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A STUDY FOR ASSESSING THE AIR QUALITY STATUS FOR RESIDENTIAL AREA AT GORAKHPUR CITY

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ABSTRACT

In the present study, a study has been carried out for assessing the status of air quality in residential area namely MMMUT Gorakhpur. Air Quality Index was calculated in the residential area considering the key pollutants like PM_{10}, SO_2 and NO_x by IND-AQI method and results were compared with the standards prescribed by CPCB. Seasonal AQI calculation indicates that air quality status in the study area was under the various classes from moderate, satisfactory, class for different AQI calculation. It was also found that during post monsoon season the condition of the air quality status at the MMMUT, Gorakhpur was moderately polluted.

Keywords: Air Quality Index (AQI), Ambient Air Quality, Air Pollutant, MMMUT Gorakhpur.

I INTRODUCTION

Air Pollution is a mixture of gases, particles, aerosols, water vapour which has originated due to human development and other natural/anthropogenic activities. Common people living in urban areas, in urban areas source of air pollution mainly are vehicular pollution, burning of solid waste, use of gensets during power cut, etc. Air pollution is serious worldwide public health problem. A large number of people are suffering from different air pollution induced respiratory and pulmonary decease with higher morbidity and mortality. Today adverse health effect of air pollution is a serious issue in urban areas particularly in developing country including India [1]. Poor air quality has both acute and chronic effects on human health [2, 3].

Air Pollution is one of the serious problems faced by the people globally, especially in urban areas of developing countries, which is not only rapid growth of population but also industrialization [4].Sulphur dioxide (SO_2), Nitrogen dioxide (NOx) and RSPM are regarded as major air pollutants in India [5].

These also have identified that PM_{10} as the dominant pollutant in the index value [6]. Sulphur dioxide (SO_2) is a gas formed when fuel containing sulphur, such as coal and oil, is burned and when gasoline is extracted from oil or metal is extracted from ore. Nitrogen oxides (NO_x) are a group of highly reactive gases containing various levels of nitrogen and oxygen.

In this paper, different method of estimating the Air Quality Index (AQI) is evaluated as a tool for assessing the impact of air pollution with a case study. Air Quality Index (AQI) is such an indicator tool which mainly uses in worldwide and in India since last 2-3 decades, includes synergistic effect estimation based on mean of the ratios of pollutant over guideline level for a certain time period. These can further be classified as AQI using IND-AQI method. Air Quality Index is the simplest and widely measure of over all air pollution of a region.

II STUDY AREA DESCRIPTION

Air quality impact assessment has been carried out at the Madan Mohan Mohan Malaviya University of Technology (MMMUT), Gorakhpur. MMMUT Gorakhpur is a Residential area in Gorakhpur district in the Indian State of Uttar Pradesh. Madan Mohan Malaviya University of Technology (MMMUT) located in Gorakhpur city and Gorakhpur - Deoria road state highway. It is located near the Nepal border, 273 kilometres east of the state capital Lucknow. The total population of the Gorakhpur as per census 2011 is 4,436,275. The district of Gorakhpur lies between Latitude 26°13′N and 27°29′N and Longitude 83°05′E and 83°56′E. It is bounded by Maharajganj district to the north, Kushinagar and deoria districts inthe east, Ambedkar Nagar, Azamgrah and Mau districts to the south and Sant Kabir Nagar district to the west. It located on the bank of river Rapti and Rohani, a Ganges tributary originating in Nepal.

The average depth of water is about 4.5 meters. The annual average temperature is 25.30^0C. But during the summer months, the mean maximum temperature shoots up to 37.50^0C whereas annual average minimum temperature is 19.34^0 C. The city receives an annual average rainfall about 1230 mm.

Figure 1: – Location of study area at Gorakhpur

2.1 Methodology

Present study is assessing the Air Quality Index (AQI) in the MMMUT, Gorakhpur during March, 2015 to February, 2016. In order to understand ambient air quality status around that area, three ambient air samples were taken. The parameters were assessed including respairable particulate matter (RSPM or PM_{10}), sulphur dioxide (SO_2) and oxides of nitrogen (NO_x) and results were compared with the standards prescribed by Central Pollution Control Board.

