Assessment of Ambient Air Quality of Lucknow City

Post-Monsoon 2020

सीएसआईआर-भारतीय विषविज्ञान अनुसंधान संस्थान
CSIR-INDIAN INSTITUTE OF TOXICOLOGY RESEARCH
VISHVIGYAN BHAWAN, 31, MAHATMA GANDHI MARG, LUCKNOW-226001, U.P., INDIA
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PROJECT PERSONNEL

Project Leader	:	Dr G.C. Kisku
Co-Project Leaders	:	Er A.H. Khan
		Dr B. Sreekanth
Team Member	:	Dr D.K. Patel
Technical Staff	:	Mr Pradeep Shukla
Project Fellows	:	Ms Priya Saxena
		Mr Abhishek Verma
		Mr Ankit Gupta
		Mr Nirmesh Srivastava
		Mr Abdul Atiq Siddiqui
		Mr Ankit Kumar
		Mr Ravi Kumar Tiwari

CONTENTS

Salient Features of the Study at a Glance

- **Geographical Position** : 26° 52' N Latitude, 80° 56' E Longitude, 128 m above Sea level
- **Lucknow Municipal Area after Dec. 2019** : 631 sq km (with addition of 88 villages)
- **Population** : 28,15,033 as per 2011 Census
- **Current Predicted Population** : Approx. 35-36 Lakhs (considering decadal growth of city & UP state)
- **Projected Population** : 65 Lakhs as per Master Plan 2031
- **General Climate of Lucknow City** : Subtropical climate, cool dry winter (Dec-Feb) & summer season (Mar-Jun). Air temperature about 40-45-°C during summer and 3-18°C during winter season. Average annual rainfall about 100 cm.
- **Total Vehicular Numbers of Lucknow City as on 31/03/2020** : 24,07,190
- **Growth rate of Vehicle over 2018-2019** : 9.70 %
- **Fuel Petrol/Diesel/CNG Filling Stations** : 106
- **Consumption of Petrol (2019-2020)** : 2,32,383 kL
- **Consumption of Diesel (2019-2020)** : 2,13,315 kL
- **Consumption of CNG (2019-2020)** : 4,23,59,025 kg
- **Major Sources of Pollution** : Vehicles, Building & Infrastructure construction, industries, burning of bio-fuels (wood/ agricultural wastes) and coal.
- **AAQ Parameters Monitored** : AAQ - PM_{10}, $PM_{2.5}$, SO_2, NO_2, Metal: Lead & Nickel, Noise Levels
- **Study Conducted by** : Environmental Monitoring Division CSIR-IITR, Lucknow

ASSESSMENT OF AMBIENT AIR QUALITY OF LUCKNOW CITY DURING POST-MONSOON, 2020

1.0 SUMMARY

The Post-monsoon ambient air quality assessment of Lucknow city was carried out by the Environmental Monitoring Division of CSIR Indian Institute of Toxicology Research, Lucknow during the months of September-October, 2020. The air quality status was evaluated through monitoring and assessment of some of critical and health affecting air pollutants like 1. **Respirable Suspended Particulate Matter:** (PM_{10}, cut off size ≤10 µm, and **Fine Particulate Matter:** ($PM_{2.5,}$ cut off size ≥2.5 µm); **2. Indicator Gases:** Sulphur dioxide (SO_2) and Nitrogen dioxide (NO_2); **3. Toxic Heavy Metals:** Lead (Pb) and Nickel (Ni), and **4. Noise levels** at 9 representative locations which are grouped into 3 categories viz., **i. Residential areas, ii. Commercial areas** and **iii. Industrial area.**

The 24 hr concentrations of PM_{10} ranged from 91.4 to 130 µg/m^3 with an average of 109.8 µg/m^3 while in case of $PM_{2.5}$, the 24 hr concentrations ranged from 49.5 to 90.6 µg/m^3 with an average of 64.6 µg/m^3. Irrespective of the locations, the average values of PM_{10} and $PM_{2.5}$ were found to be above their standards of 100µg/m^3 for PM_{10} and 60 µg/m^3 for $PM_{2.5}$ prescribed by Central Pollution Control Board, New Delhi. However, the values of PM_{10} and $PM_{2.5}$ increased by 9.6 % and 20.6 % compared to the levels measured during pre-monsoon 2020 (Lockdown) period (April-May 2020). Similarly the values of SO_2 and NO_2 increased by 111.02 % and 38.17 %. At eight out of nine air sampling locations, the mean values of PM_{10} were above the permissible limit of 100 µg/m^3 while at six sampling locations out of nine, the mean $PM_{2.5}$ values were exceeded the permissible limit of 60 µg/m^3 as prescribed by CPCB.

The 24 hr concentrations of SO_2 ranged from 11.4 to 15.5 µg/m^3 with an average of 13.1 µg/m^3 while the 24 hr concentrations of NO_2 ranged from 26.1 to 43.8 µg/m^3 with an average of 34.9 µg/m^3. The average values of SO_2 and NO_2 were found within the Standard of 80 µg/m^3 for both SO_2 and NO_2 prescribed by CPCB, New Delhi (NAAQS-2009). Toxic heavy metals like Lead (Pb) and Nickel (Ni) associated with PM_{10} were also determined. The 24 hr measured values of lead (Pb) ranged from 6.22 to 28.0 ng/m^3 with an average of 16.16 ng/m^3 and all the observed Pb values were found within the CPCB prescribed standard of 1000 ng/m^3. However in case of Nickel (Ni), the 24 hr concentrations ranged from 2.99 to 21.82 ng/m^3 with an average of 8.45 ng/m^3 and all the observed Ni values were within the CPCB prescribed standard of 20 ng/m^3.

The day time and night time noise levels ranged from 64.8 to 72.8 dB(A) and 48.7 to 65.6 dB(A) in residential areas whereas 70.1 to 76.5 dB(A) and 70.7 to 74.7 dB(A) in commercial areas respectively. These measured values were above their respective day time standard of 55 dB(A) and night time standard of 45 dB(A) for residential areas and 65 dB(A) and 55 dB(A) for commercial areas respectively. At Amausi Industrial area, the day time and night time noise levels were 73.2 dB(A) and 69.0 dB(A) respectively. The values are below the standard of 75 dB(A) for day time and 70 dB(A) for night time recommended for Industrial areas.

The present study reveals that the levels of pollutants like inhalable particulate matter, gases, and noise are gradually increasing with relaxation of lockdown and progress of time. The overall trend reveals that all the pollutants are increasing in Lucknow city.

1.1 INTRODUCTION

According to the Air (Prevention And Control of Pollution) Act, 1981, Air Pollution/ Air Pollutant "means any solid, liquid or gaseous substance (including noise) present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment". It is an Act of the Parliament of India to control and prevent air pollution in India and the law was amended in 1987. This was the first attempt by the Government of India to combat air pollution. The MoEFCC has been a leading authority on this Law since it was established in 1981. The MoEFCC authorizes its nodal agency, CPCB to protect public health by regulating the emissions of harmful air pollutants. Often the outdoor air quality is defined by indices reflecting the concentrations of hazardous air pollutants.

Air Pollutants : Revised National Ambient Air Quality Standards notified by Central Pollution Control Board (CPCB) with effect from 1st September 2009 demarcate standards for 12 criteria pollutants – Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), Particulate matter PM_{10}(size less than 10 µm) Particulate Matter $PM_{2.5}$ (size less than 2.5 µm), Ozone (O_3), Lead (Pb), Carbon Monoxide (CO), Ammonia (NH_3), Benzene (C_6H_6), Benzo(a) pyrene (BaP)- particulate phase only, Arsenic(As) and Nickel (Ni).

CSIR-IITR Pre-monsoon 2020 Study during Lockdown: A Nation-wide lockdown was declared from midnight of 23rd March 2020 and then unlock phase with some restrictions continued till September 2020 in Lucknow to check the transmission of Covid-19 disease among population. The four phases of lockdowns, phase-I LD (24th March to 14th April 2020), phase-II LD (15th April to 3rd May 2020), phase-III LD (4th May to 17th May 2020) and phase-IV LD (18th May to 31st May 2020) were implemented everywhere with strict rules and regulations. Only few government vehicles including police patrolling vehicles and ambulances were allowed to move for vigilance/ administrative purpose or to help the patients.

Therefore due to strict lockdowns especially during Phase I, II and III; plying of general vehicles were minimal/lowest and so was the diesel/petrol consumption. Many industrial houses were also in lockdown condition. As a result, the environmental pollution of city areas dropped significantly from the previous pollution levels.

CSIR-IITR carried out the usual pre-monsoon monitoring of air quality of Lucknow city with risk. The pre-monsoon report was released on World Environment Day 2020 and it was widely circulated in the print media. However, the noticed improvement of air quality was for short duration. As the lockdown was relaxed sequentially, vehicles plying on the road and other activities including the operation of industries increased gradually leading to a subsequent increase in the city's air pollution level.

Sources of Air Pollution: There are many sources of air pollution in the city viz. vehicular traffic, road dust, emission from different industries namely Hindustan Aeronautics Ltd., Tata Motors, C & W of Railways, Loco Sheds, Airports, Railway stations, many Cottage industries like Chikan Factories, Cattle Sheds, Crematorium, and two major industrial estates in city - Talkatora and Amausi and other small scale industries scattered over the city area. The city is rapidly expanding. Therefore the requirement of building and infrastructure development, other construction and demolition, renovation of old constructions and transported pollen / bio-aerosols-fungi, virus and bacteria in air escalated the deterioration of air quality. Besides, urban city dwellers mainly use LPG for heating and cooking but migrant labourers, workforce, slum dwellers are mainly burning non-LPG heating sources like agriculture residues, cow dung, wood, coal, tyres, trash and even kerosene are common in city area. All the major and unaccounted hundreds of fugitive sources add to the existing air pollution of Lucknow environment.

Due to concentric pattern (circular/spherical nature) of city orientation/development, the criss-cross dispersal of air pollution in the city is difficult and pollution remains within the city boundaries. The pollution of the city can't be carried away by wind force. Moreover, owing to winter season calm conditions (~ < 0.4 m/s wind speed), low temperature and high

humidity vertical dispersion of pollutants is difficult and pollutants mostly get trapped in the lower troposphere within a height of ~ 1.5 km. Further, during the night hours, aerosols absorb air moisture and others particles to increase its density and therefore, reduces its buoyancy and gradually pollutants come down throughout the night particularly to ground/breathing levels. Further, the low mixing height / inversion layer of the atmosphere affects the pollution levels as a result of dilution of volume of air. The dilution effect is less as compared to summer season and that is the sole cause of damage due to air pollution in all mega cities.

