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RESEARCH ARTICLE

STATUS OF AIR QUALITY AND ITS TREND IN GORAKHPUR CITY

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ABSTRACT

In this study, an attempt has been made to determine the air quality of Lucknow city during the years (2015- 2022). Data on air pollutants (NO2, SO2, and PM10) has been analyzed from three monitoring sites which are operated by Madan Mohan Malaviya University of Technology (MMMUT), Gorakhpur. There are monitoring stations in residential, commercial, and industrial areas. The annual average concentrations of AQI for 2015 -2022 rangeexceeding the National Ambient Air Quality Standards for industrial, commercial, and residential areas. The annual averagevalue of the AQIexceeded in residential, commercial, and industrial areas respectively. However, AQIindicates distinct seasonality during winter months. The months of December and January demonstrate higher concentrations of AQI exhibiting the influence of winter inversion. These values distinctly exceed in winter, which is more than 3 times the national ambient air quality standard for residential areas. The paper also investigates the count of exceedances of national ambient air quality standards and briefly compares the results with previous air quality stutus to understand the comparative status of air quality in Gorakhpur city. The exceedance count of AQI is high with values above 100 for all the years and all sites.

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INTRODUCTION

Air pollution is a pervasive issue primarily driven by escalating transportation, industrialization, and urbanization, all stemming from human anthropogenic activities. These factors adversely impact human health, vegetation, and the environment. Gaseous pollutants like NO2 and SO2 undergo atmospheric chemical transformations, resulting in the formation of aerosol constituents such as nitrates and sulphates. The substantial emissions of nitrogen oxides, including nitric oxide (NO) and nitrogen dioxide (NO2), predominantly from biomass and fossil fuel combustion, contribute to air pollution phenomena like photochemical smog and the generation of acid rain precursors. Additionally, nitrous oxide (N2O), chiefly emitted from agricultural practices, not only depletes ozone in the stratosphere but also serves as a significant greenhouse gas, contributing to global warming.In India, substantial emissions of gaseous and particulate pollutants from industries, thermal power plants, and vehicles, including heavy-duty diesel trucks and gasoline-fueled cars, pose significant health risks. Upadhyay's research underscores the profound health impact of air pollutants, particularly in the polluted urban areas of India. Delhi, the national capital, is already ranked 11th globally among the most polluted cities, primarily due to high particulate matter concentrations.

Uttar Pradesh hosts four of the world's most polluted cities with elevated aerosol concentrations, namely Allahabad, Firozabad, Lucknow, Gorakhpur and Kanpur. The escalation in concentrations of respirable particulate matter (PM10), among all criteria pollutants, significantly contributes to adverse health effects. PM10 pollution primarily originates from on-road transport, undermining the positive outcomes of emissions control programs for vehicles. Other sources include coal-based thermal power plants, small-scale industries, road dust, and non-road activities such as construction. Both local and long-distance transport also exert a noteworthy impact. Given the substantial rise in respiratory diseases in major Indian cities like Gorakhpur, there is a pressing need for the assessment of ambient air quality. Given the detrimental health effects of air quality on the residents of Gorakhpur, the present investigation aims to achieve the following objectives: assess the current state of air quality in Gorakhpur, comprehend variations in air pollutant levels across different locations, analyze seasonal and annual fluctuations in air pollutants, and gain insights into the factors contributing to elevated particulate matter concentrations.

OBJECTIVES

- This study addresses this need by examining the contemporary air quality in Gorakhpur during the recent period of 2015-2022.

