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A Study on Ambient Air Quality and Management in Commercial Areas of Gorakhpur City

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Abstract:- The current study evaluates the city of Gorakhpur's ambient air quality using an air quality index. For the period January 2018 to November 2022, the 24-hour average concentration of the three primary pollutants SO2, NO2, and PM10 in a commercial area close to Jalkal Bhawan in Gorakhpur city was measured. Pollutant measurements were made between January 2018 and November 2022. The IND-AQI technique was implemented to calculate the Air Quality Index. In July, the highest monthly average concentrations of PM10, SO2, and NO2 were recorded at 401.13, 36.41, and 54.02, respectively. The yearly average SO2 concentration was found to be within the CPCB- recommended limit, while NO2 was found to be slightly above the maximum allowable level. However, PM10 wasconsistently found to be above the CPCB-recommended limit. The average monthly concentration of NO2 is higherthan SO2, and the overall AQI rating was determined to be moderate. The global experiences clearly demonstratedthat international action had been city specific rather than country oriented, and as a result, statistics show a reduction in PM2.5 of 35%–40% in five years for cities like Beijing and Seoul, whereas cities like Santiago and Mexico Cityhave shown reductions in PM2.5 and PM10 concentration of 73% and 61% in 20 to 25 years, respectively. Recent research published in the Lancet found that over the past five years, CO and Sulphur dioxide levels decreased by 28.2% and 54.1%, respectively, while NO2 and O3 concertation showed no considerable improvement. The August 2018 TERI and ARAI report examined several interventions and predicted their possible effects. PM2.5 and PM10 levels in Delhi and the NCR are above average. A different scenario has been developed in light of the intervention that can improve air quality the most. The NCAP produces an estimated national level target of 20%-30% decreasesin PM2.5 and PM10 concentration by 2024 after taking into consideration the existing international and national studies. This keeps 2018 as the baseline year for concentration comparisons. Gorakhpur City has recently experienced an increase in development activity, which has led to particulate matter.

Keyword:- *Air Quality Index, PM10, SO2, NO2, PM2.5.*

I. INTRODUCTION

When a dangerous material is released into the atmosphere, harming the ecosystem, people's health, and their way of life. Many gases, particulate matter, aerosols, and water vapour that are released from both natural and manmade sources together constitute air pollution. Purpose of our Air Quality Monitoring System (AQMS) is to track ambient air quality. It is used to continuously calculate the amount of particulate matter and air pollutants throughout the year in the immediate vicinity. They can be deployedin a variety of locations, including businesses, hospitals, and communities, and they allow us to continuously monitor the air quality in the area. We also give wireless data transmission solutions using GSM wireless devices & any other type as necessary by Customers to transmit online data remotely to PCB Authorities or other authorities. Using AQMS, air pollutants including lead, ozone, Sulphur dioxide, carbon monoxide, particle matter, and other dangerous air pollutants can be monitored. Most health issues brought on by air pollution are avoided with AQMS. Polluted settings have been linked in studies to negative effects on health. According to studies, rising air pollution causes a decline in lung function and an increase in heart attacks. According to the EPA, persons who have asthma, other lung conditions, or heart disease are affected by extreme air pollution level. Children as well as the elderly are particularly susceptible to health problems brought on by air pollution. Its impact on human health also depends on various factors, including how healthy we are, how much air we breathe, and the quantity of contaminantsin the atmosphere. Monitoring of air quality plays a big part in resolving health problems. So, the information gathered through the monitoring procedure will help in identifying & minimizing the negativeeffects of poor air quality on public health. Any substance that is present in the atmosphere in solid, liquid, or gaseous form at amounts that have the potential to harm all living things, property, and the environmentis considered an air pollutant. Our environment is constantly being contaminated by various toxins, in diverse mode, from both man-made and natural sources, leading to toxicity, diseases, and environmentaldeterioration. As a result of recent industrialization and a growth in the number of powerful air polluting sources, such as automobiles and landfills, hazardous compounds that not only cause harm to humans butalso Threats to the ecosystem generally as well as to human health are present. In order to stop the air quality's decline, the Indian government created the Environment Protection Act, 1986, a comprehensive statute for environmental protection. In order to ensure moderate pollution concentrations and, thus, safeambient air quality,

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The Air Prevention and Control of Pollution Act was also passed in 1981. Concern over air pollution is widespread. One cannot simply refrain from pollution on a personal level since, unlikewater, the purity of which can be verified prior to consumption, air must be consumed in the form in which it is present. Many early deaths, chronic asthma, lower fertility, degraded property, and potentiallydangerous acid rains are all effects of air pollution. Therefore, it is essential that air pollutant concentrations be periodically checked and a good inventory is kept so that unplanned calamities such asThe Great Smog of 1952 in London can be anticipated. National Ambient Air Quality Monitoring network, post known as the National Air Monitoring Programme, was established by the Central PollutionControl Board (CPCB in 1984–1985 with the purpose of properly monitoring pollutant concentrations (N.A.M.P.)

The analyzed and enhancement of ambient air quality in Gorakhpur, a city in the state of Uttar Pradesh, India is the focus of the problem statement. Due to emissions from cars, factories, construction equipment, and other anthropogenic causes, Gorakhpur densely populated urban centre with a variety of commercial activities experiences substantial air pollution.

