



Assessment of Monthly concentration Of Particulate matters (PM₁₀, PM_{2.5}) And Gaseous Pollutants(SO₂, NO_x) In the Ambient Air Along NH-135 , (M.P) India

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ABSTRACT

The present study was undertaken to assess the ambient air quality status and monthly variations of ambient air pollutants. The primary focus of the study was on the Particulate Matters (PM₁₀ and PM_{2.5}), although it also deals with other gaseous pollutants like SO₂ and NO_x at seven different sites of National Highway (NH-135). The results revealed that the ambient air of National Highway deteriorated mostly by particulate matters (PM₁₀ and PM_{2.5}) especially PM₁₀ and followed by gaseous pollutants like Sulfur dioxide (SO₂) and Nitrogen oxides (NO_x). Results of investigation indicate that concentration of PM₁₀ is above the permissible limits whereas the concentration of SO₂, NO_x is below the prescribed limits as per the standards of National Ambient Air Quality Standard (NAAQS) and Central Pollution Control Board (CPCB). The combined effects of a growing population, industrialization, increased demand for private transportation, agricultural practices like stubble burning, increasing local activity along roadsides, ongoing road upgrades are significantly increase air pollution and more responsible for the emissions of particulate matter PM₁₀. The major causes include inadequate, improper traffic management system, road condition, absence of effective mass rapid transport system.

Keywords

Ambient air quality, Particulate Matter, SO₂, NO_x.

Introduction

Air pollution is considered to be primarily an urban problem as the rate of industrialization and unsystematic urbanization increases day by day. It has become a major environmental problem faced by the people globally in both developing and developed countries and India is one of them. Pollutants into the air by means of various natural as

well as anthropogenic means, released in the air due to various industrial as well as commercial activities and ongoing construction work

along with increase in the number of vehicles. The high level of pollutants which contribute to ambient air pollution are PM_{10} and $PM_{2.5}$, SO_2 , NO_x , and other air pollutants affects every one of us.

Particulate Matter (PM) consists of liquid or solid particles that are small enough to remain suspended in the atmosphere for extended periods of time. Natural phenomena like wind blown dust, volcanic activity, pollen grains and anthropogenic Industrial activities, besides transportation are the major sources of this type of air pollution. In cities particulate matters may also include particles composed of Fe, Ni, Cu and Pb . These particles influence the respiratory system immediately and make breathing difficult for people with chronic respiratory disorders. Airborne lead, formed by the burning of leaded gasoline, can accumulate in the tissues and bones of humans and other living organisms. At high levels lead can cause nervous system damage, convulsions and even death. It is especially dangerous to children and the unborn.

In air, Particulate Matter can also consists of primary pollutants that have reacted with each other or with the basic components of the atmosphere to form secondary pollutants. In cities, emissions from cars and industries combine with the help of light energy from the sun to form photochemical smog. Photochemical smog is extremely toxic to human beings, plants and other organisms.

The Characteristics, sources and potential health effects of larger or medium fraction particles (From 2.5 to 10 micrometer in diameter) and smaller or fine particles (smaller than 2.5 micrometer in diameter) are very different. Coarse & medium size particles come from sources such as windblown dust from the desert or agriculture fields and dust kicked up on unpaved roads by vehicle traffic. Fine particles are generally emitted from activities such as industrial and residential combustion and from vehicle exhaust. Fine particles are also formed in the atmosphere when gases such as Sulfur dioxide (SO_2), Nitrogen oxides NO_x) and volatile organic compounds emitted by combustion activities are transformed by chemical reactions in the air.

Air pollutants, mainly Nitrogen oxides (NO_x), Sulfur dioxide (SO_2), and particulate matters (PM_{10} , $PM_{2.5}$), have been linked to negative health consequences Rajak & Chattopadhyay, (2020). Sulfur dioxide is a short lived atmospheric air pollutants that is released or generated in the atmosphere as a result human process. Once released, SO_2 can either deposit on the surface or be chemically. Particulate Matter (i.e. sulfate aerosol). Due to its adverse health effects like respiratory irritation, mucus secretion and chronic bronchitis, it is considered a major air pollutants in many countries (2017). Transportation, Industrial operations and energy generation are the primary anthropogenic NO_x emission. Nitrogen dioxide is generated when Nitrogen combines with oxygen at high temperature has serious health impacts like respiratory and cardiovascular disease. High NO_x level in the air result in acid rain and eutrophication patterns ,(2020)

Air Quality is a major concern for human health in cities where a large portion of the population lives and the pollution levels often exceed the limit values (kumar et al.,(Zheng et al,2017). Out of all pollutants $PM_{2.5}$ poses a greater risk as it can penetrate deep into the lungs of human body

(Xing et.al.,2016) .It is observed that exposure to outdoor $PM_{2.5}$ is the fifth leading risk factor world wide and the third leading risk factor in India.

