ASSESSMENT OF AMBIENT AIR QUALITY OF LUCKNOW CITY

(POST-MONSOON)

FINDINGS OF A RANDOM SURVEY

PRESENTED ON 46th IITR FOUNDATION DAY

CSIR- INDIAN INSTITUTE OF TOXICOLOGY RESEARCH

Mahatma Gandhi Marg, Lucknow – 226001

Web: http://www.iitrindia.org

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CONTENTS

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**	**:**	28,15033 as per 2011 Census
❖ **Projected Population**	**:**	45 lakhs as per Master Plan 2021
❖ **Climate**	**:**	Subtropical climate, cool dry winter (Dec. - Feb.) & summer (Mar - Jun.). Temperature about 45^0C in summer to 3^0C in winter. Average annual rainfall about 100 cm.
❖ **Total Vehicle Population in the Lucknow city as on 31/03/2011**	**:**	12,09,745
❖ **Growth of Vehicle over 2009-2010**	**:**	9.23%
❖ **Total No. of Filling Station (Petrol/Diesel/CNG)**	**:**	98
❖ **Consumption of Petrol**	**:**	1,20,061 KL
❖ **Consumption of Diesel**	**:**	1,25,688 KL
❖ **Major Source of Pollution**	**:**	Automobiles, D. G. sets, Civil Constructions
❖ **Parameters Monitored**	**:**	PM_{10}, $PM_{2.5}$, SO_2, NO_X and trace metals (Pb and Ni)
❖ **Study Conducted by**	**:**	Environmental Monitoring Division IITR, Lucknow

SUMMARY

The study was carried out during the months of October, 2011 to see the status of air quality of Lucknow city by monitoring and assessment of some selected air pollutants namely Respirable Particulate Matter (RSPM or PM_{10}), Fine Particulates ($PM_{2.5}$), Sulphur dioxide (SO_2), Oxides of Nitrogen (NO_X) and Trace metals, Nickel (Ni) and Lead (Pb) and noise level at 10 representative locations, categorized as residential (four), commercial (five) and industrial (one) areas. The results revealed the 24 hours concentration of RSPM in the range of 129.0 to 280.4µg/m^3 with a maximum 24 hours average concentration in Charbagh (227.4µg/m^3). The corresponding 24 hours values of $PM_{2.5}$ ranged between 46.5 to 157.9 µg/m^3 with a maximum 24 hours average concentration in Chawk (129.3 µg/m^3). The values of RSPM and $PM_{2.5}$ irrespective of locations were found to be above the permissible limit (PM_{10}= 100 µg/m^3 and $PM_{2.5}$= 60 µg/m^3) prescribed by MoEF. 24 hours average concentration of SO_2 and NOx were found in the range of 22.4 to 33.5 and 37.8 to 76.9 µg/m^3 respectively and all the values were below the permissible limits (80 µg/m^3). The trace metals Pb and Ni were found in the range of 41.08 to 321.73 and 4.85 to17.94 ng/m^3 respectively and all the values were below the permissible limits (1000 for Pb and 20 for Ni ng/m^3). Noise levels during day and night time were found in the range of 57.9 to 67.5 dB (A) and 50.6 to 64.3 dB (A)) which was above the respective permissible limits except in industrial area.

1.1 INTRODUCTION

Air pollution in urban area is a matter of grave concern because it affects large number of people adversely and main source of the air pollutants is vehicular emission. There are different types of pollutants namely particulate matter (PM) in different shape and size, SO_2, NOx, CO and different types of other organic and inorganic pollutants including heavy metals. These pollutants accumulate in the ambient air and deteriorate the outdoor and indoor air quality.

Different studies have shown that air pollutants are linked to different types of human health problems of many body system including respiratory, cardiovascular, immunological, haematological, neurological and reproductive /developmental systems.

The factors affecting the human health are level of pollutants, demographic or anthropogmetric characteristics, genetic profile, race and ethnicity, lifestyle, behaviors, socioeconomic position, location of residence and daily activities.

There are several studies on air pollution level and its effects on human health in urban areas throughout the world including India and most of the studies revealed that particulate matter and its associated chemical components are mainly responsible for the human health effects.

In view of above facts, it is the need of the hour to look into the air quality of our city Lucknow, the capital of Uttar Pradesh which has a population of 28.15 Lakh (Municipal corporation + Cantonment) as per 2011 census and an area of 310 sq. km. Vehicular traffic is the main source of particulate air pollution in Lucknow city. The number of different category of vehicles registered with RTO (Regional Transport Office) Lucknow is 12, 09,745 as on 31.03.2011 which is 9.23% higher over the last year (Table 1).

As per Indian Oil Corporation (IOC), the consumption/sale of petrol and diesel was 1,20,061 and 1, 25,688 KL as on 31-03-2011. It is observed that petroleum sale have been increased by 10.1% whereas sale of diesel has increased by 10.4%. (Table 2). In Lucknow there are six CNG filling stations and consumption of CNG in last year was approximately 19,117542.14 Kg (Green Gas Limited, Lucknow). Distribution and number of CNG vehicles in Lucknow is summarized in Table 3. Considering the above, assessment of ambient air quality of Lucknow city was carried out at 10 locations during post monsoon (October), 2011 with respect to RSPM, $PM_{2.5}$, SO_2, NO_x ,Trace metals (Ni and Pb) and Noise level with the following aims and objectives.