- To ensure stringent implementation of mitigation measures for prevention, control and abatement of air pollution

METHODOLOGY

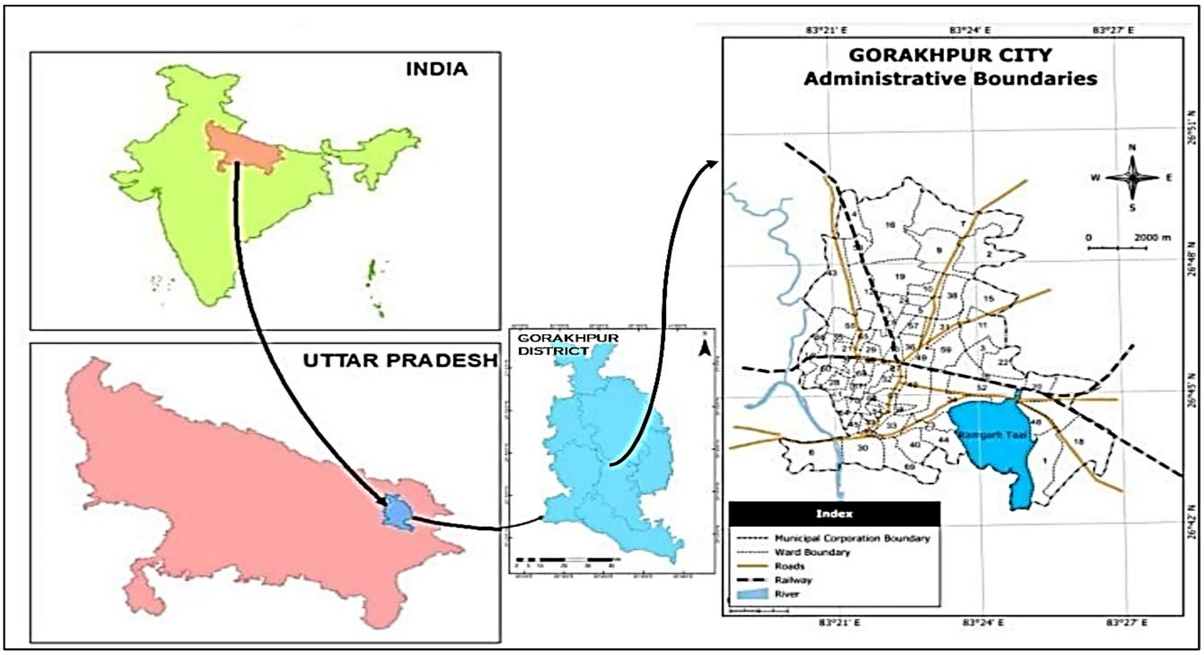
Study area: Gorakhpur is a city in the eastern part of the state of Uttar Pradesh in India, near the border with Nepal. It is the administrative headquarters of Gorakhpur District and Gorakhpur Division. Gorakhpur is one the most populated districts of Eastern Uttar PradeshIt is situated between 26°13′N and 27°29′N latitude and 83°05′E and 83°56′E longitude having long stretches of fertile alluvial plains split apart by perennial flow of Gangetic River system. Gorakhpur shares a common boundary with district Azamgarh on the south, Basti on west and district Deoria on east. It shares an international border with Nepal on the north. Gorakhpur city is situated 78 meters above mean sea level, which is not very high from the level of the river bed. It does not allow low lying areasof the city to drain properly, causing water to stand for 2-3 months in a year. Rapid pace of urban expansion however is gradually rasping the natural ecosystem around the city by either filling low-lying areas with solid waste or building constructions on them.

Availability of Data: Data pertaining to three criteria air pollutants, namely NO2, SO2, and PM10, were examined over a eight years period from 2015 to 2022. The data sources include the Uttar Pradesh Pollution Control Board, Lucknow, and the official website of the Central Pollution Control Board, Delhi (http://www.cpcb.nic.in). Table 1 provides details on the National Ambient Air Quality Standards (NAAQS) for 24-hour and annual averages of relevant air pollutants, along with the procedures for observational data measurements.

