spectrophotometric		AAS
Frequency	24 hourly	8 hourly		24 hourly
Sampling duration	Continuous for 24 hours			
No. of days of sampling at each location	4 days (Once a week)			Once a month

RDS: Respirable Dust Sampler; AAS : Atomic Absorption Spectrophotometer

1.2.2 NOISE LEVEL MEASUREMENTS

The measurement of noise level was carried out at twelve (12) 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 8.

Table 8: 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	

1.3 RESULTS

1.3.1 AIR QUALITY

The detailed results of air quality monitoring are presented in Table 9 & 10 and Fig. 1.

1.3.1.1 RESPIRABLE SUSPENDED PARTICULATE MATTER (RSPM)

In residential areas (Aliganj, Vikas Nagar, Indira Nagar and Gomti Nagar) the average concentration of RSPM was in the range of 124.3 to 169.8 µg/m^3.

In commercial areas (Hussainganj, Charbagh, Alambagh, Aminabad and Chowk) the average concentration of RSPM were in the range of 180.2 to 255.2 µg/m^3 .

In industrial area (Amausi), the mean level of RSPM were found to be 160.9 µg/m^3.

All the values of RSPM were above the prescribed National Ambient Air Quality Standard (NAAQS) of 100 for industrial, residential, rural and other area.

Table 9: Concentration (µg/m^3) of RSPM, SO_2 and NOx, during pre-monsoon 2010

Location	Days	RSPM	SO_2				NOx			
			A	B	C	**Mean**	A	B	C	**Mean**
Aliganj	I	132.8	12.2	12.8	9.9	**11.6**	28.5	32.4	20.4	**27.1**
	II	117.0	10.7	14.5	9.3	**11.5**	27.3	35.4	18.2	**26.9**
	III	127.8	14.4	12.6	10.3	**12.4**	22.7	20.3	20.7	**21.1**
	IV	119.7	11.1	13.8	9.5	**11.5**	31.9	27.4	16.6	**25.3**
	Avg	**124.3**				**11.8**				**25.1**
Vikas Nagar	I	164.4	14.1	13.5	12.5	**13.4**	26.8	29.7	26.5	**27.6**
	II	174.4	14	16.7	13	**14.6**	26.3	29.6	28.3	**28.1**
	III	172.8	12.9	14.3	9.2	**12.1**	25.2	30.1	24.6	**26.7**
	IV	165.7	9.6	11.1	12.3	**11.0**	24.4	33.9	30.3	**29.6**
	Avg	**169.3**				**12.8**				**27.7**
Indira Nagar	I	164.4	13.4	11.7	15.2	**13.4**	28.3	26.2	21.8	**25.4**
	II	191.2	15.3	14.4	15.6	**15.1**	25.7	30.6	22.3	**26.2**
	III	179.2	12.3	15.9	12.3	**13.5**	38.2	26.9	21.2	**28.7**
	IV	144.6	12.1	14.8	15.9	**14.3**	33.4	31.3	24.6	**29.7**
	Avg	**169.8**				**14.1**				**27.5**
Gomti Nagar	I	154.6	11	12.3	11.4	**11.6**	35.4	45.1	18.5	**33.0**
	II	145.7	11.8	10.8	7.8	**10.1**	27.3	24.5	25.4	**25.7**
	III	187.1	12.3	12.3	9.2	**11.3**	35.8	31.2	24.3	**30.4**
	IV	153.4	8.4	12.9	8.4	**9.9**	31.3	32.5	27.8	**30.5**
	Avg	**160.2**				**10.7**				**29.9**
Hussainganj	I	244.4	13	14.9	15.9	**14.6**	37.1	39.4	25.6	**34.1**
	II	259.6	12.2	14.8	18.5	**15.2**	37.2	49.4	16.0	**34.2**
	III	268.0	15.3	12.6	15.6	**14.5**	41.6	42.7	19.7	**34.7**
	IV	248.7	13.9	20.4	16.8	**17.0**	42.0	43.7	27.1	**37.6**
	Avg	**255.2**				**15.3**				**35.2**
Charbagh	I	187.9	16.9	16.1	13.5	**15.5**	41.3	30.5	31.6	**34.4**
	II	191.4	14.7	17.9	18.7	**17.1**	43.2	35.9	48.2	**42.4**
	III	234.9	16.1	21.8	14.7	**17.5**	35.7	44.4	21.1	**33.7**
	IV	211.1	21	20.1	17.4	**19.5**	36.6	39.9	25.2	**33.9**
	Avg	**206.3**				**17.4**				**36.1**
Alambagh	I	198.7	15.6	14	10.3	**13.3**	42.4	40.8	33.7	**39.0**
	II	209.8	10.5	15.6	12.2	**12.8**	22.5	29.0	24.5	**25.4**
	III	255.8	13	13.9	17.2	**14.7**	38.7	46.1	22.1	**35.6**
	IV	238.3	14.7	13.6	16.7	**15.0**	37.5	33.2	35.6	**35.4**
	Avg	**225.6**				**13.9**				**33.8**
Aminabad	I	225.5	10.4	14.6	8.6	**11.2**	39.2	41.7	34.8	**38.6**
	II	159.1	15.5	12.2	6	**11.2**	32.7	34.6	17.4	**28.2**
	III	229.2	12.7	16.7	9.1	**12.8**	27.1	21.5	18.1	**22.2**
	IV	239.3	12.1	15.7	7.9	**11.9**	26.2	29.5	14.1	**23.2**
	Avg	**213.8**				**11.8**				**28.1**
Chowk	I	171.9	10.8	14.8	8.2	**11.3**	36.7	39.7	29.2	**35.2**
	II	162.6	14.5	12.2	9.8	**12.2**	26.3	20.9	16.1	**21.1**
	III	207.5	16.2	15.7	11.7	**14.5**	25.4	24.3	16.3	**22.0**
	IV	178.6	14	17.9	8.9	**13.6**	28.9	33.6	19.7	**27.4**
	Avg	**180.2**				**12.9**				**26.4**
Amausi	I	169.1	8.7	12.2	8.5	**9.8**	35.0	40.2	29.6	**35.0**
	II	184.1	11.1	9.9	8.2	**9.7**	43.7	38.8	35.1	**39.2**
	III	155.0	9.4	12.3	7.9	**9.9**	43.6	37.9	30.9	**37.5**
	IV	135.6	8.7	10	7.7	**8.8**	45.1	37.4	33.6	**38.7**
	Avg	**160.9**				**9.6**				**37.6**