For RSPM analysis, the high volume air sampler (HVAS) APM 460 NL was used. The concentration was measured using quantitative analysis with glass fiber filter paper of 20.3×25.4 cm.

The sulphur dioxide (SO_2) concentration was measured using Potassium Tetrachloro mercurate (TMC) as absorbent and titrated with mercuric chloride, 0.066g EDTA and 6g potassium chloride in water and bring to the mark in 1 liter volumetric flask . In this measurement Improved West and Geake Methods are used.

The oxides of nitrogen (NOX) concentration was measured using 4g of sodium hydroxide in distilled water, add 1 g of sodium arsenite and diluted to 1 liter with distilled water. In this measurement Modified Jacob and Hochheiser Methods are used.

2.2 Air Quality Index (AQI)

Air Quality Index (AQI) is a tool which is used to report the overall air quality status and trends based on a specific standard. The index of specific pollutant is derived mainly from the physical measurement of pollutant like RSPM or PM_{10}, SO_2 and NO_x etc. PM_{10} as the dominant pollutant in the index value [6]. AQI convert the value of individual air pollutant into single number. As the increasing value of AQI that can directly adverse health effect and environment [5, 6]. In the present study, method was used to calculate ambient air quality index these are given below:

IND-AQI Method:

In this method Air Quality Index calculated by break point concentration [7, 8]. The individual air quality index for a given pollutant concentration (I_P) as based on following formula,

$$\mathbf{I_P = [\{(I_{HI} - I_{LO})/(B_{HI}-B_{LO})\} \times (C_P-B_{LO})]+ I_{LO}}$$

Where,

I_P = Pollutant concentration

B_{HI} = Breakpoint concentration greater or equal to given concentration

B_{LO} = Breakpoint concentration smaller or equal to given concentration

I_{HI} = AQI value corresponding to B_{HI}

I_{LO} = AQI value corresponding to B_{LO}

C_P = given pollutant concentration

Finally;

$$\mathbf{AQI = Max. (I_P)}$$ (Source: CPCB 2014)

Where

P = 1, 2, 3.....n, denotes n pollutants

Table 1: Proposed Breakpoints Concentration for AQI Scale

AQI	PM_{10} 24-hr	NO_2 24-hr	SO_2 24-hr
0 ─ 50	0 ─ 50	0 ─ 40	0 ─ 40
51 ─ 100	51 ─ 100	41 ─ 80	41 ─ 80

101 ─ 200	101 ─ 250	81 ─ 180	81 ─ 380
201 ─ 300	251 ─ 350	181 ─ 280	381 ─ 800
301 ─ 400	351 ─ 430	281 ─ 400	801 ─ 1600
401 +	430+	400+	1600+

(Source: CPCB 2014)

Table 2: Health Statements for AQI Categories

AQI	Description	Associated Health Impacts
0 ─ 50	Good	Minimal Impact
51 ─ 100	Satisfactory	May cause minor breathing discomfort to sensitive people
101 ─ 200	Moderately Polluted	May cause breathing discomfort to the people with lung disease such as asthma and discomfort to people with heart disease, children and older adults
201 ─ 300	Poor	May cause breathing discomfort to people on prolonged exposure and discomfort to people with heart disease
301 ─ 400	Very Poor	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases
401 +	Severe	May cause respiratory effects even on healthy people and serious health impacts on people with lung/heart diseases. The health impacts may be experienced even during light physical activity

(Source: CPCB 2014)

Table 3: Colour coding for AQI ranges

AQI	Description	Colour Coding
0 ─ 50	Good	
51 ─ 100	Satisfactory	
101 ─ 200	Moderately Polluted	
201 ─ 300	Poor	
301 ─ 400	Very Poor	
401 +	Severe	

(Source: CPCB 2014)