Vehicular emission are one of the major sources of air pollutants and have a powerful negative effect on germination and growth of plants. These pollutants may induce plant responses leading to observable changes in their morphology plant responses may vary depending on the amount of pollutants to which they are exposed. Although this has been an intense area of research which need further studies. More plants at young stage are encouraged to be planted along

roadsides as potential species since they apparently indicate the symptoms of pollutants intake in terms of stomatal index and biochemical traits to improve local air quality.

To protect communities exposed to particulate matter, US EPA and other agencies in the developed world adopted new standards for monitoring PM_{2.5} levels in addition to the PM₁₀ standards almost a decade ago. MOEF, Govt of India Notified revised National Ambient Air Quality Standard in November 2010 which include PM_{2.5} as a parameter to be monitored in community air all over the country. In 2009 Envirotech introduced the APM 550MMFC Model, which was the first indigenous PM_{2.5} sampler incorporating Mass Flow measurement and automatic flow Control.

Roadside dust is a major source of air pollution along Indian highways, contributing significantly to particulate matter levels. The movement of vehicles on both paved and unpaved roads resuspends dust and other particles, which can affect roadside plants as well as human health. Present research work was undertaken to study the ambient air quality of National Highway- 135.

Material and Methods Site selection-

The present research work was undertaken at seven sites of National Highway (NH- 135). National highway (NH-135) is a branch of National Highway 35 that connects Mirzapur in Uttar Pradesh to Mangawan in Madhya Pradesh. It stretching approximately 130 km from Mirzapur in Uttar Pradesh to Mangawan in Madhya Pradesh. The Highway passing through Mauganj, Hanumana, Deotalab towns. It runs from Mirzapur to Mangava.





Sampling and Monitoring

On the basis of anthropogenic activities and relative traffic load, air quality monitoring has been carried out at seven different sites of NH-135 have been carried out viz. : Site-1-Masuriha Toll Plaza(Hanumana), Site-2-Tiwani mod (Mangava),Site-3 Raghunathganj (Bypass), site-4 Deotalab Bypass , Site-5 Panni mod, site-6 Baba Dhaba(Mauganj)& Site -7 control site (Hanuman Mandir Higher Secondary School, Mauganj) along NH-135 for six months (May 2024 to October 2024) . Sampling was carried out at the seven different locations using Respirable Dust Sampler (Envirotech Model APM 460 BL-411) and Gaseous pollutants Sampler (Envirotech Model APM 443) for 8 hours in a day as per the standards of Central Pollution Control Board (India). Filter papers and cyclone cup were replaced at interval of 8 hours as per CPCB norms and conditions. PM_{2.5} Sampler (Envirotech Model APM 550 MMFC) for 24 hours as per the standards of Central Pollution Control Board (India) Filter paper was replaced at interval of 24 hours. Particulate matters PM₁₀ and PM_{2.5} were collected on the dust cup and glass fibre filter paper (GRA-3) respectively. Samples for determination of gaseous pollutants (SO₂ and NO_x) were collected by bubbling air samples in Potassium Tetra Chloromercurate and Sodium Hydroxide-Arsenite absorbing solutions filled in impingers, respectively. After sampling, the samples were analyzed for SO₂ and NO_x spectrophotometrically.

