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The Impact of Traffic Related Air Pollution at Various Sites in Noida

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Abstract

Aim: Aim of this study is to access the concentration of air pollutants like particulate matter, black carbon and carbon monoxide at selected roadside locations in Noida and correlate it with base line standard and; to study the adverse health effects of Noida commuters due to ambient air pollution by a survey conducted through questionnaire.

Materials and methods: Methodology being adopted for the study has been discussed under following. 1) Study sites (selection of sites based on traffic): Sites were selected to assess pollutants concentration. The selected sites were places of maximum population, heavy traffic, and commercial areas with industries - a) institutional site, Amity University Noida sector 126; b) arterial road site, Noida sector 18; c) Noida- Greater Noida Expressway; d) residential site, Arun Vihar Noida sector 37. 2) Sampling/monitoring of pollutants such as black carbon, particulate matter and carbon monoxide with the instruments: Micro Aethalometer; CO personal monitor (lengan) and; Dust monitor (grim). 3) Questionnaire survey and traffic sampling and 4) Analysis and interpretation of data.

Results: The average concentration of black carbon were found to be 25107.82 (ng/m^3), 16829.65 (ng/m^3), 23112.56 (ng/m^3) at Noida Sector 126, Noida Sector 18, Noida-Greater Noida Expressway, respectively. The concentration were compared and it was found that average concentration of black carbon level obtained at Noida Sector 126 was maximum and mean BC concentration varies from 68707.82-8760.76 (ng/m^3). This is due to traffic, vehicles and diesel combustion. The average concentration of PM10 were found to be 1737.16 ug/m^3, 632.69 (ng/m^3), 466.29(ng/m^3) at Noida sector 126, Noida Sector 18, Noida-Greater Noida Expressway respectively. The concentration were compared and it was found that average concentration of PM10 level obtained at Noida sector 126 was maximum and mean PM10 concentration varies from 2866.62-794.10 ug/m^3. This is due to high traffic on roads. Mean value of PM2.5 was maximum at Noida sector 126 and variation of PM2.5 values was highest on Noida sector 126 which suggest that contribution from different sources was varying to a great extent. The standard deviation value suggests that PM2.5 source emission rate at Noida sector 126 was varying greater than the emission rate at all the selected sites. The large variation was likely due to the differences in air mass, emission characteristics and meteorology. Results were compared with the values obtained by Central Pollution Control Board. Mean PM10 concentration at Noida sector 126 was 1737.16 ug/m^3 which is more than ten times higher than the standard value. Similarly mean PM2.5 concentration is ten times higher than the standard value. In Noida, institutional site is highly affected due to construction work and road traffic. Relevant information was gathered from questionnaire survey. It was observed that 80% of the people were suffering from eye or skin irritation at Noida sector 126 where the Black carbon and PM10, PM2.5, PM1 conc. were found maximum in comparision to all other sites.

Keywords: Pollutants; Traffic; Industrialization

Introduction

Most Indian cities are experiencing rapid urbanization, sharp increase in traffic, trajectory growth, rapid economic development and industrialization, higher level of energy consumption. This unplanned urban and industrial development has led to the problem of air pollution. Majority of the country's population is expected to live in cities within a span of next two decades. The rapid development in urban India has also resulted in a tremendous increase in the number of motor vehicles and in some cities this has doubled in the last decade. This is the main source of air pollution and poor ambient air quality impacting millions of dwellers. Commuters get exposed to traffic related particulate air pollution and has adverse health impacts with rise in respiratory disease, asthma, chronic obstructive, lung cancer, cardiovascular disease, heart attack and death [1].

Material and Methods

Study sites

1) Institutional site, Amity University Noida sector 126: This area marked as Sector-126, is for Institutional purpose as per the plan of Noida Authority. This area is suffering from air pollution due to vehicles and construction work.

Arterial road site, Noida sector 18: The Noida sector 18 is a metro station on the blue line of the Delhi metro. The massive mall The Great India Place is located just off the sector 18 market in Noida [2].

