

ASSESSMENT OF ENVIRONMENTAL STATUS OF LUCKNOW CITY

(PRE-MONSOON)

FINDINGS OF A RANDOM SURVEY



Presented on

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Select Features of the Study at a Glance

❖ 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
❖ Total Vehicle Population In the Lucknow city as on 31/03/2007	:	9,04,831
❖ Growth of Vehicle over 2006-2007	:	9.81%
❖ Road Transportation	:	Two Wheelers (9.13%) Three Wheelers (21.21%) Car (12.15%) Bus (5.3%)
❖ Total Number of Petrol Pumps	:	108
❖ Consumption of Petrol	:	93,476 KL
❖ Consumption of Diesel	:	1,59,193 KL
❖ Major Source of Pollution	:	Automobiles, D. G. sets, Civil Constructions
❖ Parameters Monitored	Air	: SPM, RSPM, SO ₂ , NO _x , and Noise
	Water	: Bacteriological Quality of Water
❖ Study Conducted by	:	Environmental Monitoring & Aquatic Toxicology Section ITRC, Lucknow

1.0 AIR POLLUTION

1.1 INTRODUCTION

Deteriorating air quality is a major environmental problem in many large urban areas in both developed and developing countries. The environmental effect of pollutant emissions from motor vehicles include global climate change from green house gases, acidification of soil and surface water, adverse effect on plant and animal species and damage to building structures. In India both rural and urban population is affected at risk of exposure. Automobile exhaust is a significant source of air pollution in the urban context. Air pollution is aggravated because of increasing traffic, growing cities, rapid economic development. Increasing vehicles and industries are mainly responsible for the deterioration of air quality as both create noise and emit air pollutants.

Technological up gradation and the development of scientific knowledge has resulted in reduced overall pollution levels in urban areas, especially the concentration of gaseous pollutants and mass concentration of particulate matter. However more efforts are needed to achieve the satisfaction level. Motor vehicles emissions results from fuel combustion or evaporation. The most common type of transport fuels are petrol for light duty vehicles and diesel for heavy duty vehicles.

Emission from motor vehicles with spark ignition engines for e.g. gasoline-fuelled vehicles are from the exhaust, engine crank-case and fuel system (carburettor, fuel tank etc.). The major pollutants emitted from fuelled vehicles are PM, CO, HC, NO_x, etc.

Over the past several decades, the rapid growth in travel has increased traffic congestion, especially in the major metropolitan areas. However, current facilities have not kept pace with increased travel demands. Traffic congestion has caused vehicular emissions to increase significantly. 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.).

The reason for double-digit growth of automobile-population especially the motorcycle and passenger car segments are that people are gradually becoming attached towards personal means of conveyance and the cities are becoming automobile dependent. This automobile dependence creates several environmental, problems e.g.

- Oil vulnerability
- Photochemical smog
- High green house gas contribution
- Increase in the fine and ultra fine particles in the ambient air
- Urban sprawl

In view of above facts, it is need of the hour to have a look at our city Lucknow the capital of Uttar Pradesh with a population of 22,45,509 (Municipal corporation + Cantonment) as per 2001 census and an area of 310 sq. km.

Total vehicle registered with RTO, Lucknow during 2006-2007 were 9,04,831 as against 8,24,003 during 2005-2006. The overall growth registered is 9.81 % during 2006-2007.

Number of registered vehicles with RTO Lucknow in different categories during last two years is given in **Table-1.1** and details of vehicles plying as public transport (non government) on different routes in Lucknow is shown in **Table-1.2**.

Table 1.1: Registered Vehicles with R.T.O. Lucknow During 2005-06 and 2006-07

Sl. No.	Type of Vehicle	Number of Registered Vehicles		% Rise
		On 31 st March, 2006	On 31 st March, 2007	
1	Multi Axial	917	1365	48.85
2	Medium and Heavy weight Vehicles	8014	8232	2.72
3	Light Commercial Vehicles (Three Wheelers)	2930	3362	14.74
4	Light commercial Vehicles (Four wheeler)	5365	6217	15.88
5	Buses	3978	4198	5.53
6	Taxi	5979	8012	34.00
7	Three Wheelers and Auto Rickshaw	12502	15154	21.21
8	Two wheelers	660093	720378	9.13
9	Car	94222	105674	12.15
10	Jeep	12428	13000	4.60
11	Tractor	13385	13923	4.02
12	Trailers	991	1062	7.16
13	Others	3199	4254	32.97
Total		8,24,003	9,04,831	9.81

Source: RTO, Lucknow

**Table-1.2 : Present Status of Public Transport Available on Different Routes
as on 31-03-07**

Sl. No.	Type of vehicles		Number
1	Nagar Bus		110
		CNG Bus	43
2	Tempo Taxi		1776
		Diesel	578
		CNG	1153
		Battery	45
3	Auto Rickshaw		2129
		Diesel	26
		CNG	2103

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 31-03-2007 is given in **Table-1.3**.

Table 1.3 : Details of Lucknow city bus service

Sl. No.	Route No.	To & Fro	No. of Buses
1	11	Chinhat –Gomti Nagar- Alambagh	18
2	12	Chinhat- Scooter India	10
3	23	Rajinikhand-Gudamba thana	11
4	24	Charbagh - Engineering College	14
5	25	Charbagh-Bijnor	02
6	31	Alambagh – IIM	02
7	33	Alambagh- Engineering College	14
8	44	Charbagh-Andhi Chowki	08
9	45	Parag Dairy – Polytechnic Chowraha	10
10	66	Hajratganj-Rajajipuram	02

Source: UPSRTC, Lucknow

Monitoring of Environmental Status of Lucknow city with respect to air and water quality is being conducted by ITRC, 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 aim 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 study bacteriological quality of potable water.
- To create a database for future use.
- To create public awareness about environmental pollution.

The present study is conducted during the month of May, 2007 representing the pre monsoon (summer) period.

In Lucknow city there are 108 petrol pumps operated by six oil companies. The break-up of these petrol pumps are given in **Table-1.4**.

Table 1.4 : Petrol Pumps in Lucknow City

Sl. No.	Agency	Number of outlet
		31 st March 2007
1	Indian Oil Corporation (IOC)	34
2	Bharat Petroleum Corporation Limited (BPCL)	23
3	Hindustan Petroleum Corporation Limited (HPCL)	25
4	Indo Burma Petroleum (IBP)	26
5	RIL	2
6	CNG	2
Total		108

Source: Indian Oil Corporation (IOC), Lucknow

The sales figure of oil companies for the year (2006-07) has been compared with sale figure of 2005-06 (**Table-1.5**). It is observed that petroleum sale have been increased marginally by 2.64% whereas sale of diesel has decreased by 37.84%.

Table 1.5: Consumption of Fuel* in Lucknow

Sl. No.	Agency	Petrol (Unleaded)			High Speed Diesel		
		Apr., 05 to Mar., 06	Apr., 06 to Mar., 07	% Change	Apr., 05 to Mar., 06	Apr., 06 to Mar., 07	% Change
1	IOC	36,186	33,216	--	43,116	56,965	--
2	BPCL	26,727	26,920	--	24,221	37,518	--
3	HPCL	19,853	18,120	--	28,778	33,220	--
4	IBP	13,243	11,200	--	19,365	23,190	--
5	RIL	---	4020	--	---	9,300	--
Total		96009	93476	2.64	115480	1,59,193	37.84

*KL (1 KL = 1000 litres). Source: Indian Oil Corporation (IOC), Lucknow

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 summarised in **Table 1.6**.

Table-1.6: 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 sites are 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. The main vehicle was two wheeler, passenger car and maxi cab (Jeep).

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 is 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 inter city 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 1.7: 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	*TCM	NaOH
Flow rate	1.0-1.3 m ³ /min	0.5 L/min	
Analytical method	Gravimetric	Spectrophotometry	
Frequency	24 hourly	8 hourly	
Sampling duration	Continuous for 24 hours		
No. of days of sampling at each location	2 days		

HVS : High Volume Sampler, RDS : Respirable Dust Sampler

*TCM: Tetra chloro mercurate

1.2.2 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- 1.8**.

Table 1.8 : Noise Monitoring Location

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- 1.9-1.10** and **Figure-1** to **4**.