Results And Discussion :-

Ambient air quality at various stations was monitored covering a period of six months from May 2024 to October 2024 by using filter papers for RDS & PM_{2.5} sampler. Compared with CPCB Gazette notification National Ambient Air Quality Standards 2009. The statistical results of PM₁₀ for different sites have been presented in table 1. The observed minimum concentration of PM₁₀ was 61.84 µg/m³ and maximum was 145.86 µg/m³ at Site-1 (Masuriya Toll Plaza, Hanumana). Minimum concentration of PM₁₀ was 68.42 µg/m³ and maximum 136.48 µg/m³ at Site-2 Tiwani mod(Mangava) and minimum concentration of PM₁₀ was 64.69 µg/m³ & maximum concentration was 122.58 µg/m³ at Site-3 Raghunathganj (Bypass). Minimum concentration was 56.45 µg/m³ & maximum concentration was 123.46 µg/m³ at site- 4 . minimum concentration was 63.42 µg/m³ & maximum concentration was 128.49 µg/m³ at site- 5, minimum concentration was 73.42 µg/m³ & maximum concentration was 146.79 µg/m³ and minimum concentration was 44.95 µg/m³ and maximum was 61.95 µg/m³ from may 2024 to October 2024. Average PM₁₀ concentration was 103.31 µg/m³, 104.63 µg/m³, 94.07 µg/m³, 93.02 µg/m³, 98.90 µg/m³, 109.88 µg/m³ & 53.27 µg/m³ at site-1, site-2, Site-3, site-4, site-5, site-6 & site-7 respectively. .

Table-2 reveals monthly concentrations of PM_{2.5} for the ambient air of selected sites of highway observed during May 2024 to October 2024 . The observed minimum PM_{2.5} concentration was 24.12 µg/m³ and maximum concentration was 34.94 µg/m³ at site-1, minimum concentration 23.29 µg/m³ & maximum concentration 39.93 µg/m³ at site-2 , minimum concentration was 24.12 µg/m³ & maximum concentration was 32.44 µg/m³ at site-3 , minimum concentration was 23.29 µg/m³ & maximum concentration was 33.27 µg/m³ at site-4 , minimum concentration was 26.62 µg/m³ & maximum concentration was 37.43 µg/m³ at site-5, minimum concentration was 27.45 µg/m³ and maximum concentration was 40.76 µg/m³ at site-7 and minimum concentration was 21.63 µg/m³ & maximum concentration was 29.11 µg/m³ at site-7 from may 2024 to October 2024 . Average concentration of PM_{2.5} was 29.04 µg/m³ , 32.99 µg/m³ , 28 µg/m³ , 28.55 µg/m³ , 31.54 µg/m³ , 34.66 µg/m³ & 24.88 µg/m³ at site-1, site-2, Site-3, site-4, site- 5, site-6 & site-7 respectively . Average concentration of PM₁₀ is site-1 , Site-2 & site- 6 comparatively more at compared to Site-3 Site-4 , site-5, & site-7.

Table-3 shows monthly concentrations of SO₂ for the ambient air of selected sites of National Highway -135

observed during May 2024 to October 2024, the ambient air SO₂ concentration were estimated in the range of 10.90 to 14.53µg/m³ at site-1, 10.90 to 14.99 µg/m³ at site-2 , 10.90 to 14.53 µg/m³ at site-3, 10.90 to 14.99µg/m³ at site-4 , 8.89 to 13.66 µg/m³at site-5, 12.18 to 15.06µg/m³ at site-6 & 8.89 to 11.35µg/m³ at site-7 from May 2024 to October 2024..Average concentration of SO₂ was 12.33 µg/m³ ,12.86 µg/m³ ,12.26 µg/m³ , 13.01 µg/m³,12.23 µg/m³ ,13.41µg/m³ & 10.08µg/m³at site-1, site-2, Site-3, site-4, site-5, site-6 & site- 7 respectively.

The monthly concentrations of nitrogen oxides (NO_x) estimated for the ambient air of selected sites of NH-135 during research period are given in table -4. NO_x concentrations were estimated in the range of 17.72 to 26.03µg/m³ at site-1, 16.06 to 22.71 µg/m³ at site-2,14.95 to 24.92 µg/m³ at site-3, 16.06 to 24.92 µg/m³ at site-4 , 17.72 to 23.82 µg/m³ at site-5 ,20.49 to 26.03µg/m³ & 14.40 to 19.38 µg/m³ at site-7 from may 2024 to October 2024. Average concentration of Nox was 21.41 µg/m³ , 18.64 µg/m³ , 20.51 µg/m³ , 20.03µg/m³ , 20.67 µg/m³ , 22.70 µg/m³ & 16.79 µg/m³ at site-1, site-2, Site-3, site-4, site-5, site-6 & site-7 respectively. Monthly variations are also found at all sites. During the month of October the concentration of PM₁₀, PM_{2.5}, SO₂ and NO_x are found to be maximum because of the festival activities like Dussehra, Diwali & starting of winter season.