2) Residential site, Arun Vihar Noida sector 37: It has been registered as a society under the Societies Registration Act, 1860, as amended and made applicable to the state of Uttar Pradesh from time to time by the concerned authorities. It is spread over 6.5 acres of land provided by Noida Authority. Arun Vihar is one of the popular residential developments in Sector-37, neighborhood of Noida. It is among the completed projects of its Builder. It has lavish yet thoughtfully designed residences.

Noida-Greater Noida Expressway: The Noida-Greater Noida

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Expressway is a six-lane highway connecting Noida, Uttar Pradesh, an industrial suburb of Delhi to Greater Noida, a new suburb. This expressway is under expansion to Taj Economic Zone, International Airport and Aviation Hub proposed to be constructed along the Yamuna Expressway (Taj Expressway). The expressway is 24.53 km long, built at a cost of 400 crores to relieve the National Highway 2 which was already congested and ran through the heart of cities like Faridabad, Ballabhgarh and Palwal. The expressway is used by bikers and cyclists [3].

Pollutants

Pollutants under study include black carbon (BC), carbon mono-oxide (CO) and particulate matter (PM10, PM2.5, PM1). The potential sources of these air pollutants in Noida are vehicular traffic, diesel generator sets, and household construction activities. BC, CO, PM10, PM2.5, PM1 were measured at different sites from morning to evening (8:00 am to 5:00 pm).

Instruments

Instruments used to assess the concentration of pollutants are: 1) Micro aethalometer: The microAeth Model AE51 is the world's first ever real-time, pocket-sized Black Carbon aerosol monitor. The instrument can operate continuously for upto 24 hours on a single battery charge and can be externally powered by the included wall power adapter, or an additional external battery option for longer run times. 2) CO personal monitor (lengan): A carbon monoxide detector is a device that detects the presence of the carbon monoxide (CO) gas in order to prevent carbon monoxide poisoning. 3) Dust monitor (grim): In dust monitor (grim), sample air is led directly into the measuring cell via the aerosol. The particles in the sample air are being detected by light scattering inside the measuring cell. The scattering light pulse of every single particle is being counted and the intensity of its scattering light signal classified to a certain particle size. In this way, concentration of particulate matter of different size is measured [4].

Questionnaire survey and traffic sampling

Traffic pollutant concentration black carbon, carbon monoxide, particulate matter were measured along with traffic count of two wheelers, three wheelers, four wheelers, low commercial vehicle, high commercial vehicle from morning to evening at selected road side locations in Noida. Questionnaire survey at all the selected sites was done to find out how the health of commuters is being affected due to traffic related air pollutants. Questionnaires included questions on the basis of age, sex, occupation of people and we estimated the no. of people suffering from the symptoms of asthma, respiratory disease, lung cancer, etc. (Tables 1-4).

Results and Discussion

From Table 5 the average concentration of black carbon were found to be 25107.82 (ng/m^3), 16829.65 (ng/m^3), 23112.56 (ng/m^3) at Noida sector 126, Noida Sector 18, Noida- Greater Noida Expressway, respectively. The concentration were compared and it was found that average concentration of Black carbon level obtained at Noida sector 126 was maximum and mean BC concentration varies from 68707.82-8760.76 (ng/m^3). This is due to heavy traffic, vehicles and diesel combustion [5-8].

From the Figure 1 and Table 6, we can conclude that mean PM10 concentration at Noida sector 126 was 1737.16 ug/m^3 which is more than ten times higher than the standard value. Similarly mean PM 2.5 concentration is ten times higher than the standard value. In Noida,

Time	Black Carbon	CO(PPM)	PM-10 (µg/m^3)	PM-2.5 (µg/m^3)	PM-1 (µg/m^3)
8:00-8:30	68707.86	1.61	2268.95	678.13	533.63
8:30-9:00	42464.07	1.04	2331.22	674.22	538.57
9:00-9:30	40296.53	1.48	2866.62	597.73	468.20
9:30-10:00	31176.58	1.71	1537.60	490.04	401.02
12:00-12:30	38958.71	0.966	794.10	222.30	178.01
12:30-1:00	12183.28	2.008	1214.27	254.95	199.38
1:00-1:30	12106.95	2.414	1224.12	242.57	184.48
1:30-2:00	10759.07	2.28	1138.67	201.33	153.47
3:00-3:30	8760.76	1.54	1308.17	172.67	116.46
3:30-4:00	10821.65	1.39	2371.25	196.07	120.83
4:00-4:30	12687.68	1.264	2040.83	191.35	118.57
4:30-5:00	12370.69	0.87	1750.18	176.05	109.73

Table 1: Traffic pollutants data collection at institutional site Amity University, Noida, sector-126.