**Once a week during March- May 2010. A = 06:00-14:00 hr., B = 14:00-22:00 hr, C = 22:00-06:00 hr*

Table 10: Average Concentration (µg/m^3) of RSPM, SO_2 and NO_x

Area	Location	RSPM	SO_2	NOx
Residential	Aliganj	124.3	11.8	25.1
	Vikas nagar	169.3	12.8	27.7
	Indiranagar	169.8	14.1	27.5
	Gomti nagar	160.2	10.7	29.9
	Average	156.0	12.4	27.5
	NAAQS	**100.0**	**80.0**	**80.0**
Commercial	Hussainganj	255.2	15.3	35.2
	Charbagh	206.3	17.4	36.1
	Alambagh	225.6	13.9	33.8
	Aminabad	213.8	11.8	28.1
	Chowk	180.2	12.9	26.4
	Average	216.2	14.3	31.9
	NAAQS	**100.0**	**80.0**	**80.0**
Industrial	Amausi	160.9	9.6	37.6
	NAAQS	**100.0**	**80.0**	**80.0**

NAAQS=National Ambient Air Quality Standards

1.3.1.2 SULPHUR DIOXIDE (SO_2)

In residential area (Aliganj, Vikas Nagar, Indira Nagar and Gomti Nagar) the average concentrations of SO_2 were in the range of 10.7 to 14.1 µg/m^3.

In commercial area (Hussainganj, Charbagh, Alambagh, Aminabad and Chowk) the average concentrations of SO_2 were in the range of 11.8 to 17.4 µg/m^3.

In industrial area (Amausi) the mean level of SO_2 was found to be 9.6 µg/m^3.

All the values of SO_2 were well below the prescribed NAAQS of 80 µg/m^3 for all the locations.

1.3.1.3 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 25.1 to 29.9 µg/m^3.

In commercial areas (Hussainganj, Charbagh, Alambagh, Aminabad and Chowk) the average concentrations of NO_X were found in the range of 26.4 to 36.1 µg/m^3.

In industrial areas (Amausi) the average concentrations of NO_x was 37.6 µg/m^3.

All the values of NO_x were within the prescribed NAAQS of 80 µg/m^3 for all the monitoring locations.