- ✓ *To assess the ambient air quality with respect to PM_{10}, $PM_{2.5}$, 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*

Table 1: Registered Vehicle with R.T.O. Lucknow during 2009-10 and 2010-11

Sl. No.	Type of Vehicle	Number of Registered Vehicles on 31st March		% Change
		2009-2010	2010-2011	
1	Multi Articulated	2134	2288	7
2	Light, Medium and Heavy Weight Vehicles	8631	9966	15
3	Light commercial vehicles(Three wheeler)	3702	2859	-22
4	Light Commercial Vehicles (Four wheeler)	4532	4302	-5
5	Buses	2930	2935	0.17
6	Taxi	5055	5354	5.0
7	Three Wheelers and Auto Rickshaw	7410	7318	-1.24
8	Two wheelers	890442	970897	9.04
9	Car	145996	165589	13.42
10	Jeep	14910	15513	4.04
11	Tractor	16464	17809	8.86
12	Trailers	1182	1318	11.5
13	Others	4067	3597	-10.2
Total		**11,07,455**	**12,09,745**	**9.23**

Source: RTO, Lucknow

Table 2: Consumption of Fuel (in KL) in Lucknow

Sl. No.	Agency	Petrol (Unleaded)			High Speed Diesel		
		Apr. 09 to Mar. 10	Apr. 10 to Mar. 11	% increase in consumption	Apr. 09 to Mar. 10	Apr. 10 to Mar. 11	% increase in consumption
1	IOC	60163	65961	9.6	66719	70179	5.1
2	BPCL	28828	31272	8.5	22252	25944	16.5
3	HPCL	19968	22828	14.3	24808	29565	19.1
Total		**1,08,959**	**1,20,061**	**10.1**	**1,13,779**	**1,25,688**	**10.4**

Source: Indian Oil Corporation (IOC), Lucknow

Table 3: Distribution of CNG vehicles

Sl. No.	Vehicles	Number
1	Auto Rickshaw	4213
2	Tempo Taxi	2534
3	Buses (UPSRTC)	247
4	Buses (Private)	26
5	School Buses	363
6	School Van	295
7	Private Vehicles	80
	Total	7758

Source : UPSRTC, Lucknow

1.2 MONITORING LOCATIONS AND METHODOLOGY

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 4 and parameters along with methodology is given in Table 5.

Table 4: Monitoring Locations

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

Table 5: Parameters and Methodology for Air Quality Monitoring

Sl. No.	Parameters	Time Weighted average	Methods of Measurement
1	RSPM/PM_{10} and $PM_{2.5}$	24 hours	Gravimetric
2	Sulphur dioxide (SO_2)	24 hours	Improved West Gaeke
3	Nitrogen Dioxide(NO_2)	24 hours	Modified Jacob & Hochhesier (Na-arsenite)
4.	Lead (Pb) and Nickel (Ni)	24 hour	AAS method using EPM 2000.
5.	Noise Level	1 hour	Day time (6 AM to 10 PM) & night time (10 PM to 6 AM) by Noise Meter.

1.3 RESULTS

The detailed results of air quality monitoring are presented in Table 6.

1.3.1 Respirable Suspended Particulate Matter (RSPM or PM_{10})

Twenty four hours mean concentration of RSPM were in the range of 159.2 to 173.1 $\mu g/m^3$ with an average of 167.2 $\mu g/m^3$ in residential areas (4 locations), in commercial areas (5 locations) were in the range of 166.6 to 227.4 $\mu g/m^3$ with an average of 187.9 $\mu g/m^3$. In industrial area (Amausi), it was 145.0 $\mu g/m^3$.

The maximum mean concentration of RSPM was found in Indira Nagar (173.1 $\mu g/m^3$) in residential area and Charbagh (227.4 $\mu g/m^3$) in commercial area. All the values of RSPM were above the prescribed National Ambient Air Quality Standard (NAAQS) of 100 $\mu g/m^3$ for industrial, residential, rural and other area respectively.

1.3.2 Fine Particles ($PM_{2.5}$)

Twenty four hours mean concentration of $PM_{2.5}$ were in the range of 76.2 – 111.1 $\mu g/m^3$ with an average of 94.8 $\mu g/m^3$ in residential areas (4 locations), in commercial areas (5 locations) were in the range of 71.4 to 129.3 with an average of 98.3 $\mu g/m^3$. In industrial area (Amausi), it was 89.7 $\mu g/m^3$.

The maximum 24 hours mean concentration of fine particles was in Aliganj (111.1 $\mu g/m^3$) in residential area and Chowk (129.3 $\mu g/m^3$) in commercial area. All the values of $PM_{2.5}$ were above the prescribed National Ambient Air Quality Standard (NAAQS) of 60 $\mu g/m^3$ at all ten monitoring locations.

1.3.3 Sulphur dioxide (SO_2)

Twenty four hours mean levels of SO_2 were in the range of 22.4 to 29.7 $\mu g/m^3$ with an average of 26.2 $\mu g/m^3$ in residential area (4 locations), in commercial area (5 locations) were in the range of 26.9 to 33.5 $\mu g/m^3$ with an average of 30.5 $\mu g/m^3$. In industrial area (Amausi) the average concentration of SO_2 was 25.7 $\mu g/m^3$. All the values of SO_2 were well below the prescribed NAAQS of 80 $\mu g/m^3$ for all the locations.