Time	Black Carbon	CO (PPM)	PM-10 (µg/m^3)	PM-2.5 (µg/m^3)	PM-1 (µg/m^3)
8:00-8:30	36021.81	3	997.05	543.90	445.75
8:30-9:00	24033.56	4.21	850.25	485.58	406.67
9:00-9:30	15879.20	4.26	1045.82	482.28	404.06
9:30-10:00	16970.39	3.77	883.73	503.33	421.82
12:00-12:30	15468.57	3.95	486.24	269.99	225.89
12:30-1:00	14415.67	4.66	495.63	246.42	205.87
1:00-1:30	14198.17	4.27	437.32	213.50	178.42
1:30-2:00	14447.00	4.68	440.50	204.70	170.42
3:00-3:30	5848.83	3.44	411.51	150.01	121.39
3:30-4:00	12026.17	3.42	569.80	184.57	148.38
4:00-4:30	14609.83	3.32	500.36	152.14	122.38
4:30-5:00	18036.60	3.45	474.02	155.94	114.95

Table 2: Traffic pollutants data collection at arterial site, Noida sector-18.

Time	Black Carbon	CO(PPM)	PM-10 (µg/m³)	PM-2.5 (µg/m³)	PM-1 (µg/m³)
8:00-8:30	51838.00	4.78	466.96	186.88	147.20
8:30-9:00	47255.50	5.27	482.88	195.87	153.45
9:00-9:30	32428.33	6.12	580.50	188.18	143.33
9:30-10:00	24529.00	4.45	592.10	184.07	142.33
12:00-12:30	20961.40	8.33	377.05	135.72	105.33
12:30-1:00	17139.17	13.45	333.92	98.48	73.28
1:00-1:30	14439.67	13.288	379.75	108.88	80.98
1:30-2:00	11922.00	14.93	353.17	104.18	77.72
3:00-3:30	12674.83	7.41	494.44	135.74	103.37
3:30-4:00	18118.83	5.74	478.05	143.25	110.80
4:00-4:30	11143.33	4.97	561.00	131.52	99.30
4:30-5:00	14900.60	4.518	495.67	129.43	96.95

Table 3: Traffic pollutants data collection at Noida-Greater Noida Expressway.

Time	CO (PPM)
8:00-8:30	6.59
8:30-9:00	2.61
9:00-9:30	2.28
9:30-10:00	3.07
12:00-12:30	1.3
12:30-1:00	2.49
1:00-1:30	0.48
1:30-2:00	3.59
3:00-3:30	1.48
3:30-4:00	0.98
4:00-4:30	1.14
4:30-5:00	2.44

Table 4: Traffic pollutants data collection at Residential site - Arun Vihar, Noida sector 29.

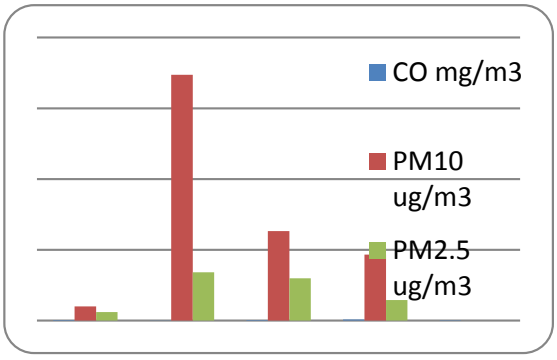

Figure 1: National ambient air quality standards.

