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Analysis of Trends in Air Ambient Quality Index: A Case Study of Guwahati City of Assam, India

SHARMISTHA CHAKRABORTY[1], MAROMI ROY[1], NAZIMA SULTANA[2], and MEHDI AL KAUSOR[1]*

[1]Department of Chemistry, Science College, Kokrajhar, Assam, India.
[2]University of Science & Technology Meghalaya, Techno City, Ri-Bhoi, Meghalaya, India.
*Corresponding author E-mail: mehdialkausar@gmail.com

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ABSTRACT

The daily air pollution levels are crucial, especially for those people who are suffering from some air borne diseases. The air quality index (AQI) values may increase due to increased emissions from vehicles, construction activities, flyovers, road widening, traffic discharge, and lack of rain. Monitoring these factors is essential for maintaining a healthy environment. The study was conducted w.r.t. some major gaseous air pollutants like CO, SO_2, NO_2, O_3, and NH_3 along with some fine particulate matter such as PM_{10} and $PM_{2.5}$ covered under AQI worldwide. This paper analyzes the AQI data in Guwahati City, Assam, India, aiming to raise public awareness about potential health issues and suggest effective measures for controlling the deteriorating air quality and promoting swift action against air pollution. The investigation revealed a slight increase in aggregate levels of five pollutants, resulting in poor overall AQI levels during the winter session. The study suggests that the increase in AQI value in Guwahati, Assam, India, may be due to construction, flyovers, road widening, and excessive traffic, leading to low visibility and suggests government intervention through smart policies and regular monitoring. The study could be expanded to other districts and regions, conducted cross-nationally for more tangible results, and seasonal variations may be increased for better results.

Keywords: Air quality index, Air pollution, SO_2, NO_2, Particulate matter 10, Particulate matter 2.5.

INTRODUCTION

The global pollution in air has been appeared as a rising problem across the globe in many metropolitan cities. In recent years, India is seeming industrial, rapid urbanization, infrastructure and economic growth[1] and the issue of pollution in air in metropolitan cities is a serious concern[2]. The air pollution is occurred mainly due the presence of gases like CO, SO_2, NO_2, O_3, and NH_3 along with some particulate matter such as PM_{10} and $PM_{2.5}$. PM_{10} (diameter = 10 µm) and $PM_{2.5}$ (diameter = 2.5 µm) are both found in dust and smoke. The PM10 particles can easily penetrate nose, throat, and lungs and cause coughs, colds and eye burns. Similarly, due to higher levels of $PM_{2.5}$, the atmosphere appears opaque and visibility is reduced. Many Indian metropolitan cities are considered to be the among most 20 polluted cities across the globe. In 2015, almost 10 lakhs of people perished in India

only as a result of particulate matter pollution[3]. The particulate matters are regarded as the most dominant pollutant which are contaminating the air by automobiles, industrial, house-hold activities across many parts in India[4]. Severe air pollution increases the risk of heart stroke, heart related diseases, other acute respiratory diseases including cancer in lungs and asthma. Higher concentration of SO_2 and NO_2 in the atmosphere may exert serious effect on soil, water, and cropping pattern[5,6]. In addition to that, air pollution also reduces the atmospheric visibility and change the climate[7]. Even the internal quality of air also remarkably impacts the human health and overall well-being of those who reside in these spaces[8,9].

The quality of air on day-to-day basis is measured in terms of the AQI value. AQI is used to estimate how polluted the air is and how that local air quality may affect a person's health. AQI is obtained from the average readings of some air quality sensors. This AQI may increase as result of any kind of activities that leads to air pollution. The pollutants detected by the sensors include gaseous pollutant viz. CO, O_3, NO_2, SO_2 etc. along with PM_{10} and $PM_{2.5}$. The increasing levels of these gases and particulate matters are considered to be severe air pollutants in urban areas[10,11]. The AQI sometimes may increase when the air gets polluted to a significant extent. The main reasons behind this are the ongoing construction of houses, buildings and multi-story apartments, flyovers, road and highway widening activities[12] polluted gas emissions from excess vehicles and also the atmosphere with dust, sand and smog due to lack of rainfall. This causes poor visibility and burns people's eyes.