1.3.4 Oxides of Nitrogen (NOx)

Twenty four hours the average concentrations of NO_X were found in the range of 37.8 to 48.5$\mu g/m^3$ with an average of 41.2 $\mu g/m^3$ in residential areas (4 locations), in commercial areas (5 locations) were in the range of 46.4 to 76.9 $\mu g/m^3$ with an average of 61.4 $\mu g/m^3$ and in industrial area (Amausi) it was 48.8 $\mu g/m^3$. All the values of NO_x were within the prescribed NAAQS of 80 $\mu g/m^3$ for all the monitoring locations.

Table 6: Concentration (µg/m^3) of PM_{10}, $PM_{2.5}$, SO_2 and NOx during Post monsoon 2011

Location	RSPM			$PM_{2.5}$			SO_2			NOx		
	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Residential Area												
Aliganj	129.0	201.9	170.0	82.3	126.3	111.1	24.7	27.0	26.1	35.9	43.2	39.4
Vikas Nagar	150.6	182.8	166.3	64.8	105.0	85.8	18.5	26.1	22.4	24.2	43.9	37.8
Indira Nagar	131.4	218.3	173.1	80.7	141.7	105.9	23.8	35.6	29.7	35.4	59.5	48.5
Gomti Nagar	147.6	173.0	159.2	53.9	103.5	76.2	24.2	29.8	26.5	35.4	44.9	38.9
Average			167.2			94.8			26.2			41.2
Commercial Area												
Hussainganj	131.6	196.7	166.6	61.3	101.0	76.9	21.4	30.0	26.9	52.4	62.7	59.5
Charbagh	197.6	273.6	227.4	98.5	157.9	123.8	27.4	39.0	33.5	55.3	81.9	76.9
Alambagh	125.7	247.9	172.5	61.0	135.3	90.2	29.1	37.6	32.6	52.3	73.8	63.2
Aminabad	129.1	280.4	171.1	46.5	109.7	71.4	23.4	31.3	27.6	35.3	52.3	46.4
Chowk	170.5	228.4	201.9	95.6	145.8	129.3	29.0	35.5	32.0	51.6	68.8	61.1
Average			187.9			98.3			30.5			61.4
Industrial Area												
Amausi	130.8	157.9	145.0	69.7	99.5	89.7	20.9	31.6	25.7	41.9	52.1	48.8
NAAQS	100			60			80			80		
WHO Guidelines	50			25			20			40*		

N=4; *= Annual Average, NAAQS=National Ambient Air Quality Standards

1.3.5 Trace Metal (Ni and Pb) in Ambient Air (RSPM or PM_{10})

The trace metals (Pb and Ni) were estimated in ambient air associated with PM_{10} at 10 monitoring locations. The results are present in Table 7.

The 24 hours concentration of Pb was found to be maximum in Vikas Nagar 210.98 and minimum in Aliganj Nagar 78.67 ng/m^3 with an average of 116.08 ng/m^3 in residential area. In case of commercial locations, minimum in Alambagh 41.08 and maximum in Hussainganj 321.73 ng/m^3 with an average of 173.39 ng/m^3. In Amausi it was 79.10 ng/m^3. All the values of lead were found below the prescribed limit of NAAQS 1000 ng/m^3 .

The 24 hours concentration of Ni was found to be minimum in Aliganj 5.56 ng/m^3 and maximum in Vikas Nagar 12.03 with an average of 8.58 in residential area. In case of commercial area, minimum in Aminabad 6.93 and maximum in Alambagh 17.94 ng/m^3 with an average of 12.32 ng/m^3. In Amausi it was found 4.85 ng/m^3.

All the values of Nickel were found below the limit of NAAQS (20 ng/m^3).

Table 7: Average value (ng/m^3) of Lead (Pb) and Nickel (Ni)

Location	Pb	Ni
Residential Area		
Aliganj	78.67	5.56
Vikas Nagar	210.98	12.03
Indira Nagar	90.84	10.61
Gomti Nagar	83.84	6.14
Average	**116.08**	**8.58**
Commercial Area		
Hussainganj	321.73	14.30
Charbagh	90.49	13.15
Alambagh	41.08	17.94
Aminabad	187.65	6.93
Chowk	225.98	9.27
Average	**173.39**	**12.32**
Industrial Area		
Amausi	79.10	4.85
NAAQS	**1000.0**	**20**

1.3.6 Noise

The monitoring data recorded during the post monsoon period (October, 2011) is presented in Table 8.

In residential areas, the day and night time noise level were recorded between 57.9 to 60.6 and 50.6 to 57.8 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 64.3 to 67.5 and 55.6 to 64.3 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.

In industrial area, Amausi the day and night time noise levels were recorded between 63.3 and 58.6 dB (A) respectively. Noise level at industrial location in the day and night time was found within the prescribed limit of 75.0 and 70.0 dB (A) respectively.

Table 8: Noise Level dB (A) during Day and Night Time

Sl. No.	Area	Location	Noise level dB(A)	
			Day	**Night**
1	**Residential**	Aliganj	58.9	50.6
		Vikas Nagar	57.9	53.2
		Indira Nagar	60.6	57.8
		Gomti Nagar	58.3	53.2
		Standard	**55.0**	**45.0**
2	**Commercial**	Hussainganj	65.4	59.5
		Charbagh	67.5	64.3
		Alambagh	65.4	58.6
		Aminabad	66.4	55.6
		Chowk	64.3	56.3
		Standard	**65.0**	**55.0**
3	**Industrial**	Amausi	63.3	58.6
		Standard	**75.0**	**70.0**

1.4 TRENDS OF AMBIENT AIR QUALITY IN LUCKNOW CITY

The observed RSPM, SO_2 and NO_x for the last 3 years data (2008-10) have been compared with present post monsoon data to find out the prevailing trend of air pollution in Lucknow city (Fig. 1- 3). The slight decrease or increase in the values may be attributed to some local environmental and climatic factors.