III RESULT AND DISCUSSION

The overall Air Quality Index was found to fall under the category of satisfactory to moderately polluted area in the MMMUT, Gorakhpur. The Average concentration of PM_{10} in MMMUT, Gorakhpur varies between 61.90µg/m^3 to 127.50µg/m^3, concentration SO_2 varies between 5.90µg/m^3 to 11.50µg/m^3, and concentration of NO_x varies between 16.90µg/m^3 to 25.20µg/m^3 in MMMUT, Gorakhpur.Concentration of pollutants ambient air quality with respect to PM_{10}, SO_2, and NO_2 during the period of March 2015 to February 2016 as shown below:

Table 4: Concentration of pollutant at MMMUT Gorakhpur (µg/m^3)

Sr. No.	Location	Month	PM_{10}	SO_2	NO_X
1	MMMUT Gorakhpur	March	63.40	9.40	19.40
2		April	121.10	**11.50**	**25.20**
3		May	113.90	10.50	22.80
4		June	98.80	8.50	18.40
5		July	**61.90**	8.00	17.60
6		August	105.30	7.20	17.30
7		September	97.20	7.50	19.30
8		October	89.80	6.00	17.30
9		November	93.70	**5.90**	**16.90**
10		December	109.20	6.80	17.50
11		January	118.50	7.94	19.84
12		February	**127.50**	8.70	17.40
13		**Standard**	**100**	**80**	**80**