It is evident from the results that air quality of National Highway deteriorating mainly due to particulate matters. Out of seven Sampling sites, the average concentration of Particulate Matters (PM₁₀ & PM_{2.5})in the ambient air of site-1Masuriya Toll Plaza, Hanumana , site-2 Tiwani mod (Bypass) & site-6 Baba Dhaba (Mauganj) exceeded the permissible limits (100 µg/m³) prescribed by CPCB, New Delhi. The Average PM₁₀ Concentrations in the ambient air at site -3 Raghunathganj (Bypass) , site-4 Deotalab (Bypass) , site-5 Panni mod near (bus stop) & Control site Hanuman Mandir Higher Secondary School Mauganj were observed bellow the prescribed standard value. Gaseous pollutants (So₂ and NO_x) were always found to be below the standard value (80 µg/m³) prescribed by the CPCB, New Delhi throughout the study period. Results revealed that there was significant difference in PM₁₀, PM_{2.5}, SO₂ and NO_x concentrations in Ambient air of Highway among different months. The lowest concentrations of Hanuman Mandir Higher Secondary School ,Mauganj due to thick vegetation cover and restricted vehicular movements .

Table 1. Monthly average concentration of PM₁₀ (µg/m³) at Seven sites of Alongside NH-135(M.P.)

Months	Site-1 Hanumana near Masuriya Toll Plaza	Site-2 Tiwani Mod (Mauganj)	Site-3 Raghunathganj (Bypass)	Site-4 Deotalab (Bypass)	Site-5 Panni mod near (bus stop)	Site-6 Baba Dhaba (Mauganj)	Site -7 Hanuman Mandir Higher Secondary School, Mauganj
May	112.60	114.24	99.78	102.32	108.56	116.23	57.93
June	108.82	109.84	96.48	98.69	102.72	113.86	54.98
July	61.84	68.42	66.46	56.45	63.42	73.42	44.95

August	63.85	71.94	64.69	59.88	66.57	78.58	48.97
September	126.89	126.88	114.46	117.37	123.69	130.46	50.86
October	145.86	136.48	122.58	123.46	128.49	146.79	61.95

Table 2. Monthly average concentration of PM_{2.5} (µg/m³) at Seven sites of Alongside NH-135 (M.P.)

Months	Site-1 Hanumana , Near Masuriya Toll Plaza	Site-2 Tiwani mod (Manga va)	Site-3 Raghunathg anj (Bypass)	Site-4 Deotala b (Bypass)	Site-5 Panni Mod (Near Bus- stop)	Site-6 Baba Dhaba (Ma uganj)	Site- 7 Hanuman Mandir Higher Secondar y School, Mauganj
May	28.28	35.77	26.62	28.28	32.44	36.60	24.12
June	27.87	33.27	27.45	29.11	30.78	34.94	23.71
July	24.12	27.45	24.12	23.29	26.62	27.45	21.63
August	25.79	23.29	25.79	24.95	27.03	28.28	23.29

September	33.26	38.26	31.61	32.44	34.94	39.93	27.45
October	34.94	39.93	32.44	33.27	37.43	40.76	29.11

Table 3. Monthly average concentration of SO₂ (µg/m³)at Seven sites of Alongside NH-135

Months	Site-1 Hanumana,Ne ar Masuriya Toll Plaza	Site-2 Tiwani Mod (Mangava)	Site-3 Raghunathga nj (Bypass)	Site-4 Deotala b near (Bypass)	Site - 5 Panni i Mod near Bus - stop)	Site-6 Baba Dhaba (Mauganj)	Site-7 Hanuma n Mandir Higher Secondar y School, Mauganj
May	12.26	13.17	11.81	13.62	14.08	14.07	10.90
June	11.81	12.71	11.35	12.71	13.62	13.16	9.18
July	10.90	10.90	10.90	10.90	8.89	12.18	8.89
August	11.35	11.81	11.35	11.35	10.90	12.33	9.18

September	13.17	13.62	13.62	14.53	12.26	13.69	10.99
October	14.53	14.99	14.53	14.99	13.66	15.06	11.35

Table 4. Monthly average concentration of NO_x (µg/m³) at seven sites of Rewa Division Alongside NH-135 (M.P.)