1.4.1 Respirable Suspended Particulate Matter (RSPM or PM_{10})

In all the locations in residential areas, higher values were estimated over last year. Among the commercial areas, RSPM values showed increasing trend except at Alambagh than the last year. Amausi under industrial area showed higher value over the last year. All the values are higher than the NAAQS (Fig. 1).

1.4.2 Sulphur dioxide (SO_2)

The level of SO_2 during pre monsoon since 2008 is presented in Fig. 2 for all the locations.

SO_2 values showed increasing trend at all the ten monitoring locations of residential, commercial and industrial areas. All the values of the present study were found to be lower than the NAAQS (Fig. 2).

1.4.3 Oxides of Nitrogen (NO_x)

The level of NOx during pre monsoon since 2008 is presented in Fig. 3 for all the locations.

NOx values showed increasing trend at all the ten monitoring locations situation in residential, commercial and industrial areas. All the values of the present study were found to be lower than the NAAQS (Fig. 3).

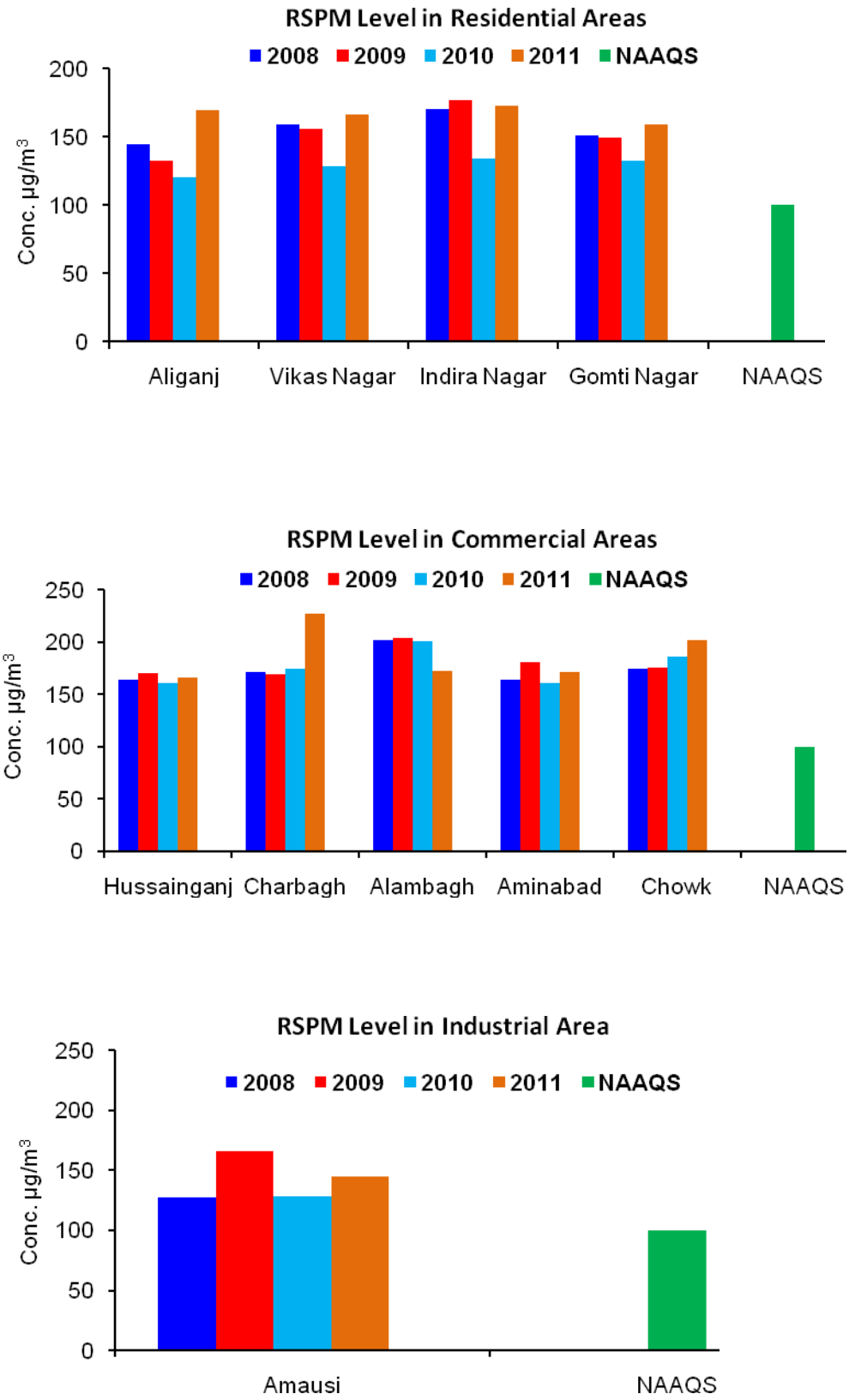


Fig 1: Concentration (µg/m^3) of RSPM in Residential, Commercial and Industrial areas of Lucknow city during 2008 to 2011 and compared with prescribed National Ambient Air Quality Standard (NAAQS)