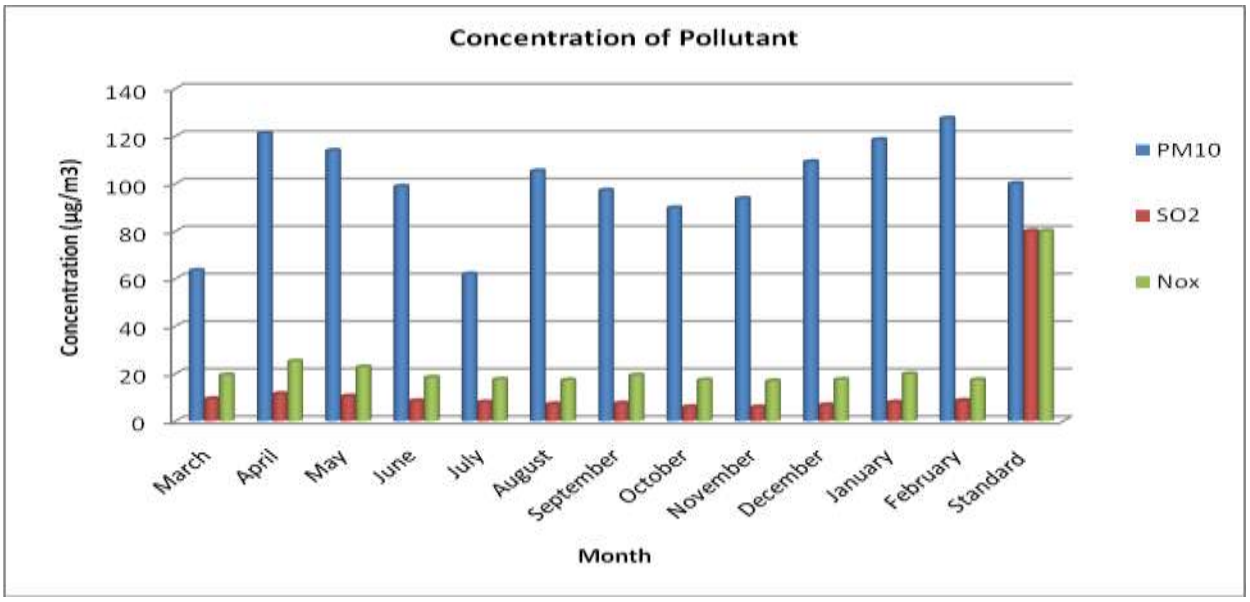

Figure 1: Concentration of Pollutants at MMMUT, Gorakhpur

Table 5: AQI value obtain at MMMUT Gorakhpur by IND-AQI with Colour Coding

Sr. No	Month	AQI value due to each pollutant			IND-AQI	Pollutant responsible for AQI	Status
		PM 10	SO2	NOx			
1	March	63.40	11.75	24.25	63.40	PM10	Satisfactory
2	April	114.07	14.38	31.50	114.07	PM10	Moderately Polluted
3	May	109.26	13.13	28.50	109.26	PM10	Moderately Polluted
4	June	98.80	10.63	23.00	98.80	PM10	Satisfactory
5	July	61.90	10.00	22.00	61.90	PM10	Satisfactory
6	August	103.53	9.00	21.63	103.53	PM10	Moderately Polluted
7	September	97.20	9.38	24.13	97.20	PM10	Satisfactory
8	October	89.80	7.50	21.63	89.80	PM10	Satisfactory
9	November	93.70	7.38	21.13	93.70	PM10	Satisfactory
10	December	106.13	8.50	21.88	106.13	PM10	Moderately Polluted
11	January	112.33	9.93	24.80	112.33	PM10	Moderately Polluted
12	February	118.33	10.88	21.75	118.33	PM10	Moderately Polluted

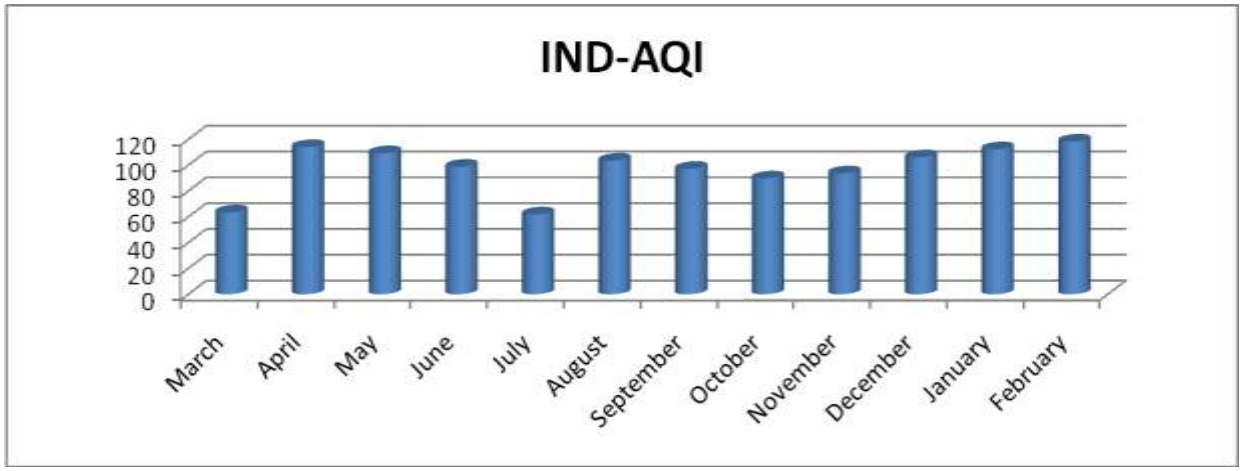

Figure 2: AQI of MMMUT, Gorakhpur

Table 6: Concentration of Pollutants in Season

Location	Ambient Air Quality		
MMMUT, Gorakhpur	PM 10	SO2	NOx
Pre Monsoon (March 15- June-2015)	99.3	9.97	21.45
Monsoon (July 2015 - Oct 2015)	88.55	7.17	17.87
Post Monsoon (Nov 2015 - Feb 2016)	112.22	7.33	17.91
Standard	**100**	**80**	**80**

The Average concentration of PM_{10} in MMMUT, Gorakhpur varies between 88.55µg/m^3 to 112.22µg/m^3, concentration SO_2 varies between 7.17µg/m^3 to 9.97µg/m^3, and concentration of NO_x varies between 17.87µg/m^3 to 21.45µg/m^3 in MMMUT, Gorakhpur. In post monsoon season PM10 was found that cross the prescribed limit by CPCB and all other seasons within the prescribed limit. SO_2 and NOx concentration was found that within the prescribed limit by CPCB.