The decreasing air quality and its negative consequences on public health, environment, and general quality of life in the commercial sector are the main causes for worry. High levels of air pollutants, such as volatile organic compounds (VOCs), particulate matter (PM10), nitrogen oxides (NOx), Sulphur dioxide (SO2), and carbon monoxide (CO), can be harmful to human health, resulting in respiratory issues, cardiovascular disorders, and other related conditions.

➢ *The Following are the Particular Goals for Improving the Quality of the Ambient Air in Gorakhpur's Business District:*

- Analyzing the current levels of different air contaminants in the commercial area by doing extensive air quality monitoring and analysis. The identification of hotspots or regions with unusually high pollution levels should be a part of this study.
- Finding Pollution Sources: Locating the main sources of air pollution in the commercial region, suchas industrial emissions, traffic, building projects, and commercial buildings. Effective mitigation measures must take into account how each source contributes to overall pollution levels.
- Health Impact Assessment: Analyzing the effects of poor air quality on the health of locals, employees, and customers. The assessment should take into account vulnerable populations like children, the elderly, and people with current medical conditions.
- Developing Mitigation Strategies entails coming up with and putting into action practical solutionsto reduce air pollution in the commercial sector. Adopting cleaner technologies, boosting public transportation and non-motorized modes of transportation, enforcing emission limits, promoting sustainable business practices, and increasing stakeholder awareness are a few examples of how to do this.
- Establishing a reliable system for monitoring air quality and ensuring compliance with environmental regulations and legislation. Regular monitoring and reporting of air quality data allowing for the tracking of advancements and the identification of problem regions.

➢ *The following are Some Examples of Ambient Air Quality's Goals:*

- To evaluate the ambient air quality's state and progress. Checking whether the required levels are being met
- To determine which cities, have pollution concentrations that are higher than allowed.
- To comprehend and learn in order to create preventative and remedial procedures.
- To comprehend how the environment continuously purifies itself through processes such dilution, dispersion, wind-based movements, dry deposition, chemical transformation, and precipitation.

➢ *National Ambient Air Quality Standards (NAAQS) are Intended to:*

- To identify the minimum levels of air quality and suitable safety zones needed to guaranteethe preservation of the environment, health and property of people.
- To aid in setting priorities for the pollution control and reduction.
- To offer a standardized metric for gauging air quality on a nationwide scale.
- To describe the scope and necessity of the monitoring programme.

II. METHODOLOGY

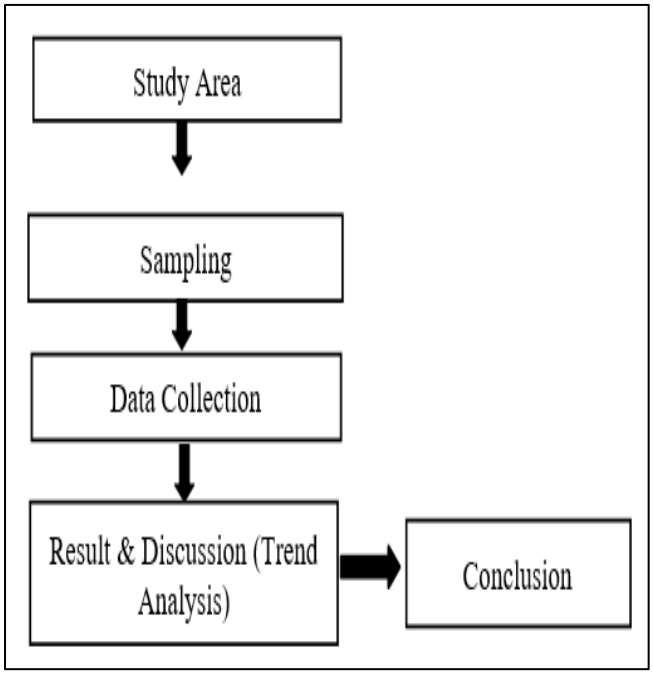

Fig 1: Flow Chart

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A. Study Areas

The city of Gorakhpur, which has a total area of 5484 km^2 and is located between latitudes 26°13'N and27°29'N and longitude 83°56'E along the Rapti River in the eastern part of the Indian state of U.P. It is situated 273 kilometers east of the state capital Lucknow, close to the Nepal border. The city has an average elevation of 84 meters, 1393.1 millimeters of annual rainfall, 70-80% relative humidity, and a mean temperature of 26 degrees Celsius. In a business sector near Jalkal Vibhag in Gorakhpur, air pollution was monitored. The location's latitude and longitude are 26.750 and 83.3695, respectively. HVSis positioned 9.4 meters from the road and 10.6 meters above ground. NO_2, PM_{10} and SO_2 analysis performed by the RSPM (APM460NL) between January 2018 and November 2022. The Gorakhpur Division is headquartered at Gorakhpur City. Gorakhpur, Deoria, Mahrajganj, and Kushinagar are the four districts that make up the Gorakhpur division. In the sixth century B.C., Gorakhpur was a part of the renowned Koshal empire, one of the sixteen Mahajan padas.