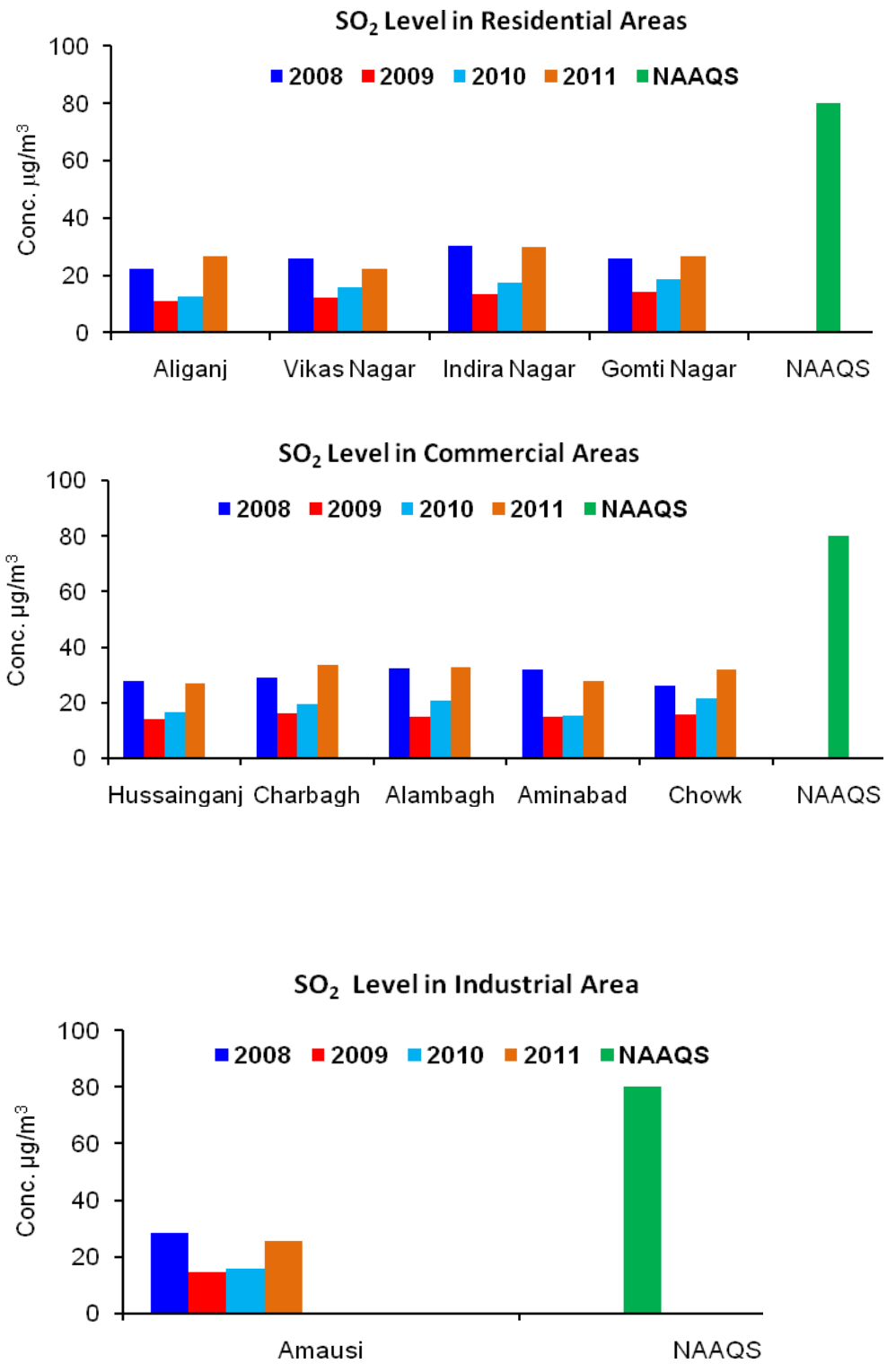
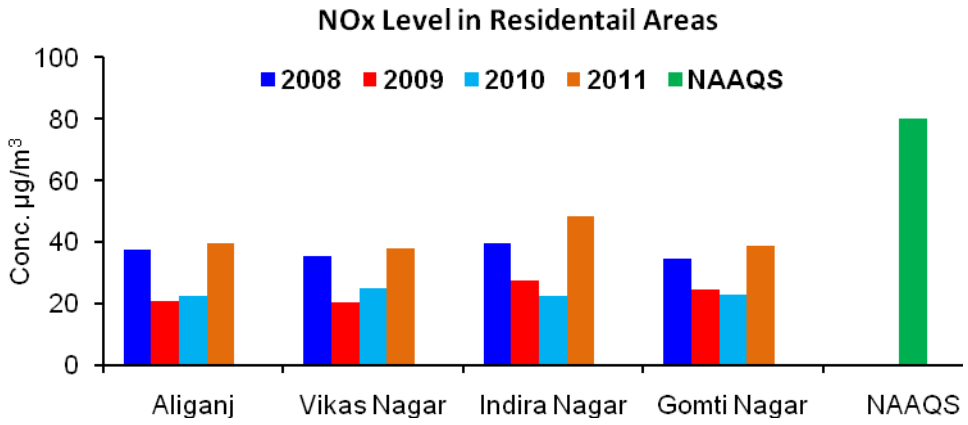
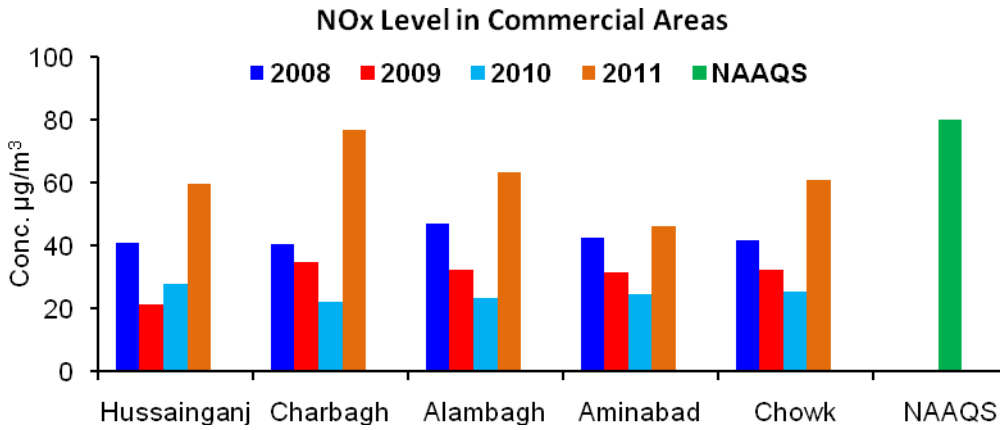