1.3.1.1 PARTICULATE MATTER (RSPM and SPM)

Residential Area

In residential areas (Aliganj, Vikas Nagar, Indira Nagar and Gomti Nagar) the average concentration of RSPM and SPM were in the range of 164.9 to 185.0 and 312.0 to 348.4 $\mu\text{g}/\text{m}^3$ respectively.

Commercial Area

In commercial areas (Hussainganj, Charbagh, Alambagh, Aminabad and Chowk) the average concentration of RSPM and SPM were in the range of 173.6 to 220.7 and 335.9 to 419.7 $\mu\text{g}/\text{m}^3$ respectively.

Industrial Area:

In industrial area (Amausi), the average concentration of RSPM and SPM were found to be 157.0 and 317.1 $\mu\text{g}/\text{m}^3$ respectively.

The details of SPM & RSPM levels are presented in **Table 1.9** and average of SPM and RSPM in **Table 1.10** and **Figure-1 & 2**.

All the values of RSPM and SPM, except in Amausi under industrial area were above the prescribed National Ambient Air Quality Standards (NAAQS) 100 and 150 $\mu\text{g}/\text{m}^3$ for RSPM and 200, and 500 $\mu\text{g}/\text{m}^3$ for SPM in residential, rural and other area and Industrial areas respectively.

Table 1.9 : Concentration ($\mu\text{g}/\text{m}^3$) of SPM, RSPM, SO_2 , and NO_x ,

Location	Days	SPM	RSPM	SO_2				NO_x			
				A	B	C	Mean	A	B	C	Mean
Aliganj	I	305.3	148.8	15.1	18.5	13.2	15.9	18.4	33.8	24.1	25.5
	II	372.1	196.7	20.9	27.5	15.41	21.3	28.7	30.2	28.2	29.0
	Avg	338.7	172.7	18.0	23.0	14.3	18.4	23.6	32.0	26.2	27.2
Vikas Nagar	I	336.0	195.4	18.8	25.1	15.3	21.2	23.5	30.1	23.0	25.7
	II	288.0	160.7	20.7	30.3	21.1	24.0	20.7	25.3	15.8	20.7
	Avg	312.0	178.0	19.7	27.7	18.2	22.6	22.1	27.7	19.4	23.1
Indira Nagar	I	355.9	181.7	14.2	30.2	20.1	21.5	23.0	36.9	30.6	30.2
	II	361.4	188.3	26.4	29.3	19.1	24.9	28.2	32.2	29.2	29.8
	Avg	348.4	185.0	20.3	29.7	19.6	23.2	25.6	34.5	29.9	30.0
Gomti Nagar	I	355.3	174.4	21.9	22.7	19.3	21.3	26.7	27.7	23.5	25.9
	II	317.6	155.3	20.1	24.5	15.2	19.9	24.5	26.2	18.5	23.1
	Avg	336.4	164.9	21.0	25.6	17.3	20.6	25.6	26.9	21.0	23.5
Hussainganj	I	405.3	202.7	31.8	44.2	25.8	33.9	27.7	49.5	31.3	36.2
	II	434.1	238.8	27.4	33.3	28.1	29.6	36.8	52.2	28.5	39.2
	Avg	419.7	220.7	29.6	38.8	26.9	31.7	32.3	50.9	29.9	37.7
Charbagh	I	358.9	181.4	25.2	37.7	31.3	31.4	38.4	50.5	33.4	40.7
	II	421.9	211.2	28.3	31.8	24.3	28.1	40.3	48.4	29.7	39.5
	Avg	390.2	196.3	26.7	34.7	27.6	29.7	39.4	49.5	31.5	40.1
Alambagh	I	381.3	202.6	20.2	33.7	21.0	24.9	34.3	41.1	35.9	37.1
	II	318.8	174.6	19.5	32.1	17.3	22.9	33.3	34.3	29.5	32.3
	Avg	350.1	188.6	19.8	32.9	19.2	23.9	33.8	37.7	32.7	34.8
Aminabad	I	378.7	180.6	16.3	19.7	15.4	17.1	19.9	26.9	14.1	20.3
	II	315.7	166.5	15.2	24.0	14.5	17.8	24.7	29.3	11.7	21.9
	Avg	347.2	173.6	15.7	21.8	14.9	17.5	22.3	28.1	12.9	21.1
Chowk	I	344.6	205.4	16.4	31.7	19.5	22.5	23.3	46.4	29.7	33.2
	II	327.3	164.1	17.7	25.3	23.1	22.0	28.7	33.9	28.2	30.3
	Avg	335.9	184.7	17.1	28.5	21.3	22.3	26.0	40.1	28.9	33.2
Amausi	I	302.3	145.3	13.8	13.6	10.4	12.0	14.1	22.2	15.9	17.4
	II	331.8	168.7	14.1	18.3	15.7	16.1	17.22	22.4	19.2	19.6
	Avg	317.1	157.0	13.9	15.9	13.1	14.4	15.7	22.3	17.5	18.5

A=06:00 – 14:00 hr., B= 14:00 – 22:00 hr, C= 22:00 – 06:0 hr

Table 1.10: 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	338.7	172.7	18.4	27.2
	Vikas nagar	312.0	178.0	22.6	23.1
	Indiranagar	348.4	185.0	23.2	30.0
	Gomti nagar	336.4	164.9	20.6	23.5
	Average	333.9	175.2	21.2	25.9
Commercial	Hussainganj	419.7	220.7	31.7	37.7
	Charbagh	390.2	196.3	29.7	40.1
	Alambagh	350.1	188.6	23.9	34.8
	Aminabad	347.2	173.6	17.5	21.1
	Chowk	335.9	184.7	22.3	33.2
	Average	431.8	192.8	25.0	33.4
Industrial	Amausi	317.1	157.0	14.4	18.5