In India, the AQI provides a straightforward, 1-number-1-color-1-description for individuals to assess the air quality in their specific area which was launched by National Air Quality Index (NAQI) mission. The Central and State Pollution Control Boards (CPCB & SPCB) regularly conduct a National Air Monitoring Program (NAMP) that covers as much as two hundred forty cities across the country. For continuous monitoring of the real time data, authorized centers were established in several cities. A board of members comprising air quality experts from medical colleges and hospitals, education departments, advocacy groups and state pollution control boards was formed along with Indian Institute of Technology (IIT) Kanpur. The I.I.T. Kanpur along with the board members suggested the AQI scheme[13]. The AQI has six categories, such as good, satisfactory, moderately polluted, poor, very poor, and severe. The]is proposed AQI covers eight pollutants viz CO, SO_2, NO_2, O_3, NH_3 Pb, PM_{10}, and $PM_{2.5}$ for which short-term national air standards (average terms per hour) are set. Based on levels of these atmospheric pollutants and the associated standards, the potential health impacts are suggested for each of these pollutants for a particular range of AQI values. According to the initial inputs, the range of various AQI categories and the various pollutants and the potential health impacts for these pollutants are given in Table 1 and Table 2 respectively[13].

Table 1: The six categories of AQI range along with various pollutants

AQI Range	PM_{10}(µg/m³) 24 h	$PM_{2.5}$(µg/m³) 24 h	NO_2(µg/m³) 24 h	O_3(µg/m³) 8 h	CO(µg/m³) 8 h	SO_2(µg/m³) 24 h	NH_3(µg/m³) 24 h	Pb(µg/m³) 24 h	Indicating Colour
0-50	0-50	0-30	0-40	0-50	0-1.0	0-40	0-200	0-0.5	Light Blue
51-100	51-100	31-60	41-80	51-100	1.1-2.0	41-80	201-400	0.5-1.0	Green
101-200	101-250	61-90	81-180	101-168	2.1-10	81-380	401-800	1.1-2.0	Pink
201-300	251-350	91-120	181-280	169-208	10-17	381-800	801-1200	2.1-3.0	Yellow
301-400	351-430	121-250	281-400	209-784*	17-34	801-1600	1200-1800	3.1-3.5	Red
401-500	430+	250+	400+	784+	34+	1600+	1800+	3.5+	Maroon

Table 2: The six categories of AQI and the associated health effects of each category

AQI	Category	Associated health effects
0-50	Good	Lowest impact
51-100	Satisfactory	Sensitive people may have slight difficulty breathing.
101-200	Moderately polluted	Asthma, lungs and heart disease, children and orderly people with may suffer breathing.
201-300	Poor	Long time exposure may cause breathing difficulty, and heart disease.
301-400	Very poor	Long time exposure can develop respiratory diseases. Such affects may be prominent for people suffering from lung and heart disease.
401-500	Severe	Long time exposure may develop respiratory diseases even in healthy people as well, and may cause severe health issues in people suffering from lung and heart disease.

Source: Central Pollution Control Board, Ministry of Environment, Forests and Climate Change

The monitoring of the AQI of a particular region is crucial for swift action against the deterioration of quality of air and creating a public awareness. However, the critical analysis and research on this field is limited. In this paper, comprehensive analysis of the ambient AQI data in terms of, CO, SO_2, NO_2, NH_3, O_3, PM_{10} and $PM_{2.5}$ of Guwahati City of Assam, India is carried out to create an awareness about the AQI among the mass people regarding the probable health issues that might arise due to air pollution and suggest some effective measures in controlling the air quality index.

MATERIALS AND METHODS

In India, the ambient air quality data is collected by monitoring the continuous ambient air quality at the authorized monitoring stations. The monitoring of air pollutants is being conducted with the assistance of State Pollution Control Boards (SPCB), Pollution Control Committees (PCC). The CPCB collaborates with these agencies to ensure the uniformity and consistency of air quality data. At the AQI monitoring sites, all data for specific pollutants are taken from its 24-h average concentration (8-h in the case of CO and O_3). Sometimes data for the pollutants may not be monitored at the stations. The AQI is calculated based on data for the lowest three pollutants, including $PM_{2.5}$ or PM_{10}, which requires a minimum of 16 h of data. It is determined in real time by an automated web-based system without any human intervention, displaying the average, minimum and maximum levels of the selected pollutants along with the average AQI values.