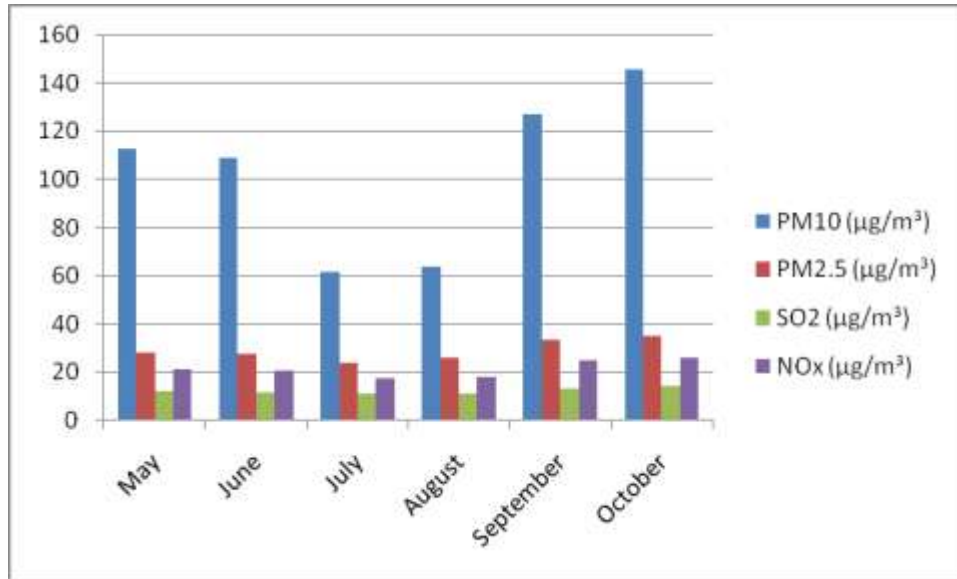
Months	Site-1 Hanumana near Masuriya Toll Plaza	Site-2 Tiwani mod (Mangava)	Site-3 Raghunathga nj near (Bypass)	Site-4 Deotala b (Bypass)	Site 5 Panni Mod Near (Bus-Stop)	Site 6 Baba Dhaba (Mauganj)	Site-7 Hanuman Mandir Higher Secondary School, Mauganj
May	21.05	18.28	19.94	19.94	20.49	21.05	17.17
June	20.49	17.72	17.72	18.83	21.05	21.60	16.06
July	17.72	15.51	14.95	16.06	17.72	20.49	14.40
August	18.28	16.06	16.06	17.72	19.38	22.15	14.95
September	24.92	21.60	29.49	22.71	21.60	24.92	18.83
October	26.03	22.71	24.92	24.92	23.82	26.03	19.38

Table 5. Average concentration (µg/m³) of different pollutants for six Months at seven sites of Alongside NH-135 (M.P.)

Parameters	Site-1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
PM ₁₀	103.31	104.63	94.07	93.02	98.99	109.89	53.27
PM _{2.5}	29.04	32.99	28	28.55	31.54	34.66	24.88
SO ₂	12.33	12.86	12.26	13.01	12.23	13.41	10.08
NO _x	21.41	18.64	20.51	20.03	20.67	22.70	16.79

Research Through Innovation

Figure-1 Monthly concentration of parameters PM₁₀, PM_{2.5}, SO₂,NO_x(ug/ M3) in the ambient air at Masuriha,Toll Plaza