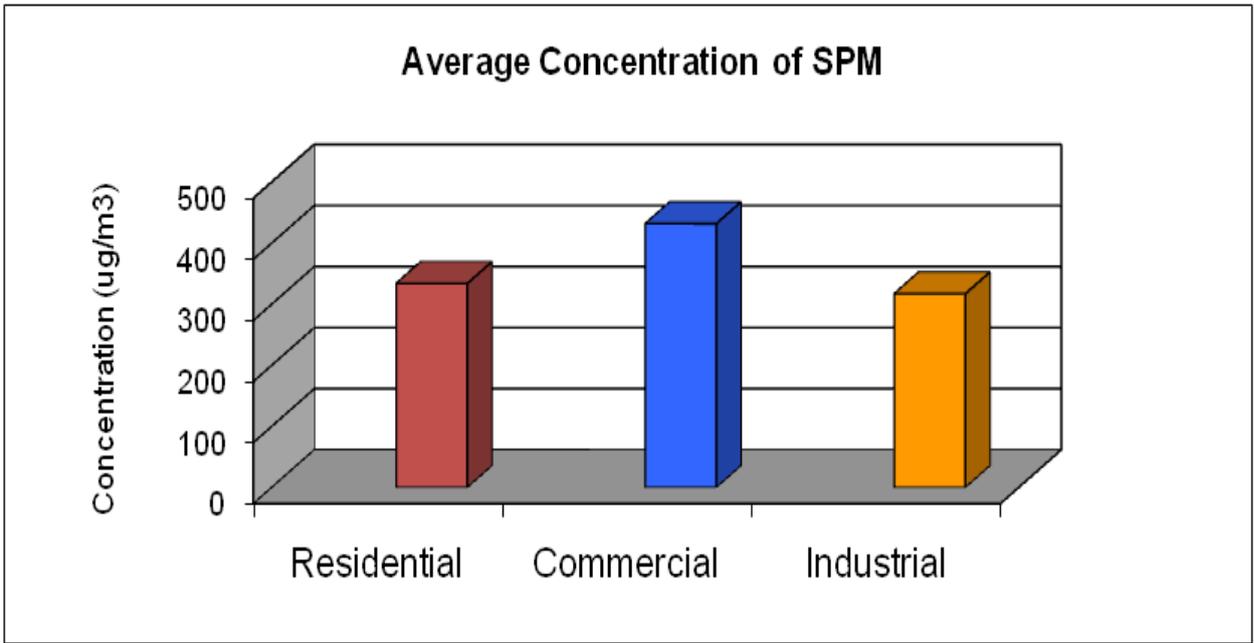


Figure 1: Concentration of SPM in different areas

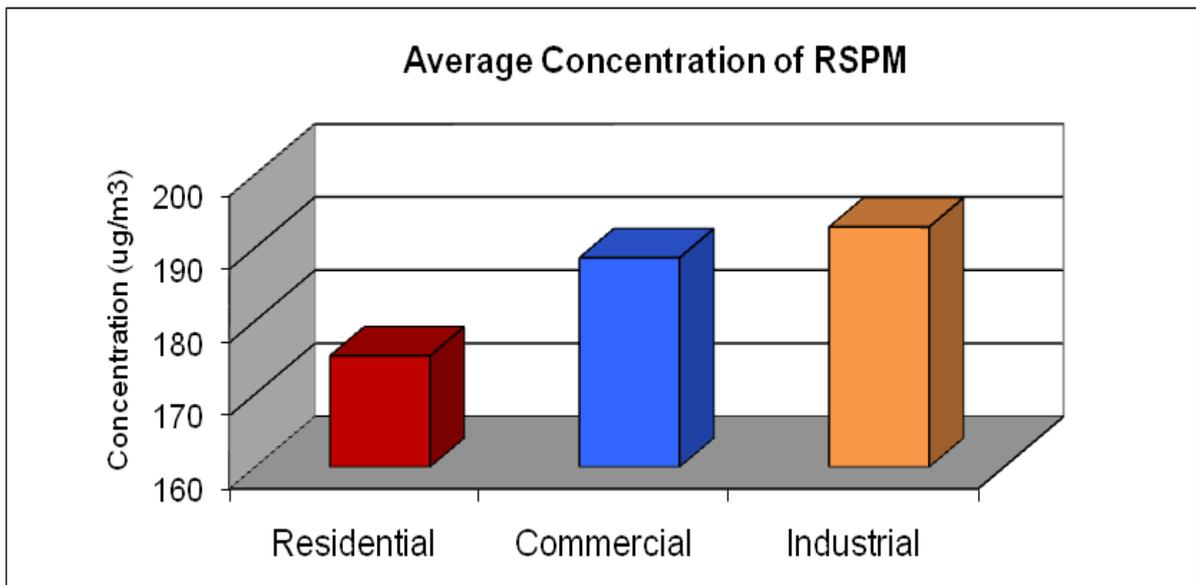


Figure 2: Concentration of RSPM in different areas

1.3.1.2 SULPHUR DIOXIDE (SO₂)

Residential Area

In residential area (Aliganj, Vikas Nagar, Indira Nagar and Gomti Nagar) the average concentrations of SO₂ were in the range of 18.4 to 23.2 µg/m³.

Commercial Area

In commercial area (Hussainganj, Charbagh, Alambagh, Aminabad and Chowk) the average concentrations of SO₂ were in the range of 17.5 to 31.7 µg/m³.

Industrial Area

In industrial area (Amausi) the average concentrations of SO₂ was found in the range of 14.4 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. The details of 8 hourly SO₂ levels at different locations are presented in **Table 1.9** and average concentration of SO₂ in **Table 1.10** and **Figure-3**.

The main source of SO₂ is the sulphur content in diesel fuel, which is normally present at 0.035 to 0.05% (Source : IOC). The level of SO₂ depends on the engine efficiency as well as on the quality and quantity of fuel used. Redesigning of the engine to follow the Bharat - I and II norm reduced the SO₂ level in urban areas to some extent, but levels may increase due to day-by-day increase in number of vehicle, especially diesel engine driven in the long run.

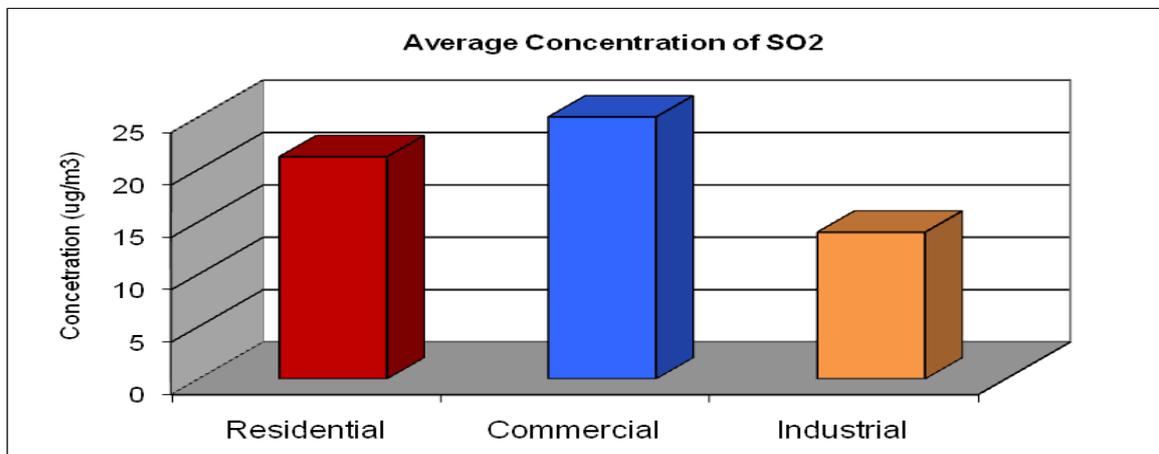


Figure-3: Concentration of SO₂ in different areas

1.3.1.3 OXIDES OF NITROGEN (NO_x)

Residential Area:

In residential areas (Aliganj, Vikas Nagar, Indira Nagar and Gomti Nagar) the average concentrations of NO_x were found in the range of 23.1 to 30.0 µg/m³.

Commercial Area

In commercial areas (Hussainganj, Charbagh, Alambagh, Aminabad and Chowk) the average concentrations of NO_x were found in the range of 21.1 to 40.1 µg/m³.

Industrial Area

In industrial areas (Amausi) the average concentrations of NO_x was 18.5 µg/m³.

All the values of NO_x were within the prescribed NAAQS of 80 for residential, rural and other areas and 120 µg/m³ for industrial area. The details of 8 hourly NO_x levels at different locations are presented in **Table-1.9** and average concentration in **Table 1.10** and **Figure-4**.

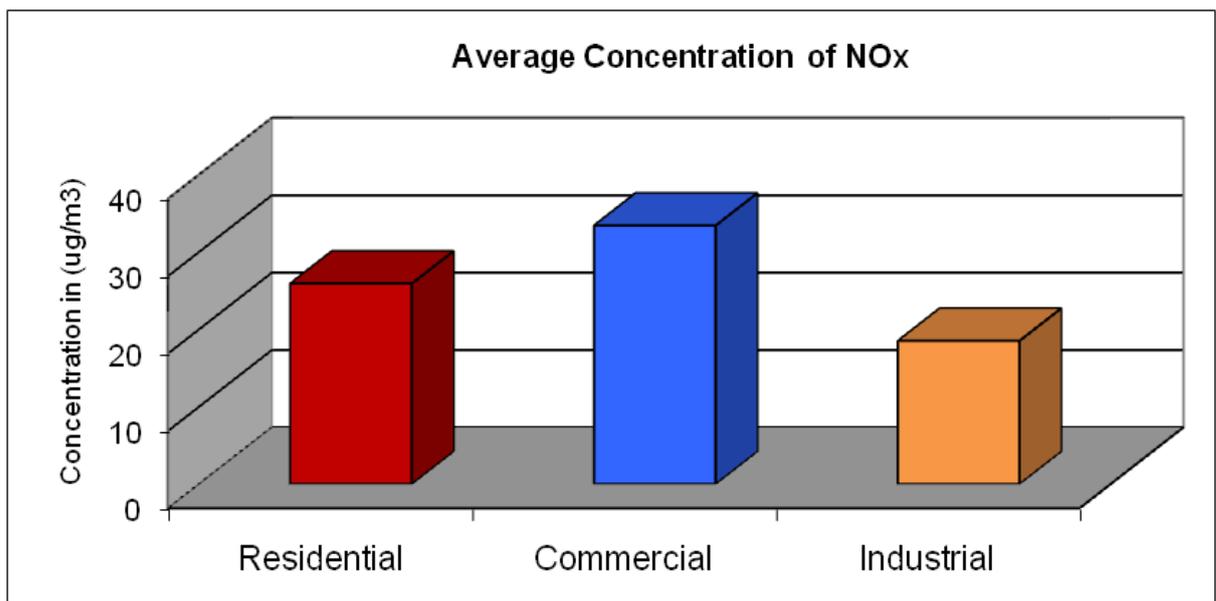


Figure-4: Concentration of NO_x in different areas

1.3.2 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. In general, from small vehicles the major part of noise emitted is at the pavement-tyre interface, heavy vehicles emit much of their noise at the engine/exhaust. The monitoring data recorded during the pre monsoon period- (May, 2007) is presented in **Table- 1.11**.