Data Analysis: Based on the three metrics PM10, SO2, and NO2, the Air Quality Index for the three manual monitoring sites has been developed for the past eight years. While it is crucial to note that Gorakhpur City's AQI has moved from a moderate to a low category since the 2018 winter. The recent increase in industrial activity and building, combined with inadequate or nonexistent control mechanisms, are the key factors contributing to Gorakhpur's declining air quality. The levels of PM10, SO2, and NO2 have also grown due to an increase in the number of cars, traffic congestion caused by narrow roads, an increase in roadside encroachments that impede the free flow of traffic, and an increase in the influx of unintended traffic.. The air quality of Gorakhpur city is monitored by 3 manual monitoring stations which are operated by Madan Mohan Malaviya University of Technology (MMMUT), Gorakhpur. There are monitoring stations in residential, commercial, and industrial areas.

SI	Pollutant	Time Weighted	Concentration in	Ambient Air (in ug/m3)
No		Average	Industrial, Residential, Rural and Other Areas	Ecologically Sensitive area2
1	SO2	Annual*	50	20
		24 h#	80	80
2	NO2	Annual*	40	30
		24 h#	80	80
3	PM10	Annual*	60	60
		24 h#	100	100
4	PM2.5	Annual*	40	40
		24 h#	60	60
5	Lead	Annual*	0.5	0.5
		24 h#	1.0	1.0
6	Ammonia	Annual*	100	100
		24 h#	400	400
7	Ozone(O3)	8 h#	100	100
		1 h#	180	180
8	CO	8 h#	2	2
		1 h#	4	4
9	Benzene	Annual*	5	5
10	Benzo (a) Pyrene particulate Phase Only	Annual*	1	1
11	Arsenic	Annual*	6	6
12	Nickel	Annual*	20	20