Institutional site- Amity University Noida, Sector-126					
	Mean	**Median**	**Maximum**	**Minimum**	**Standard deviation**
Black Carbon (ng/m³)	25107.82	12529.19	68707.86	8760.76	19048.61
CO (PPM)	1.55	1.51	2.41	0.87	0.49
PM-10 (µg/m³)	1737.16	1643.89	2866.62	794.10	633.45
PM-2.5 (µg/m³)	341.45	232.43	678.13	172.67	205.04
PM-1 (µg/m³)	260.20	181.25	538.57	109.73	172.08
Arterial Site-Noida, Sector-18					
	Mean	**Median**	**Maximum**	**Minimum**	**Standard deviation**
Black Carbon (ng/m³)	16829.65	15039.2	36021.81	5848.83	7332.84
CO (PPM)	3.87	3.86	4.68	3.00	0.55
PM-10 (µg/m³)	632.69	498	1045.82	411.51	238.31
PM-2.5 (µg/m³)	299.38	229.96	543.9	150.01	155.90
PM-1 (µg/m³)	247.16	192.14	445.75	114.95	131.91
	Mean	**Median**	**Maximum**	**Minimum**	**Standard deviation**
Black Carbon (ng/m³)	23112.56	17629	51838	11143.33	13758.17488
CO (PPM)	7.77	5.93	14.93	4.45	3.883425
PM-10 (µg/m³)	466.29	480.47	592.1	333.92	88.2580197
PM-2.5 (µg/m³)	145.18	135.73	195.87	98.48	34.987302
PM-1 (µg/m³)	111.17	104.35	153.45	73.28	28.59637
Residential Site- Arun Vihar, Noida, Sector-29					
	Mean	**Median**	**Maximum**	**Minimum**	**Standard deviation**
CO (PPM)	2.370833	2.36	6.59	0.48	1.6188068

Table 5: Descriptive data of traffic related air pollutants.

S. No.	Pollutant	Time Weighted Average	Conc. in Ambient Air	Methods of Measurement
1	CO	8 h	02 mg/m^3	Non Dispersive infrared
		1 h	04 mg/m^3	NDIR Spectroscopy
2	PM 10	Annual Average	60 µg/m^3	Gravimetric
		24 h	100 µg/m^3	Beta Attenuation
3	PM 2.5	Annual Average	40 µg/m^3	Gravimetric
		24 h	60 µg/m^3	Beta Attenuation

Table 6: National ambient air quality standards.

Time	Amity Traffic	Arterial Traffic	N-GN Traffic	Residential Traffic
8:00-8:30	0.00	516	2286	60
8:30-9:00	805	879	3142	86
9:00-9:30	762	1694	3109	111
9:30-10:00	707	1774	2513	111
12:00-12:30	531	1784	1411	165
12:30-1:00	588	1707	1733	93
1:00-1:30	436	1625	1373	122
1:30-2:00	545	1264	1410	91
3:00-3:30	604	1020	1635	112
3:30-4:00	694	1421	1539	82
4:00-4:30	614	1314	1612	107
4:30-5:00	567	1450	1377	95

Table 7: Traffic data of various selected sites of Noida.

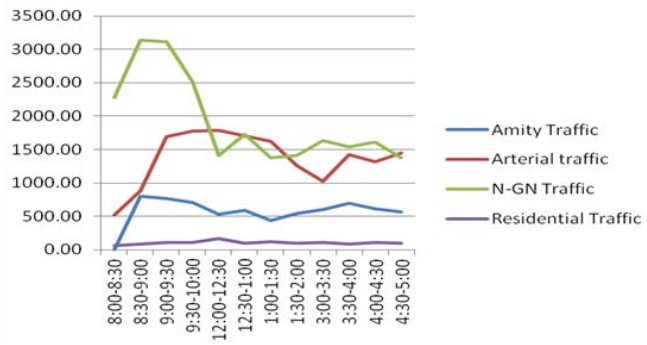

Figure 2: Traffic data of various selected sites of Noida.