In residential areas, the day and night time noise level were recorded between 68.7 to 74.6 and 61.3 to 71.0 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 73.5 to 79.5 and 60.8 to 75.2 dB(A) respectively. Noise level at all the commercial sites during day and night time are above the prescribed limit of 65 and 55 dB(A).

In industrial areas, Amausi and Talkatora the day and night time noise level were recorded between 72.1 to 77.8 and 68.5 to 70.9 dB(A) respectively. Noise level at Talkatora in the day time and night time were higher than the prescribed standard of 75 and 70 dB(A) respectively.

Table 1.11: Noise Level dB(A) during Day and Night Time

Sl. No.	Area	Location	Day	Night
1	Residential	Aliganj	73.5	64.1
		Vikas Nagar	71.9	65.8
		Indira Nagar	74.6	71.0
		Gomti Nagar	68.7	61.3
2	Commercial	Hazratganj	76.9	62.8
		Hussainganj	77.7	68.4
		Charbagh	78.9	74.5
		Alambagh	79.5	75.2
		Aminabad	76.9	60.8
		Chowk	73.5	69.5
3	Industrial	Amausi	72.1	68.5
		Talkatora	77.8	70.9

1.4 TRENDS

1.4.1 AMBIENT AIR QUALITY

The observed RSPM, SO₂ and NO_x for 5 years data have been compared to find out the prevailing trend of air pollution in Lucknow city.

1.4.1.1 Respirable Suspended Particulate Matter (RSPM)

In all the locations in residential areas, slight increase was recorded over previous year except Indira Nagar and all the values are higher than the NAAQS. **(Figure-5).**

Among the commercial areas, RSPM values showed increasing trend at all the locations except in Charbagh and Aminabad, which showed slightly lower or equal values respectively than the previous year. All the values are higher than the NAAQS. **(Figure-6).**

Amausi under industrial area showed increasing trend over the previous year

and little higher than the NAAQS. **(Figure-7)**.

1.4.1.2 Sulphur Dioxide (SO₂)

SO₂ level in residential areas namely Vikas Nagar and Gomti Nagar registered slightly increasing trend in comparison to last years **(Figure-8)**.

In the commercial areas, SO₂ registered a decreasing trend at all the locations when compared with the last year values **(Figure-9)**.

The only industrial area Amausi showed almost equal value when compared with last year value **(Figure-10)**.

1.4.1.3 Oxides of Nitrogen (NO_x)

Among the four locations showed slightly lower values in comparison to last year **(Figure-11)**.

Among commercial areas, NO_x registered decreasing trend at all the locations when compared with the last year data. **(Figure-12)**.

The only industrial area Amausi showed decreasing trend **(Figure-13)**.