Lucknow City and Its Boundary: Lucknow is the capital and largest city of Uttar Pradesh. It is the eleventh most populous city and the twelfth most populous urban agglomeration of India. Lucknow has always been known as a multicultural city that flourished as a North Indian cultural and artistic hub, and the seat of power of Nawabs in the 18th and 19th centuries. Lucknow city had an area of 402.65 sq. km till December 2019, when 88 villages were added to the municipal limits and the area increased to 631 sq. km. It is bounded on the east by Barabanki, on the west by Unnao, on the south by Raebareli and in the north by Sitapur and Hardoi. The Gomti River flows across Lucknow dividing the city into Cis-Gomti (main city/ right bank) and Trans-Gomti (left bank) areas. The population was 28.15 lakh (as per 2011 census) and now the population would be around 35 lakh assuming the decadal growth rate ~ 20% (inherent + migrated + added villagers of 88 villages). As the population increases, their basic needs like housing, foods, vehicles also increase and so does the daily solid wastes generation which leads to increased pollution. State Government of UP has been continuously improving and expanding existing infrastructure, improving road conditions, constructing new flyovers, expanding narrow roads, removing bottle necks, installing traffic lights to avoid traffic jams, providing new electric e- rickshaws, better solid wastes disposal and systems removing the road sides dust specially dust deposited along the divider. Metro Rail Corporation has completed Phase-I and II development.

Registered Vehicles in Lucknow: The total number of vehicles registered with RTO (Regional Transport Office) Lucknow was 24,07,190 as on 31.03.2020 which is 9.7% higher than 2019. Besides, daily thousands of outside vehicles are coming to Lucknow for different

purposes or sometimes to stay for a short duration of time. Table 1 presents the comparison between vehicular numbers of current-2020 and last year-2019 of Lucknow city. Uttar Pradesh State Road Transport Corporation (UPSRTC) introduced bus services under the banner "Lucknow City Transport Services Limited" on different routes of Lucknow city. The details of bus routes and number of buses plying as on 31.03.2020 are tabulated in Table 2. In Lucknow city, there are 106 fuel filling stations for petrol, diesel and CNG operated by different oil and gas companies. Table 3 presents the number of fuel outlets with corresponding agencies.

From our research experience and scientific studies, we presume that about 40-60 % air pollution of city is linked to vehicular emission, one of the major sources of air pollution in Lucknow city. The city has become denser with traffic congestion and increased vehicular emission which impacts health of public mainly drivers, commuters and individuals living near roads.

Fuel Consumption of Lucknow: As per Oil Marketing Companies (IOC, BPCL and HPCL), the consumption/sale of petrol and diesel was 2,32,383 and 2,13,315 kL respectively as on 31-03-2020. It is observed that petroleum sale has increased by 3.06% whereas sale of diesel has decreased by 3.0% (Table 4). In Lucknow, there are 9 CNG filling stations and the consumption of CNG in the last year was 4,23,59,025 kg (2019-20) which was 9.96% lower than the previous year (2018-19). The distribution and number of CNG vehicles plying in Lucknow city are summarized in Table 5. The increased diesel/petrol consumption has resulted in increase air pollution levels in the city.

Role of CSIR-IITR: CSIR-Indian Institute of Toxicology Research, Lucknow, under the aegis of Council of Scientific & Industrial Research, New Delhi, Govt. of India is one of the premier national research institutes assessing ambient air quality of Lucknow city twice in a year, Pre-monsoon (April-May) and Post-monsoon (September-October) since 1997 to protect community health, environment and to increase public awareness. For Post-monsoon study, Environmental Monitoring Division initiated AAQ monitoring and noise measurement during September-October 2020. Air quality monitoring was carried out at nine locations representing residential, commercial cum traffic and industrial areas. These locations are same as the previous year to avoid variation.

Purpose of the Survey:

Keeping in view the urban air pollution problem, the assessment of ambient air quality of Lucknow city was monitored at 9 representative locations during September-October, 2020 with the following aims and objectives:

- *to assess the levels of ambient air quality parameters with respect to Particulates (PM_{10} & $PM_{2.5}$), gases (SO_2 & NO_2), toxic heavy metals (Pb & Ni) associated with particles and day and night time noise levels,*
- *to study the trends of air pollutants over a period of time of Lucknow city,*
- *to create a baseline data for current action and to adopt necessary preventive / precautionary measures that can bring down the air pollution load of city and provide baseline data for future use and*
- *to create public awareness about environmental pollution in Lucknow city.*

Table 1 : Comparison of Vehicular Population in Lucknow

S.No.	Type of Vehicle	Number of Registered Vehicles as on 31st March		Change in %
		2018-19	2019-20	
1	Multi Articulated	5777	6144	6.35
2	Light, Medium and Heavy weight Vehicles (Four wheeler)	42318	47745	12.82
3	Light commercial vehicles (Three wheeler)	3482	3652	4.88
4	Buses	3876	4291	10.71
5	Omni Buses	489	489	0.00
6	Taxi	24851	30362	22.18
7	Light Motor Vehicles (Passenger)	8191	10157	24.00
8	Two wheelers	1708874	1804077	5.57
9	Motorcycle on hire	377	384	1.86
10	Car	297774	313597	5.31
11	Jeep	62398	85689	37.33
12	Tractor	26902	27136	0.87
13	Trailers	1946	1961	0.77
14	Others	7006	71506	920.64
Total		**21,94,261**	**24,07,190**	**9.70**

Source: RTO, Lucknow

Table 2 : Details of Lucknow City Bus Service, 2020

S. No.	Route No.	To and Fro	No. of Buses	Frequency
1	101	BBD – Dayal- Residency-Matiyari Tiraha-Petrolpump-Chinhat-Kathauta-M T Hahnemann- Judicial- Husadiya-Maliktimber-Patrakarpuram- P S Gomti Nagar Vishalkhand-CMS-Vipulkhand-Ambedkar Smarak-BBD Academy- Jansatta-Lohiya Park-FunRepublic-Baluadda-MM Malviya- Tikoniya Park- Dainik Jagaran- Sikanderbagh-Jawahar Bhavan- Shakti Bhavan-GPO-Bapu Bhavan-Burlington- Hussainganj-Vikasdeep-KKC- Charbagh.	10	11 minute interval
2	102	Virajkhand – Hahnemann- MT Kathauta-Vikrant Kahnd- Vijaypur-IndiraGandhi Prathisthan –Lohia Hospital-Picup-Polytechnic-HA.L.-Bhoothnath- Nilgiri-Lekhraj- Shaktinagar- Badshahnagar-Nishatganj-Papermil- Gokhale marg-Sikandarbagh- Jawahar Bhavan- Shakti Bhavan-GPO- Bapu Bhavan-Burlington-Hussainganj-Vikasdeep-KKC- Charbagh- Mawaiya-PS Alambagh-Tedhipuliya- Bus Station- Alambagh Chauraha- Ramnagar- Puran Nagar- Sringarnagar- Awadh Hospital-Krishna Nagar-Awadh College-Purani Chungi-Hindnagar- Shivdev-Paragdairy- Parag terminal-Nageshwar-Sector N-Pasiqiula- Ambedkar University.	06	18 minute interval
3	103	Charbagh – KKC- Vikas Deep-Husainganj-Burlington—Bapu Bhawan- GPO-Ayakar Bhavan-Shakti Bhawan- Jawahar Bhavan-Sikanderbagh- Gokhle Marg-Nishatganj-Gole Market-Badshahnagar-Polytechnique-Kamta-Chinhat-Telco-Samarpan.	09	12 minute interval
4	104	Swaroop College-Tiwariganj-BBD- Dayal residency-Matiyari Tiraha-Petrol Pump-Chinhat Mod-Kamta- Surendra Nagar-Ismailganj- sector 8- Polytechnique- Lohiya Park- 1090 Chauraha-Baluadda - Dainik Jagaran- Sikanderbagh-Jawahar Bhavan- Shakti Bhavan-GPO- Bapu Bhavan- Hussainganj-Vikasdeep-KKC-Charbagh.	04	21 minute interval
5	201	SGPGI Campus, SGPGI –Old Moyaia- Krishna viharcolony-Sardar Patel Dental College-Uttaria-Vindravan yajona-Awadth silpa Gram-Delhi Public school—Awadth Silpa Gram 2-CMS-Ahimamao-Criket stadium-DPS 2-Homeguard office—Hysadia- Gomti Nagar bus station-High court (Kamta).	03	28 minute interval
6	202	Industrial Area-Scooter India—Gouri vihar- Hindol colony-Sainik School-shanti nagar-Natherganj-Airport—bagia number- 3-Bagia Number-2-transport nagar- Auranga bad-Romabai Maidan-Shuvam south city-Uttaria-- Vindravan yajona-Awadth silpa Gram-Delhi Public school—Awadth Silpa Gram 2-CMS-Ahimamao-Criket stadium-DPS 2-Homeguard office—Husadia- Gomti Nagar bus station-High court (Kamta).	26	05 minute interval

7	301	Engineering College-Sector Q-Beligaradh-PNT-Purania- Regional Science Centre-Kapporthala-Channilal-Mahanagar-Gole Market-Badshanagar-Nishaganj-Paper Mill-Gokhale marg-Sikandarbagh-Jawahar Bhavan- Shakti Bhavan-GPO- Bapu Bhavan-Burlington-Hussainganj-Vikasdeep-KKC- Charbagh- Mawaiya-PS Alambagh-Tedhipuliya- Bus Station-Alambagh Chauraha- Ramnagar- Puran Nagar- Sringarnagar- Awadh Hospital-Krishna Nagar- Transport Nagar- Nadarganj-Scooter India.	06	06 minute interval
8	302	Engineering College-Sector Q-Beligaradh-PNT-Purania- Regional Science Centre-Kapporthala-Channilal-Mahanagar-Gole Market-Badshanagar-Nishaganj-Paper Mill-Gokhale marg-Sikandarbagh-Jawahar Bhavan- Shakti Bhavan-GPO- Bapu Bhavan-Burlington-Hussainganj-Vikasdeep-KKC- Charbagh- Mawaiya-PS Alambagh-Tedhipuliya- Bus Station-Anand Nagar-Banglapur-Shiv Mandir-Telibagh- Uthretia- South City- PGI.	04	26 minute interval
9	402	P.S. Gudamba-Vikas nagar-Nishatganj-paper mill-Ghole Marg--Sikandarbagh- Jawahar Bhavan- Shakti Bhavan-GPO- Bapu Bhavan-Burlington- Hussainganj-Vikasdeep-KKC- Charbagh.-Mayaiba-Awadth hospital – PS Alambagh-Teri phulia-Bus stand-Ajanta- Alambagh chowraha-Ram nagar-Puran nagar-Singar Nagar-Awadh hospital-L.D.A. colony-Paskila chowraha-Rajanikhand.	10	11 minute interval
		Total	**78**	

Source: Lucknow City Transport Services Limited.