Source: CPCB,2009



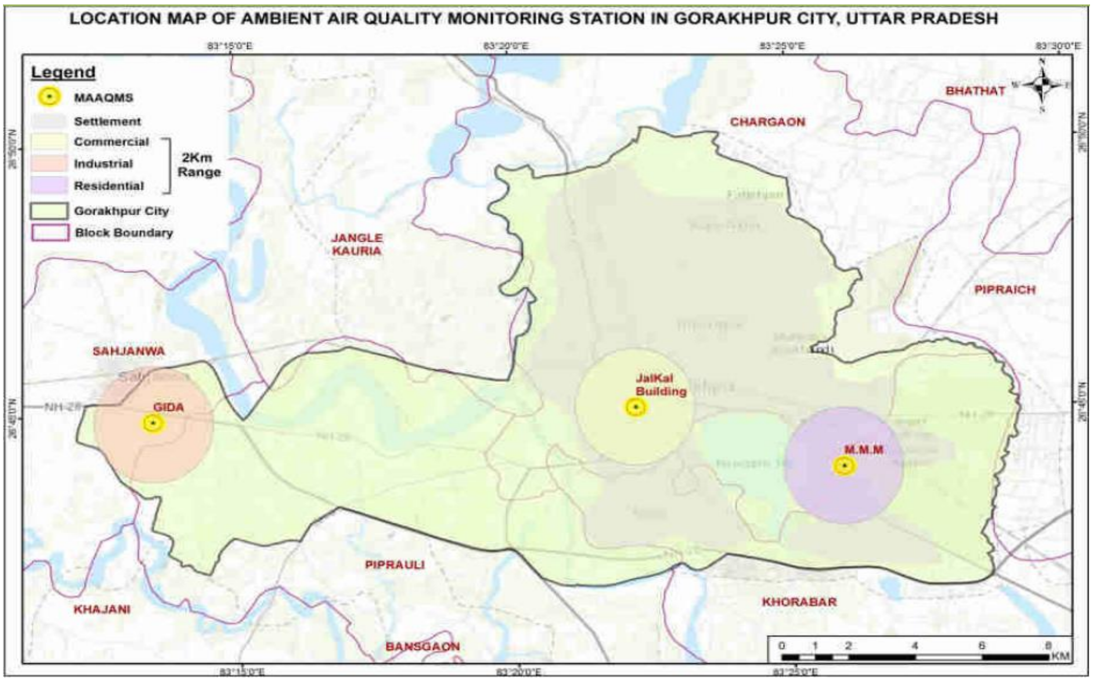


Table 2. Details of existing air quality monitoring stations

S. NO.	NAME OF THE STATION	LATITUDE	LONGITUDE	CATEGORY OF STATION	TYPE OF STATION	PARAMETERS MONITORED
1	Station Code-728, M.M.M. University of Technology, Gorakhpur	26˚43'53.1"	83˚25'57.5"	Residential	Manual	PM_{10}, SO_2, NO_2
2	Station Code-729, India Glycol LTD., GIDA, Gorakhpur	26˚44'52.8"	83˚13'28.1"	Industrial	Manual	PM_{10}, SO_2, NO_2
3	Station Code-730, Jal Kal Building, Golghar, Gorakhpur	26˚45'2.2"	83˚22'12.3"	Commercial	Manual	PM_{10}, SO_2,NO_2

Source: Clean Air report, UPPCB

The metrics used to determine data characteristics atdifferent observational sites were annual averages. Analyzing air pollutants spatially and temporally reveals variations in the short-term, seasonal, and long-term. Annual averages provide insights into the representative long-term impact of air pollutants. To assess the air quality status in a region, it is crucial to evaluate whether the long-term (annual averages) threshold values mandated by the Central Pollution Control Board (CPCB) are met. If these standards are not met, understanding the extent of the violations provides insights into how well the regions have achieved their air quality objectives.Monthly averages serve as valuable indicators of overall trends throughout the year, aiding in a better understanding of seasonal patterns in air quality. Air pollution poses a significant health risk, affecting even those who are generally healthy. Its adverse effects include respiratory irritation, asthma, and breathing difficulties, particularly during outdoor activities. The impact of air pollution on health varies depending on individual health conditions, the types of air particles present, the specific pollutants involved, the duration of exposure, and the concentration of air particles.To assess and address air quality concerns, countries establish their own standards and guidelines for measuring air quality indices. In India, for instance, the Central Pollution Control Board (CPCB) plays a crucial role. The CPCB not only provides guidelines for the air quality index but also actively monitors it through initiatives like the National Air Monitoring Program (NAMP). The primary objective of NAMP is to observe and calculate the air quality index in various regions across India. NAMP sets guidelines for industries and other pollution sources, aiming to regulate and control air pollution to maintain acceptable air quality standards.

Categories of Air Quality Index along with the expected impact: The air quality index is categorized into different levels, including Good, Satisfactory, Moderately Polluted, Poor, Very Poor, and Severe.

Each category has specific standard values based on the concentration of air pollutants. Exceeding these limits can have varying impacts on health, ranging from minor to severe, as illustrated in Figure 1. Summarizing the statistical range of air pollution and its health impacts provides a clearer understanding of how exceeding these limits can affect the human body.The Air Quality Index is a mechanism for clearly explaining the state of the air quality to the general public. It simplifies complicated information about the air quality caused by different contaminants into a single number (index value), name, and colour.

Good (0 – 50)	Minimal Impact
Satisfactory (51–100)	Minor breathing discomfort to sensitive people
Moderate (101–200)	Breathing discomfort to the people with lung, heart disease, children and older adults
Poor (201–300)	Breathing discomfort to people on prolonged exposure
Very Poor (301–400)	Respiratory illness to the people on prolonged exposure
Severe (>401)	Respiratory effects even on healthy people

Source: clean air action plan, Gorakhpur

RESULTS AND DISCUSSION

Over the past seven years, the Air Quality Index (AQI) for Gorakhpur city has been assessed based on three parameters: PM10, SO2, and NO2. Notably, the city's AQI transitioned from a moderate category to poor starting from the winter of 2018. This decline in air quality is primarily attributed to a recent surge in construction and industrial activities, coupled with inadequate control measures.