Fig 2: Concentration (µg/m^3) of SO_2 in Residential, Commercial and Industrial areas of Lucknow city during 2008 to 2011 and compared with prescribed National Ambient Air Quality Standard (NAAQS)





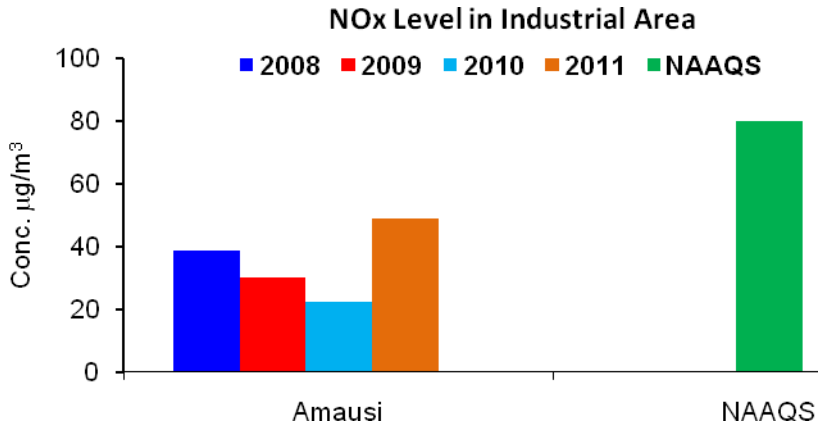


Fig 3: Concentration (µg/m^3) of NO_x in Residential, Commercial and Industrial areas of Lucknow city during 2008 to 2011 and compared with prescribed National Ambient Air Quality Standard (NAAQS)

1.4.4 Trends of Noise Level

Current year's noise data has been compared with the corresponding data of last three years (2008 to 2010) and are presented in Fig. 4 and 5. The comparative noise level in residential, commercial and Industrial areas is described below:

1.4.4.1 Day time Noise Level

In residential areas all the locations showed slightly decreasing trend over the last year. In commercial cum traffic areas slightly lower levels at all locations were recorded over the last year. In industrial area, Amausi the noise level was recorded lower value over last year data. The comparative data are presented in (Fig. 4).

1.4.4.2 Night time Noise Level

All four residential areas showed slightly lower trend was recorded over the last year level except Aliganj during day time. Among commercial areas, all the locations showed lower values except Hussainganj and Charbagh during night time than the last year. In industrial area, also recorded little lower value during night time over last year data. The comparative data are presented in (Fig. 5).