Table 3 : Fuel Outlets in Lucknow City

S.No.	Agency	Number of outlets as on 31st March 2020
1	Indian Oil Corporation (IOC)	45
2	Bharat Petroleum Corporation Ltd. (BPCL)	24
3	Hindustan Petroleum Corporation Ltd. (HPCL)	28
4	Compressed Natural Gas Stations (CNG)*	9
Total		**106**

Source: Indian Oil Corporation (IOC), Lucknow, Bharat Petroleum Corporation (BPCL), Lucknow, Hindustan Petroleum Corporation (HPCL), Lucknow

** CNG Source: Green Gas Limited, Lucknow.*

Table 4 : Consumption of Fuel in Lucknow

S. No.	Agency	Petrol in kL			High Speed Diesel in kL			CNG in kg		
		Apr. 18 to Mar. 19	Apr. 19 to Mar. 20	% Change	Apr. 18 to Mar. 19	Apr. 19 to Mar. 20	% Change	Apr. 18 to Mar. 19	Apr. 19 to Mar. 20	% Change
1	IOC	105486	102941	-2.41	86173	79421	-7.84	--	--	--
2	BPCL	63144	62793	-0.56	63457	49800	-21.52	--	--	--
3	HPCL	56848	66649	17.24	70284	84094	19.65	--	--	--
4	Green Gas	--		--	--		--	47044857	**42359025**	**-9.96**
Total		**225478**	**232383**	**3.06**	**219914**	**213315**	**-3.00**	**47044857**	**42359025**	**-9.96**

Source: Indian Oil Corporation (IOC), Lucknow, Bharat Petroleum Corporation (BPCL), Lucknow, Hindustan Petroleum Corporation (HPCL), Lucknow
CNG Source: Green Gas Limited, Lucknow.

Table 5 : Distribution of CNG Vehicles

S. No.	Vehicles	Number		% Change
		2018-19	2019-20	
1	Auto Rickshaws	4343	4343	--
2	Tempo Taxi	2575	2575	--
3	Buses (UPSRTC)	260	260	--
4	Buses (Private)	40	40	--
5	School Buses	1253	1557	24.26
6	School Van	1946	2231	14.65
7	Private Vehicles	205	472	130.24
8	Private Cars	11885	21168	78.11
	Total	**22,507**	**32,646**	**45.05**

Source: RTO, Lucknow

1.2 MONITORING LOCATIONS AND METHODOLOGY

Nine air quality monitoring locations representing different activities/areas i.e., four in residential, four in commercial cum traffic and one industrial area were selected for the study as summarized in Table 6. & Fig.1 and the parameters along with methodologies are given in Table 7.

Table 6 : Air and Noise Monitoring Locations

SI.No.	Locations	Activities
1	Aliganj	Residential
2	Vikas Nagar	Residential
3	Indira Nagar	Residential
4	Gomti Nagar	Residential
5	Charbagh	Commercial cum traffic
6	Alambagh	Commercial cum traffic
7	Aminabad	Commercial cum traffic
8	Chowk (King George's Medical University campus)	Commercial (sensitive zone)
9	Amausi	Industrial

Table 7 : Parameters and Methodologies followed for Air Quality Monitoring

S. No.	Parameters	Time weighted average	Methods of Measurement
1	Particulate Matter (PM_{10})	24 hours	Gravimetric
2	Fine Particulate ($PM_{2.5}$)	24 hours	Gravimetric
3	Sulphur dioxide (SO_2)	24 hours	Improved West and Gaeke
4	Nitrogen Dioxide (NO_2)	24 hours	Modified Jacob & Hochhesier (Na-Arsenite)
5	Trace Metals (Pb, Ni)	24 hours	AAS method after sampling on EPM 2000
6	Noise Level	1 hour	The measurement of noise level was carried out during the day (6 AM to 10 PM) and night time (10 PM to 6 AM) by Noise Level Meter

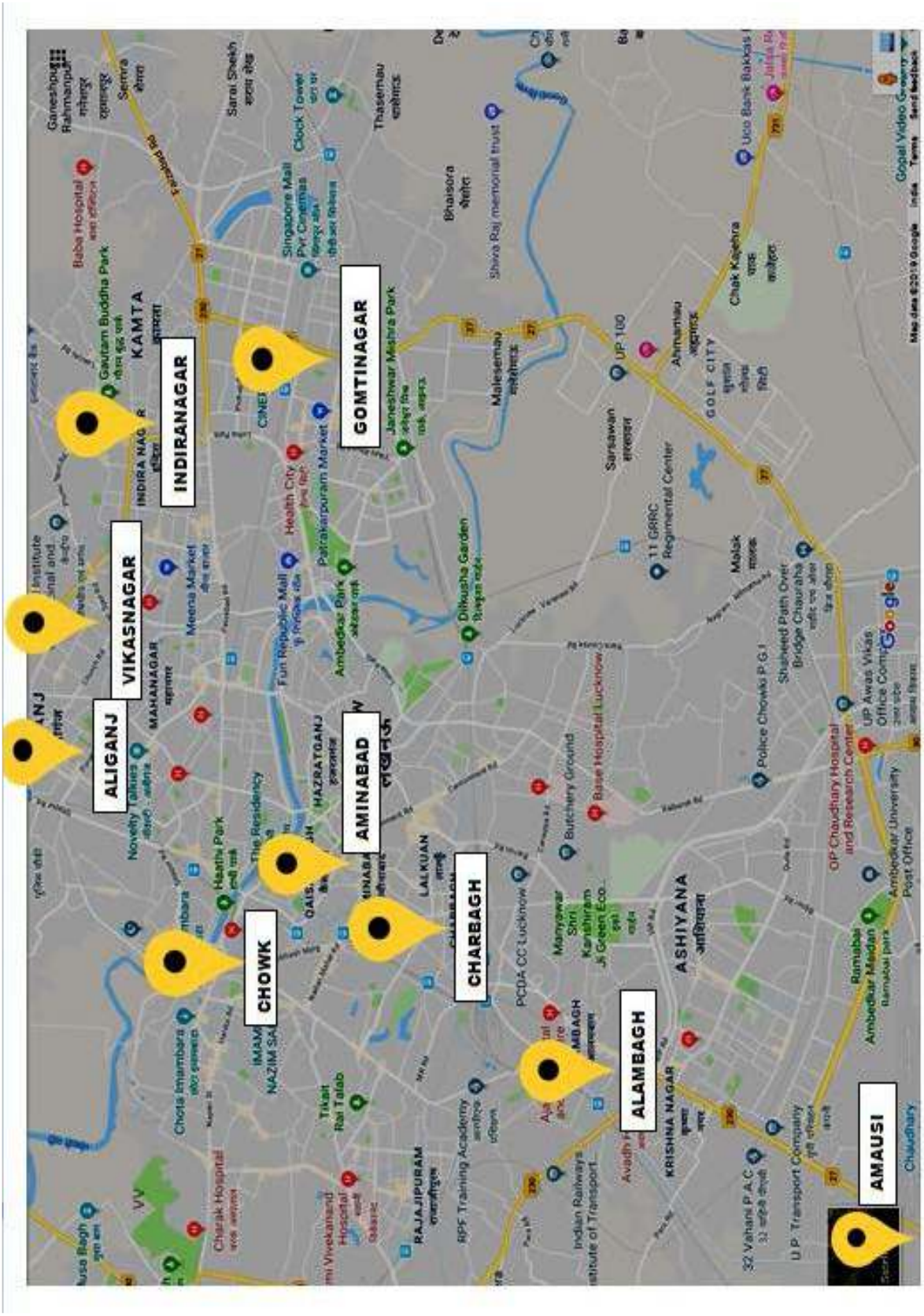


Figure 1: Ambient Air Pollution Monitoring Locations of Lucknow City

1.3 RESULTS

The detailed results of air quality monitoring are presented in Table 8 and Fig. 2.

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

In residential areas (Aliganj, Vikas Nagar, Indira Nagar and Gomti Nagar), the 24 hours average concentrations of PM_{10} were in the range of 91.4 to 118.0 µg/m^3 with an average of 103.0 µg/m^3. In commercial areas (Charbagh, Alambagh, Aminabad and Chowk) the average concentrations of PM_{10} were in the range of 102.9 to122.1 µg/m^3 with an average of 111.5 µg/m^3 respectively. At Amausi industrial area, the average concentration of PM_{10} was 130.0 µg/m^3.

The maximum 24 hours mean concentration of PM_{10} was 118.0 µg/m^3 and 122.1 µg/m^3 at residential area (Vikas Nagar) and at commercial area (Alambagh) respectively. However, at 8 locations out of 9, the mean values of PM_{10}were found to exceed the prescribed National Ambient Air Quality Standard (NAAQS) of 100 µg/m^3 for industrial, residential, rural and other areas.

1.3.2 Fine Particulate Matter ($PM_{2.5}$)

In residential areas (Aliganj, Vikas Nagar, Indira Nagar and Gomti Nagar), the 24 hours average concentrations of $PM_{2.5}$ were in the range of 49.5 to 67.8 µg/m^3 with an average of 59.2 µg/m^3. In commercial areas (Charbagh, Alambagh, Aminabad and Chowk); the average concentrations of $PM_{2.5}$ were in the range of 53.7 to 71.3 µg/m^3 with an average of 63.6 µg/m^3 respectively. At Amausi industrial area, the average concentration of $PM_{2.5}$ was 90.6 µg/m^3.

The maximum 24 hours mean concentration of $PM_{2.5}$ was observed in Aliganj (67.8 µg/m^3) among residential areas and at Charbagh (71.3 µg/m^3) among commercial areas. Over all at all the locations mean values of $PM_{2.5}$ were above the prescribed National Ambient Air Quality Standard (NAAQS) of 60 µg/m^3 for industrial, residential, rural and other areas.

1.3.3 Sulphur dioxide (SO_2)

In residential areas (Aliganj, Vikas Nagar, Indira Nagar and Gomti Nagar), the mean levels of SO_2 were in the range of 11.4 to 12.6 µg/m^3 with an average of 12.0 µg/m^3. In commercial areas (Charbagh, Alambagh, Aminabad and Chowk), the average concentrations of SO_2 were in the range of 13.0 to 15.5 µg/m^3 with an average of 14.1 µg/m^3. At Amausi industrial area, the average concentration of SO_2 was 13.8 µg/m^3. All the values of SO_2 were well below the prescribed NAAQS of 80 µg/m^3 for all the locations.

1.3.4 Nitrogen dioxide (NO_2)

In residential areas (Aliganj, Vikas Nagar, Indira Nagar and Gomti Nagar), the 24 hours average of NO_2 were in the range of 30.7 to 34.3 µg/m^3 with an average of 32.5 µg/m^3. In commercial areas (Charbagh, Alambagh, Aminabad and Chowk), the average of NO_2 were in the range of 26.1 to 43.8 µg/m^3 with an average of 38.0 µg/m^3. At Amausi industrial area, the average concentration of NO_2 was 31.8 µg/m^3. All the mean values of NO_2 were within the prescribed NAAQS of 80 µg/m^3 for all the monitoring locations.