Table 3. Air quality index trend at MMMTU monitoring station (residential) in mg/m3

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
2015	63.0	121.0	63.0	114.0	109.0	99.0	62.0	104.0	97.0	90.0	94.0	106.0
2016	112.0	118.0	122.0	118.0	118.0	122.0	55.0	56.0	62.0	67.0	67.0	108.0
2017	109.0	112.0	107.0	108.0	107.0	108.0	90.0	55.0	68.0	78.0	92.0	112.0
2018	117.0	117.0	118.0	117.0	117.0	116.0	104.0	89.0	110.0	115.0	177.0	243.0
2019	273.0	246.0	249.0	240	225.0	152.0	135.0	135.0	133.0	145.0	161.0	163.0
2020	146.0	145.0	249.0	55.0	55.0	55.0	60.0	73.0	82.0	92.0	104	126
2021	147.0	148	146.0	137	136.0	77.0	59.0	76.0	74.0	97.0	114.0	117.0
2022	116.0	118	111.0	106.0	117.0	120.0	123.0	120.	69.0	78.0	127	124

Source: Clean Air report, UPPCB

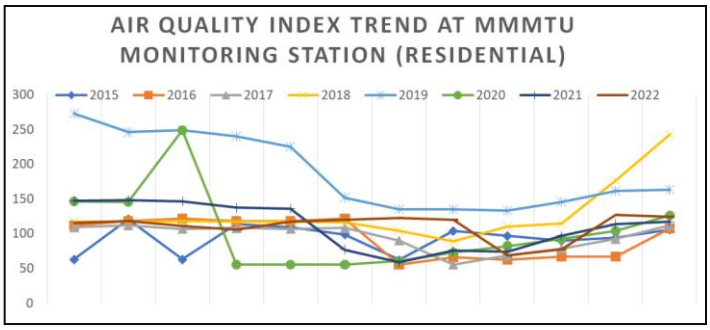
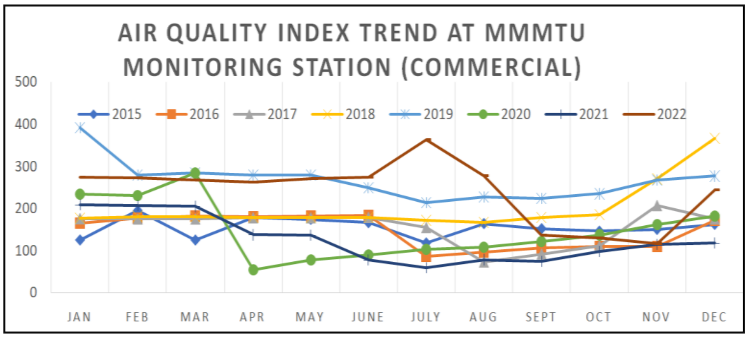


Table 4. Air quality index trend at Jalkal Bhavan monitoring station (commercial) in mg/m3

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
2015	125.0	195.0	125.0	179.0	174.0	166.0	118.0	164.0	152.0	146.0	150.0	162.0
2016	166.0	178.0	183.0	180.0	183.0	184.0	87.0	97.0	107.0	110.0	111.0	172.0
2017	176.0	175.0	175.0	178.0	178.0	179.0	155.0	73.0	92.0	111.0	207.0	175.0
2018	177.0	181.0	180.0	179.0	178.0	179.0	172.0	167.0	179.0	185.0	270.0	366.0
2019	392.0	280.0	285.0	280.0	280.0	249.0	214.0	227.0	224.0	235.0	267.0	277.0
2020	234.0	231.0	285.0	55.0	78.0	90.0	104.0	109.0	122.0	138.0	163.0	182.0
2021	208.0	206	204.0	137.0	136.0	77.0	59.0	78.0	74.0	97.0	114.0	117.0
2022	275.0	273.0	269.0	263.0	272.0	275.0	364.0	278.0	137.0	131.0	259.0	245