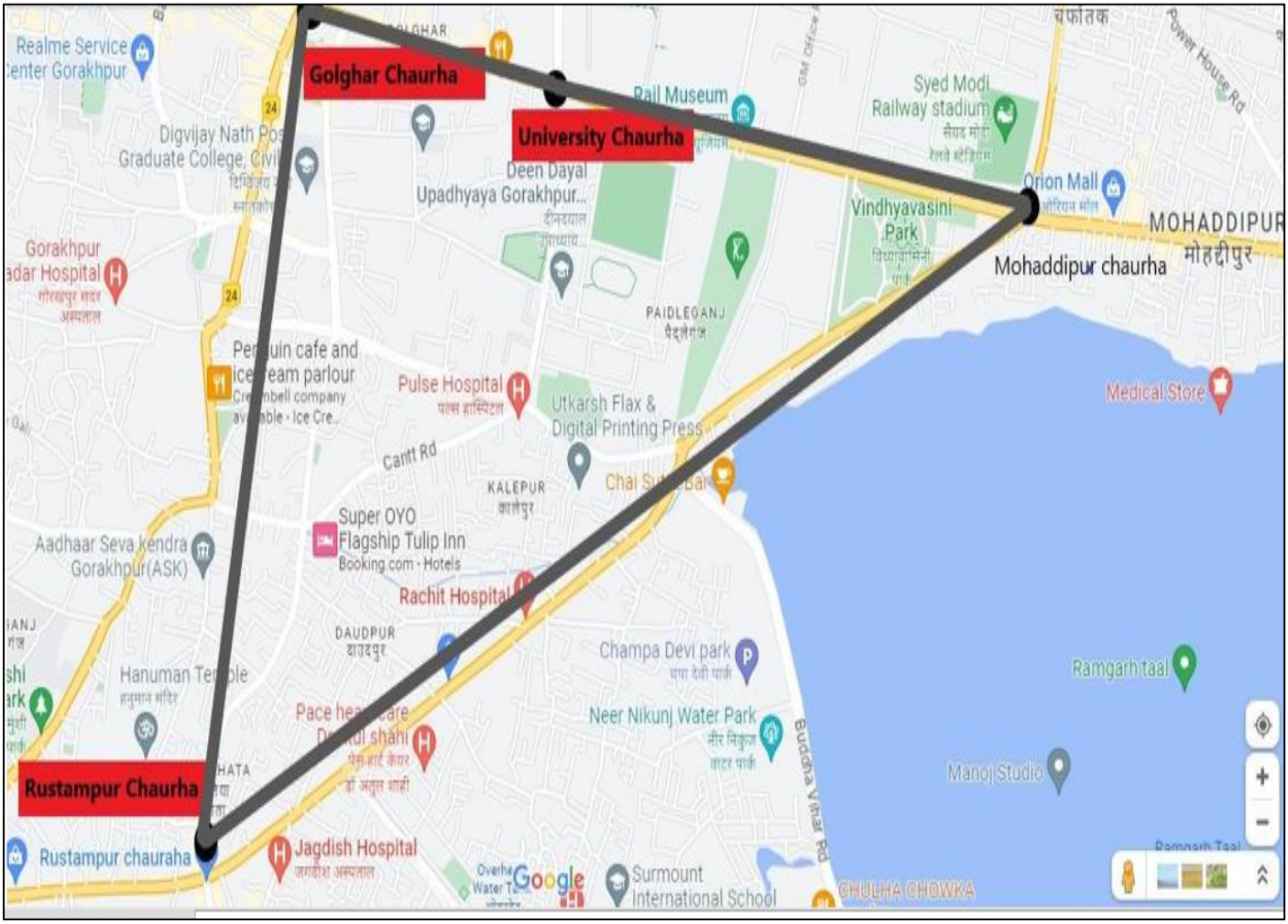

Fig 2: Commercial Area of Gorakhpur City (U.P) Map

At a commercial area close to Jalkal Vibhag in Gorakhpur, a High-Volume Sampler (APM 460NL) is used for manual monitoring so as to understand how pollutants change with the four seasons of the climate. Measurements were made by calculating the annual arithmetic mean. There at least twice a week, 24 hoursa day, at regular intervals. The APM 460NL, an upgraded version of the APM 451, and it has a conical hopper where heavy particles are settled by cyclonic air movement. By using a gravimetric approach, PM_{10} is calculated. The air is drawn in through the suction intake at a rate of 0.9 to 1.4 m^3 per minute, and the particles larger than 10 m are separated in the hopper (due to the cyclonic action of the air), with the remaining particles being passed through filter paper. The mass of these particles is determined by the variation in filter weights between before and after sampling. The concentration of PM_{10} in the chosen size range is calculated by dividing the weight gain of the filter by the air volume measured. APM 460NL and APM411gaseous sampling attachment are used for gas analysis. Four impinger are included in the gaseous attachment, allowing for simultaneous analysis of four different gases. Filtered air is run through an impinger containing an absorbing solution at a flow rate of 1 LPM. The solution absorbs some of the specific gases, such as NO_2, SO_2, etc., and the concentration of these pollutants is then determined using a straightforward wet chemistry procedure.