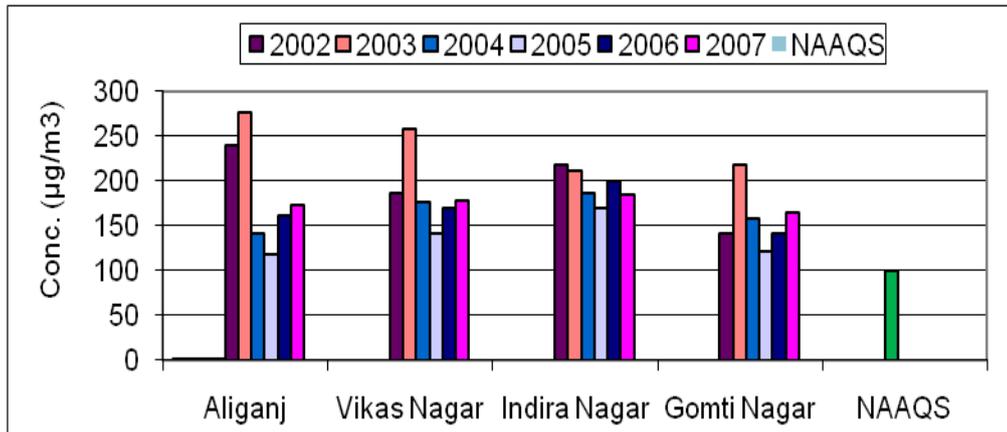


Figure-5: Trend of RSPM During 2002-2007 at Residential Area

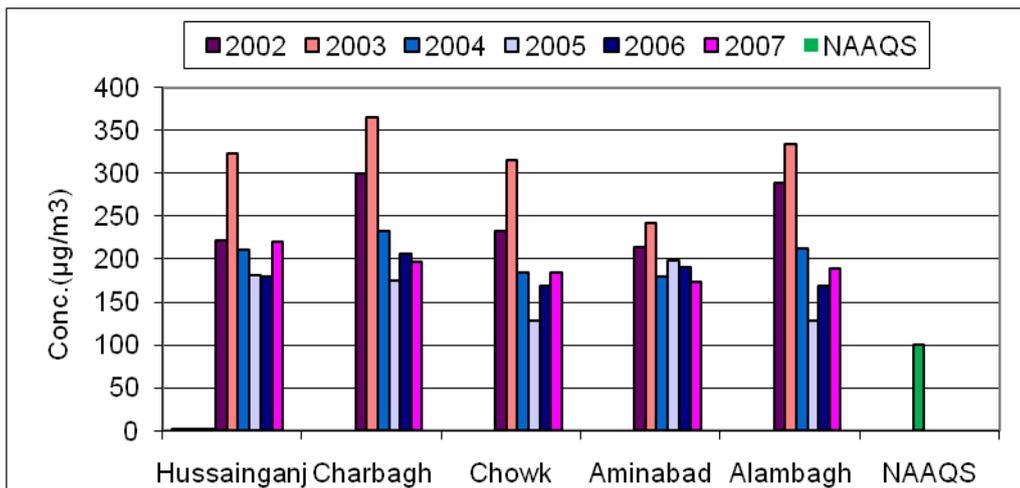


Figure-6: Trend of RSPM During 2002-2007 at Commercial Area

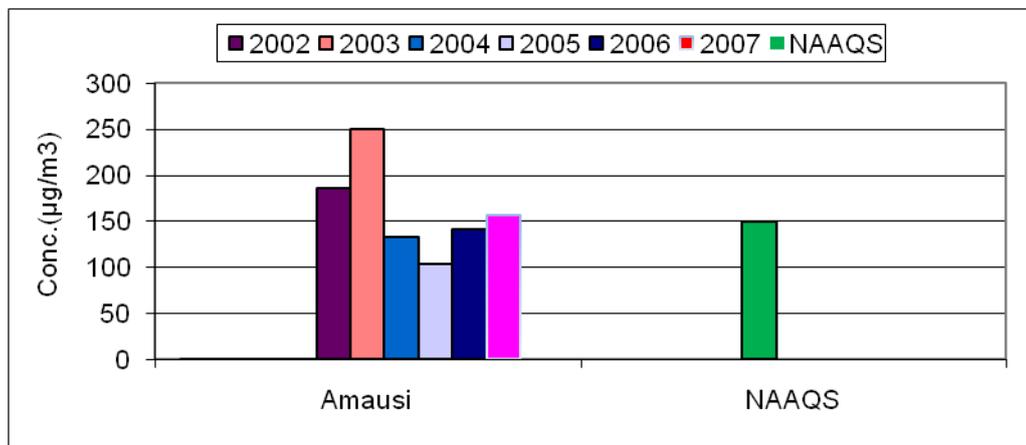


Figure-7: Trend of RSPM During 2002-2007 at Industrial Area

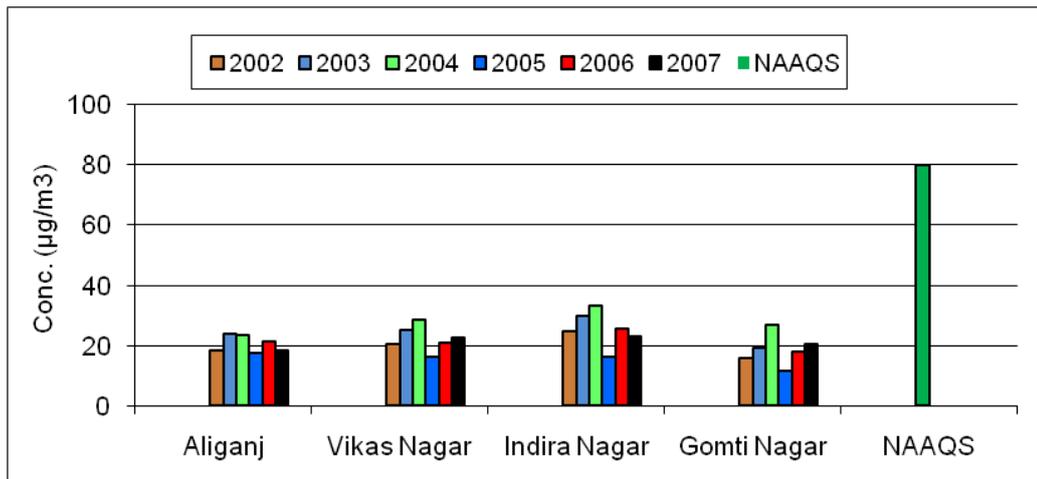


Figure-8 : Trend of SO₂ During 2002-2007 at Commercial Area

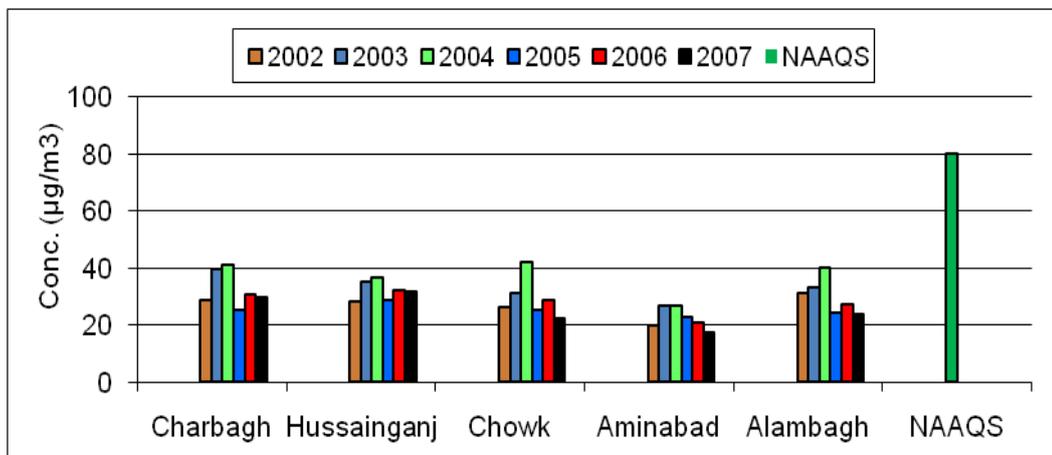


Figure-9: Trend of SO₂ During 2002-2007 at Commercial Area

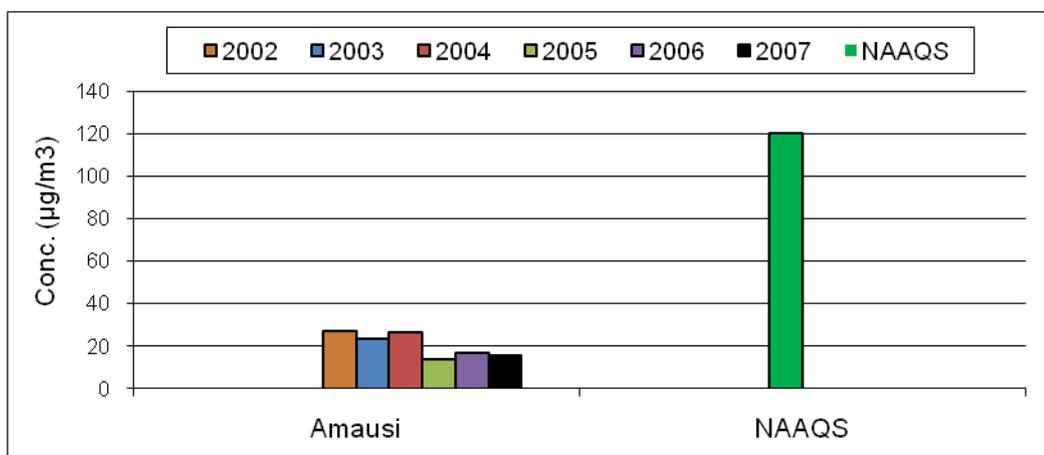


Figure-10 : Trend of SO₂ During 2002-2007 at Industrial Area

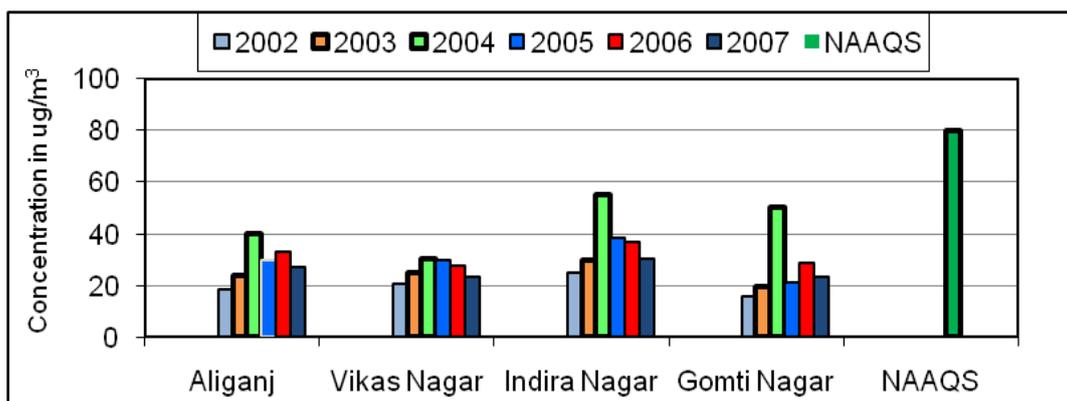


Figure-11: Trend of NOx During 2002-2007 at Residential Area

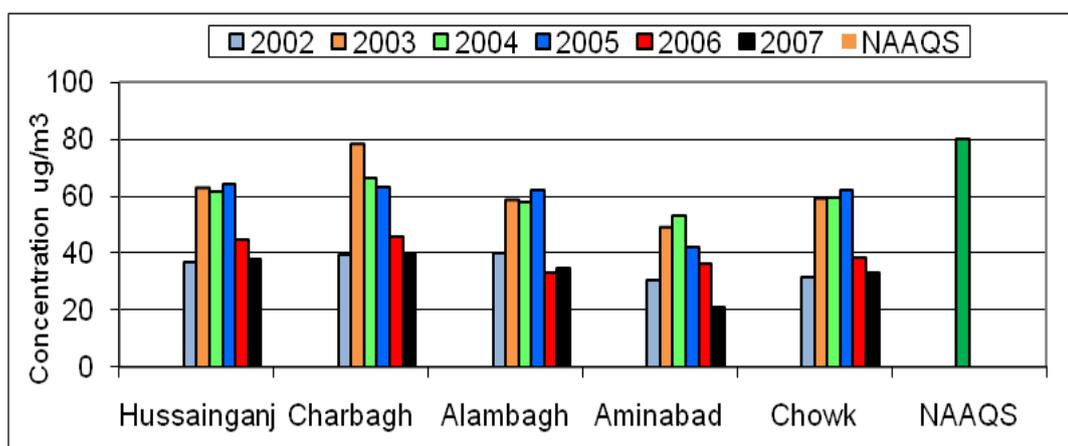


Figure-12: Trend of NOx During 2002-2007 at Commercial Area

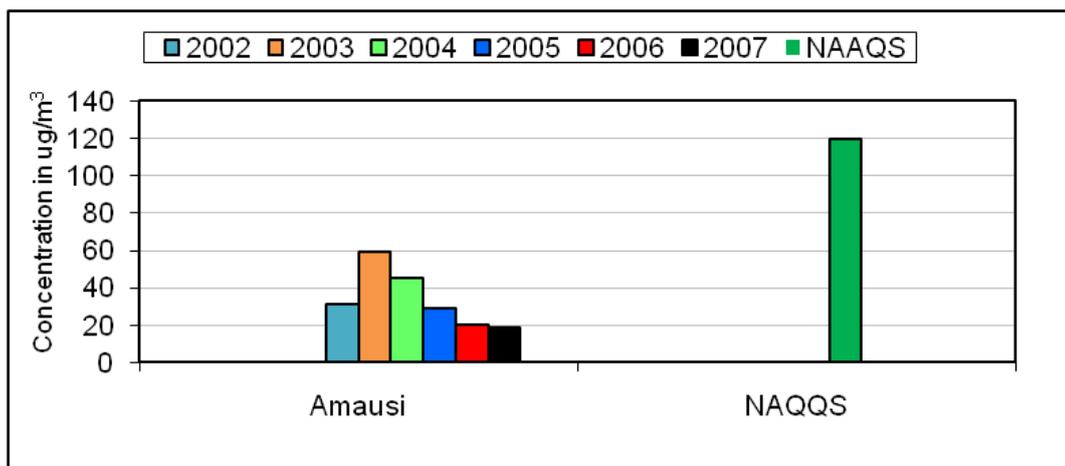


Figure- 13: Trend of NOx During 2002-2007 at Industrial Area

1.4.2 TRENDS OF NOISE LEVEL

Current year's noise data has been compared with the corresponding data of previous years and are presented in **Figure-14 to 19**. The comparative noise level in residential, commercial and Industrial areas is described below:

1.4.2.1 Day Time Noise Level

In residential areas slight increase was recorded at all the locations over the last year level. (**Figure-14**).

