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EVALUATE INDORE CITY'S AMBIENT AIR QUALITY USING THE REAL TIME-AIR QUALITY INDEX (RT-AQI)

Mr. Sourabh Jain[*1] Mr. Anil Ekvan [2]

sourabhjainft@ipsacademy.org ; anil.ekvan@meu.edu.in

Assistant Professor[1] Assistant Professor[2]

Department of Fire Technology & Safety Engineering, IPS Academy IES Indore (M.P.)

ABSTRACT

This effort aims to express the ambient air quality of Indore city as a real-time air quality index (RTAQI). Readings were taken early in the morning (8:00 AM to 10:00 AM) and during the evening rush hour (8.00 PM to 10:00 PM) to assess PM2.5, PM10, sulphur dioxide (SO2), nitrogen dioxide (NO2), ozone (O3), carbon monoxide (CO), and NH3 at several places in Indore. With those readings, the air quality level is compared. Readings were taken for about thirty minutes in each region.

The Real-Time Air Quality Index (RTAQI) method is employed to compute the Air Quality Index (AQI) in real-time. The findings indicate that at all of the city's chosen sites, RSPM concentrations are higher than allowed limits and that SO2, NO2, CO, and O3 levels are below the guidelines set forth by the Indian NAAQS 2009. It was discovered that the PM2.5 and PM10 concentrations above the minimum limits set forth in the Indian NAAQS 2009.

Keywords: Real time Air Quality Index (RTAQI), Ambient Air Quality, PM2.5 and PM10, NO_2, O_3, SO_2, CO, NH_3

INTRODUCTION

Indore, located in the Indian state of Madhya Pradesh, stands as the most populous city in the region. Serving as the headquarters for both the Indore Division and the Indore District, this city lies on the southern fringe of Malwa. It holds the distinction of being the loftiest among the major cities in Central India, boasting an average elevation of 553 meters (1,814 feet) above sea level. The state capital, Bhopal, is approximately 120 km (190 km) west of the city. The 2011 census yielded an estimated population of 1,994,397 in the municipal corporation and 3,570,295 in the urban agglomeration of Indore[1-5].

Covering approximately 200 square miles (530 square kilometers), Indore stands out as the

most densely populated major city in the heart of the province. It has been designated as one of the 100 Indian cities slated for transformation into smart cities under the Smart Cities Mission. Indore successfully cleared the initial round of the Smart Cities Mission and was chosen as one of the inaugural twenty cities to undergo development as Smart Cities. After taking part in Swachh Survekshan from the beginning, Indore finished 25th in 2016. It has been recognized as India's cleanest city for seven consecutive years—2017, 2018, 2019, 2020, 2021, 2022, and 2023—by the Swachh Survekshan[6-9].

Indore has earned the distinction of being India's inaugural "water plus" city, as recognized in the Swachh Survekshan 2021. Moreover, it stands as the sole other Indian city chosen to participate in the Global Clean Air Catalyst Initiative. The city's endeavor towards air purification is backed by funding from both the Madhya Pradesh Pollution Control Board and the Indore Municipal Corporation, with the project slated to span a duration of five years. The air quality index (AQI) is a tool used by government agencies to notify the public about current and anticipated air pollution levels. The Air Quality Index (AQI) is determined by aggregating readings obtained from an air quality sensor and calculating an average. The AQI may increase due to many factors such as forest fires or vehicle traffic. Ozone, sulfur dioxide, and nitrogen dioxide are a few of the contaminants that are investigated[10-15].

The public's health is more at risk as the AQI rises, especially for the elderly, young, and those with respiratory or cardiovascular diseases. Usually, government agencies urge people to stay inside during these periods or to minimize their time spent outdoors. Wearing face masks, like cotton masks, may also be suggested.

The Central Pollution Control Board (CPCB) establishes National Ambient Air Quality Standards (NAAQS) that are enforceable across the country. Six categories make up the AQI: Very Poor, Severe, Good, Satisfactory, and Moderately Polluted respectively. The suggested Air Quality Index (AQI) will account for eight pollutants (PM10, PM2.5, NO2, SO2, CO, O3, NH3, and Pb) for which short-term National Ambient Air Quality Standards, based on a 24-hour averaging period, have been established. The health impact, relevant standards, and measured ambient concentrations are used to produce a sub-index for each of these pollutants table 1[16-19].

Table 1: The eight contaminants that were detected, together with their AQI values, corresponding ambient concentrations (health breakpoints), and likely health effects