Table 8 : Concentration of PM_{10}, $PM_{2.5}$, SO_2 and NO_2 during, Pre-Monsoon, 2020 (Complete Lockdown 25.03.2020 to 31.05.2020) and Post-Monsoon 2020

Locations	PM_{10} (RSPM)			$PM_{2.5}$			SO_2			NO_2		
Residential Area												
	Pre-monsoon 2020	**Post-monsoon 2020**	Change (%)	**Pre-monsoon 2020**	**Post-monsoon 2020**	Change (%)	**Pre-monsoon 2020**	**Post-monsoon 2020**	Change (%)	**Pre-monsoon 2020**	**Post-monsoon 2020**	Change (%)
Aliganj	98.5	101.4	2.94	65.5	67.8	3.51	5.5	12.6	129.09	27.4	32.9	20.07
Vikas Nagar	112.0	118.0	5.36	65.0	63.9	-1.69	5.6	11.4	103.57	23.9	30.7	28.45
Indira Nagar	94.7	91.4	-3.48	41.9	49.5	18.14	6.5	12.2	87.69	21.9	31.9	45.66
Gomti Nagar	90.1	101.2	12.32	52.8	55.5	5.11	5.9	11.8	100.00	32.8	34.3	4.57
Commercial Area												
Charbagh	77.0	102.9	33.64	43.6	71.3	63.53	7.0	15.5	121.42	20.5	43.8	113.66
Alambagh	112.8	122.1	8.24	59.6	61.0	2.35	6.0	14.3	138.33	28.5	39.9	40.00
Aminabad	*NM	104.1	.....	*NM	53.7	.....	*NM	13.6	....	*NM	42.3	....
Chowk	*NM	116.7	.....	*NM	68.3	.....	*NM	13.0	....	*NM	26.1	....
Industrial Area												
Amausi	120.2	130.0	8.15	59.0	90.6	53.56	7.0	13.8	97.14	27.7	31.8	14.80
Min.	77.0	91.4		41.9	49.5		5.5	11.4	---	20.5	26.1	
Max.	120.2	130.0		65.5	90.6		7.0	15.5	---	32.8	43.8	
Mean	100.75	109.75	9.59	55.34	64.62	20.64	6.21	13.10	111.03	26.10	34.85	38.17
NAAQS	100			60			80			80		
WHO Standard	50			25			20			40*		

N=9, *= Annual average, NAAQS=National Ambient Air Quality Standard
NM=Not Monitored due to lockdown restrictions

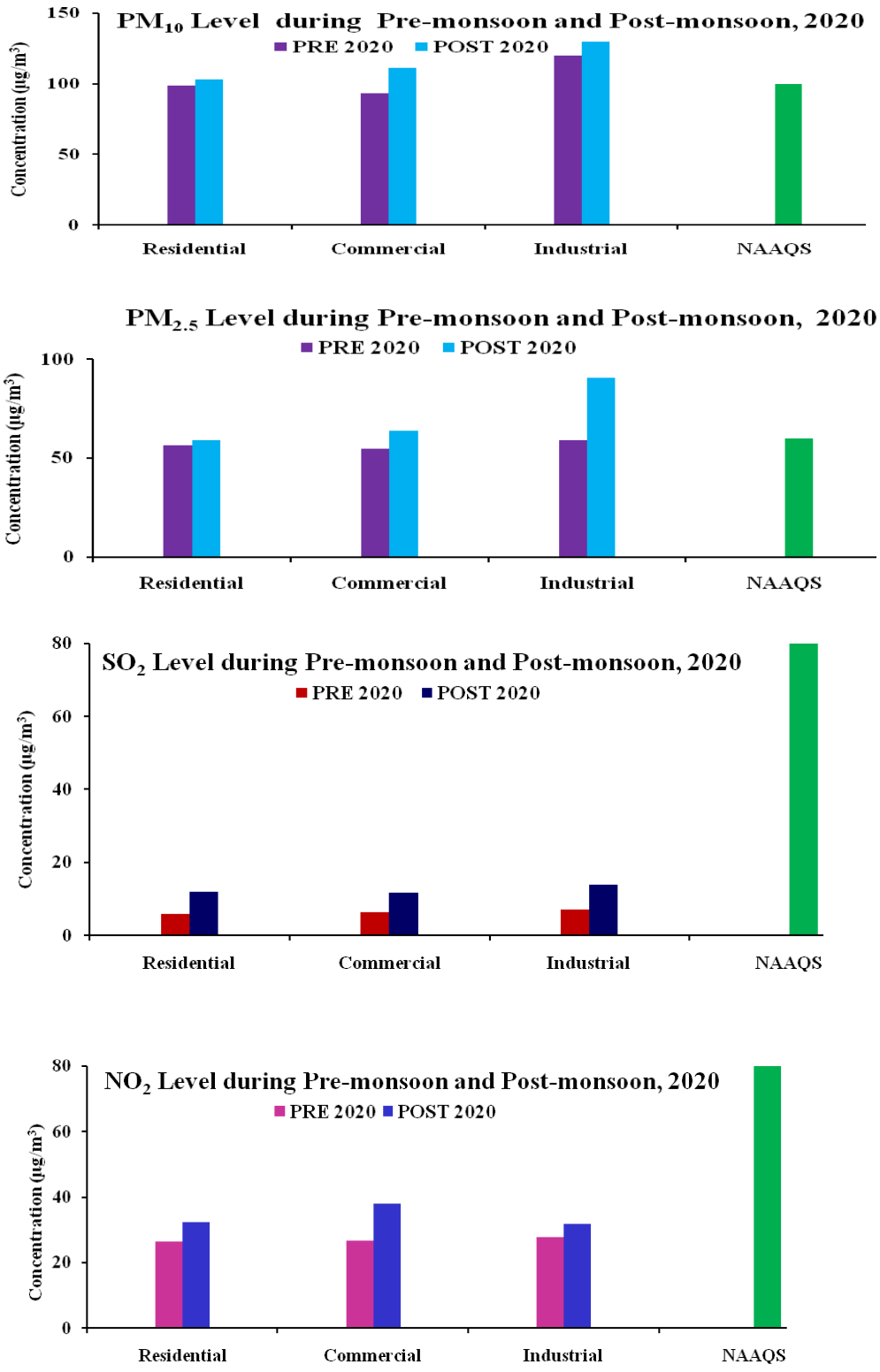


Figure 2: The concentrations of PM_{10}, $PM_{2.5}$, SO_2 and NO_2 of Lucknow city during Pre-monsoon 2020 & Post-monsoon 2020 and their Comparison with prescribed National Ambient Air Quality Standard (NAAQS)

1.3.5 Heavy Metals in Ambient Air (PM_{10})

Heavy metals, lead and nickel associated with PM_{10} particulates were estimated at 9 monitoring locations. The analyses results are presented in Table 9. The Ni concentration during 24 hr sampling ranged from 2.99 to 21.82 ng/m^3 with an average of 8.45 ng/m^3 whereas the Pb concentration ranged from 6.22 to 28.0 ng/m^3 with an average of 6.16 ng/m^3 .

Table 9 : Lead and Nickel Concentration associated with PM_{10}

Sl. No.	Location	Lead (Pb)*	Nickel (Ni)**
		ng/m^3	
1	Aliganj	8.37	4.33
2	Vikas Nagar	19.51	6.26
3	Indira Nagar	21.69	16.65
4	Gomti Nagar	12.87	3.18
5	Charbagh	7.15	2.99
6	Alambagh	28.0	6.87
7	Aminabad	14.40	21.82
8	Chowk	27.21	4.40
9	Amausi	6.22	9.57
	Mean	**16.16**	**8.45**
	NAAQS	**1000.0***	**20****

**Ni = Annual Average; *Pb =24 hrs Average

1.3.6 Noise Level

The noise monitoring data during the Post-monsoon period is presented in Table 10. In residential areas, the day and night time noise levels were between 64.8 to 72.8 dB(A) and 48.7 to 65.6 dB(A) respectively. All the values were higher than the prescribed limit of 55 dB(A) and 45 dB (A) for day and night time respectively.

In commercial and heavy traffic area, the day and night time noise levels were between 70.1 to 76.5 dB(A) and 70.7 to 74.7 dB(A) respectively. The Noise levels recorded during day and night time at all the commercial sites were above the prescribed respective limits of 65 dB(A) and 55 dB(A) respectively.

At Amausi industrial area, the noise levels during day and night time were 73.2 dB(A) and 69.0 dB (A) respectively. The noise levels recorded at the industrial location during day and night time were below the prescribed limits of 75.0 dB(A) and 70.0 dB(A) respectively.

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

Sl. No.	Area	Location	Noise level dB(A) Pre-monsoon 2020		Noise level dB(A) Post-monsoon 2020	
			Day	Night	Day	Night
1	**Residential**	Aliganj	62.0	44.5	72.8	65.6
		Vikas Nagar	58.6	43.8	64.8	65.5
		Indira Nagar	60.2	42.7	72.6	58.5
		Gomti Nagar	54.4	NM*	71.8	48.7
		Standard			**55.0**	**45.0**
2	**Commercial**	Charbagh	68.3	47.8	70.1	73.4
		Alambagh	60.1	NM*	76.2	71.6
		Aminabad	NM*	NM*	70.3	74.7
		Chowk	NM	NM*	76.5	70.7
		Standard			**65.0**	**55.0**
3	**Industrial**	Amausi	70.2	NM*	73.2	69.0
		Standard			**75.0**	**70.0**

*NM = Not Monitored due to lockdown restrictions

1.4 TRENDS OF AMBIENT AIR QUALITY DURING POST-MONSOON 2020 OF LUCKNOW

The observed PM_{10}, $PM_{2.5}$, SO_2, NO_2, Pb and Ni values have been compared with the last 3 years data to find out the prevailing trend of air pollution in Lucknow city (Fig.3-8).

1.4.1 Respirable Suspended Particulate Matter (PM_{10})

In all the residential, commercial and industrial areas, the PM_{10} levels of Post-monsoon 2020 were decreased as compared to the levels of Post-monsoon 2018 and Post-monsoon 2019. Further, the PM_{10} levels of Post-monsoon 2020 in all locations except Indira Nagar exceeded the NAAQS standards (Fig.3).

1.4.2 Fine Particulate Matter ($PM_{2.5}$)

In all the residential, commercial and industrial areas, the $PM_{2.5}$ levels of Post-monsoon 2020 were decreased as compared to the levels of Post-monsoon 2018 and Post-monsoon 2019. Further, the $PM_{2.5}$ levels of Post-monsoon 2020 in 6 locations out of 9 locations exceeded the NAAQS standards (Fig.4). In the other 3 locations (Indira Nagar, Gomti Nagar, Aminabad) the $PM_{2.5}$ levels were within the acceptable limits.

1.4.3 Sulphur dioxide (SO_2)

In all the residential, commercial and industrial areas; the SO_2 levels of Post-monsoon 2020 were found well below than the NAAQS. However, the SO_2 levels of Post-monsoon 2020 were relatively higher than the levels during Post-monsoon 2018 and Post-monsoon 2019 (Fig.5).

1.4.4 Nitrogen dioxide (NO_2)

In all the residential, commercial and industrial areas; the NO_2 levels of Post-monsoon 2020 were below the NAAQS. However, a distinct trend was not observed for NO_2 levels of Post-monsoon 2020 when compared with levels of Post-monsoon 2018 and Post-monsoon 2019 (Fig.6).

1.4.5 Lead and Nickel

In all the residential, commercial and industrial areas; the Lead and Nickel levels of post-monsoon 2020 were found below than the NAAQS. However, the lead levels of last 3 years data showed the decreasing trend (Fig.7). In case of nickel, there was no clear trend found among the years (Fig.8).