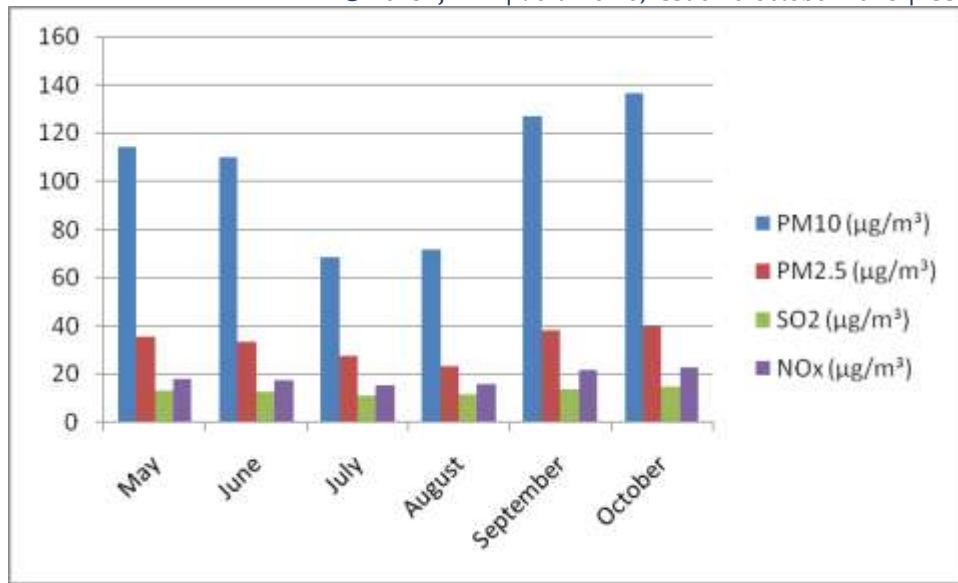


Figure-2 Monthly concentration of parameters PM_{10} , $\text{PM}_{2.5}$, SO_2 , NO_x ($\mu\text{g}/\text{m}^3$) in the ambient air at Tiwani mod (Mangava) Alongside NH-135

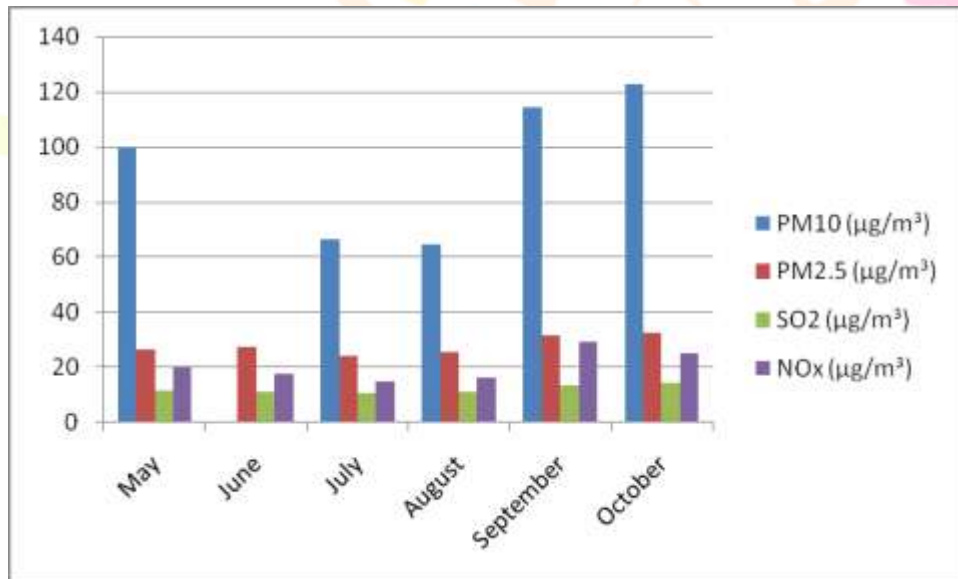


Figure-3 Monthly concentration of parameters PM_{10} , $\text{PM}_{2.5}$, SO_2 & NO_x ($\mu\text{g}/\text{m}^3$) in the ambient air at Raghunathganj (Bypass) Alongside NH-135