AQI	Level of Air Pollution	Consequences for Health	Warning (for PM2.5)
0 - 50	Good	The air quality is considered excellent and the risk of air pollution is little to nonexistent.	None
51 -100	Moderate	The air quality is sufficient, although some pollutants may be	People with respiratory conditions like asthma, as well as active adults

		mildly harmful to health for a very small number of people who are extremely sensitive to air pollution.	and children, should avoid extended outdoor exertion.
101-150	Unfit for Sensitive Populations	Sensitive group members may have negative health repercussions. It seems unlikely that the general population will be impacted.	People with respiratory conditions like asthma, as well as active adults and children, should avoid extended outdoor exertion.
151-200	Unhealthy	Negative health impacts may start to affect everyone, but those who are more susceptible may see worsening symptoms.	All other individuals, particularly children, ought to limit lengthy outdoor physical activity; those with respiratory disorders like asthma, as well as energetic children and adults, have to refrain from prolonged outdoor physical activity.
201-300	Very Unhealthy	Health alerts on emergency situations. There is a greater chance that everyone will be impacted.	All other individuals, particularly kids, ought to restrict their outside exercise, but individuals with respiratory disorders like asthma, as well as toddlers and adults who are active, have to abstain from all outdoor activities.
300+	Hazardous	Health warning: More serious health problems could affect everyone	Everyone should avoid all outdoor exertion

MATERIAL AND METHODS

Three areas in the city of Indore—Regional Park, Residency Park, and Chhoti Gwaltoli—were used for the monitoring of air pollution. A sample of particular parameters was taken using the Real-time Air Quality Index (RTAQI). The standard procedures specified by the Central Pollution Control Board (CPCB) were adhered to in order to examine the various parameters that were sampled.1.

Particulate Matter (PM10 & PM2.5)

Particulate matter is made up of both airborne particles and liquid droplets. PM 10 refers to particles that are smaller than or equal to 10 microns, whereas PM2.5, or ultra-fine particles, are smaller than or equal to 2.5 microns.

Sources:

Particulate matter is released into the air by construction, smoking, cleaning, remodeling, demolition, and natural disasters like earthquakes and volcanic eruptions. Furthermore, it is produced by emissions from pulp and paper mills, brick kilns, and other industrial sources.

Associated outcomes:

Breathing in these particles can cause respiratory diseases such as asthma, coughing, sneezing, irritation of the eyes, throat, and airways, among other symptoms. Additionally,

these particles have the ability to enter the respiratory system deeper. Research has also demonstrated a connection between diabetes and PM exposure.

Safe exposure limits:

PM10 and PM2.5 are two of the measures used by the US EPA and the Indian government to calculate the air quality index (AQI). According to the Indian CPCB, the allowed exposure levels for PM10 (24 hours) and PM 2.5 (24 hours) are 0-100 ug/m3 and 0-60 ug/m3, respectively.

2. Carbon Monoxide (CO)

Sources:

This colorless gas is released into the atmosphere by gas stoves, kitchen chimneys, industrial processes, fires, generators, and wood-burning smoke. It is also released by automobile emissions.

Associated outcomes:

In humans, carbon monoxide poisoning (interference with oxygen-hemoglobin binding) results from exposure, along with heart disease, impaired mental capacity, eye issues, and chest pain. It also contributes to the creation of smog.

Level of safe exposure:

Both the US EPA and the Indian government utilize it as an AQI criterion. The Indian government states that a 1-hour exposure of 0-04 mg/m3 is safe.

3. Ozone (O3)

There are three oxygen atoms in one ozone layer. It creates the shield that keeps dangerous UV radiation from penetrating the planet. Ground-level ozone poses a significant threat to both human health and the environment.

Sources:

It is emitted by automotive emissions, electrical equipment, solvents, chemicals, fuel vapors, and factories. Ground ozone production is also influenced by total volatile organic compounds (tVOCs) and nitrogen oxides (NOx).

Associated outcomes:

Ground ozone increases a plant's susceptibility to environmental stressors and impedes its ability to respire. Humans that inhale ozone experience decreased lung function, airway inflammation, and eye, nose, and throat irritation.

Level of safe exposure:

One of the AQI criterion used by the US and Indian EPAs is ozone. The Indian government states that 8 hours of exposure between 0 and 100 ug/m3 is safe.

4. Nitrogen Dioxide (NO2)

One well-known extremely reactive gas found in the environment is nitrogen dioxide.

Sources:

Automobile emissions, the production of energy, fuel combustion, the burning of fossil fuels,

and many industrial activities all release it into the environment.

Associated outcomes:

Poisoning from nitrogen dioxide is just as dangerous as that from carbon monoxide. It occurs when something is breathed and can seriously harm the heart by being absorbed by the lungs, causing inflammation and irritating the airways. Smog and plant damage are two negative effects of nitrogen dioxide on the environment.

Level of safe exposure:

Nitrogen dioxide is a factor used by the US EPA and the Indian government to calculate the AQI. The Indian government states that a 24-hour exposure range of 0-80 ug/m3 is safe.

5. Sulfur Dioxide (SO2)

Sulfur dioxide, represented by the chemical formula SO2, is an odorless gas with a burnt scent. The gas is caustic and acidic by nature, and it can combine with other substances in the atmosphere to produce sulfuric acid and other sulfur oxides.

Sources:

Sulfur dioxide enters the atmosphere as a result of emissions from factories, cars, burning fossil fuels, energy production, etc.

Associated outcomes:

Sulfur dioxide reacts and generates particle matter, which is a key cause of haze creation, acid rain, and damage to buildings, monuments, and flora. In humans, it results in breathing difficulties, asthma, irritation of the eyes, nose, and throat, inflammation of the airways, and cardiac disorders.