The data required for the present investigation were collected from the website of CPCB (https://airquality.cpcb.gov.in/AQI_India_Iframe/) under Ministry of Environment, Forest and Climate Change (MoEFCC), Govt. of India. The monthly variation of the average AQI values is then critically analyzed and the ambient air quality at each sampling sites are categorized from which information regarding the status of the air quality is ascertained.

Study area

Guwahati City, located in Kamrup district of Assam, India, is the largest commercial, industrial, and educational center in the N-E region. The location of the city is in between 25.46° and 26.49° North Latitude and between 90.48° and 91.50° East Longitude. The Guwahati Metropolitan area have a population of around a million and a population density of 2695.43/km^2.

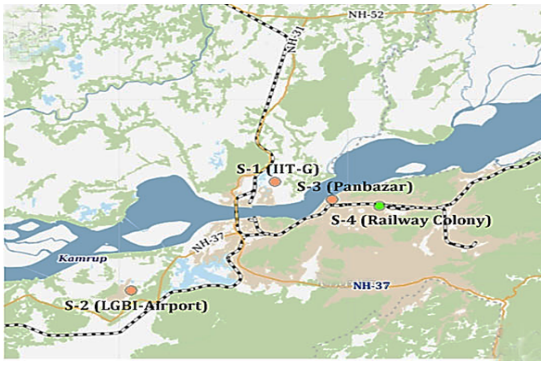

Fig. 1. The study area (Source: https://airquality.cpcb.gov.in/AQI_India_Iframe/)

The city is located on an undulating plain with altitudes ranging from 49.5 to 55.5 meters above sea level, surrounded by hillocks, swamps, marshes, and water bodies like Deepor Beel, Silpukhuri, Dighali Pukhuri, Borsola Beel and Silsakoo Beel. The southern and eastern sides of the city are sorrounded by hillocks. The central part of the city also has small hillocks like Sarania hill (193 m), Nabagraha hill (193 m) and Chunsali hill (293 m). The sampling was done at four different locations which are IIT Guwahati (Location: S-1), LGBI Airport (Location S-2), Pan Bazar (Location S-3), and Railway Colony (Location S-4). The ambient air quality data in these four stations were collected from the CPCB website.

RESULTS AND DISCUSSION

The maximum AQI at S-1 for the month of October/2022 was reported as 148 on dated 20/10/2022 with $PM_{2.5}$ particles being the prominent one. Similarly, the maximum AQI values of the other three sampling stations were reported as follows: 96 on dated 01/10/2022 at S-3, and increased to 188 on dated 26/10/2022 at S-4 with prominent particles being PM_{10} and $PM_{2.5}$ respectively. Average AQI at S-2 was not recorded during this month and the overall AQI was found to be moderately polluted as S-1 and S-4 but satisfactory at S-3. In the month of November almost similar data was recorded: 175 on dated 23/11/2022 at S-1, 170 on dated 23/11/2022 at S-3 and 158 on the same date at S-4 with prominent particles being $PM_{2.5}$ in all sampling sites. On this month also, the

AQI at S-2 was not recorded. The overall AQI was found to be moderately polluted. In the month of December/2022, the maximum AQI at S-1 was reported as 305 on dated 27/12/2022 with $PM_{2.5}$ particles being prominent. Similarly, the maximum AQI values of the other three sampling stations were reported as follows: 279 on dated 27/12/2022 at S-2, 282 on dated 31/12/2022 at S-3 and 312 on dated 31/12/2022 at S-4 with prominent particles being $PM_{2.5}$ at S-1, S-2 and S-4 and PM_{10} at S-3. The overall AQI was found to be poor at S-1, S-2 and S-3, but very poor at S-4.

Table 2: Analysis of maximum AQI and the level of pollution

Months	Sampling site	Maximum AQI	Date	Category
October/2022	S-1	148	20/10/2022	Moderately polluted
	S-2	NA	NA	-
	S-3	96	01/10/2022	Satisfactory
	S-4	188	26/10/2022	Moderately polluted
November/2022	S-1	175	23/11/2022	Moderately polluted
	S-2	NA	NA	-
	S-3	170	23/10/2022	Moderately polluted
	S-4	158	23/10/2022	Moderately polluted
December/2022	S-1	305	27/12/2022	Poor
	S-2	279	27/12/2022	Poor
	S-3	282	31/12/2022	Poor
	S-4	312	31/12/2022	Very poor
January/2023	S-1	359	16/01/2023	Very poor
	S-2	346	15/01/2023	Very poor
	S-3	386	15/01/2023	Very poor
	S-4	419	15/01/2023	Severe
February/2023	S-1	346	06/02/2023	Very poor
	S-2	348	21/02/2023	Very poor
	S-3	355	21/02/2023	Very poor
	S-4	356	21/02/2023	Very poor
March/2023	S-1	333	10/03/2023	Very poor
	S-2	258	12/03/2023	Poor
	S-3	289	12/03/2023	Poor
	S-4	296	12/03/2023	Poor