Source: Clean Air report, UPPCB

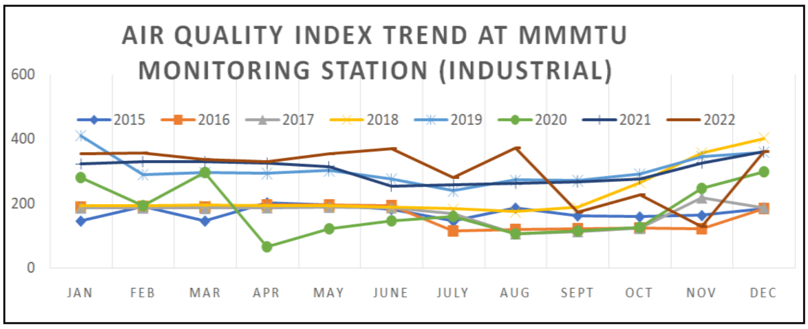


Source: Clean Air report, UPPCB

Table 5. Air quality index trend at GIDA monitoring station (industrial) in mg/m3

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
2015	146.0	191.0	146.0	202.0	195.0	182.0	145.0	186.0	162.0	159.0	163.0	184.0
2016	189.0	192.0	190.0	196.0	195.0	194.0	115.0	119.0	122.0	123.0	121.0	185.0
2017	186.0	186.0	185.0	187.0	188.0	187.0	168.0	106.0	113.0	123.0	217.0	187.0
2018	192.0	193.0	194.0	191.0	191.0	188.0	182.0	174.0	187.0	265.0	356.0	402.0
2019	409.0	289.0	296.0	293.0	302.0	275.0	239.0	272.0	271.0	291.0	344.0	358.0
2020	282.0	193.0	296.0	65.0	121.0	145.0	160.0	106.0	115.0	125.0	248.0	299.0
2021	322.0	330.0	329.0	324.0	314.0	253.0	257.0	263.0	267.0	275.0	326	361.0
2022	355.0	357.0	337.0	333.0	355.0	369.0	280.0	372.0	171.0	226.0	292.0	360

Source: Clean Air report, UPPCB



Source: Clean Air report, UPPCB

The rise in the number of vehicles, traffic congestion due to insufficient road width, and an increase in roadside encroachments have further exacerbated the situation, leading to elevated levels of PM10, SO2, and NO2.The spike in SO2 and NO2 levels observed in 2018 may also be influenced by local factors. However, the COVID-19 pandemic and the subsequent lockdown had a positive impact on the environment worldwide, including Gorakhpur. During the lockdown in April 2020, there was a significant improvement in AQI, with a remarkable 77%, 80%, and 78% decline in residential, commercial, and industrial areas, respectively, compared to the previous year. This decline can be attributed to reduced human activities and emissions during the lockdown period.Following the pandemic-induced lockdown, the AQI in the residential area of Gorakhpur remained in the satisfactory category until October 2020. However, in the post-lockdown period, the AQI in both commercial and residential areas shifted to the moderate category.In summary, the AQI trends in Gorakhpur reflect the impact of various factors such as industrial and construction activities, vehicular emissions, and the positive influence of the COVID-19 lockdown on air quality. Ongoing efforts and measures are essential to address the root causes and sustain improvements in air quality in the city.