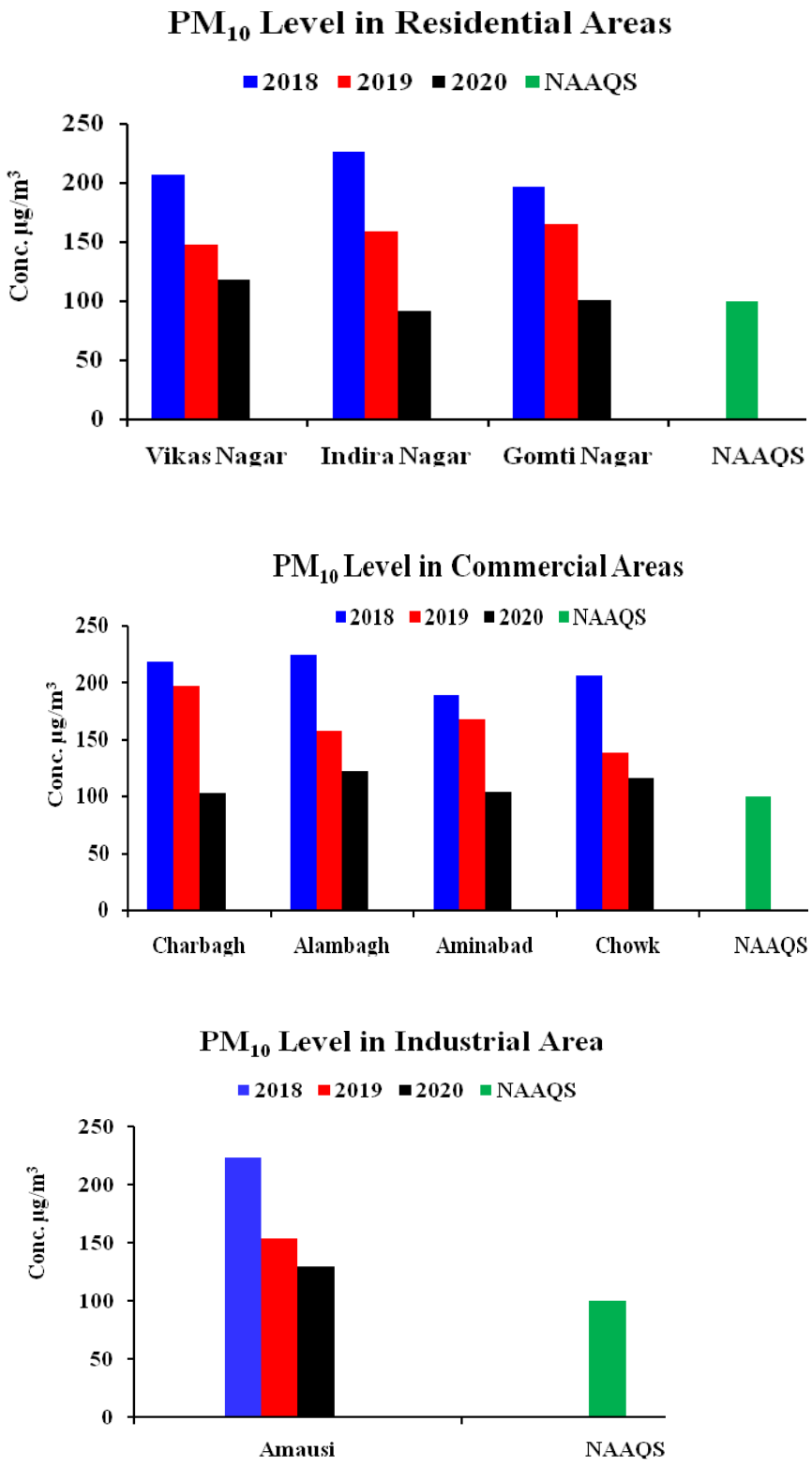


Figure 3: Concentration (µg/m^3) of PM_{10} (RSPM) in Residential, Commercial and Industrial areas of Lucknow city during Post-monsoon 2018, 2019 and 2020 and comparison with prescribed National Ambient Air Quality Standard (NAAQS)

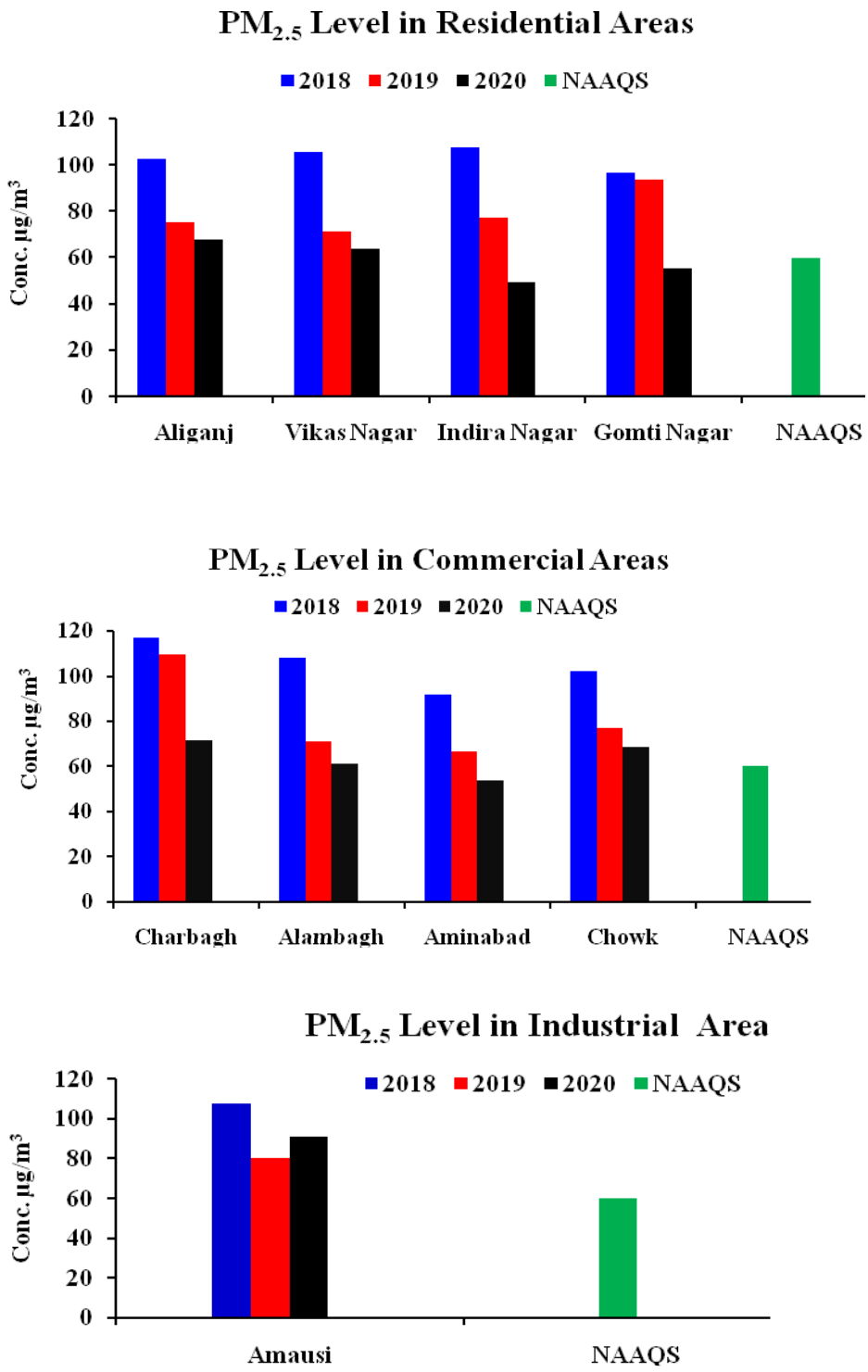


Figure 4: Concentration (µg/m^3) of $PM_{2.5}$ in Residential, Commercial and Industrial areas of Lucknow city during Post-monsoon 2018, 2019 and 2020 and comparison with prescribed National Ambient Air Quality Standard (NAAQS)

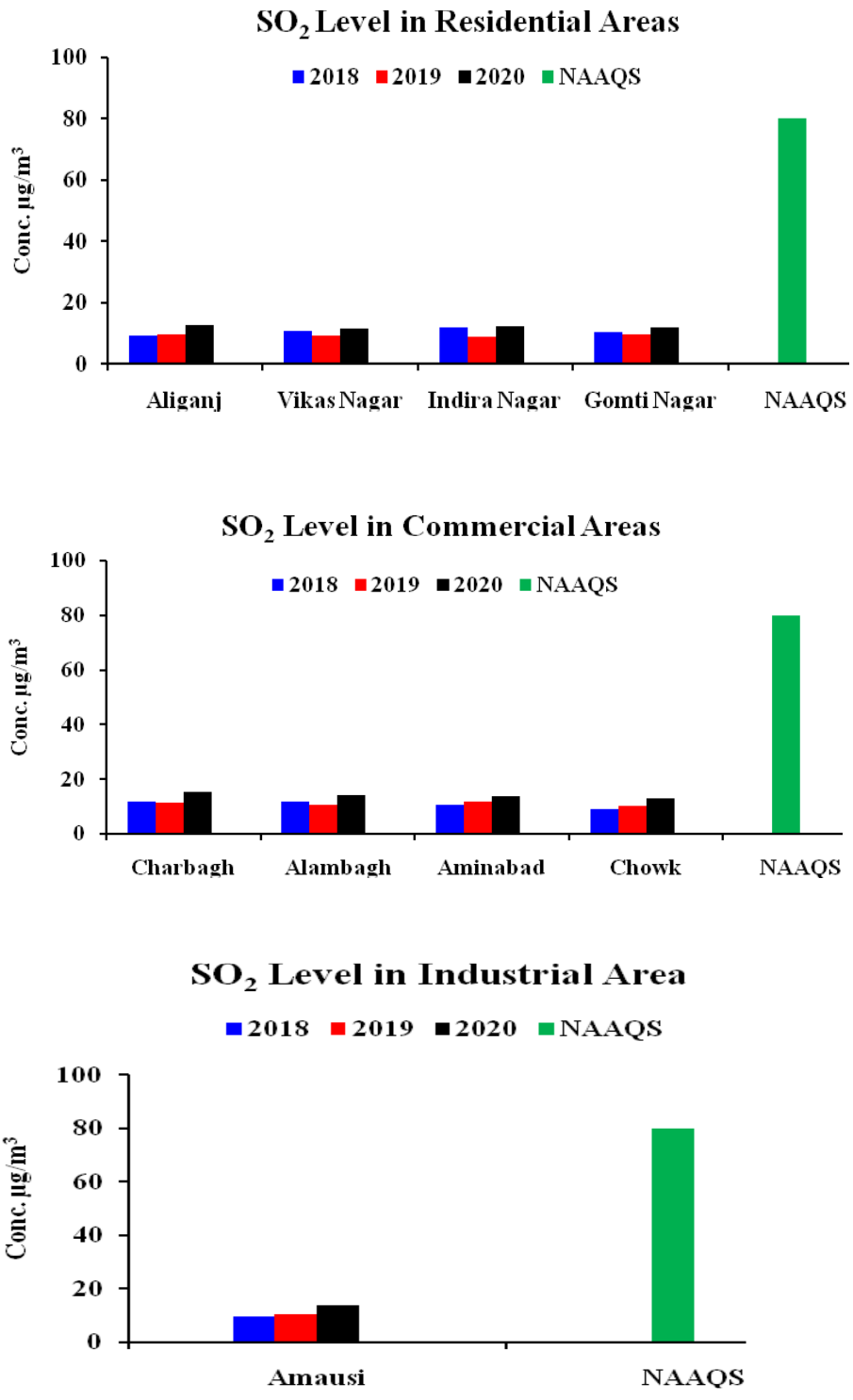


Figure 5: Concentration (µg/m^3) of SO_2 in Residential, Commercial and Industrial areas of Lucknow city during Post-monsoon 2018, 2019 and 2020 and comparison with prescribed National Ambient Air Quality Standard (NAAQS)