In commercial cum traffic areas slightly higher levels were recorded at Hazaratganj, Chowk and Aminabad whereas at other locations slightly decreasing trends was recorded over the last year (**Figure-15**).

In industrial area, in both the locations the noise level was recorded higher over last year data. The comparative data are presented in **Figure-16**.

1.4.2.2 Night Time Noise Level

Amongst the four residential areas except Aliganj, where the level remained almost same, slight increase was recorded at the remaining locations over the last year level (**Figure-17**).

Among commercial areas, Charbagh and Chowk showed almost the same values as in the last, Hussainganj showed slightly higher values whereas Aminabad and Alambagh slightly lower values than the previous year (**Figure-18**).

In both the locations of industrial area, registered a slight decrease in the noise level during nighttime over last year data (**Figure-19**).

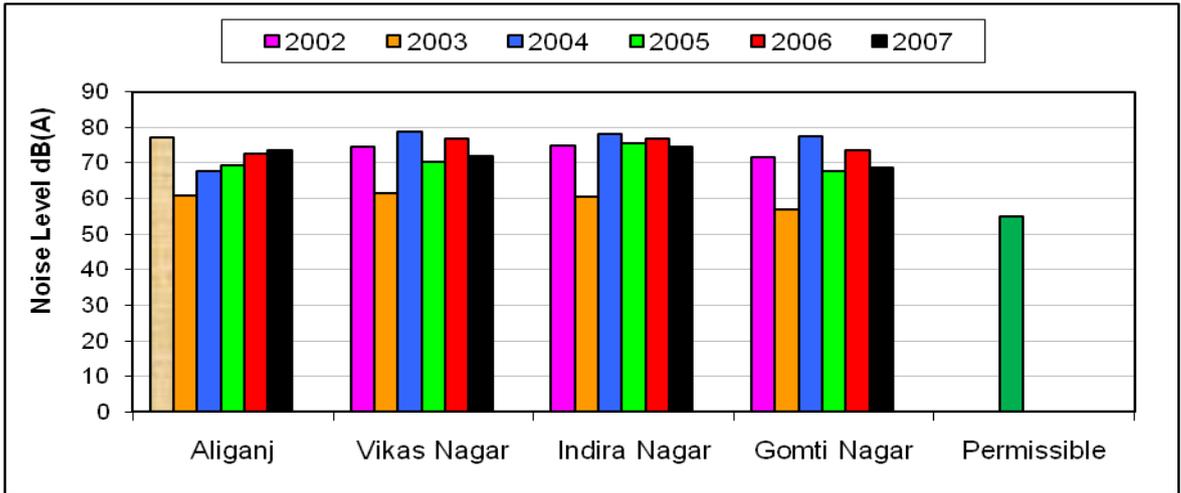


Figure-14: Comparison of Day Time Noise Level dB(A) in Residential Area During 2002-07

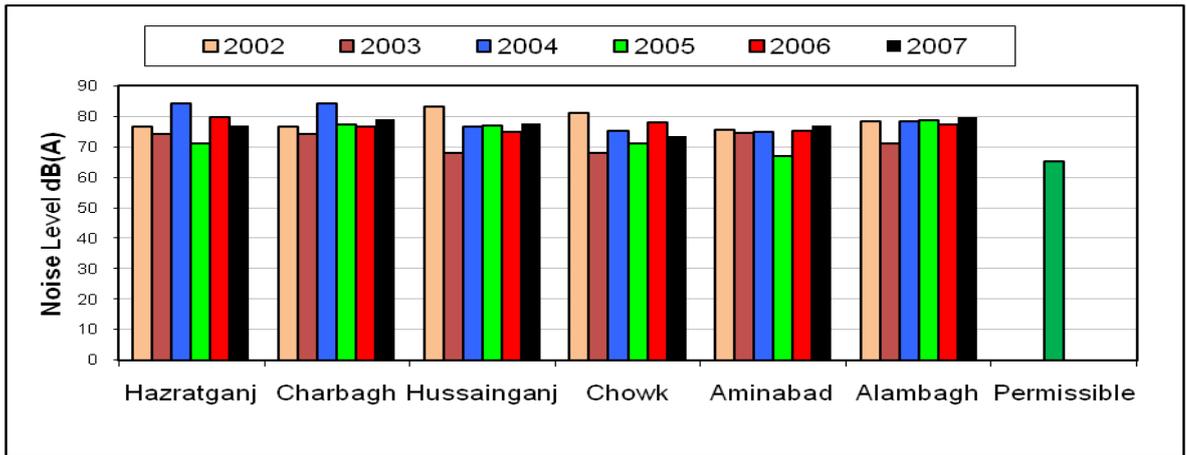


Figure-15: Comparison of Day Time Noise Level dB(A) in Commercial Area During 2002-07

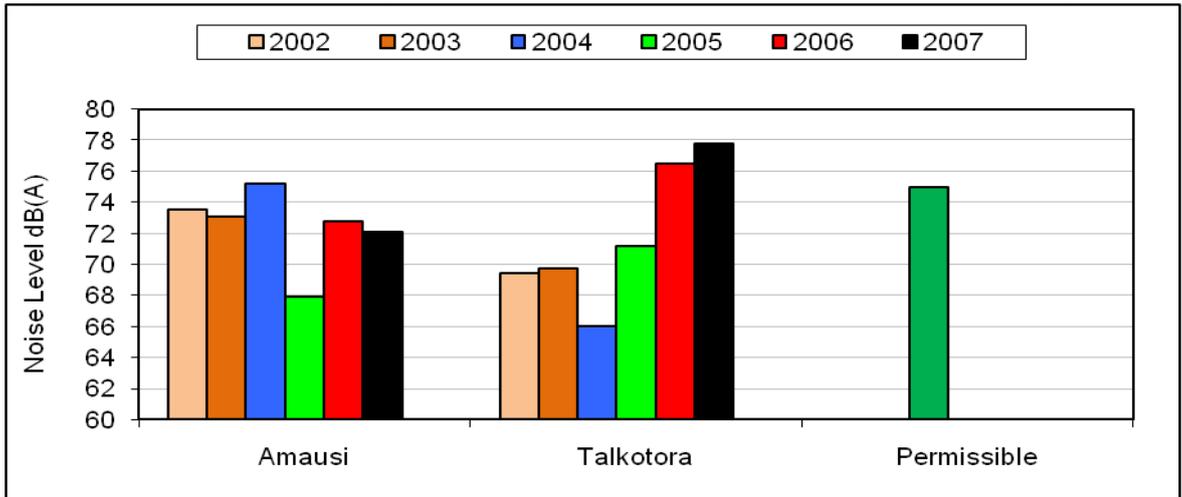


Figure-16 : Comparison of Day Time Noise Level dB(A) in Industrial Area During 2002-07