	Black Carbon (ng/m^3)	CO (PPM)	PM-10 (µg/m^3)	PM-2.5 (µg/m^3)	PM-1 (µg/m^3)
Black Carbon (ng/m^3)	1				
CO (PPM)	-0.264040021	1			
PM-10 (µg/m^3)	0.394866395	0.3316891	1		
PM-2.5 (µg/m^3)	0.89702404	0.1084726	0.602788475	1	
PM-1 (µg/m^3)	0.858303899	0.0792245	0.548742249	0.977378557	1

Table 8: Correlation between all the pollutants at institutional site, Noida, sector-126.

	Black Carbon (ng/m^3)	CO (PPM)	PM-10 (µg/m^3)	PM-2.5 (µg/m^3)	PM-1 (µg/m^3)
Black Carbon (ng/m^3)	1				
CO (PPM)	-0.270441616	1			
PM-10 (µg/m^3)	0.65227377	-0.1369168	1		
PM-2.5 (µg/m^3)	0.704094631	0.00356979	0.943199953	1	
PM-1 (µg/m^3)	0.68621121	0.02984695	0.937586106	0.999337194	1

Table 9: Correlation between all the pollutants at arterial site, Noida, sector-18.

institutional site is highly affected due to construction work and road traffic.

Highest traffic was found at Noida-Greater Noida Expressway but the conc. of pollutants like Black Carbon, PM10, PM2.5 and PM1 was maximum at Noida sector 126 (Amity University). This is due to the road digging, building construction, dust particles in air and stagnant traffic at road sides (Table 7 and Figure 2).

Black carbon was highly well correlated with PM2.5 and PM1, it shows that BC, PM10 and PM1 originated from the same source. BC was negatively correlated with CO, this shows that for BC and CO generation sources were different (Table 8).

PM2.5 was highly related with PM1 which indicates that both the pollutants were generated from the same source. BC was positively related with PM10, PM2.5 and PM1 whereas BC was negatively correlated with CO. BC and CO generated from different source (Table 9).

At Noida-Greater Noida Expressway PM2.5 were highly related with PM1 which indicates that both the pollutants were generated from the same source. BC was positively related with PM2.5, PM1 whereas BC was negatively correlated with CO. BC and CO generated from different source (Table 10).

From the above mentioned graph (Figure 3), it is observed that PM10 conc. was found to be maximum above 8000 ug/m^3 in morning 8:00-10:00am at Noida Sector 126, Amity University, Institutional site in comparision to all other sites. This is due to stagnant traffic, vehicular exhaust, road digging, building construction, etc., and in afternoon conc. of pollutants was low due to less traffic, dust.

At Noida-Greater Noida, CO (PPM) conc. was high in afternoon (12:00-2:00 pm) in comparision to all other sites, but the traffic was found to be maximum in morning, this is due to materiological effect [9,10]. Black carbon was found to be maximum at Amity University (institutional site) in morning (08:00-10:00) but the traffic was high at Noida-Greater Noida Expressway in morning, this was due to the stagnant traffic at Amity University (Noida sector-126) whereas there was running traffic at Noida-Greater Noida Expressway (Figure 4).

	Black Carbon (ng/m³)	CO (PPM)	PM-10 (µg/m³)	PM-2.5 (µg/m³)	PM-1 (µg/m³)
Black Carbon (ng/m³)	1				
CO (PPM)	-0.434428279	1			
PM-10 (µg/m³)	0.219641585	0.8311802	1		
PM-2.5 (µg/m³)	0.821745834	0.7487312	0.689858137	1	
PM-1 (µg/m³)	0.835681297	0.7461575	0.665886665	0.998802387	1

Table 10: Correlation between all the pollutants at Noida-Greater Noida Expressway.