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Table 1: Shown in Maximum Traffic Congestion in Gorakhpur at a Different Areas

S. No	Areas
1	Mohaddipur Chauraha
2	University Chowk
3	Golghar Chauraha
4	Kacheri Chauraha
5	Shastri Chowk
6	Betihata Chowk
7	Transport nagar
8	Rustampur Chauraha
9	Fal mandi Chauraha
10	Maheva Mandi

➢ *Indicator of Air Quality*

A metric used is the AQI, which ranges from 0 -500. As the AQI readings rise, so are the amount of air pollution and the health risk which occurs. An AQI score of 50 or less, as an example, indicates healthy airquality, whereas one of over 300 indicates hazardous air quality.

Typically, an ambient air concentration of 100 for each pollutant satisfies the short-term national ambient air quality requirement for protecting public health. AQI values of 100 or less are usually considered to be acceptable. When AQI levels exceed 100, the air becomes harmful for everyone.

The AQI is divided into six categories. Each category has a different level of health concern. Each groupalso has a distinctive colouring. Due to the colour and texture of the air, people can instantly tell if the air quality in their neighbourhoods has reached unsafe levels. Table No. 1 on the fundamentals of air quality index (AQI) for ozone and particulate matter pollution shows which areas are still able to support life in different colours.

B. Sampling

Using observed data from the commercial locations near Jalkal Bhawan in Gorakhpur, the IND-AQI (break point concentration) technique was used to generate the air quality index. Because the sub-index of PM10 isalways bigger than the sub-indexes of SO2 and NO2, it is chosen for the Air Quality Index as the dominatingpollutant. During the year, the monthly average concentration of the pollutants SO2 and NO2 is below the CPCB-specified threshold. The Central Pollution Control Board's annual average concentration standards for SO2 and NO2 were both determined to be marginally exceeded. The overall AQI ranged from Moderate to High (101-200). Those with lung diseases, such as asthma, as well as persons with heart diseases, children, and older adults, may experience breathing difficulties as a result of it.

Table 2: National Ambient Air Quality Standards (2019) for Pollutant SO2, NO2, PM10.

Commercial Area	NO_2 (µg/m^3)	SO_2 (µg/m^3)	PM_{10} (µg/m^3)
ANNUAL	40	50	60
24 HOURS	80	80	100

Fig 3: Monitoring Station at Jalkal Bhawan

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Fig 4: Sampling Done at Jalkal BhawanGorakhpur

C. Data Collection

Table 3: Monthly Average Pollutant Concentration and Air Quality Index in Gorakhpur's JalkalBhawan Commercial Area

Monitoring Station- JALKAL BHAWAN Gorakhpur (2018)				
MONTHS	**PM10 (µg/m^3)**	**SO2 (µg/m^3)**	**NO2 (µg/m^3)**	**AQI**
JANUARY	215.94	35.08	53.85	177
FEBRAURY	221.06	35.39	54.49	181
MARCH	219.43	35.98	54.36	180
APRIL	218.16	35.98	53.57	179
MAY	217.03	35.30	53.13	178
JUNE	217.98	33.12	51.09	179
JULY	208.07	28.87	44.49	172
AUGUST	200.37	23.63	44.39	167
SEPTEMBER	217.90	28.30	45.52	179
OCTOBER	227.09	29.29	47.95	185
NOVEMBER	319.69	39.66	59.01	270
DECEMBER	403.15	48.44	70.84	366

The information in Table No. 3 from the UPPCB site and the commercial area in Gorakhpur for the year2018 demonstrates which pollutant is the most detrimental to the environment.

Table 4: Monthly Average Pollutant Concentration and Air Quality Index in Gorakhpur's Jalkal BhawanCommercial Area

Monitoring Station- JALKAL BHAWAN Gorakhpur (2019)				
MONTHS	**PM10 (µg/m^3)**	**SO2 (µg/m^3)**	**NO2 (µg/m^3)**	**AQI**
JANUARY	423.37	50.05	72.10	392
FEBRUARY	330.05	36.85	47.11	280
MARCH	334.53	37.19	48.12	285
APRIL	218.16	35.98	53.57	179
MAY	329.94	35.02	45.64	280
JUNE	299.35	20.63	32.70	249
JULY	263.51	18.09	28.07	214
AUGUST	276.67	12.35	27.97	227
SEPTEMBER	273.75	11.97	26.78	224
OCTOBER	284.7	13.4	27.4	235
NOVEMBER	317.33	12.11	26.14	267
DECEMBER	327.13	13.39	28.41	277

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The information in Table No. 4 from the UPPCB site and the commercial area in Gorakhpur for the year2019 demonstrates which pollutant is the most detrimental to the environment.

Table 5: Monthly Average Pollutant Concentration and Air Quality Index in Gorakhpur's Jalkal BhawanCommercial Area

Monitoring Station- JALKAL Bhawan Gorakhpur (2020)				
MONTHS	**PM10 (µg/m^3)**	**SO2 (µg/m^3)**	**NO2 (µg/m^3)**	**AQI**
JANUARY	284.21	8.98	21.53	234
FEBRUARY	280.68	8.56	21.71	231
MARCH	334.53	37.19	48.12	285
APRIL	44.52	1.27	3.26	45
MAY	78.46	2.55	6.97	78
JUNE	89.82	3.60	9.23	90
JULY	105.71	3.10	9.58	104
AUGUST	113.78	4.51	9.88	109
SEPTEMBER	133.69	4.75	10.38	122
OCTOBER	157.10	9.08	27.68	138
NOVEMBER	194.47	5.87	15.44	163
DECEMBER	222.75	5.07	16.19	182

Table No. 5 displays data for the year 2020 in a commercial location in Gorakhpur and details which pollutants have the most detrimental effects on the environment. The data collection site also shows thatthe air quality during the months of April, May, and June is quite good.