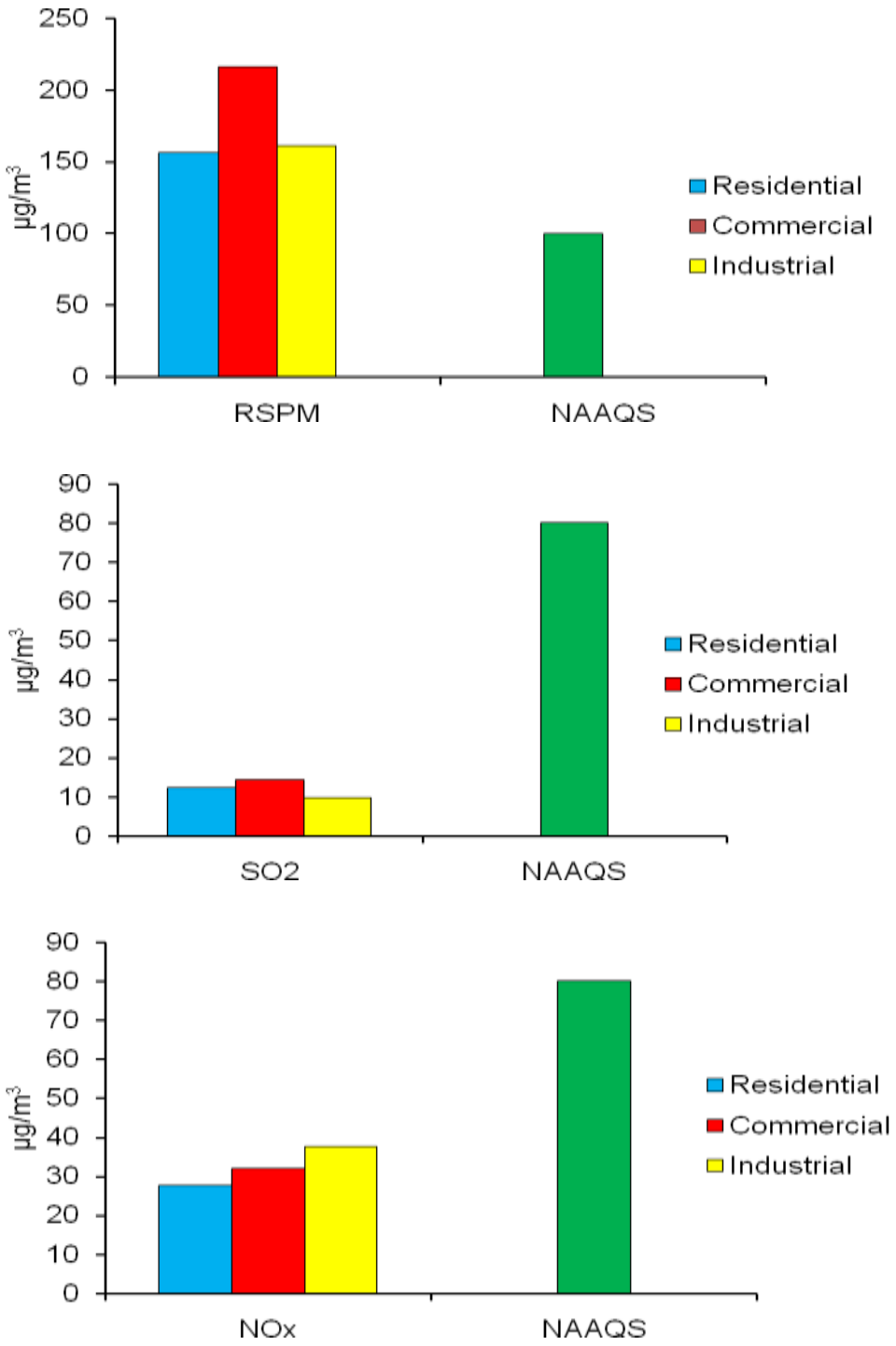

Fig. 1: Concentration (µg/m^3) of RSPM, SO_2 and NO_x in different areas of Lucknow city during pre-monsoon season (2010) and compared with prescribed National Ambient Air Quality Standard (NAAQS).

1.3.2 METALS ASSOCIATED WITH RESPIRABLE PARTICULATE MATTER (RSPM)

Trace elements are elemental parts of PM and are more enriched in the coarse mode than in fine mode. They may also originate from resuspension of soil. Many trace metals are present in leaded and unleaded petrol, diesel oil, antiwear substances which are added to lubricants, brake pads and tyres and are emitted by vehicles via their exhaust pipe [9]. 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. Average value of Lead (Pb) and Nickel (Ni) concentrations in ng/m^3 of all locations has been shown in Table 11.

The 24 hr mean concentration of Pb was found to be Maximum in Gomti Nagar 486.45 minimum in Indra Nagar 72.63 ng/m^3 in residential area. In case of commercial locations minimum in Alambagh 60.39 and maximum in Aminabad 878.78 ng/m^3 respectively. In Amausi it was found 989.70 ng/m^3. All the values of lead was found below the prescribed limit of NAAQS 1000.0 ng/m^3 while found higher than EPA limit 150 ng/m^3 (Three month average).

The hierachy of locations for Lead were arranged in descending order of their average concentrations as given below.

Amausi>Aminabad>Chowk>Gomti Nagar> Hussainganj>Charbagh>Vikas Nagar>Aliganj>Indira Nagar>Alambagh

The 24 hr mean concentration of Ni was found to be Maximum in Vikas Nagar 23.95 minimum in Gomti Nagar 1.32 ng/m^3 in residential area. In case of commercial minimum in Chowk 11.29 and maximum in Alambagh 25.80 ng/m^3. In Amausi was found 7.43 ng/m^3.
Except in Alambagh and Vikas nagar all the values of Nickel was found below the prescribed limit of NAAQS 20 ng/m^3.

The hierachy of locations for Nickel were arranged in descending order of their average concentrations as given below.

Alambagh>Vikas Nagar>Aliganj>Aminabad>Hussainganj>Indira Nagar>Charbagh> Chowk>Amausi>Gomti nagar

Table 11 Average value (ng/m^3)of Lead (Pb) and Nickel (Ni)

Location	Pb	Ni
Residential Area		
Aliganj	78.80	20.45
Vikas Nagar	117.50	23.95
Indra Nagar	72.63	13.32
Gomti Nagar	486.45	1.32
Average	**188.80**	**14.76**
Commercial Area		
Hussainganj	336.20	17.90
Charbagh	258.05	13.30
Alambagh	60.39	25.80
Aminabad	878.78	19.50
Chowk	686.39	11.29
Average	**443.96**	**17.56**
Industrial Area		
Amausi	989.70	7.43
NAAQS	1000.0	20.0

1.3.3 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, 2010) is presented in Table 12.

In residential areas, the day and night time noise level were recorded between 55.1 to 68.8 and 54.6 to 67.9 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 58.8 to 85.7 and 53.9 to 67.3 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 except Chowk at night.

In industrial areas, Amausi and Talkotora the day and night time noise level were recorded between 73.0 to 75.3 and 54.4 to 57.1 dB(A) respectively. Noise level 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 except Amausi showed little higher during day time.