* NA: Not Available

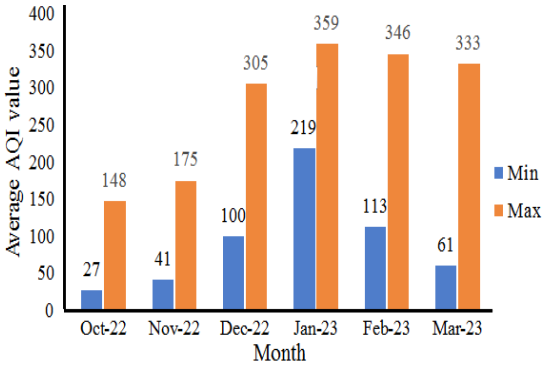

Fig. 2. Monthly variation of average AQI values at S-1

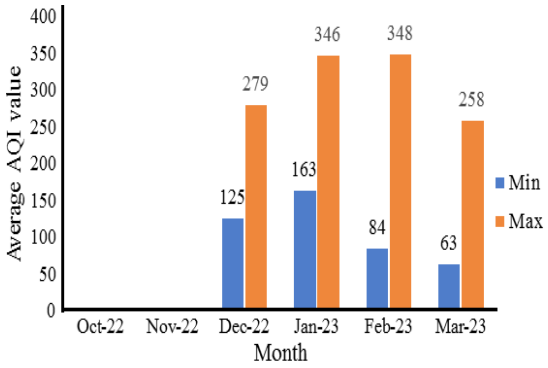

Fig. 3. Monthly variation of average AQI values at S-2

Similarly, in the month of January/2023 almost similar data was recorded: 359 on dated 16/01/2023 at S-1, 346 on dated 15/01/2023 at S-2, 386 on dated 15/01/2023 at S-3 but the average AQI was increased to 419 on dated 15/01/2023 at S-4 with prominent particles being $PM_{2.5}$ and PM_{10} respectively. However, unfortunately in this month, the overall AQI was found to be very poor except at S-4 where, the overall AQI was found to be severe. Again, in the month of February/2023 almost similar data was recorded: 346 on dated 06/02/2023 at S-1, 348 on dated 21/02/2023 at S-2, 355 on dated 21/02/2023 at S-3, and 356 on dated 21/02/2023 at S-4 with prominent particles being $PM_{2.5}$ in all the sampling sites. However, unfortunately in this month, the overall AQI was also found to be very poor. It was found that the PM_{10} levels during were higher than usual, indicating longer residence times due to stagnant conditions and low mixing heights in the atmosphere[14].