Table 6: Monthly Average Pollutant Concentration and Air Quality Index in Gorakhpur's Jalkal BhawanCommercial Area

Monitoring Station- JALKAL BHAWAN Gorakhpur (2021)				
MONTHS	**PM10 (µg/m^3)**	**SO2 (µg/m^3)**	**NO2 (µg/m^3)**	**AQI**
JANUARY	258.49	5.06	16.63	208
FEBRUARY	255.70	4.96	15.62	206
MARCH	253.74	4.88	14.82	204
APRIL	248.91	3.98	12.98	199
MAY	245.74	3.32	11.94	197
JUNE	212.73	4.88	14.54	175
JULY	218.04	4.76	14.55	179
AUGUST	222.25	4.93	15.07	182
SEPTEMBER	225.61	5.03	15.43	184
OCTOBER	237.84	5.17	16.37	192
NOVEMBER	304.51	8.40	25.34	255
DECEMBER	325.79	8.03	27.53	276

Data from the Commercial Area in Gorakhpur for the year 2021 are provided in Table No. 6, together with information about which pollutants have the most detrimental effects on the environment. The year's most detrimental consequence is PM10.

Table 7: Monthly Average Pollutant Concentration and Air Quality Index in Gorakhpur's JalkalBhawan Commercial Area

Monitoring Station- JALKAL BHAWAN Gorakhpur (2022)				
MONTHS	**PM$_{10}$ (µg/m^3)**	**SO$_2$ (µg/m^3)**	**NO$_2$ (µg/m^3)**	**AQI**
JANUARY	324.59	7.93	26.38	275
FEBRUARY	322.67	7.68	25.52	273
MARCH	318.64	7.88	25.45	269
APRIL	312.66	7.64	23.46	263
MAY	321.61	7.83	24.39	272
JUNE	324.74	8.03	24.71	275
JULY	401.13	36.41	54.02	364
AUGUST	327.83	8.03	24.91	278
SEPTEMBER	155.44	5.46	17.19	137
OCTOBER	146.84	6.46	19.68	131
NOVEMERER	308.85	7.27	21.11	259

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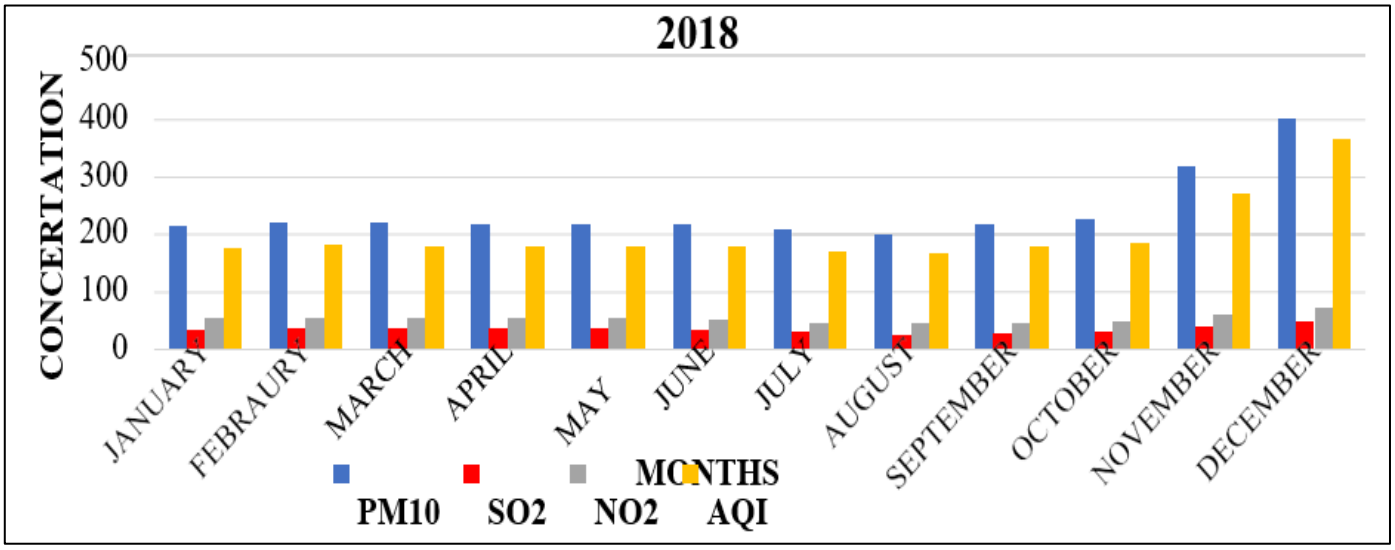
According to the AQI, PM10 has a greater impact in the months of July because a new road was built that year, according to data from the Commercial Area in Gorakhpur collected by the UPPCBsite in