Table 12: Noise Level dB(A) during Day and Night Time (May, 2010)

Sl. No.	Area	Location	Noise level dB(A)	
			Day	Night
1	Residential	Aliganj	56.1	54.6
		Vikas Nagar	55.1	57.9
		Indira Nagar	68.8	61.2
		Gomti Nagar	63.6	67.9
		Standard	**55.0**	**45.0**
2	Commercial	Hazratganj	68.8	67.3
		Hussainganj	85.7	60.9
		Charbagh	66.6	64.3
		Alambagh	76.9	66.0
		Aminabad	67.1	66.1
		Chowk	68.1	53.9
		Standard	**65.0**	**55.0**
3	Industrial	Amausi	75.3	57.1
		Talkatora	73.0	54.4
		Standard	**75.0**	**70.0**

1.4 TRENDS

1.4.1 AMBIENT AIR QUALITY

The observed RSPM, SO_2 and NO_x data for 5 years 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.

1.4.1.1 Respirable Suspended Particulate Matter (RSPM)

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

Among the commercial areas, RSPM values showed increasing trend at all the locations except in Alambagh which showed significantly lower value than the last year. All the values are higher than the NAAQS (Fig 2).

Amausi under industrial area showed decreasing trend over the last year and marginally higher than the NAAQS (Fig. 2).

1.4.1.2 Sulphur Dioxide (SO_2)

SO_2 level in all residential areas showed decreasing trend. (Fig.3).

In the commercial areas, SO_2 showed decreasing trend at all the locations when compared with the last year values (Fig. 3).

The industrial area Amausi showed decreasing trend with the last year. (Fig.3).

1.4.1.3 Oxides of Nitrogen (NO_x)

Among the Residential areas all the locations showed slightly decreasing trend except Gomti Nagar (Fig.4).

Among commercial areas, NOx registered decreasing trend at all the locations when compared with the last year data. (Fig.4).

The industrial area Amausi showed increasing trend when compared with the last year data (Fig.4).