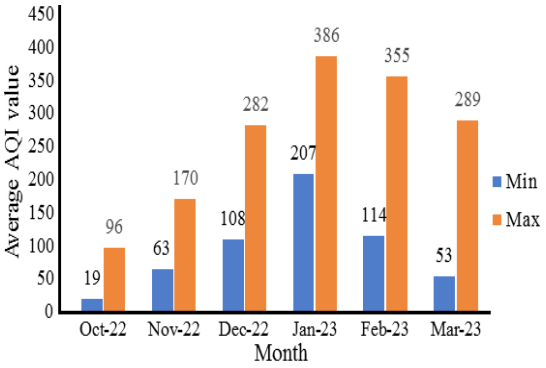

Fig. 4. Monthly variation of average AQI values at S-3

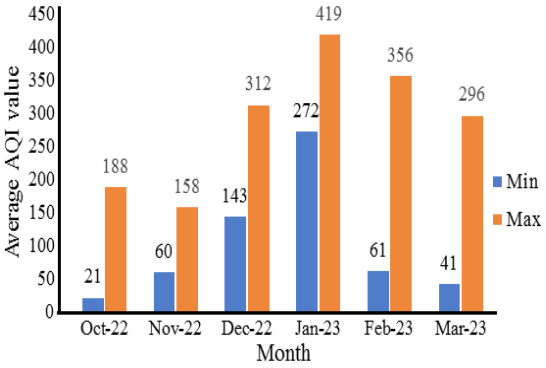

Fig. 5. Monthly variation of average AQI values at S-4

On February 21, the National AQI bulletin of the CPCB revealed that at 7 pm, at the railway colony monitoring station (S-4), the $PM_{2.5}$ and PM_{10} levels had come down to unhealthy levels. The Superintendent of Gauhati Medical College and Hospital, Assam reported that 36 children with bronchiolitis, asthma and pneumonia problems under the influence of unhealthy air were admitted to the Hospital. However, their health gets better later on. The CPCB's national AQI bulletin showed that on 19th February, 2023 at around 10 pm, the $PM_{2.5}$ and PM_{10} around the railway colony monitoring station had deteriorated to two "severe" levels. Even as compared to around 6 a.m. the next day, the level of $PM_{2.5}$ rose and touched a high value of 353 at around 10 am. According to data from the AQI bulletin on 21st February, at around 7 pm, the $PM_{2.5}$ and PM_{10} levels have deteriorated to two "unhealthy" levels. On the other hand, in the month of March/2023 the average AQI was recorded as follows: 333 on dated 10/03/2023 at S-1, 258 on dated 12/03/2023 at S-2, 289 on dated 12/03/2023 at S-3 but the average AQI was slightly decreased to 296 on dated 12/03/2023 at S-4 with prominent particles being PM2.5 at S-1 and S-2, but PM_{10} at S-3 and S-4 respectively. However, in this month, the overall AQI was found to be very poor at S-1 and poor at other sampling stations.

Policy Implication and Suggestions

As the value of AQI increases, public health risks may increase. Especially children, elderly people and people suffering from respiratory or cardiovascular diseases may be affected. During this time people should generally be avoided to reduce outdoor physical activities or even avoid going out from homes. Masks or masks should be used if you have to go out for special purposes. Although the AQI level in Guwahati city has gone down recently but if we are satisfied, it will not happen. The way climate is changing now, no one can predict when the situation is again. Therefore, it is time for the CPCB, SPCB, the Government and all concerned authorities to prepare a long-term plan and think about how to keep the air quality of the city good and take appropriate action. It is important to note that we all should be aware of the daily levels of air pollution. Especially those suffering from diseases caused by exposure to polluted air need to be careful by monitoring the quality of AQI. The AQI value may increase due to increased emissions of various types of polluting gases in the atmosphere. For example, excessive vehicular movement during peak hours and industrial activities as well as daily construction activities may result in an increase in air pollutants[15,16]. Air pollution can occur in local areas due to stable air, often cyclones, temperature reversals, or low wind speeds, thereby obscuring the atmosphere around due to chemical reactions between high concentration pollutants and air pollutants.

The authors believe that main reason behind this increase in AQI value at Guwahati city of Assam, India may be due to the ongoing construction of houses, buildings and multi-storied apartments, flyovers, widening of roads and highways, discharge of polluted gas from excess traffic as well as lack of rain engulfing the atmosphere with dust sand, smoke and fog (smog), which resulted in low visibility of people. The study recommends the government adopting forced measures to combat pollution in cities, including smart policies, legislation, and regular monitoring of AQI values, with the aim of ensuring a pollution-free environment.

CONCLUSION

It is important to note that we all should be

aware of the daily levels of air pollution. Especially those suffering from diseases caused by exposure to polluted air need to be careful by monitoring the quality of AQI. The AQI value may increase due to increased emissions of various types of polluting gases in the atmosphere. For example, excessive vehicular movement during peak hours, an increase in air pollutants is likely to increase during daily construction activities. Air pollution can occur in local areas due particulate matter emission from the ongoing construction of houses, buildings and multi-storied apartments, flyovers, widening of roads and highways, discharge of polluted gas from excess traffic as well as lack of rain. The study was conducted w.r.t. some the main air pollutants responsible for generating AQI worldwide and the data revealed that some of the pollutants under investigation, have shown a slight increase due to which the overall AQI levels was found to be in the poor range during winter session. This type of study could be expanded to other districts and regions, with a cross-nation study for more concrete results, and the survey time as well as the seasonal variations may be studied for better results.

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Conflict of interest

The authors declare that there is no any conflict of interest including any financial, personal or other relationships with other people or organizations that can influence this work.

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