III. RESULT & DISCUSSIONS

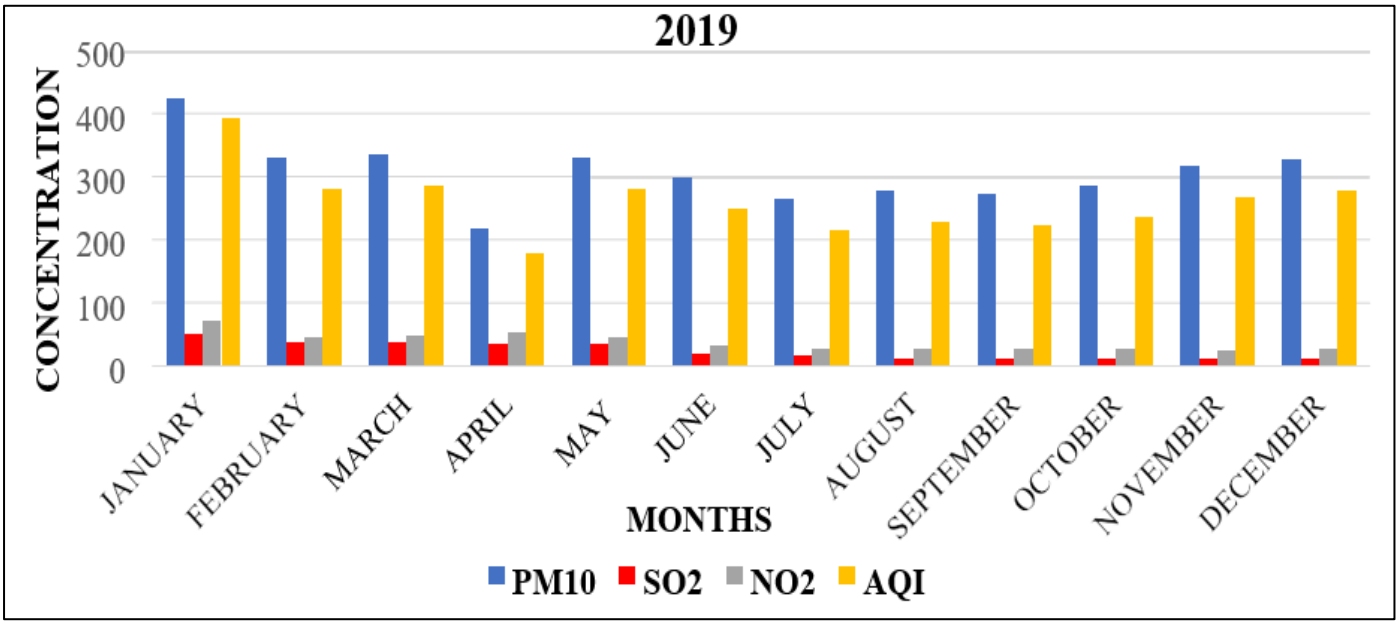
The health of the surrounding people is particularly at risk from air pollution from improper disposal sites,which poses a major risk to both human health and the environment. Continued inhalation of particulate matter, such as smoke, fumes, mist and dust can lead to respiratory issues and lung damage.

The bar graph below shown the analysis of PM10, NO2, SO2 and AQI in the year 2018, which are recorded as 403.19, 70.84, 48.44, and 366 respectively in the month of December lying in very poor range while August shows satisfactory conditions of ambient air. All other months from January to October shows moderate quality of air and then from November to December shows very poor quality of air.



Graph 1: Yearly Trend of PM10, SO2, NO2, and AQI (µg/m^3) in Commercial Area Gorakhpur 2018

The Trend Analysis of PM10, SO2, NO2 and AQI in the Year 2019 is Shown Below. It has been Observed that in January, February, March, May, November and December, Values Lies in Poor Range While Months from April to October Depicts Moderate Condition of Ambient Air.



Graph 2: Yearly Trend of PM10, SO2, NO2, and AQI (µg/m^3) in Commercial Area Gorakhpur 2019

The Trend Analysis of PM10, SO2, NO2 and AQI in the Year 2020 is Shown Below. It has been Observed that in January, February, March, Values Lies in Poor Range while Months from April to November Depicts Good Condition of Ambient Air.