The air quality index trends are given as: The provided data represents**table no 4** air quality index (AQI) values for each month from January 2015 to December 2022, sourced from the Clean Air report by the Uttar Pradesh Pollution Control Board (UPPCB). The AQI is a numerical scale that quantifies the quality of air based on various pollutants, providing an overall assessment of air cleanliness and potential health risk. The values range from 55.0 to 273.0, indicating fluctuations in air quality over the years. There is noticeable variability in AQI values across months and years, suggesting diverse pollution levels throughout the given period. Higher values, such as those exceeding 100, generally indicate poorer air quality, while lower values reflect better air quality. The highest values are observed in 2019, with a peak AQI of 273.0, possibly signifying a period of heightened pollution. Some months exhibit consistently higher or lower AQI values, indicating recurring patterns in air quality. It's essential to analyze this data in conjunction with pollutant concentration standards to assess the severity of air pollution. Moreover, trends over the years can provide insights into the effectiveness of pollution control measures and highlight areas that may require targeted interventions for improving air quality. The data provided represents in table no 5 air quality index (AQI) values for each month from January 2015 to December 2022. The AQI is a measure that reflects the overall air quality based on the concentrations of various pollutants. The AQI values vary across different months and years, indicating fluctuations in air quality.Higher values typically suggest poorer air quality, while lower values indicate better air quality. In 2015, the AQI ranged from 118.0 to 195.0, with the highest value observed in February. The year 2016 showed fluctuations, with the highest AQI recorded in December. 2017 exhibited relatively stable values, while 2018 saw a significant increase, reaching a peak in December with a value of 366.0. The highest AQI values were recorded in 2019, particularly in January, indicating a period of severe pollution. Subsequent years, such as 2020 and 2021, show some improvement but still include months with elevated AQI values. Some months consistently have higher or lower AQI values, indicating potential seasonal or localized pollution patterns. In 2022, the AQI values remained relatively high, with the highest value observed in July. Monthly fluctuations continue, emphasizing the dynamic nature of air quality. Additionally, comparing this data with established air quality standards can help assess the severity of air pollution and guide efforts to improve air quality in the region.

The provided data represents table no 6 air quality index (AQI) values for each month from January 2015 to December 2022. The AQI is a numerical representation of overall air quality, taking into account various pollutants. AQI values exhibit fluctuations across different months and years, suggesting variations in air quality over time. Higher AQI values generally indicate poorer air quality, while lower values signify better air quality. In 2015, AQI values ranged from 145.0 to 202.0, with the highest value recorded in April. Subsequent years, such as 2016 and 2017, show fluctuations with peaks in December. The year 2018 saw a significant increase in AQI values, reaching a peak in December with a value of 402.0. The highest AQI values were observed in 2019, particularly in January, indicating a period of severe pollution. Notable peaks are also observed in 2020, with a spike in January, and in 2021, with an increase in December. Some months consistently have higher or lower AQI values, suggesting potential seasonal or localized patterns in air pollution. In 2022, AQI values remained relatively high, with noticeable fluctuations throughout the months. The highest AQI value in 2022 was observed in August. Understanding the specific pollutants contributing to these AQI values would provide insights into the sources of pollution. Comparing the data against established air quality standards helps evaluate the severity of air pollution and informs strategies to improve air quality in the region. Overall, the data underscores the dynamic nature of air quality, influenced by seasonal, environmental, and anthropogenic factors.

CONCLUSION

Based on the provided air quality index (AQI) The residential area, represented by MMMTU monitoring station, shows fluctuations in AQI values over the years. Notably, the year 2019 witnessed a severe pollution event in January, reflected by extremely high AQI values.The data suggests a need for ongoing monitoring and potential interventions to address air quality concerns in this residential zone. the commercial area, monitored by Jalkal Bhavan, exhibits variations in AQI values over the year. Similar to the residential area, 2019 stands out with exceptionally high AQI values in January. Continued monitoring and targeted measures may be necessary to manage pollution sources in this commercial zone.The industrial area, represented by GIDA monitoring station, shows fluctuations in AQI values with notable increases in certain months. Severe pollution events, particularly in January 2019, indicate potential challenges related to industrial emissions. Consistent monitoring and proactive measures are crucial to manage and control industrial-related air pollution. All three monitoring stations highlight certain months consistently showing higher AQI values, suggesting potential seasonal patterns or recurring pollution sources.The data underscores the dynamic nature of air quality in different zones, emphasizing the importance of consistent monitoring and analysis.The data for the year 2022 indicates continued fluctuations in AQI values across all monitoring stations.Ongoing monitoring and responsive measures are crucial to address air quality challenges in the current year. In conclusion, the data underscores the importance of continuous monitoring and targeted interventions to address air quality issues in different zones, whether residential, commercial, or industrial. The severe pollution events in specific months, especially in 2019, call for sustained efforts to manage and control air pollution sources in the region.