Research Through Innovation

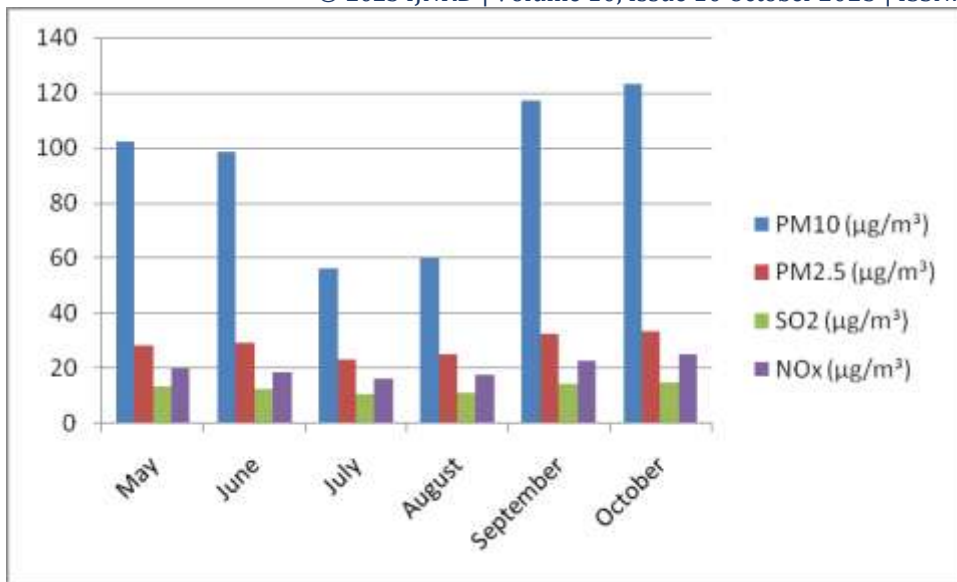


Figure-4 Monthly concentration of parameters PM₁₀, PM_{2.5}, SO₂ & NO_x (µg/m³) in the ambient air at Deotalab (Bypass) Alongside NH-135

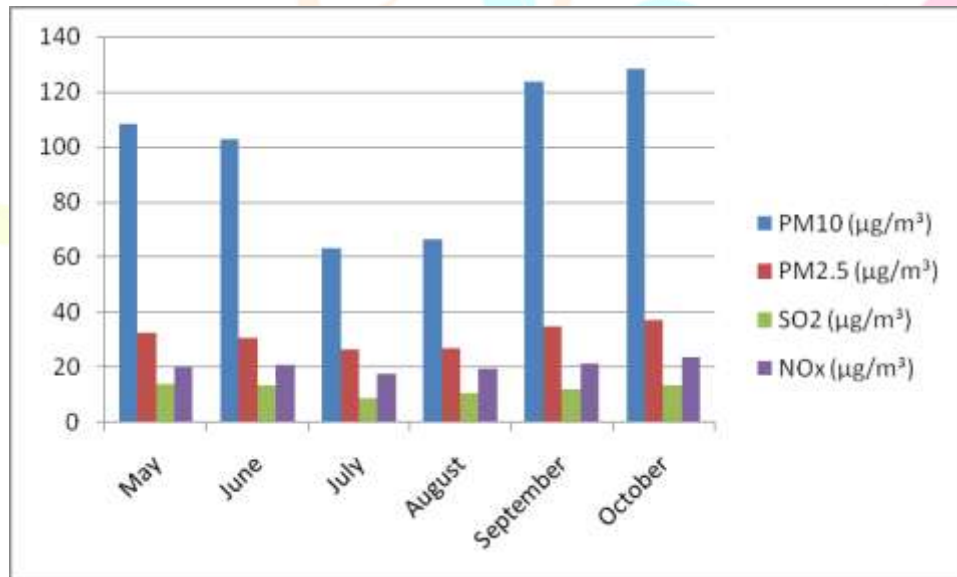


Figure-5 Monthly concentration of parameters PM₁₀, PM_{2.5}, SO₂ & NO_x(µg/m³) in the ambient air at Panni mod Alongside NH-135

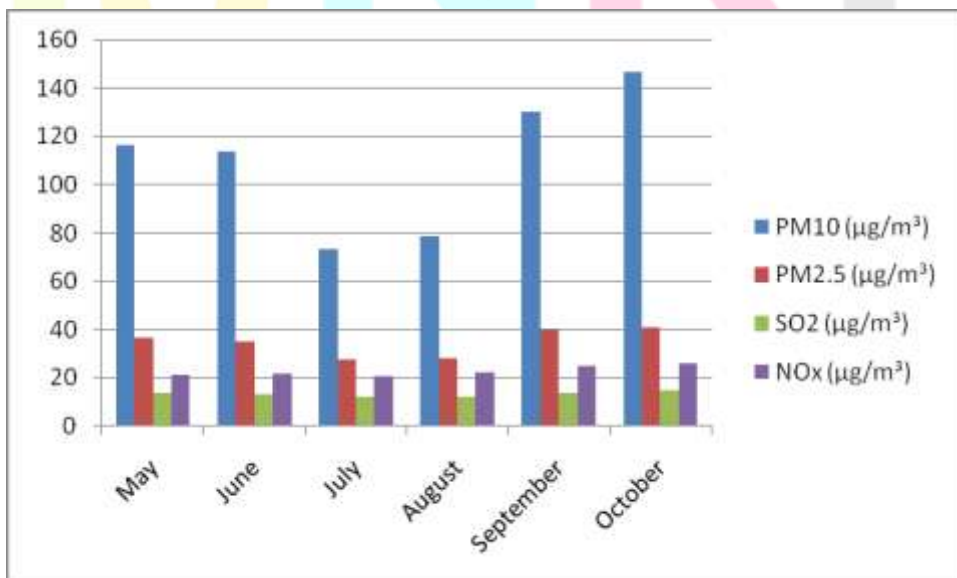


Figure-6 Monthly concentration of parameters PM₁₀, PM_{2.5}, SO₂ & NO_x (µg/m³) in the ambient air at Baba Dhaba (Mauganj) Alongside NH-135