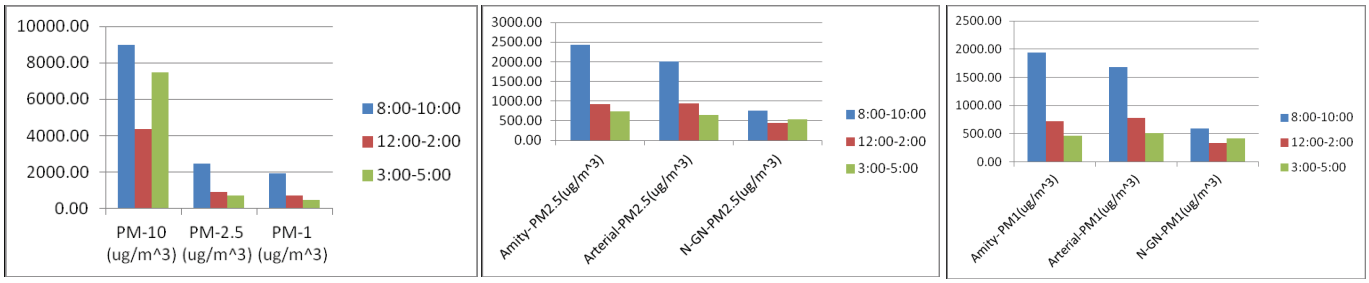

Figure 3: Concentration of PM10, PM2.5 and PM1 at selected sites Noida sector 126 (Amity), Arterial site (Noida sector 18), Noida-Greater Noida Expressway.

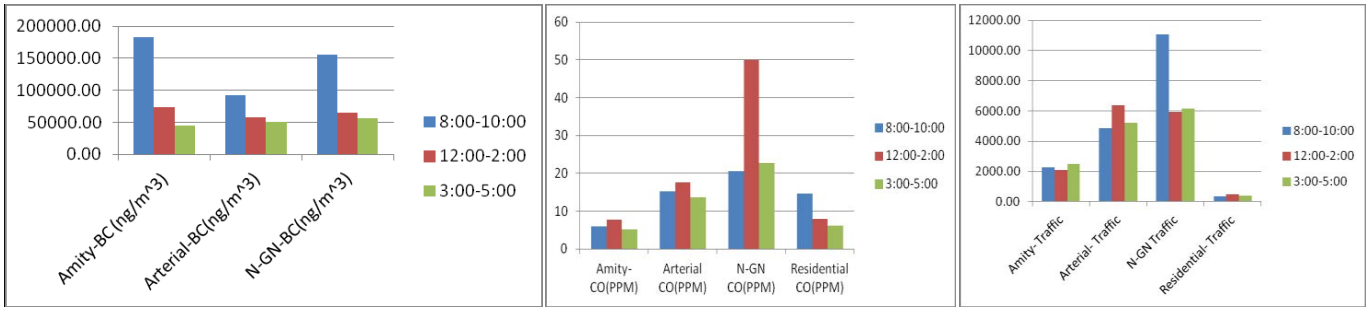

Figure 4: Concentration of Black Carbon (BC), CO at selected sites Noida sector 126 (Amity), Arterial site (Noida sector 18), Noida-Greater Noida Expressway.

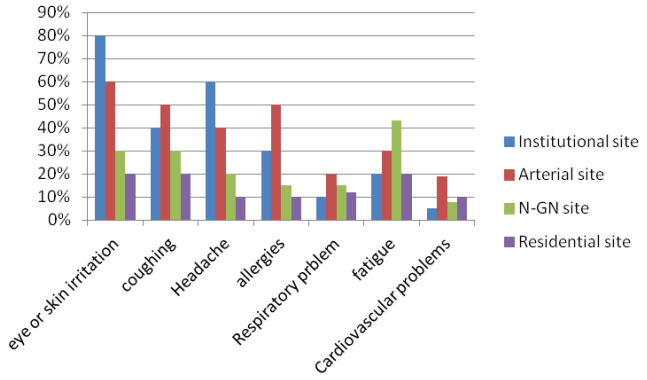

Figure 5: People suffering from the symptoms of asthma, respiratory disease, lung cancer, etc.

Result obtained from questionnaire survey

Questionnaire survey at all the selected sites was done to find out how the health of commuters is being affected due to traffic related air pollutants. Questionnaires included questions on the basis of age, sex, occupation of people and we estimated the no. of people suffering from the symptoms of asthma, respiratory disease, lung cancer, etc.

Conclusion

Relevant information was gathered from questionnaire survey. It was observed that 80% of the people were suffering from eye or skin irritation at Noida sector 126 where the black carbon and PM10, PM2.5, PM1 conc. were found maximum in comparision to all other sites.

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