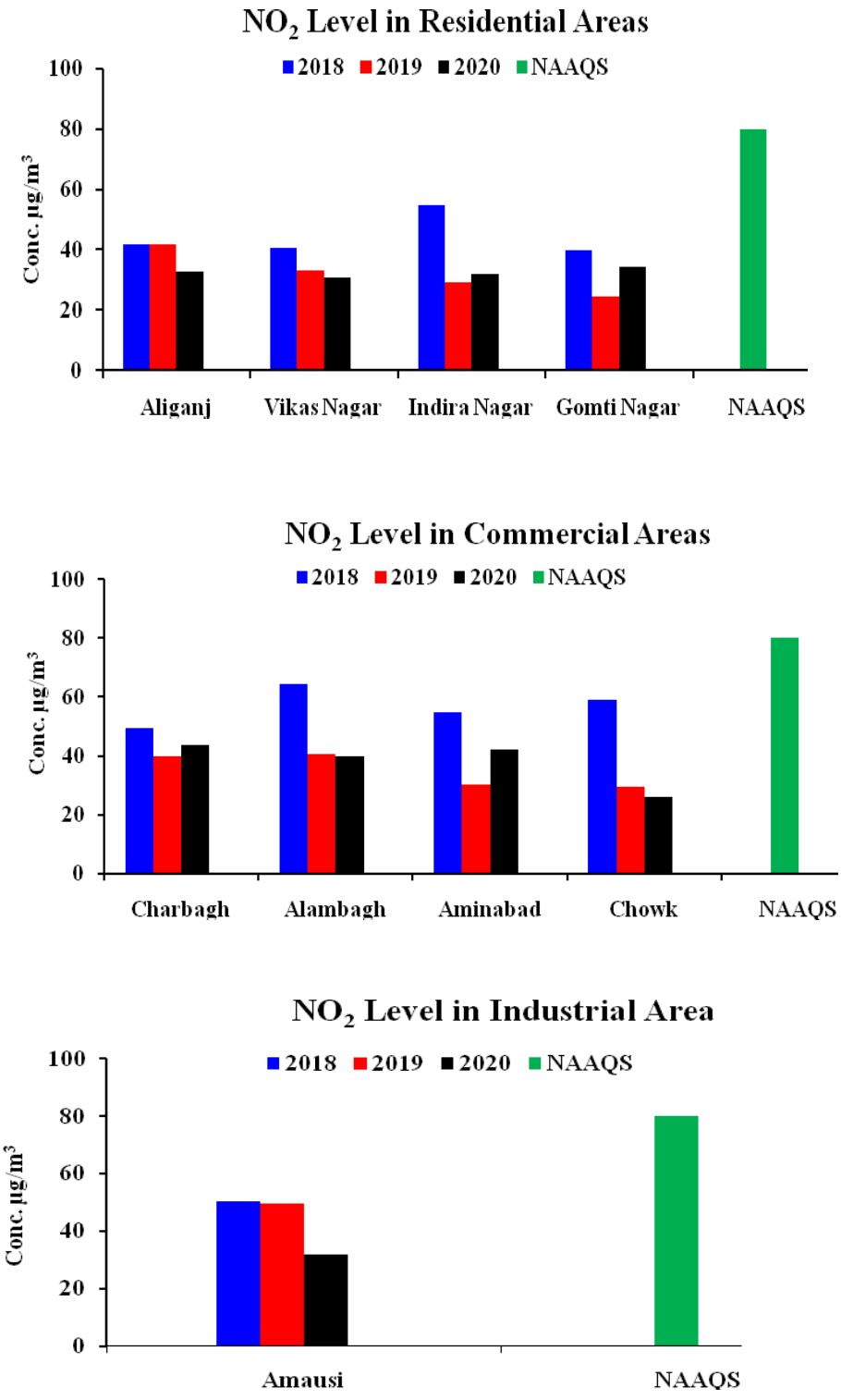


Figure 6: Concentration (µg/m^3) of NO_2 in Residential, Commercial and Industrial areas of Lucknow city during Post-monsoon 2018, 2019 and 2020 and comparison with prescribed National Ambient Air Quality Standard (NAAQS)

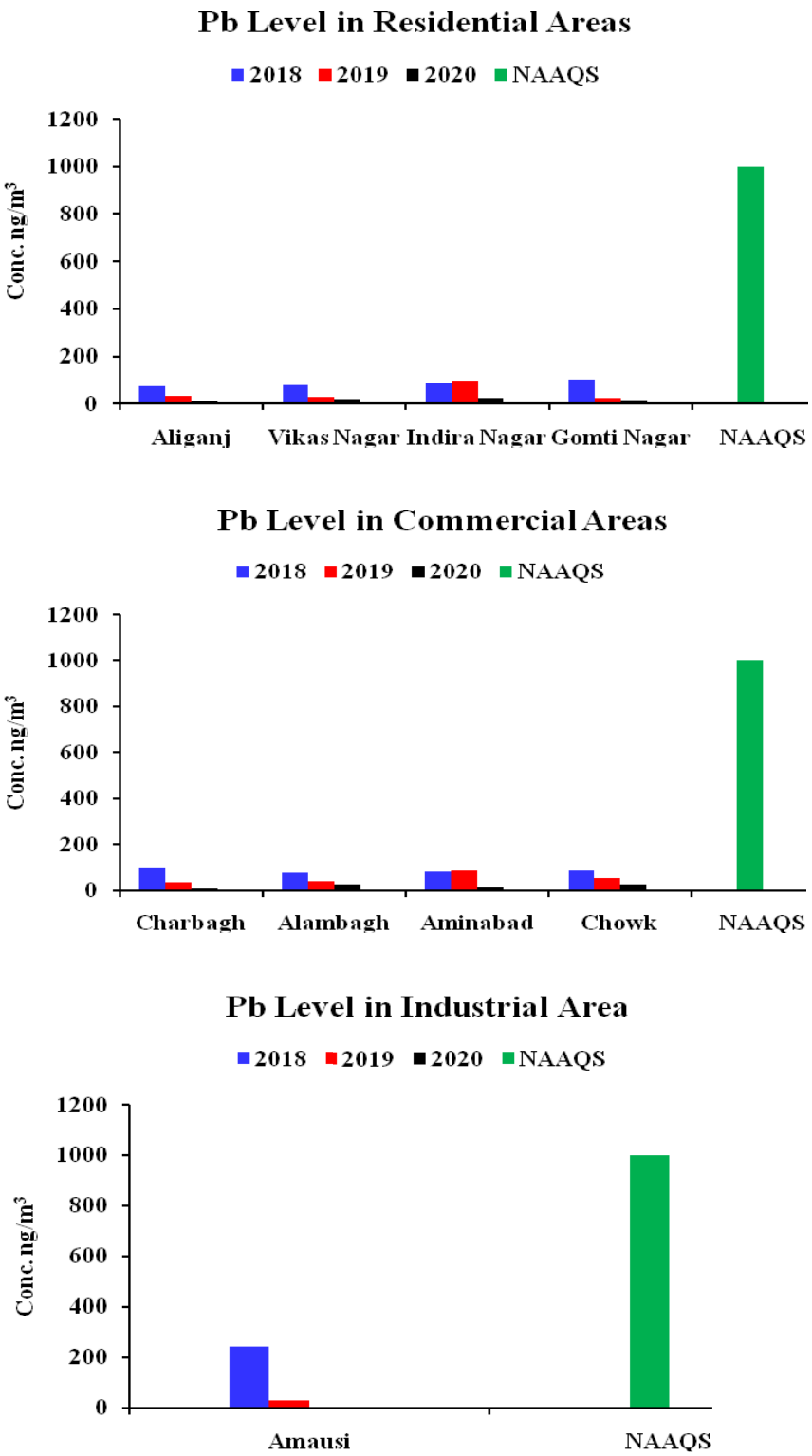
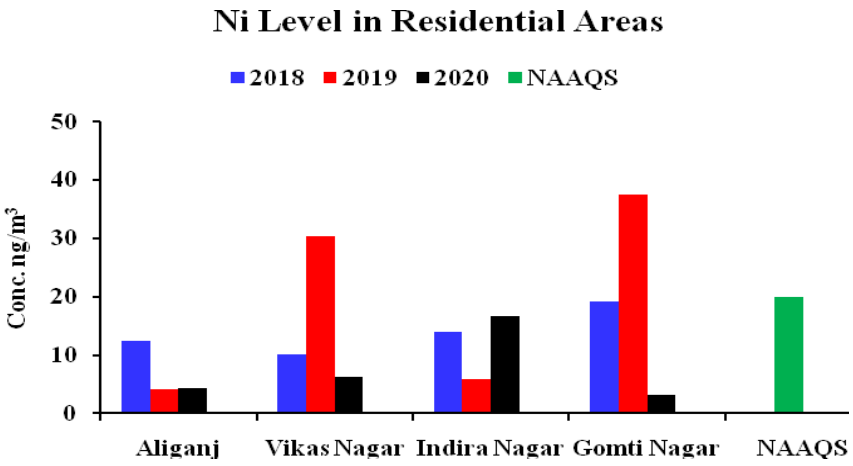
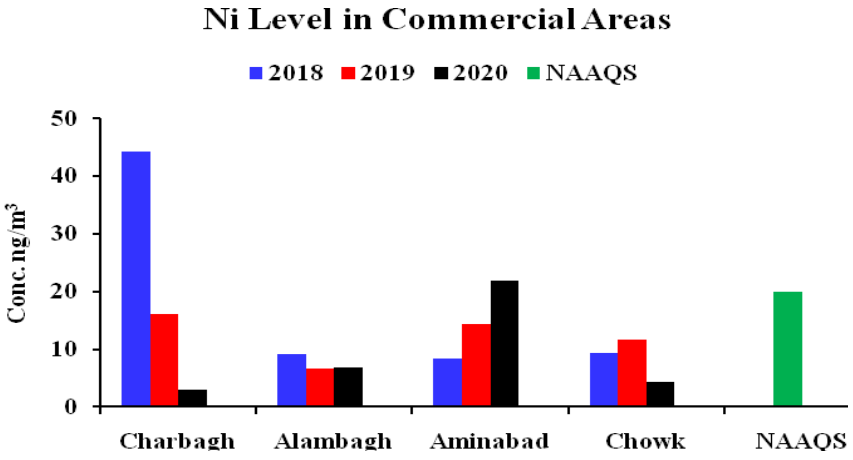