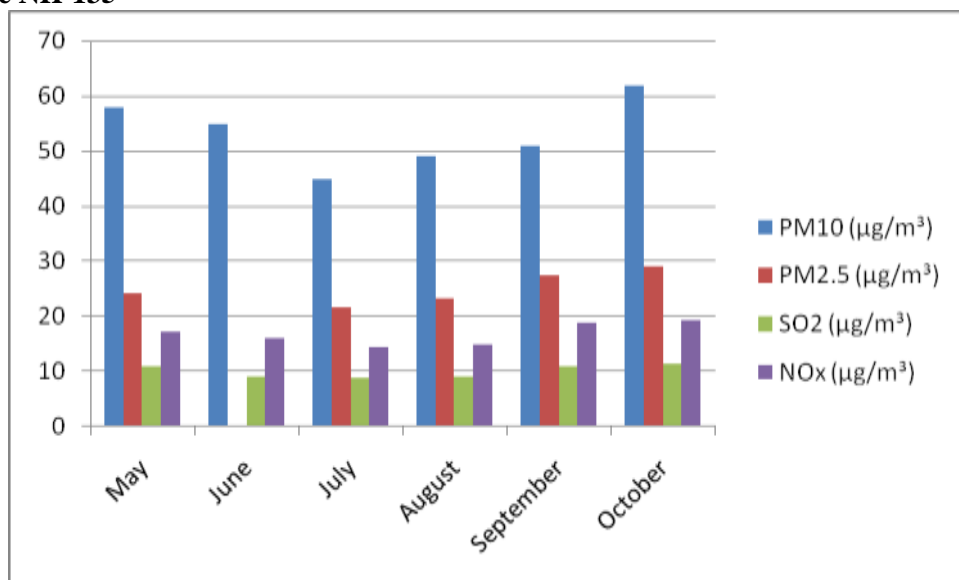


Figure-7 Monthly concentration of parameters PM₁₀, PM_{2.5}, SO₂, NO_x (µg/m³) in the ambient air at Hanuman Mandir Higher Secondary School, Mauganj

NATIONAL AMBIENT AIR QUALITY STANDARDS (2009)

Pollutants	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Sulphur Dioxide (SO ₂), µg/m ³	Annual*	50	20
	24Hours**	80	80
Nitrogen Dioxide (NO ₂), µg/m ³	Annual	40	30
	*24Hours**	80	80
Particulate Matter (Size less than 10µm) or PM ₁₀ , µg/m ³	Annual	60	60
	*24Hours**	100	100
Particulate Matter (Size less than 2.5µm) or PM _{2.5} , µg/m ³	Annual	40	40
	*24Hours**	60	60

Conclusion:-

Air pollution around National Highways are going to be day by day growing due to transportation of heavy vehicles, commercial activities, which requires immediate attention on the part of Town & County Planning as well as National Highway Authority. The detailed background information on Air quality status is very much essential for local agencies to implement the air quality management programme. High Particulate matter concentration is due to poor traffic management, growth of large commercial as well as private vehicles, illegal parking of vehicles, road congestion and vehicles of obsolete two stroke technology, heavy transport activity in study area, apart from commercial units' emissions, dust from paved roads, garbage burning in open, use of convectional fuels like wood, cow dung etc for cooking and other domestic purposes. Particulate pollution is

mainly responsible for ambient air pollution alongside NH135. The analyzed values of PM₁₀, PM_{2.5}, SO₂ and NO_x at the sampling sites clearly illustrates that the ambient air quality of Highways city is primarily deteriorated by particulate matters (PM₁₀, PM_{2.5}) followed by gaseous pollutants (SO₂ and NO_x). Suitable plantation as per Environmental norms along National Highways is the utmost requirement for control of dust pollution. However, this requires a systematic, cost effective and efficient air quality monitoring and modeling procedure.

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