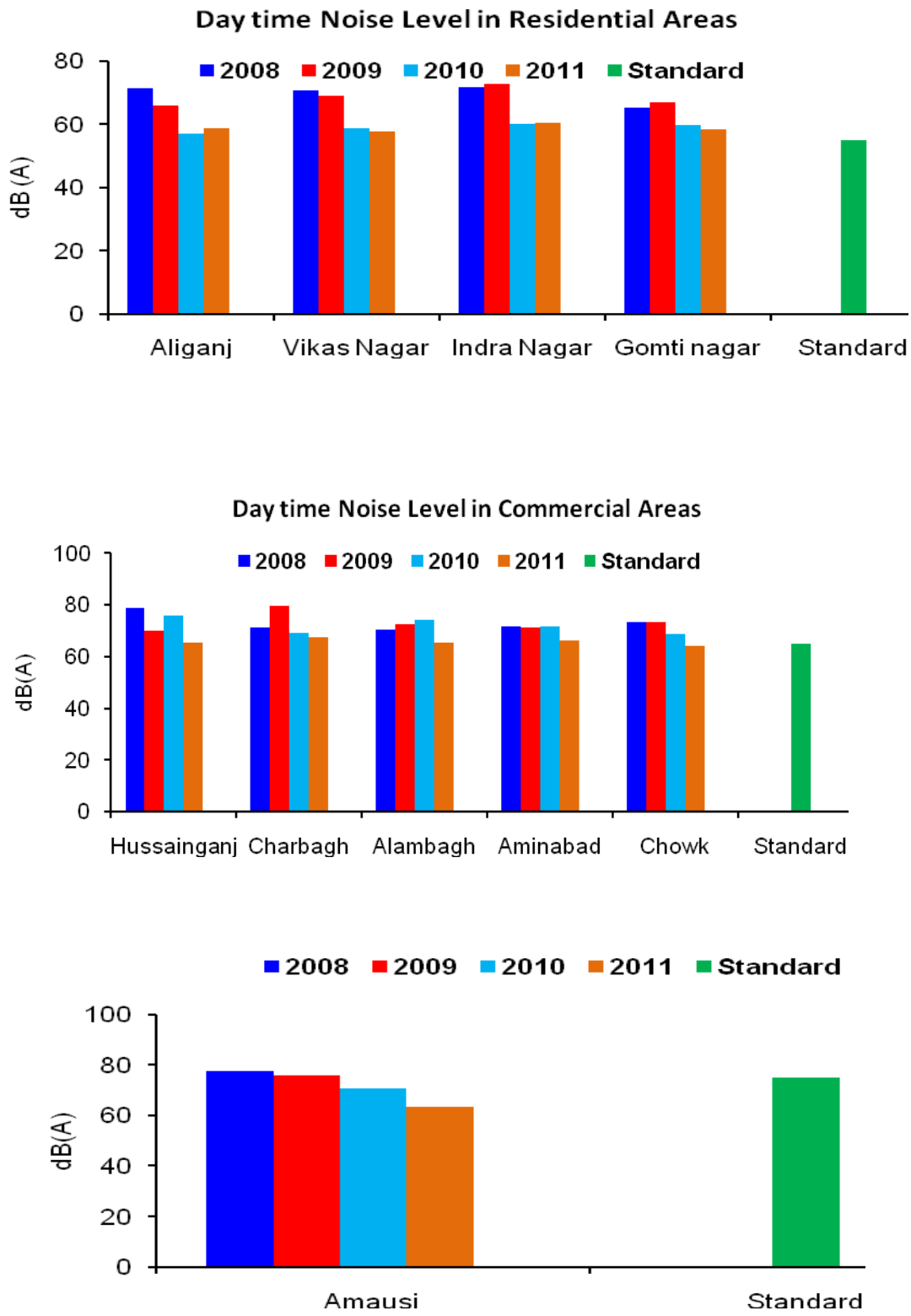


Fig 4: Comparison of day time Noise Level dB(A) in different areas of Lucknow city (2008-2011)

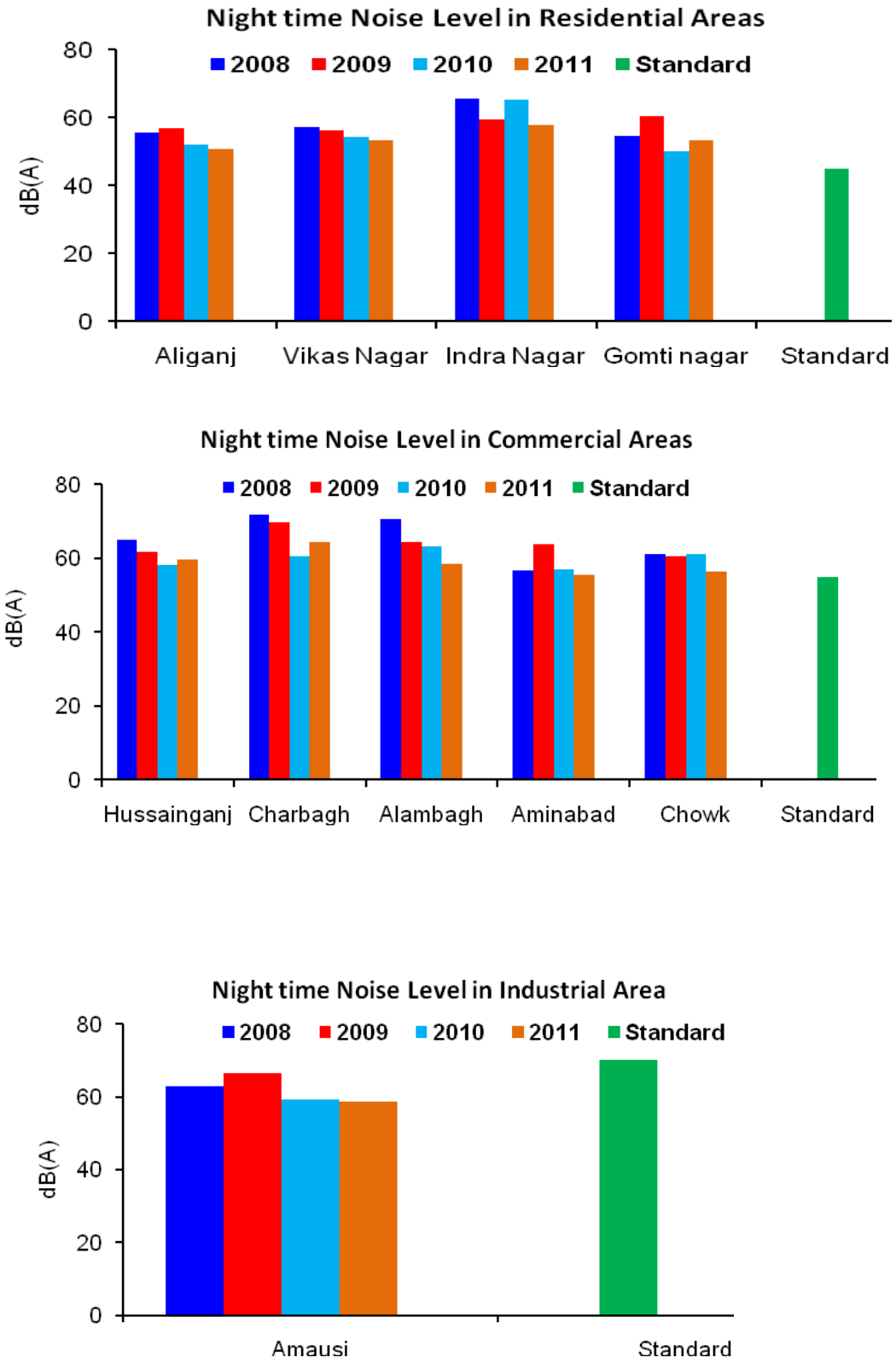


Fig 5: Comparison of night time Noise Level dB (A) in different areas of Lucknow city (2008-2011)