Figure 7: Concentration (μg/m^3) of Pb in Residential, Commercial and Industrial areas of Lucknow city during Post-monsoon 2018, 2019 and 2020 and comparison with prescribed National Ambient Air Quality Standard (NAAQS)





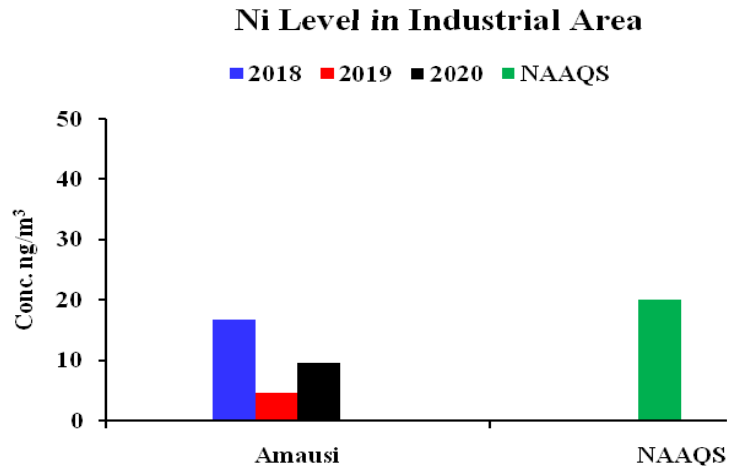


Figure 8: Concentration (µg/m^3) of Ni in Residential, Commercial and Industrial areas of Lucknow city during Post-monsoon 2018, 2019 and 2020 and comparison with prescribed National Ambient Air Quality Standard (NAAQS).

1.4.6 Noise Level

Noise levels of Post-monsoon 2020 have been compared with the corresponding noise levels of the previous three years and their comparisons are described below (Fig.9 & Fig.10).

1.4.6.1 Day time Noise Level

Among the residential areas, three locations showed a slightly increasing trend over the previous year whereas one location showed a decreasing trend. However, among the commercial cum traffic areas; the noise levels showed higher levels at two locations and lower levels at two other locations when compared with previous years. At Amausi industrial area, the noise data among the previous three years were relatively similar. The measured noise levels during the day time in all locations exceeded the prescribed standard except in industrial area (Fig.9).

1.4.6.2 Night time Noise Level

Among the residential areas, two locations showed a higher and two locations showed a lower value than the previous year. However, among the commercial cum traffic areas; the noise levels were higher at all the four locations when compared with previous years. At Amausi industrial area, the comparison of noise data among the previous three year does not shown any clear cut trend. The measured noise levels during the night time in all locations exceeded the prescribed standard except in industrial area (Fig.10).

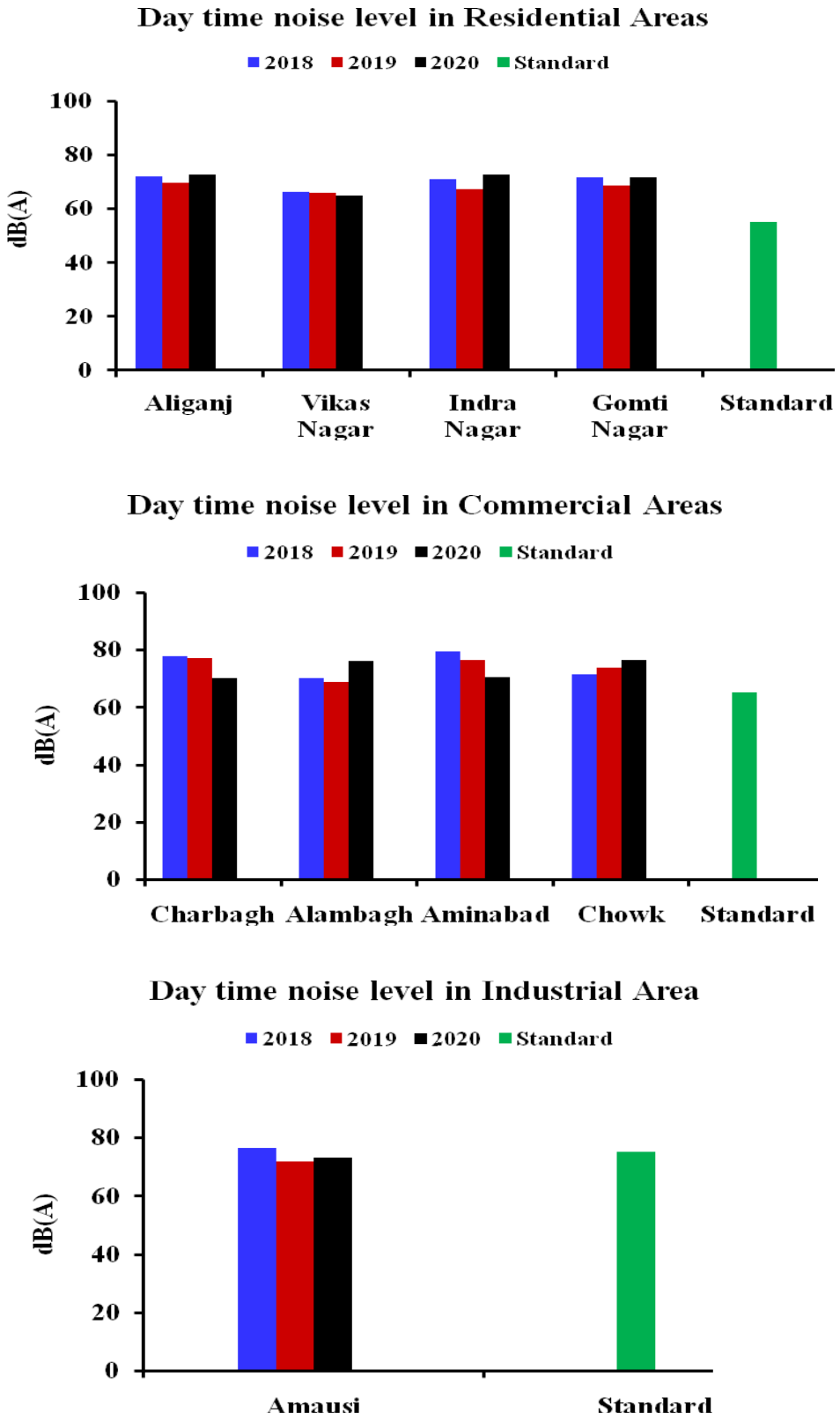


Figure 9: Comparison of day time Noise Level dB (A) in different areas of Lucknow city (Post-monsoon 2018, 2019 and 2020)

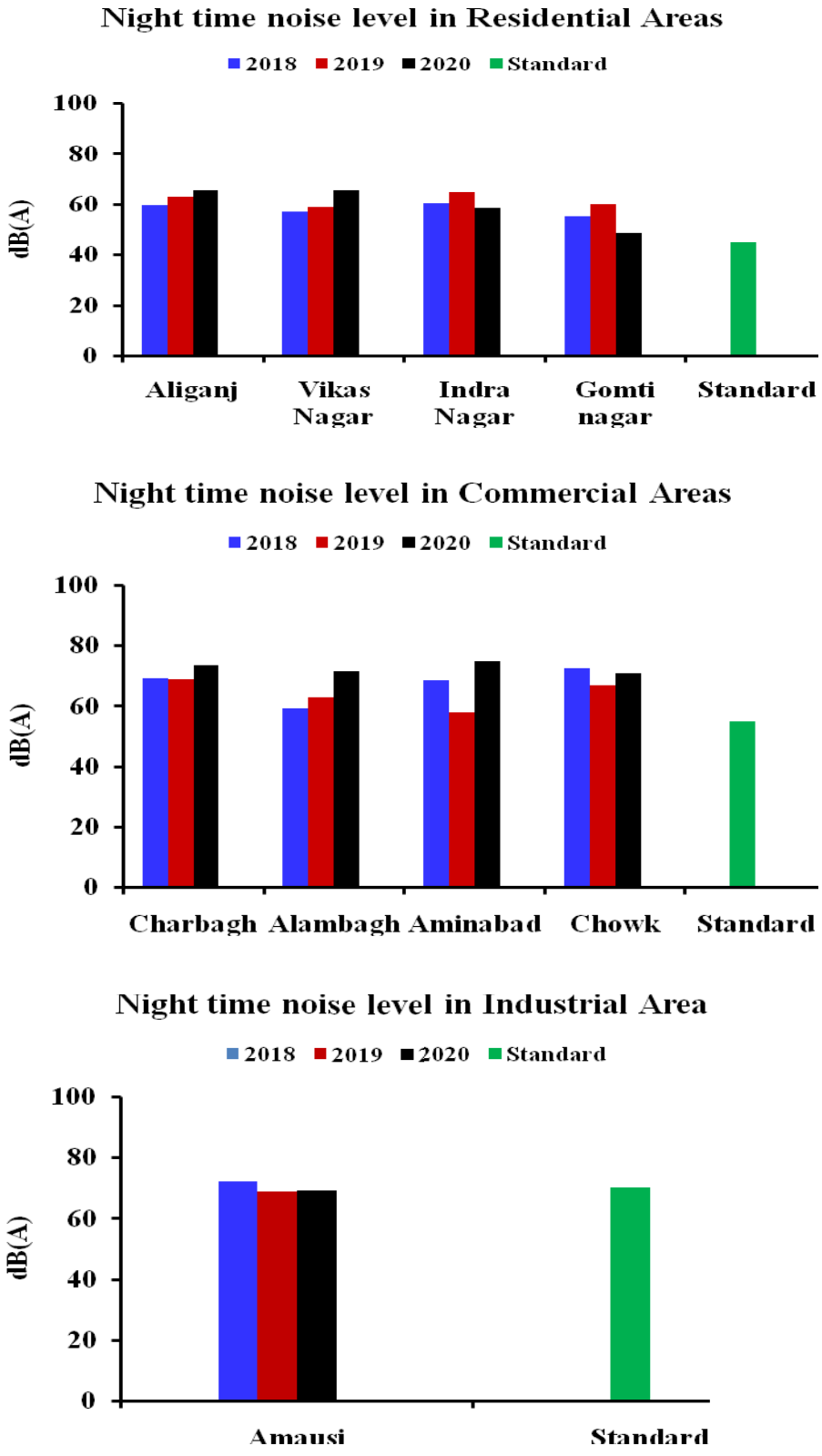


Figure 10: Comparison of night time Noise Level dB (A) in different areas of Lucknow city (Post-monsoon 2018, 2019 and 2020)

1.5 HEALTH EFFECTS

The continuous emission of a variety of pollutants from hundreds of point and non-point fugitive sources; which are either unidentified & unqualified or considered to be a minor source are constantly deteriorating urban air quality and adversely affecting human health.