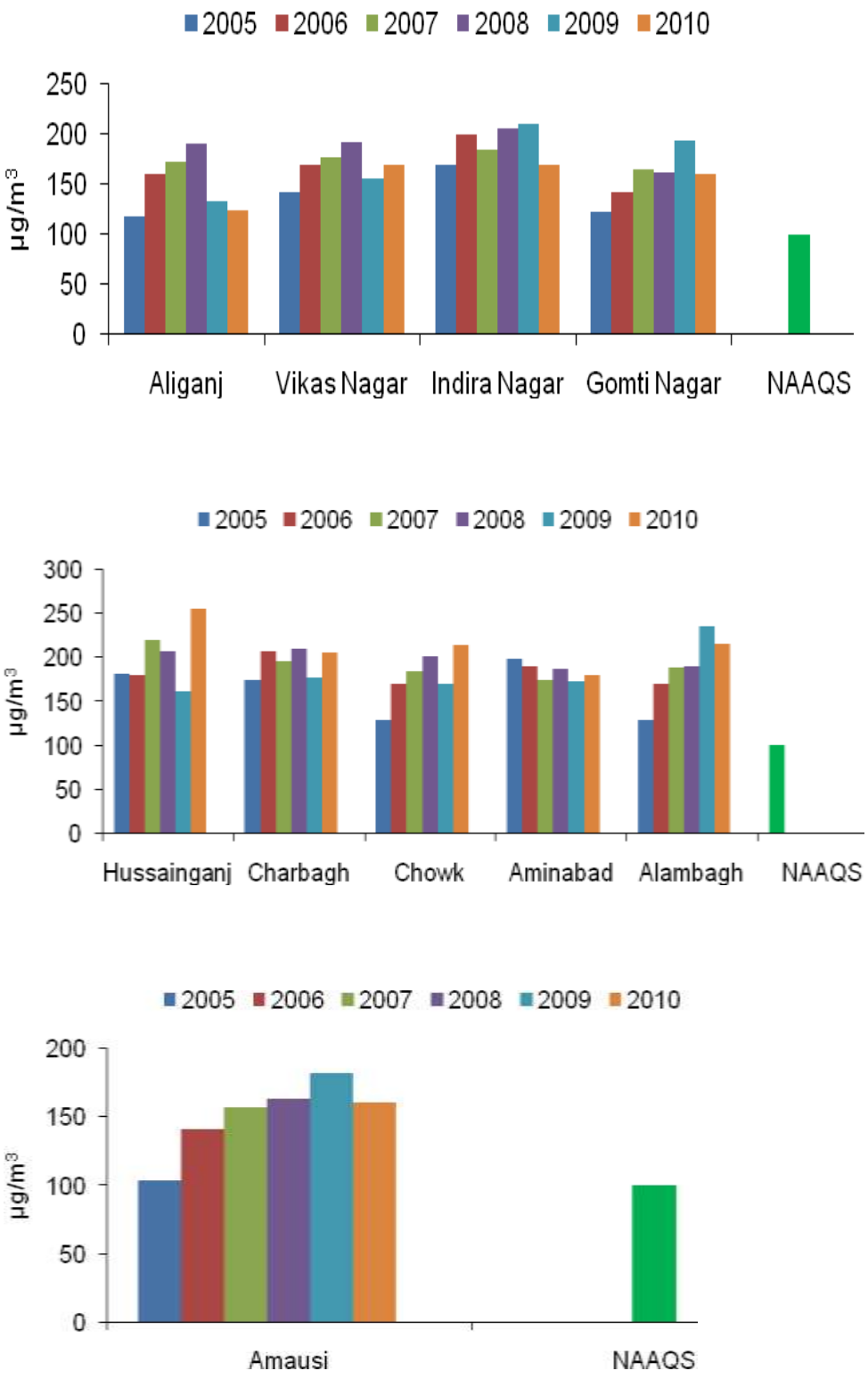

Fig. 2: Concentration (µg/m^3) of RSPM in Residential, Commercial and Industrial areas of Lucknow city during 2005 to 2010 and compared with prescribed National Ambient Air Quality Standard (NAAQS).

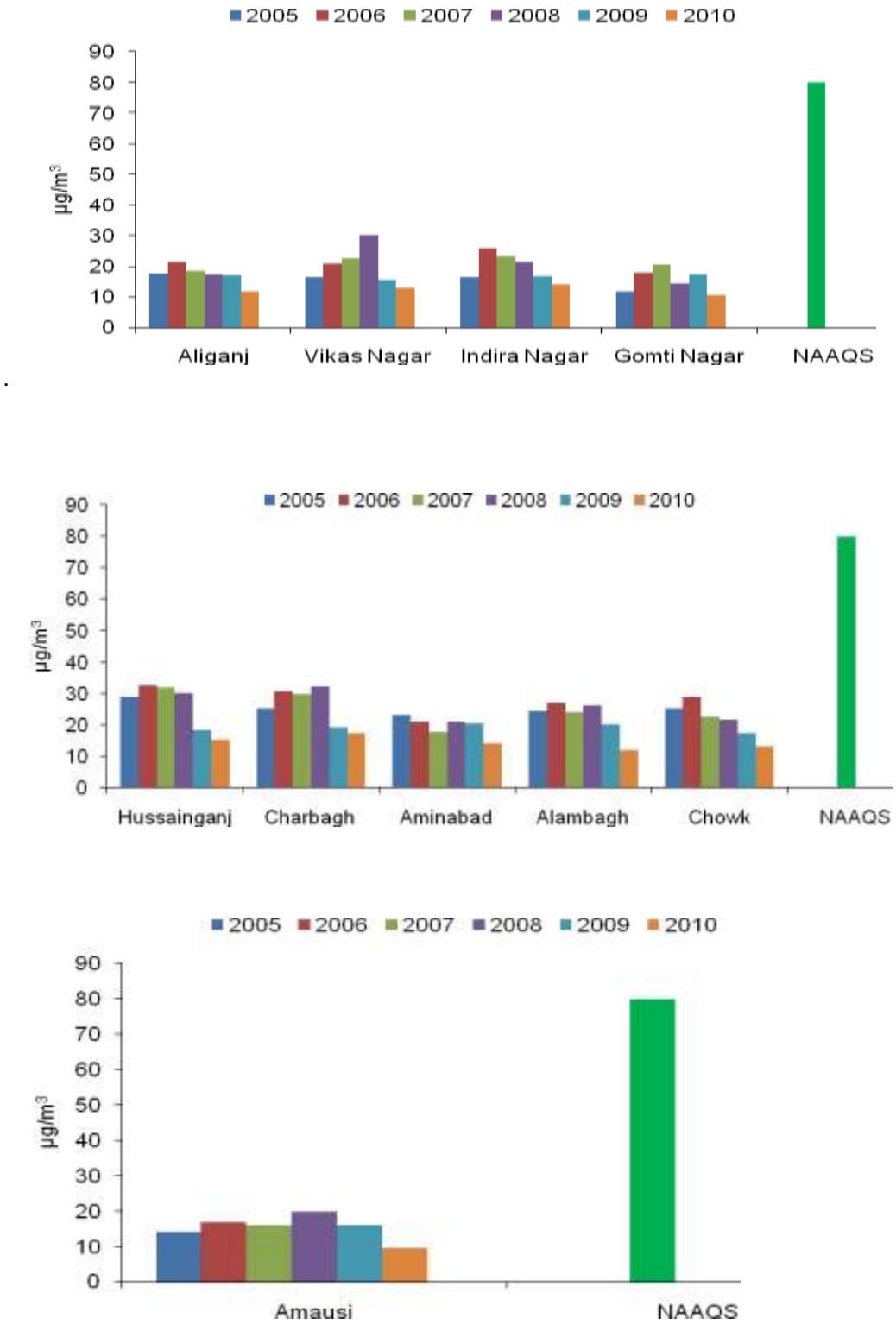

Fig. 3: Concentration (µg/m^3) of SO_2 in Residential, Commercial and Industrial areas of Lucknow city during 2005 to 2010 and compared with prescribed National Ambient Air Quality Standard (NAAQS).