REFERENCES

Upadhyay, E. 2014. “An Introduction to Air Quality Index and HealthConcerns”, Bio-Evolution, 1 (2),pp. 51-54.

Erisman, J. W. 2007. A. Bleeker, A. Hensen and A. Vermeulen,“Agricultural air quality in Europe and the future perspectives”,Atmospheric Environment.

WHO, 2016. “Air Pollution in Cities Database”, Geneva, 2014.http://www.who.int/phe/health_topics/outdoorair/databases/AAP_database_results_2014.pdf Accessed on.

Kampa M. and E. Castanas, 2008. “Human health effects of air pollution.Environmental Pollution”, 151(2), pp. 362-367.

Lin, H. J. Tao, Y. Du, T. Liu, Z. Qian, L. Tian, Q. Di, W. Zeng, J.Xiao, L. Guo, X. Li, Y. Zu and W. Ma, “Differentiating the effectsof characteristics of PM pollution on mortality from ischemic andhemorrhagic strokes”, Environmental Health, 219, pp. 204-211,2016.

Upadhyay, E. 2014. “An Introduction to Air Quality Index and HealthConcerns”, Bio-Evolution, 1 (2), pp. 51-54.

Erisman, J. W. 2007. A. Bleeker, A. Hensen and A. Vermeulen,"Agricultural air quality in Europe and the future perspectives",Atmospheric Environment.

WHO, 2016. "Air Pollution in Cities Database", Geneva, 2014.http://www.who.int/phe/health_topics/outdoorair/databases/AAP_database_results_2014.pdfAccessed on 27.11.

Qing, H. A, Xingqin, T. Yan and S. Zhaobin, 2016. "Assessment ofresident's exposure level and health economic costs of PM10 inBeijing from 2008 to 2012", Science of The Total Environment,Vol. 563–564, 1, pp. 557-565.

Ghosh, S. J. Biswas, S. Guttikunda, S. Roychowdhury and M. Nayak, 2015. "An investigation of potential regional and local sourceregions affecting fine particulate matter concentrations in Delhi",India. Journal of Air and Waste Management Association, Vol. 65(2), pp. 218-31.

Biswas, E. Upadhyay, M. Nayak and A.K. Yadav, J. 2011. "An analysisof Ambient Air Quality Conditions over Delhi, India from 2004 to2009", Atmospheric and Climate Sciences, Vol-1, pp. 214-224.

Verma, K. A.1. Saxena, A. H. Khan and G. D. Sharma, 2015. "AirPollution Problems in LucknowCity, India: A Review", Journal ofEnvironmental Research and Development, Vol. 9, pp.11761188.

Lawrence and N. Fatima, 2014. "Urban air pollution & its assessment inLucknow City - The second largest city of North India", Science ofThe Total Environment, Vol-488–489, pp. 447-455.

WHO, 2006. "Application of guidelines in policy formulation. Air quality guidelines global update 2005: particulate matter, ozone, nitrogendioxide and sulfur dioxide",WHO Regional Office for Europe,Copenhagen, pp. 176.

Shukla, R. K. Mishra and M. Parida, 2010. "Estimation of Composite AirQuality Index for Lucknow Institute of Town Planners", IndiaJournal, 7 - 4, pp. 45 – 56.

Mendoza-Dominguez and A.G. Russell, 2001. "Emission StrengthValidation UsingFourDimensional Data Assimilation: Applicationto Primary Aerosol and Precursors to Ozone and SecondaryAerosol", *Journal of the Air & Waste Management Association*,Vol-51, pp.1538-1550, November.

Lawson, D. R. and R. E. Smith, 1998. "The Northern Front Range AirQuality Study – A Report to the Governor and General Assembly".

Guttikunda, S. 2009. "Air Quality Management in Delhi, India: Then,Now and Next. Air QualityManagement in Delhi, India," SIM-AirWorking Paper Series, Vol. 22, pp. 1-8.

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