Earlier, the air quality was categorized as Poor air quality (201-300 µg/m^3), Very poor air quality (301-400 µg/m^3) and Severe air quality (>400 µg/m^3). At present, Air Quality Index (AQI) has been developed and the respective colour coding (viz. **Green** for good AQI, **Red** for bad AQI and **Orange** for mild/moderately polluted AQI) being used by CPCB to communicate easily with public.

The higher levels of air pollutants containing metals (cadmium, nickel, lead) and metalloid (arsenic) have adverse effects on human and environmental health. Air pollution creates a series of significant health problems including (i) premature death (ii) aggravated asthma (iii) acute respiratory symptoms and (iv) decreased lung function in the form of shortness of breath and chronic bronchitis etc.

Particulates are also a major cause of visibility impairment enhancing coefficient of haze in many Asian countries and the United States because these particulates can scatter and absorb light thereby hampering the energy/heat balance of earth surface and atmosphere. Further, these fine particulates remain suspended in air and can be carried away by wind to long distances across regional and international borders without sinking and gravity settling. Many epidemiological studies established the fact that an increase of particulate concentration is directly associated with mortality and hospitalization for respiratory and cardio vascular diseases and increase of respiratory symptoms and decrease of lung functions.

There are several published research reports suggesting that the gaseous pollutants are related to respiratory diseases and reproductive and developmental effect even at low concentrations.

Sulphur dioxide (SO_2) is a colorless water-soluble gas and smells like burnt matches. It can be oxidized to sulphur trioxide, which in the presence of water vapor is readily transformed to sulphuric acid mist.

Nitrogen dioxide (NO_2) 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. NO_2 can have both acute and chronic effects on health, particularly in people with asthma. NO_2 causes inflammation of the airways. Vehicular traffic and NO_2 are associated significantly higher risk of lung cancer.

The higher levels of noise have adverse health effects varying from hearing loss to annoyance. However, annoyance and psychological damages occur at much lower noise levels.

It is a known fact that air borne particles (PM_{10} and $PM_{2.5}$) at high concentration increase the mortality and morbidity in the exposed people. The exact mechanism of particulate matter toxicity is yet to be understood clearly. The degree of effectiveness depends on the physico-chemical properties of the particulate matters which depend largely on the level of associated metal oxides, constituents of inorganic/organic chemicals/ pollutants as well as the other bio-aerosols (bacteria, virus and pollen). Overall, the effects/toxicity depends on the cumulative or synergistic effects of physico-chemical properties of particulate matters, meteorological condition and other environmental circumstances including receptor conditions. Though, the inorganic Pb and Ni components may constitute a small fraction by mass of the particulates but they may have profound health effects. The high level of Pb can induce severe neurological and hematological problems in the exposed population especially children and young one. The details of health effects of individual pollutant are described in sub-heading 1.5.1.

1.5.1 Health Effects of Particulate Matters (PM_{10} and $PM_{2.5}$)

When we inhale a gas mixture with particles of a diameter ≤ 10 μm and fine particles of a diameter ≤ 2.5 μm it causes severe health impairment. These particles can penetrate beyond the larynx and deposit in the lungs and have a lesser chance to come out with spit or cough.

- ❖ Small particles penetrate deep into the lungs 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 lungs and to the alveolar sacs where gaseous exchange occurs.
- ❖ Further, these tiny 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 Health Effects of Sulfur dioxide (SO_2)

A higher concentration 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 is particularly likely to occur in people suffering from asthma and chronic lung disease, whose airways are often inflamed and easily irritated.
- ❖ Oral inhalation of large volumes may reach the segmental bronchi and damage the organ and exposure of the eyes (eg. in an industrial accident) can cause severe burns and result 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 Health Effects of Oxides of Nitrogen (NO_2)

Oxides of Nitrogen (NO_x) causes a wide variety of health and environmental impacts because of various compounds and derivatives of nitrogen oxides, including nitrogen dioxide, nitric acid, nitrous oxide, nitrates, and nitric oxide.

NO_x is associated with mortality and a range of morbidity conditions.

- NO_2 can be used as a marker of traffic proximity and a convenient metric for modeling the health impact of traffic pollution and evaluating abatement policies.
- Long term exposure to NO_2 may affect lung function and lower 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 oedema, diffuse lung injury and development of acute or chronic bronchitis. Industrial exposures 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.

Although, the observed concentration of SO_2 and NO_2 are well below the permissible limit of 80 $\mu g/m^3$, yet we can't rule out the adverse effects of gases at various stages of life (infant-baby-children-adult-old age) or a patient suffering from various ailments as low dose of toxic gases may not be a life risk to adults but it may be life threatening to younger or older ones.

1.5.4 Health Effects of Lead and Nickel

1.5.4.1 Lead (Pb)

- Lead is a neurotoxin and may cause impairment of neural development in children and affect development of brain in the fetus.
- Cognitive and neuro-behavioural deficits are exhibited among children at low levels of exposure.
- Mortality of workers exposed to high level of lead is increasing.
- Decreased nerve conduction velocity, cognitive development, hearing loss, jaundice, anaemia in children is also some of the effects.

1.5.4.2 Nickel (Ni)

- The harmful human health effect of nickel include allergic reactions, chronic bronchitis, reduced lung function, lung cancer and nasal sinus cancer
- Animal studies have found increased deaths of new-born and also decrease in weight of new-born after ingesting nickel.

1.5.5 Health Effects of Noise Pollution

The elevated Noise levels of ambient air may have adverse health effects.

- The higher noise can induce both temporary and permanent hearing loss.
- It can range from the bursting of the eardrum to permanent hearing loss, cardio vascular changes, stress, fatigue, dizziness and lack of concentration.
- Continuous noise causes an increase of blood cholesterol resulting in constriction of the blood vessels making one prone to heart attack and stress.

1.6 CONCLUSIONS

Air pollutants such as PM_{10}, $PM_{2.5}$, SO_2, NO_2, lead and nickel as well as day & night noise level were monitored during Post-monsoon, 2020 in order to assess the ambient air quality at 9 locations of Lucknow city and the findings are as follows:

- The inhalable fine particulates (PM_{10} and $PM_{2.5}$) levels at most of the monitoring locations (residential, commercial and industrial areas) were found to be higher than the National Ambient Air Quality Standards (NAAQS).

- The post-monsoon 2020 PM_{10} concentration has increased by 9.6 % w.r.t. Pre-monsoon 2020 (lockdown period) while the Post-monsoon 2020 $PM_{2.5}$ concentration has increased by 20.6% w.r.t. Pre-monsoon 2020 (lockdown period).

- The concentration of gaseous pollutant, SO_2 and NO_2 was well below the prescribed NAAQS (80 $\mu g/m^3$) at all the locations. However, the Post-monsoon 2020 gaseous pollutant concentrations of were higher at all the locations w.r.t. Pre-monsoon 2020 (lockdown period). The average values of SO_2 and NO_2 has increased by 111.0 % and 38.2 %.

- The day and night time noise levels exceeded the prescribed national standards at all the locations. However, the noise levels of Post-monsoon 2020 were found increased marginally at all the locations w.r.t. Pre-monsoon 2020 (lockdown period).

The present study revealed that the levels of pollutants like inhalable particulate matter, gases, and noise are gradually increasing with relaxation of lockdown and progress of time. The o*verall trend reveals that all the pollutants are increasing in Lucknow city.*

1.7 RECOMMENDATIONS FOR MITIGATION OF AIR POLLUTION

1. Construction and demolition activities should be planned with dust obstacles as well as following the construction and demolition waste management rule.
2. Retrofitting of particulate matter filter should be encouraged in vehicles and the usage of BS VI vehicle models should be enforced.
3. Wrong side parking or blocking of roads should not be allowed.
4. Water spraying operation during dry weather conditions to be maintained in city main roads for dust entrainment.
5. All active city roads should be maintained clean by frequent water sprinkling/ sweeping operations.
6. Subsidized public transport systems such as metro-rail & buses should be promoted and public awareness to utilize the subsidy and reduce the private vehicle emissions should be created.
7. Improvement of road condition / congested crossings and advanced traffic management system for smooth traffic flow needs to be undertaken.
8. All transportation goods/HCV/LCV should be covered properly before entering highways.
9. Engines should be switched off at major traffic points.
10. CNG based vehicle and electrical/ battery operated or hybrid vehicle use to be encouraged.
11. Solid-waste dump yards should be shifted from road sides and solid waste must be disposed off in completely covered conditions.
12. Burning of waste and trash should be banned.
13. CNG filling stations across the city should be increased.
14. The usage of Green crackers during Diwali festival should be promoted.
15. Pressure horns to be removed from vehicles and minimal usage of horns be promoted.
16. Public awareness programme to be organized about air pollution and its health effects, reduction of automobile emission by proper maintenance of vehicles, driving skills.
17. Heavy dust removal system at major traffic points needs to be which may be operated during peak hours.

Every year, State Government Authority/district administration may organize a short duration (1/2 days) seminar inviting agencies viz. UPPCB, zonal office of CPCB, CPWD, research organizations, universities, engineering institutes, social workers, regulatory bodies, city planners, NGOs, general public for their valuable input/ ideas and recommendations through debate & discussion about the causes and effects of air pollution and preventive control measures which are to be adopted in the forum itself. Again, the next year, the same forum should evaluate the previous work done and formulate new programmes towards curbing pollution. This type of continued long term approaches will be helpful to stake holders of city for management of air pollution.

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- Computational Toxicology

R&D Partnership for Industries & Startup

- Centre for Innovation and Translational Research (CITAR)

Technologies Developed/ Available

- Oneer- A Novel Solution for Safe Drinking Water
- Portable Water Analysis Kit
- Mobile Laboratory for Environment and Human Health
- AO Kit for Rapid Screening of Argemone in Mustard Oil
- MO Check for Detection of Adulterant Butter Yellow in Edible Oils

Services Offered

- GLP Certified Pre-clinical Toxicity Studies
- NABL (ISO/IEC 17025:2005) Accredited
- Safety/ Toxicity Evaluation of NCEs
- Water Quality Assessment and Monitoring
- Analytical Services
- Environmental Monitoring and Impact Assessment
- Information on Chemicals/Products
- Computational Predictive Toxicity Assessment

Recognitions

- Scientific & Industrial Research Organizations (SIROs)
- UP Pollution Control Board (Water & Air)
- Indian Factories Act (Drinking water)
- Bureau of Indian Standards (Synthetic Detergents)
- Food Safety & Standards Authority of India (FSSAI)

विषविज्ञान भवन, 31, महात्मा गाँधी मार्ग,
लखनऊ-226001, उ.प्र, भारत

VISHVIGYAN BHAWAN, 31, MAHATMA GANDHI MARG,
LUCKNOW-226001, U.P., INDIA

Phone:+91-522-2627586, 2614118, 2628228 Fax:+91-522-2628227, 2611547
director@iitrindia.org www.iitrindia.org

एनएबीएल द्वारा रासायनिक एवं
जैविक परीक्षण हेतु प्रत्यायित
Accredited by NABL for chemical
and biological testing

विषाक्तता परीक्षण: जीएलपी अनुरूप सुविधा
Toxicity Testing: GLP Test Facility