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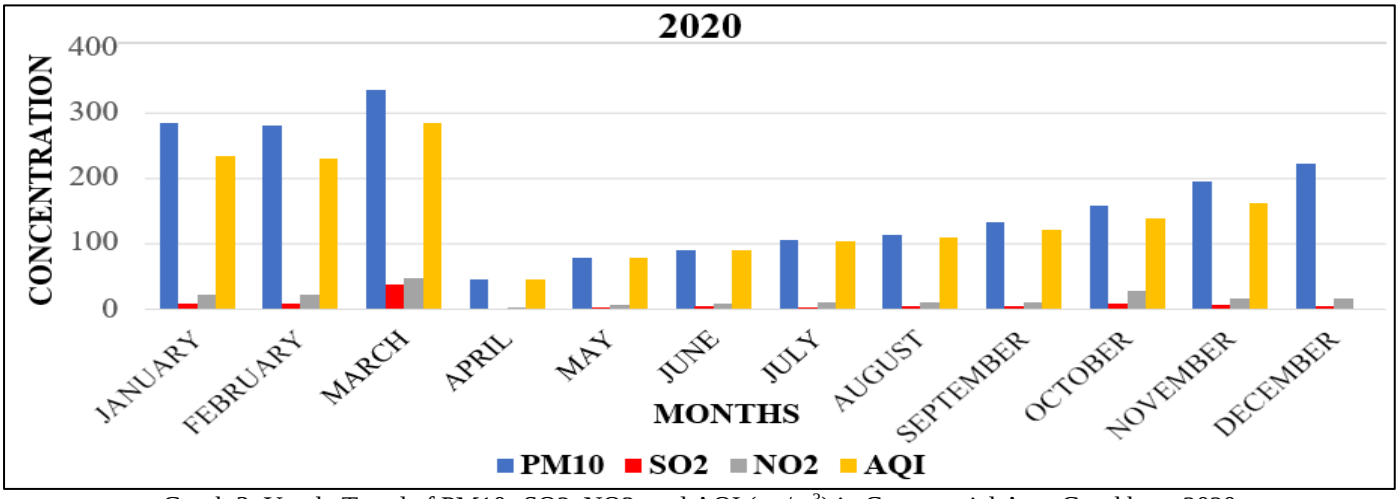
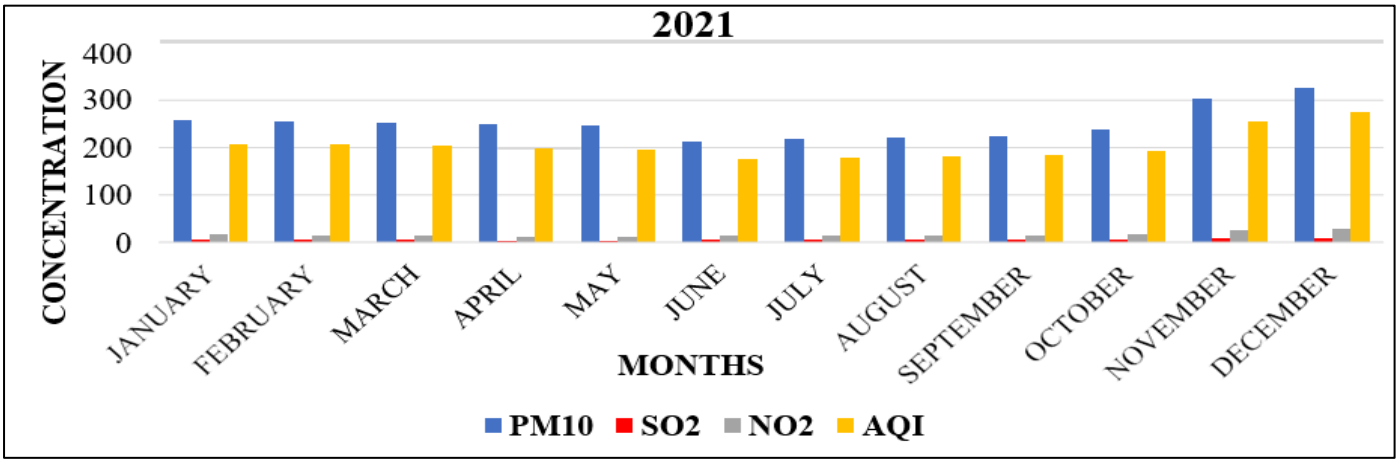


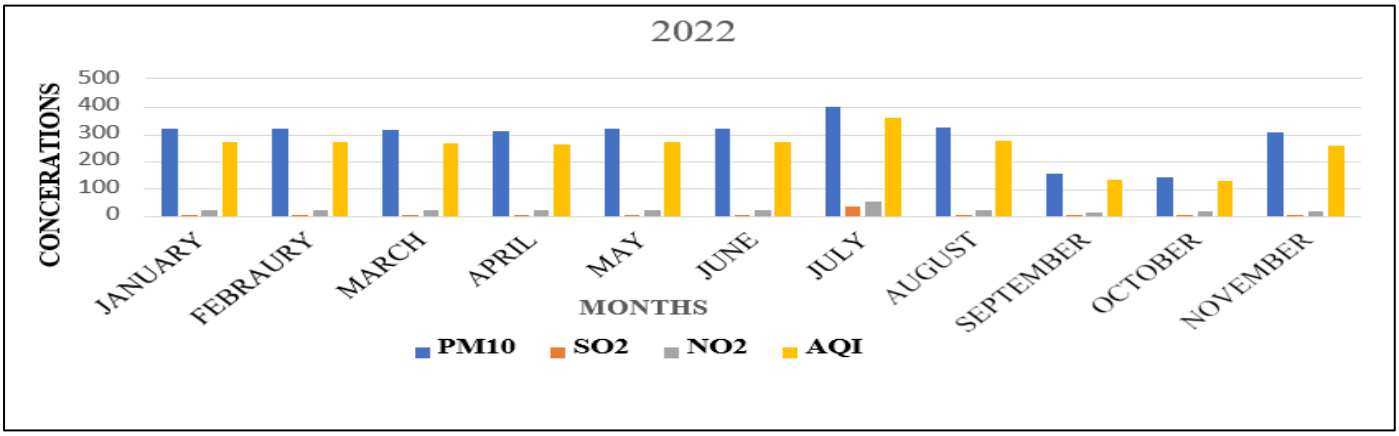
Graph 3: Yearly Trend of PM10, SO2, NO2, and AQI (µg/m^3) in Commercial Area Gorakhpur 2020

The chart below displays the trend analysis for PM10, SO2, NO2, and AQI in 2021. Because Gorakhpur started developing that year, it has been noted that most months have moderate levels of ambient air pollution and a significant impact from PM10.