1.5 HEALTH EFFECTS OF AIR POLLUTANTS

1.5.1 Particulate Matter (PM_{10} and $PM_{2.5}$)

Sources – Particles are derived from suspension or resuspension of dust soil or other crustal materials from roads, farming, mining, windstorms and direct emission of combustion process such as burning of wood, vehicle use of gasoline and diesel, coal burning and other industrial process.

Effects- Irritation to eyes, skin, throat, upper respiratory system. Particle pollution contains microscopic solids or liquid droplets that are so small that they can get deep into the lungs and cause serious health problems. The size of particles is directly linked to their potential for causing health problems. Small particles less than 10 micrometers in diameter pose the greatest problems, because they can get deep into lungs, and some may even get into bloodstream. Carriers of toxic air pollutants including heavy metals and organic compounds, chronic exposure may lead to lung cancer.

1.5.2 Sulfur dioxide (SO_2)

Sources - It is produced by volcanoes and in various industrial processes. Since coal and petroleum often contain sulfur compounds, their combustion generates sulfur dioxide unless the sulfur compounds are removed before burning the fuel.

Effects- Irritation to eyes, nose, throat, rhinorrhea (discharge of thin nasal mucus), choking, cough, reflex bronchoconstriction.

1.5.3 Oxides of Nitrogen (NO_X)

Sources- Combustion of automobile fuels, coal, which have significant nitrogen content.

Effects- Decrease lung function and increase the risk of respiratory symptoms such as acute bronchitis and cough and phlegm, particularly in children.

1.5.4 Lead (Pb)

Sources - Paint, urban dust, and folk remedies, use of heat guns, battery making, smelter work, plastic manufacturers.

Effects- It damages the nervous system and causes brain disorders. Excessive lead also causes blood disorders in mammals including human being.

1.5.5 Nickel (Ni)

Sources - Coal burning units in utility, industrial and residential use sectors and municipal and sewage sludge incinerators, high temperature metallurgical operations (steel and nickel alloy manufacturing, secondary metals smelting, and co-product nickel recovery), chemical and catalyst sources (nickel chemical manufacturing, electroplating, nickel-cadmium battery manufacturing, and catalyst production, use, and reclamation).

Effects- Sensitization dermatitis, allergic asthma, cough, shortness of breath, pneumonitis; decreased sense of smell, Nickel sulfide fume and dust is believed to be carcinogenic, and various other nickel compounds may be as well. Nickel carbonyl, [$Ni(CO)_4$], is an extremely toxic gas. Sensitized individuals may show an allergy to nickel affecting their skin, also known as dermatitis.

1.5.6 Noise

Sources –Traffic noise from motor vehicle is one of major source of noise pollution in urban area others short term noise generated from commercial, construction, religious activities,etc.

Effects- Noise often causes discomfort, fatigue and sometimes pain. Noise induced hearing loss temporarily or permanently depends on the intensity and exposure period.

1.6 CONCLUSIONS

We have monitored air pollutants such as PM_{10}, $PM_{2.5}$, SO_2, NOx, Ni and Pb for assessment of ambient air quality. Besides, noise level was monitored during day and night time at 10 locations and results showed the following-

- The RSPM (PM_{10}) level at all the monitoring locations of residential, commercial and industrial areas was higher than the NAAQS (100 µg/m^3). Increasing trend for the RSPM was found at all the locations over last year except at Alambagh

- Fine Particle ($PM_{2.5}$) level at all the monitoring locations of residential, commercial and industrial areas were higher than the NAAQS (60 µg/m^3).

- The concentration of gaseous pollutants, SO_2 and NO_x were well below the prescribed NAAQS (80 µg/m^3) at all the locations but showed increasing trend.

- The noise level at all the locations except and in industrial areas during day and night time showed lower level than the respective permissible limits. Overall all the values showed comparatively lower values than last year value with few exceptions.

- Level of lead and nickel at all the locations found to be under permissible limit (Pb= 1000 and Ni=20 ng/m^3).

The results of the present study revealed that the level of PM_{10} and $PM_{2.5}$ are the major concern because their level is higher than the permissible limit. These are the criteria pollutants for the assessment of air quality. Both the size ranges have been associated with excess mortality and morbidity.

Results also indicate the presence of other pollutants like SO_2, NOx and metals like lead and nickel in the urban area of Lucknow city. Some of these pollutants are carcinogenic but present in comparatively low level. Continuous exposure is a matter of concern with respect to health of Lucnowites in the long run.

Thus it is necessary to monitor the air quality as well as the health effects on regular interval at strategic locations. Our 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 RECOMMENDATIONS

- Public awareness programme for automobile pollution
- 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.
- Pressure horns to be removed from all vehicles and avoid use of horn.
- Government should increase the parking charges on hourly basis to discourage the use of personal vehicle.
- Congestions charges for certain area for peak hours.
- Restore foot path for pedestrian .

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