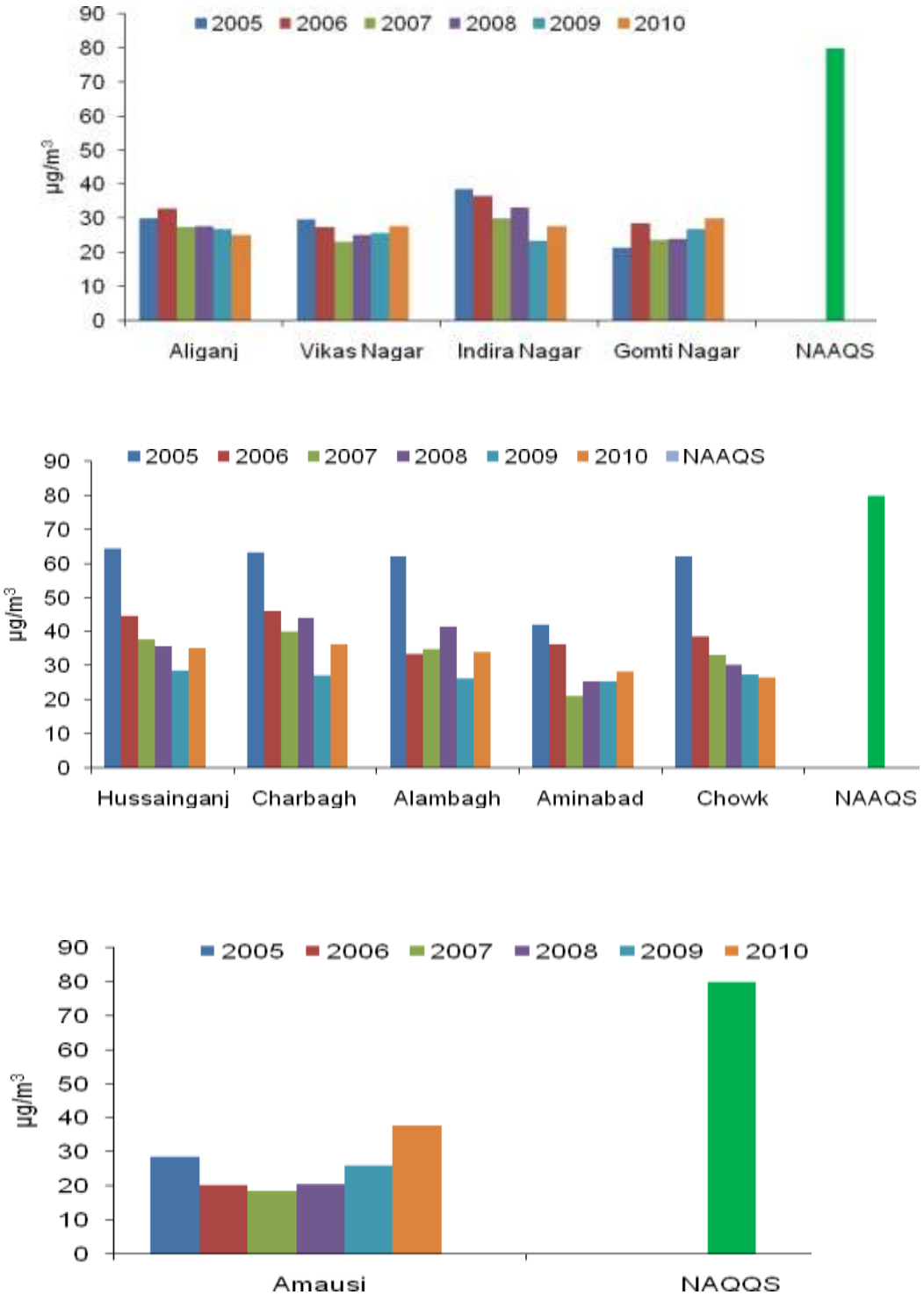

Fig. 4: Concentration (µg/m^3) of NO_x in Residential, Commercial and Industrial areas of Lucknow city during 2005 to 2010 and compared with prescribed National Ambient Air Quality Standard (NAAQS).

1.4.2 TRENDS OF NOISE LEVEL

Current year's noise data has been compared with the corresponding data of previous five years and are presented in Fig. 5 and 6. The comparative noise level in residential, commercial and Industrial areas is described below:

1.4.2.1 Day Time Noise Level

In residential areas all the locations shows slightly decreasing trend over the last year level. (Fig. 5).

In commercial cum traffic areas slightly lower levels were recorded except Alambagh, and Hussainganj which showed higher levels over the last year (Fig.5).

In industrial area, in both the locations the noise level was recorded higher over last year data. The comparative data are presented in (Fig. 5).

1.4.2.2 Night Time Noise Level

All four residential areas showed slightly higher trend except Gomti Nagar which showed higher levels over the last year (Fig. 6).

Among commercial areas, all the locations almost slightly lower values except Aminabad and Hazratganj than the last year (Fig. 6).

Both the locations of industrial area, registered a decrease in the noise level during nighttime as compare to last year data (Fig. 6).