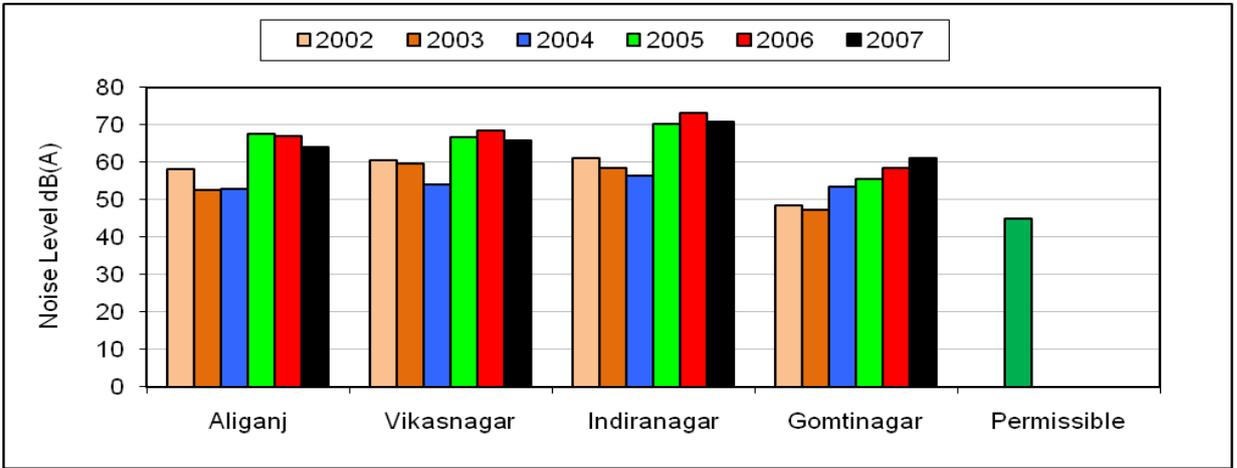


Figure-17: Comparison of Night Time Noise Level dB(A) in Residential Area During 2002-2007

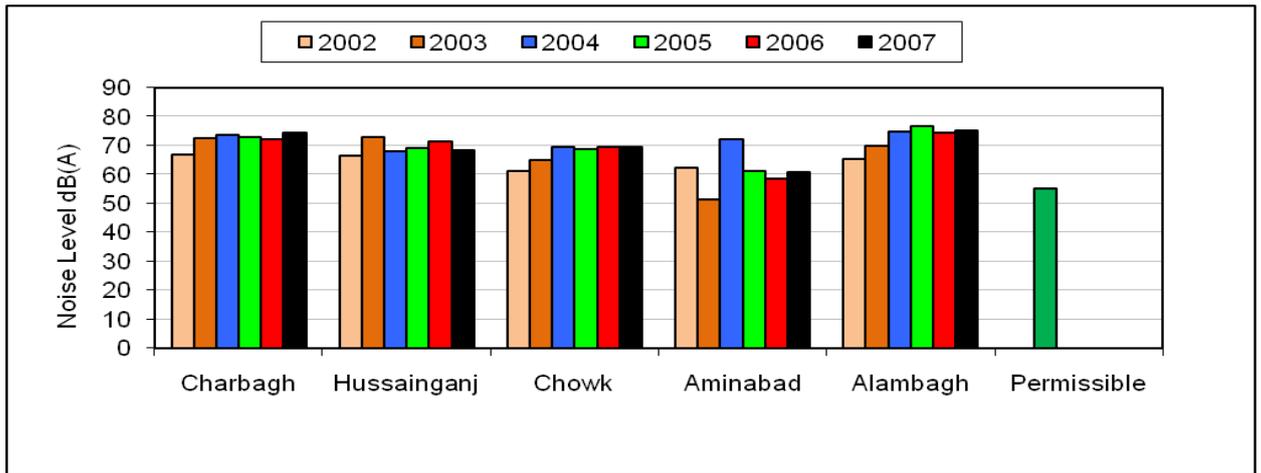


Figure-18: Comparison of Night Time Noise Level dB(A) in Commercial Area During 2002-2007

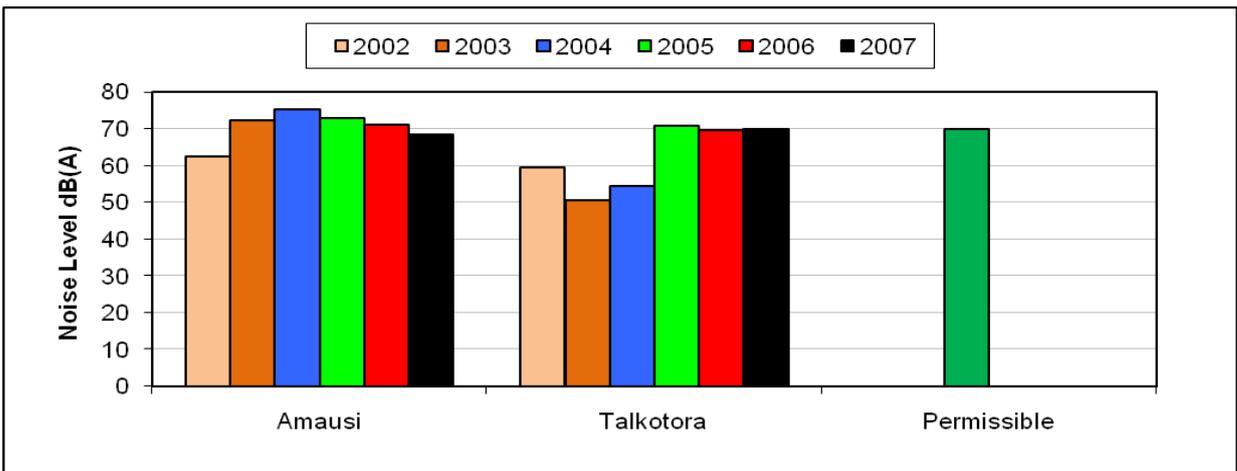


Figure-19: Comparison of Night Time Noise Level dB(A) in Industrial Area During 2002-2007

1.5 HEALTH HAZARDS OF AIR POLLUTANTS

1.5.1 Particulate Matter

Particles known as PM₁₀ have a diameter less than 10 µm and when inhaled would penetrate beyond the larynx.

Particulate air pollution is associated with a range of effects on health including effects on the respiratory and cardiovascular systems, asthma and mortality. In addition, constituents of particulate matter, such as acid sulphates, may irritate the upper airway and deep lung, reduce bronchial clearance, and modify the lung's resistance to infection.

Effects:

- Small particles can penetrate deeply into the lung and result in bronco-constriction and an alteration in respiratory mechanisms.
- Ultra fine particles ranging from 0.001 to 0.1 micron in diameter are able to penetrate deep down into the lung and to the alveolar sacs where gaseous exchange occurs.
- Small particles penetrate deeply into sensitive parts of the lungs and can cause or worsen respiratory disease such as emphysema and bronchitis, and aggravate existing heart disease.
- They work by increasing both 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 (SO₂)

SO₂ is a colorless water-soluble gas. It smells like burnt matches. It can be oxidized to sulphur trioxide, which in the presence of water vapour is readily transformed to sulphuric acid mist. Sulphur dioxide is detectable to the human nose at concentrations of around 0.5–0.8 parts per million (1400–2240 µgm⁻³).

It causes-

- Exposure to concentrations of 10 to 50 parts per million for 5 to 15 minutes causes irritation of the eyes, nose and throat, choking and coughing.
- This causes a 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
- For nasal breathing with low to moderate volumes the penetration into the lungs is negligible.
 - For oral inhalation and larger volumes, doses may reach the segmental bronchi
 - Exposure of the eyes to liquid sulfur dioxide, (from, for example 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)

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.

NO₂ is a reddish-brown gas with a pungent and irritating odour. It transforms in the air to form gaseous nitric acid and toxic organic nitrates.

Nitrogen Dioxide (NO₂) can have both acute (short term) and chronic (long-term) effects on health, particularly in people with asthma. Its toxicity relates to its ability to form nitric acid with water in the eye, lung, mucus membrane and skin.