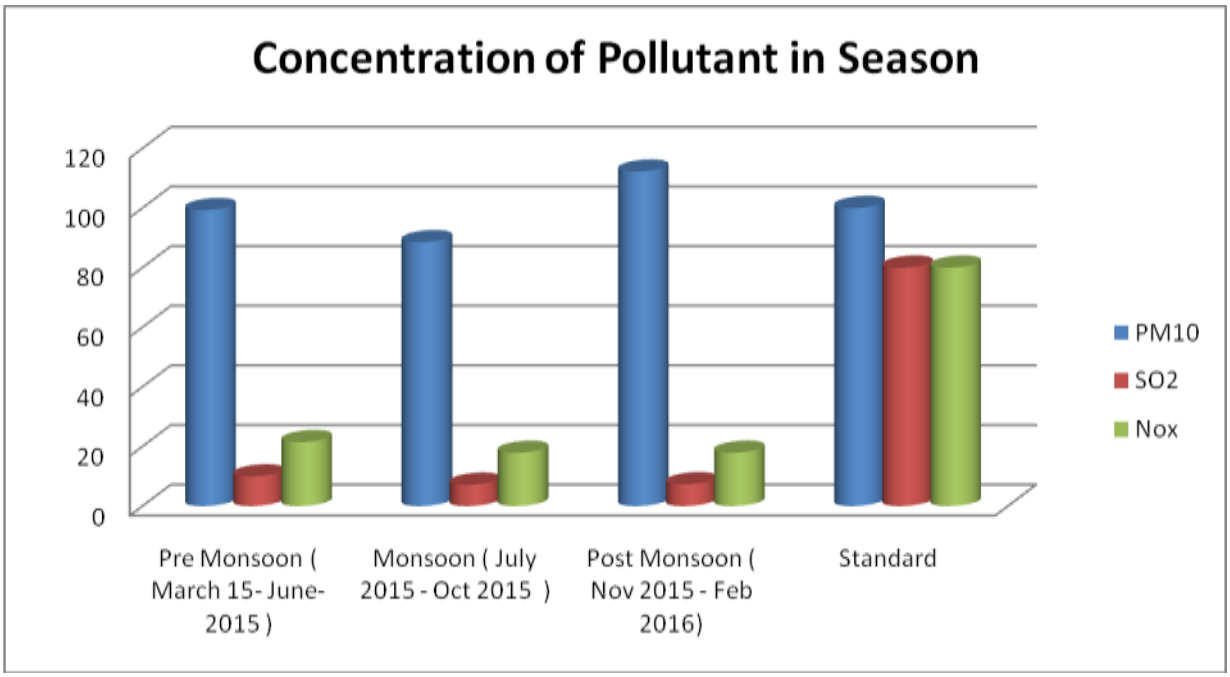

Figure 3: Concentration of Pollutant in Season

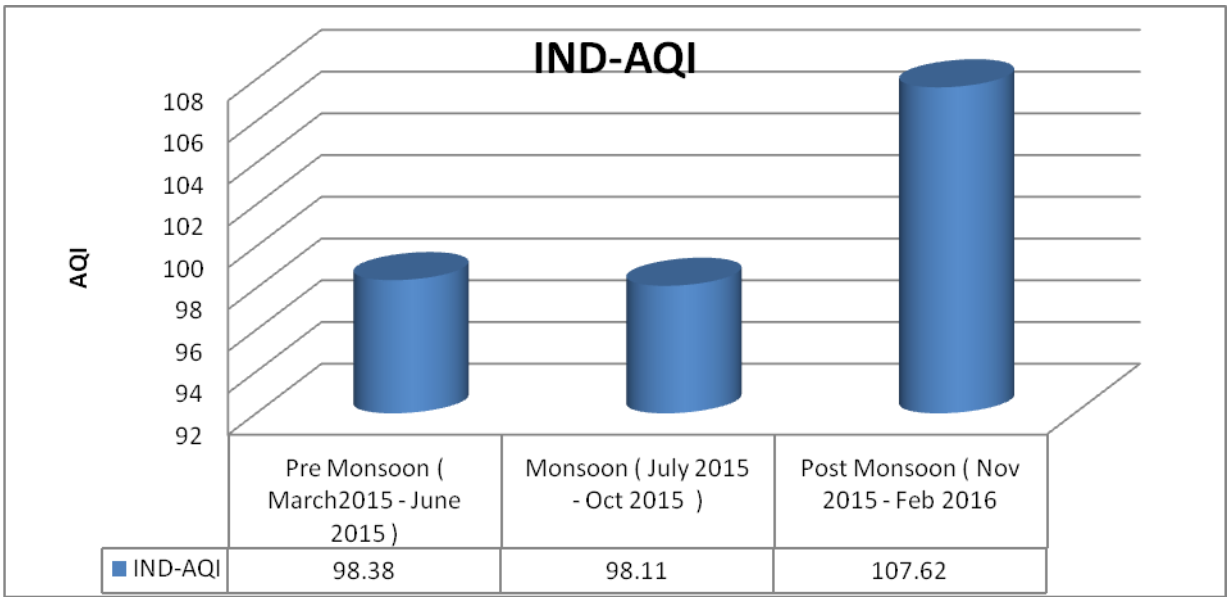

Figure 4: AQI by IND-AQI method in seasons

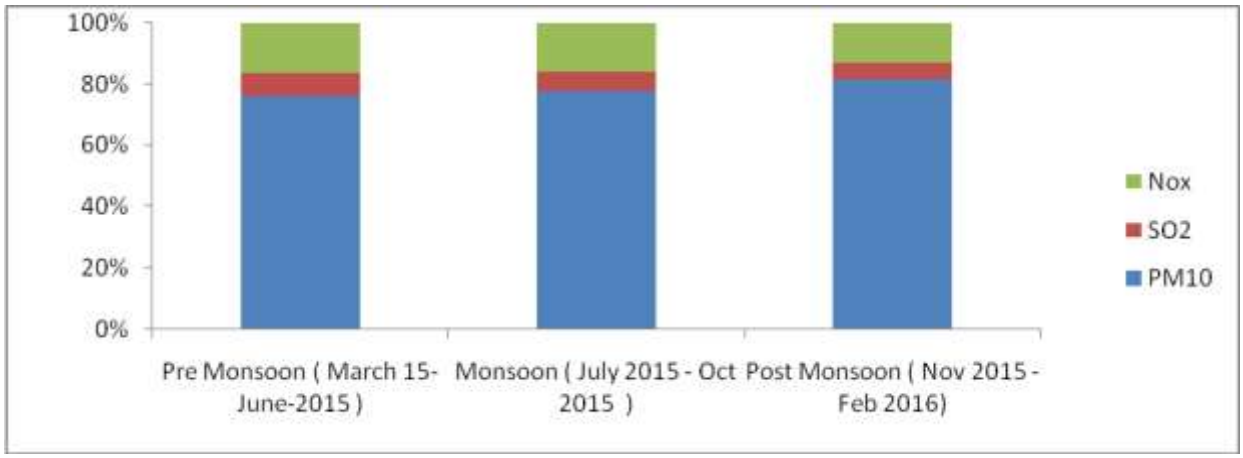

Figure 5: Percentage occurrences of three pollutants in the MMMUT, Gorakhpur

IV CONCLUSION

The study carried out, regarding the assessing study of with respect to the residential area. The AQI study found that PM_{10} was mainly responsible for the high range of AQI value. Particulate matter is mainly responsible for the serious public health problem in the residential area. The AQI found to be under the category of satisfactory and moderately polluted. For minimizing the pollution in the surrounding areas, some remedial measure like plantation and green belt can be formed that area for betterment of human life. Air Quality Index can be useful establishing a meaningful assessment of air pollution in the common man perception.

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