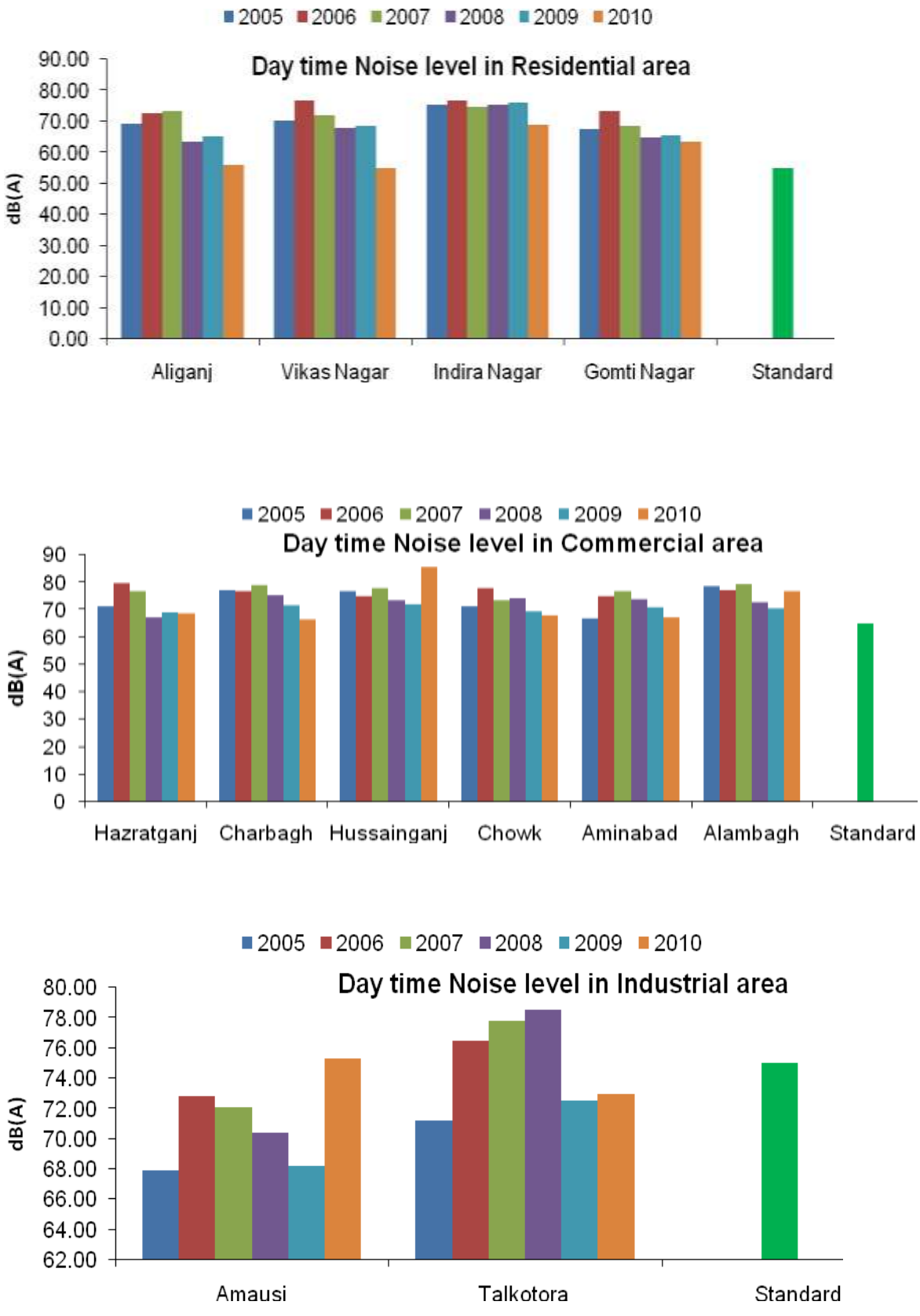

Fig. 5: Comparison of day time Noise Level dB(A) in different areas of Lucknow city (2005-2010)