Graph 4: Yearly Trend of PM10, SO2, NO2, and AQI (µg/m^3) in Commercial Area Gorakhpur 2021

The chart below displays the trend analysis for PM10, SO2, NO2, and AQI in 2022. It has been noted that readings for the months of January, February, March, April, May, June, July, and August are in the poor category, whereas those for the months of September through October show the ambient air to be in a moderate condition. Because they increased road width and demolished buildings with the use of heavy machinery, the July values for PM10 (401.13), SO2 (36.41), NO2 (54.02), and AQI (364) each month increased the range and had a greater impact on air pollution in the bar graph.



Graph 5: Yearly Trend of PM10, SO2, NO2, and AQI (µg/m^3) in Commercial Area Gorakhpur 2022

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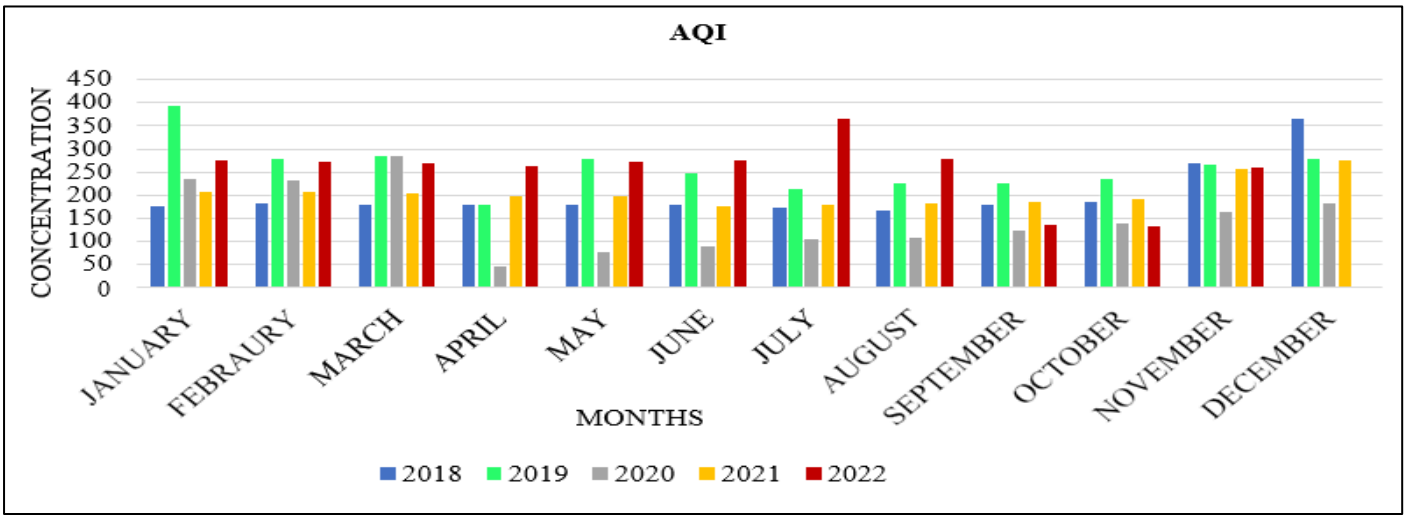
The bar graph depicts the AQI value for 2022 in the month of July, which has a significant impact on the environment and negatively affects human health (bad range, 251-350). The Air Quality Index (AQI) is a numerical scale, used to assess and report the level of air quality in a specific area. By providing details onthe quantity of various toxins in the air, it aids people in understanding the potential health effects connectedto the current air quality. The AQI typically has a range of 0 to 500, with different categories representing different degrees of air quality.



Graph 6: Air Quality Index Trend in the Year 2018,2019,2020,2021 and 2022 Jalkal BhawanGorakhpur

IV. CONCLUSION

In the current study, trend analysis of the air pollutants PM10, SO2, and NOx was conducted to evaluate theambient air quality in Gorakhpur's commercial areas. The data analysis is displayed in various tables and graphs. The Respirable Suspended Particulate Matter (RSPM) dust sampler is placed at Jalkal Bhawan rooftop in Golghar area of Gorakhpur city to monitor all the commercial areas of Gorakhpur city mainly Golghar, Indra Bal Vihar, Transport Nagar, Rustampur, Bank Road. At these places the traffic congestion is very high because of narrow road lanes and running of large number of vehicles on them resulting in excess amount of NO_x produced from vehicular emissions. Pollutants levels of SO_2 and NO_2 are significantlylower than those of PM_{10}. As Respirable Suspended Particulate Matter, PM_{10} causes discomfort to asthmaticpatients and children because it enters to lungs through inhalation. Pollution can be reduced more effectivelyby switching to clean fuel CNG for vehicles, closing commercial buildings, phase-out of older cars, and promoting the use of high-capacity buses and metro trains.

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