Effects :

- Eye, nose, and throat irritation
- NO₂ causes inflammation of the airways.
- 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.
- It can cause collapse, rapid burning and swelling of tissues in the throat and upper respiratory tract, difficult breathing, throat spasms, and fluid build-up in the lungs.

- It can interfere with the blood's ability to carry oxygen through the body, causing headache, fatigue, dizziness, and a blue color to the skin and lips.
- Industrial exposure to nitrogen dioxide may cause genetic mutations, damage a developing fetus, and decrease fertility in women.
- 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 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 vessel making prone to heart attack and stress.

1.6 DISCUSSION

The automobile exhaust directly influences ambient air quality in urban area. Overall the pollution levels show a increasing trend with respect to RSPM, at most of the locations where SO₂ and NO_x showed decreasing trend with compared with previous year results.

The particles emitted by motor vehicles are mostly black carbon soot. Vehicular exhaust consists of mainly thoracic and alveolar particles (PM_{<10} and <2.5 μm respectively), which are mainly responsible for morbidity and mortality in the urban area. All the RSPM monitoring result presented in **Table-1.9** showed higher concentration than the permissible limit. In our country the NAAQS for RSPM (PM₁₀) is comparatively higher than the US-EPA and EC (European Commission)

prescribed limit. The annual daily limit has been fixed by EPA (1996) is $50 \mu\text{g}/\text{m}^3$ and new EC directive establish $20 \mu\text{g}/\text{m}^3$ and the 24 hour limit value of $50 \mu\text{g}/\text{m}^3$, which can not be exceeded for more than 7 days/year.

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 short term 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 also help the planners for sustainable development of the city.

1.7 CONCLUSIONS

The higher growth of vehicular population and individualism is a matter of concern because that the system becoming automobile dependence which not only effect the environment also effect the economic and social aspect and not viable for sustainable developments for any cities or community.

Civilizing the car through technological advances is part of the solutions but it is insufficient because the sheer volume of cars overwhelms cities. Despite doubling in fuel efficiency for new cars, increase the oil consumption. Heavy oil dependence is a significant threat to the sustainability of many cities as well as the countries.

Now it is evident that major problem arises for space occupied by cars (Parking space), which is not reduced by better technologies. A car required at least three parking space (residence, working place, market etc.).

So it is need of the hour to recognise the costs to the environment are real cost there is no simple choice between expensive environmental protection option and a cheap option trying to ignore environmental impacts.

1.8 RECOMMENDATIION

- Public mass transport must be strengthened to reduce personal vehicle on the road.
- Traffic rule must be strictly enforced.
- Encroachment should be removed for smooth flow of traffic.

- Improvement of fuel quality and checking of fuel adulteration.
- Public awareness programme for automobile pollution is essential.
- Pressure horn must be banned.
- Overall development of the city roads are essential
- Solid waste must be properly handled

2.0 BACTERIOLOGICAL QUALITY OF DRINKING WATER IN LUCKNOW CITY

Drinking water is one of the basic needs of life. According to the World Health Organization (WHO) about 80% diseases world wide are associated with contaminated drinking water. Water borne diseases like gastroenteritis, cholera, dysentery and typhoid are most common in tropical as well as subtropical countries. The objective of this surveillance is to assess the bacteriological quality of drinking water in Lucknow city and to aware the masses for the water borne diseases and its health risk.

2.1 WATER SAMPLING

A water quality surveillance (pre-monsoon) of drinking water from piped water supplies (50 Nos.) and ground water sources (50 Nos.) in Lucknow city was conducted during April-May, 2007 using with global positioning system (GPS) for exact location of sampling site. For convenience in survey, the city was divided mainly in residential, commercial and industrial areas based on the population and social activities. The localities identified for the survey were Aliganj, Indira Nagar, Gomti Nagar and Alambagh in residential area, Chowk, Hazratganj and Aminabad in commercial area and Aishbagh, Amausi and Talkatora in industrial area. Water samples were collected in sterilized glass bottles and analysed in the laboratory for their bacteriological quality by determining the most probable number (MPN) of coliforms and faecal coliforms according to standard methods (BIS, 2003 and APHA, 2005).

2.2 OBSERVATIONS AND RECOMMENDATION

In residential area 33% samples (13/40) , in commercial area 43% samples (13/30) and in industrial are 27% sample (08/30) were found to be contaminated with >10 coliforms and/or >1 faecal coliforms/100 ml as per Indian standard for drinking water. The analysis showed that bacterial contamination was higher in samples from commercial areas than those from residential and industrial areas (**Table-2.1**). Source wise observations revealed that 42% piped supplied and 26% of ground

water samples (hand pumps) were found to be bacteriologically unsafe for drinking purpose (**Table 2.2 & Figure 20**). Therefore, it is suggested that periodic water quality monitoring as well as proper disinfection and maintenance of drinking water sources are required.

Table 2.1 : Bacteriological quality of drinking water in Lucknow city during pre-monsoon, 2007

Sl. No.	Areas	Locations	No. of analysed samples	No. of contaminated samples*	Total & % contaminated samples
1	Residential	Aliganj	10	6	13/40 32.5% =33%
2		Indira Nagar	10	3	
3		Gomti Nagar	10	2	
4		Alambagh	10	2	
5	Commercial	Chowk	10	4	13/30 43.33%=43%
6		Hazratganj	10	4	
7		Aminabad	10	5	
8	Industrial	Amausi	10	3	08/30 26.67%=27%
9		Talkatora	10	3	
10		Aishbagh	10	2	
	Total		100	34	34/100 34.00%=34%

*Maximum permissible limit is >10 coliform/100 ml and/or > 1 faecal coliform /100 ml as per Indian Standard for Drinking Water Specifications of Bureau of Indian Standard (BIS, 2003).

Table 2.2 : Contamination profile of drinking water in Lucknow city during pre-monsoon, 2007

Area	Piped supply water (PS)		Ground water (GW)		Total samples	
	No. of sample analyzed	No. of contaminated Samples (%)	No. of Sample analyzed	No. of Contaminated samples(%)	No. of Sample analyzed	No. of contaminated samples (%)
Residential	20	8(40.00)	20	05(25.00)	40	13(32.50)
Commercial	15	10(67.00)	15	03(20.00)	30	13(43.33)
Industrial	15	03(20.00)	15	05(33.00)	30	08(26.67)
Total	50	21(42.00)	50	13(26.00)	100	34(34.00)

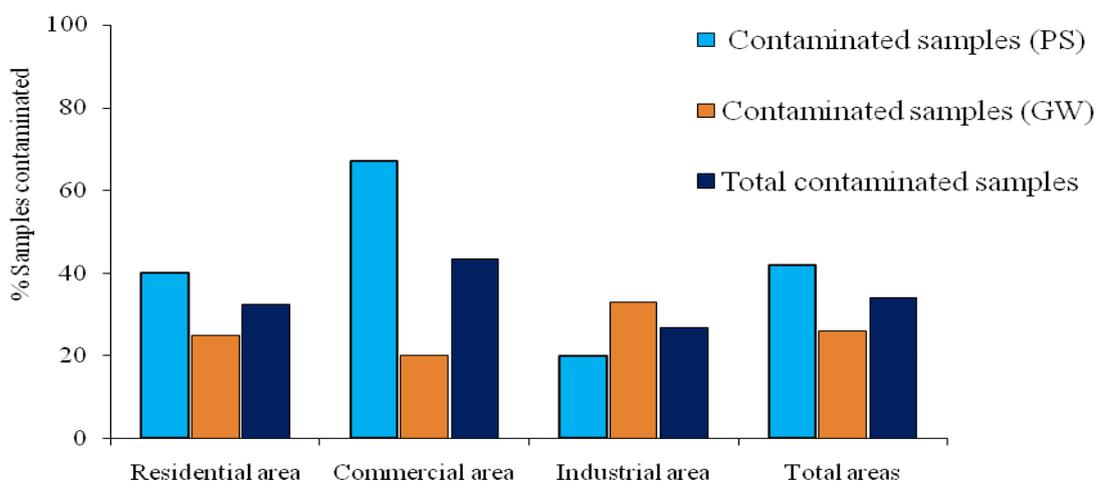


Figure 20 : Status of bacterial contamination in drinking water sources of Lucknow city during pre-monsoon, 2007