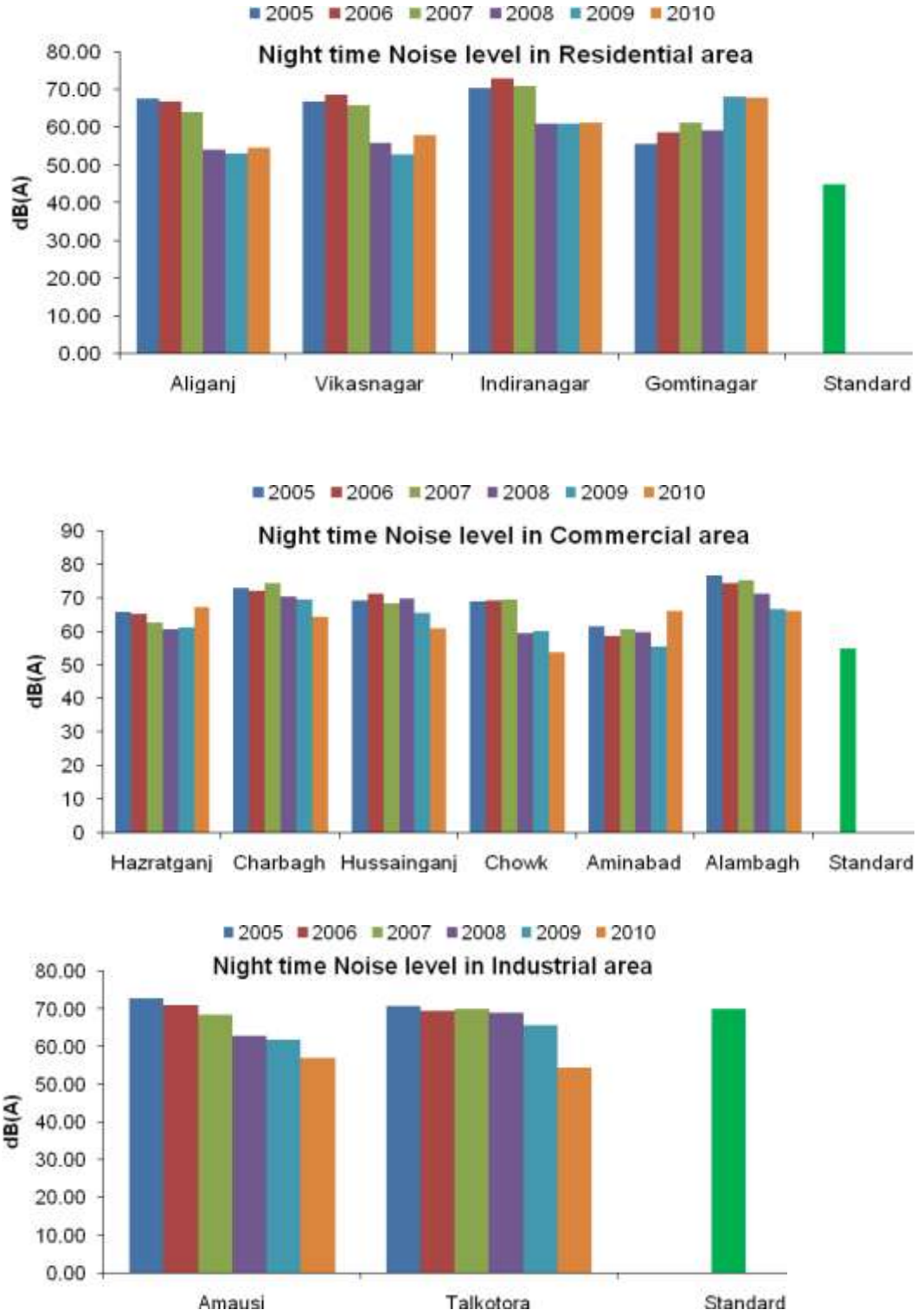

Fig. 6: Comparison of night time Noise Level dB(A) in different areas of Lucknow city (2005-2010)

1.5 HEALTH HAZARDS OF POLLUTANTS

1.5.1 Particulate Matter

The respirable particles known as PM_{10} 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.

1.5.2 Sulfur Dioxide (SO_2)

Elevated value of SO_2 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.

1.5.3 Oxides of Nitrogen (NO_x)

NOx 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 NO_2 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 NO_2 may result in pulmonary edema and diffuse lung injury.
- Continued exposure to high NO_2 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.

1.5.4 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.

1.5.5 Metals

Trace element which are bind to inhalable particulate fraction (PM_{10}) easily bind to cell membrane, affecting transport processes through the cell wall. Trace metals absorbed in human body through inhalation eventually reach to target organ the brain, liver, blood, reproductive organ or any other system of body. The high level of Pb can induce severe neurological and hematological effects on the exposed population especially children, whereas Ni are known for inducing carcinogenic effects in human through inhalation.

1.6 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 RSPM, at most of the locations and which are higher than the prescribed limit, whereas SO_2 and NOx also showed decreasing trend as compared with previous year results except few locations but well below the prescribed limit recommended by MoEF, New Delhi.

The study revealed that concentration of the particulate matter (RSPM) 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.). The level of metals namely Pb and Ni were found within respective NAAQS prescribed limits with exception for Ni level in Aliganj, Vikas Nagar and Alambagh.

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.

1.7 CONCLUSIONS

Monitoring of air pollutants such as RSPM, Heavy Metals, SO_2 and NO_x at 10 locations during pre-monsoon, 2010 revealed that-

- The RSPM level at all the monitoring locations of residential and commercial areas were higher than the NAAQS.

- The concentration of gaseous pollutants, SO_2 & 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 Vikas Nagar, Hussainganj, Charbagh and Aminabad. 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.

- Level of Lead at all the locations found to be under permissible limit.

- Level of Nickel at all the locations found to be under permissible limit except Aliganj, Vikas Nagar and Alambagh.

- Overall results indicate that RSPM and associated metals are one of the major causes for deterioration of ambient air quality.

1.8 RECOMMENDATIONS

- Public mass transport must be strengthened to minimize use of personal vehicle.
- Improvement in the traffic management.
- Travel at moderate and steady speeds. High speeds result in greater emissions.
- 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 and avoid use of horn.
- Keep vehicles in good mechanical condition. Poorly maintained or malfunctioning vehicles can release as much as 10 times the emissions of those that are well-maintained.
- Keep tires inflated to the proper level to prevent a loss of fuel economy.
- Fix air conditioning leaks and pay attention to dashboard warning lights.
- Don't burn wood or trash. Burning firewood and trash are among the major sources of particle pollution (soot). Use a fireplace or stove for heat, convert woodstoves to natural gas, which produces far fewer emissions.
- Look for the most efficient, lowest polluting model--or even use either a non-polluting car or zero emission vehicles.
- Extensive plantation should be done along the roads, in and around the public gardens
- All the roads either trunk route or loop lines should be metalloid and timely repairing and maintenance is needed
- Government should increase the parking charges on hourly basis for discourage the use of personal vehicle.
- Congestions charges for certain area for peak hours.

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