Level of safe exposure:

Sulfur dioxide is one of the criteria used by the Indian government and the US EPA to determine the Air Quality Index (AQI). The safe exposure limits are 0-80 ug/m3 (24 hours) and 0-75 ppb (1 hour), according to the US-EPA and the Indian government, respectively table 2.

S.No.	Air Quality Index Parameters	Measuring Method
1	Particulate Matter (PM10 & PM2.5)	Particulate matter can be measured with a laser PM sensor using the light scattering approach. Furthermore, a PM sensor can measure pollution in real time.
2	Carbon Monoxide	The electrochemical technique can be used by a sensor to monitor carbon monoxide. A CO sensor will measure pollutants in real time.
3	Ozone	A sensor can use the electrochemical approach to measure ozone gas. The O3 sensor will measure the pollutant in real time.
4	Nitrogen Dioxide	The electrochemical approach can be used to measure

		NO2 gas with a sensor. The NO2 sensor allows for real-time pollution measurement.
5	Sulfur Dioxide	SO2 gas can be measured with a sensor that uses the electrochemical technique. Pollutant measurement is done in real time via the SO2 sensor.

Table 2: Approach for Measuring Air Quality Index Parameters

RESULT AND DISCUSSION

The IND-AQI was computed using information gathered from ambient air quality monitoring at three sites—Chhoti Gwaltoli, Regional Park, and Residency Park—within the study area.

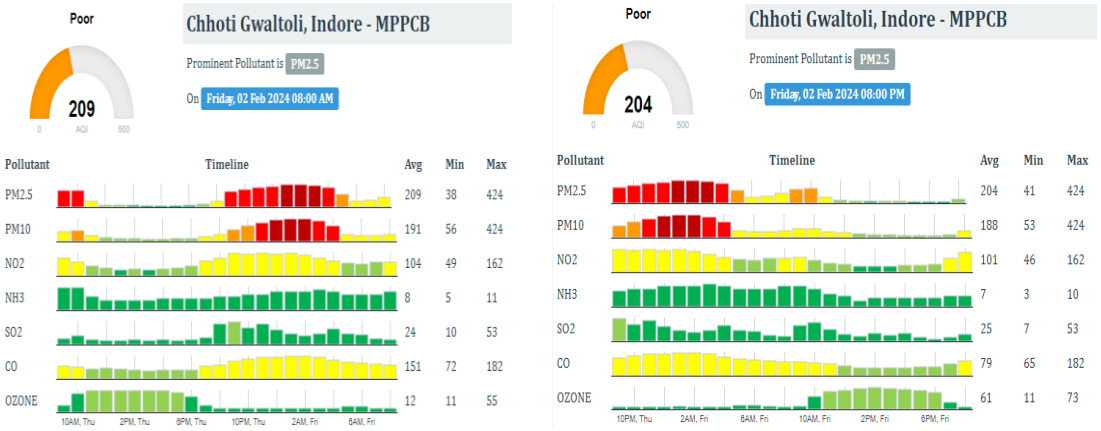

Figure 1: Analyzing the air quality in the morning and evening in Chhoti Gwaltoli

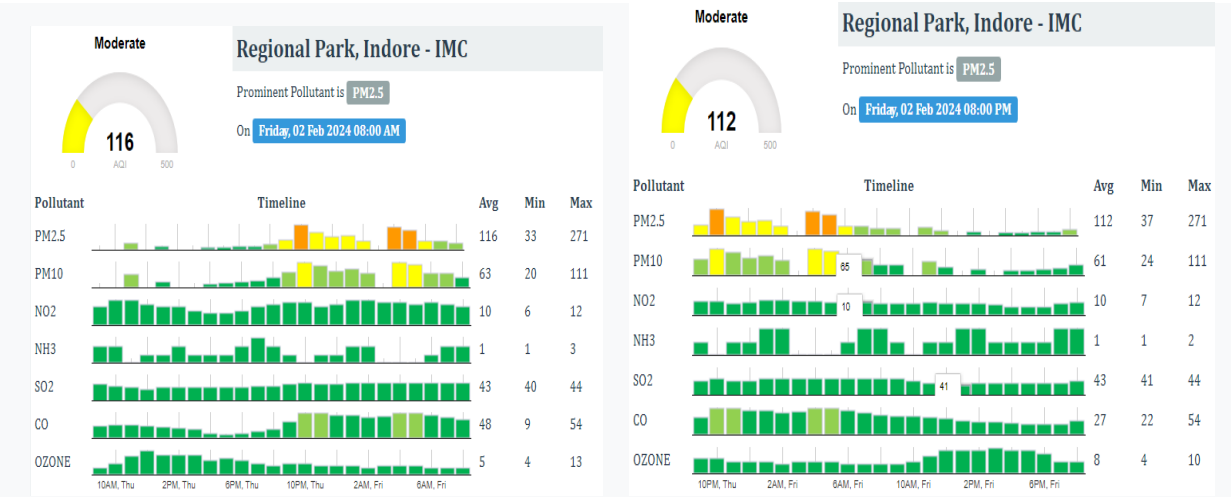

Figure 2: Analyzing the air quality in the morning and evening in Regional Park

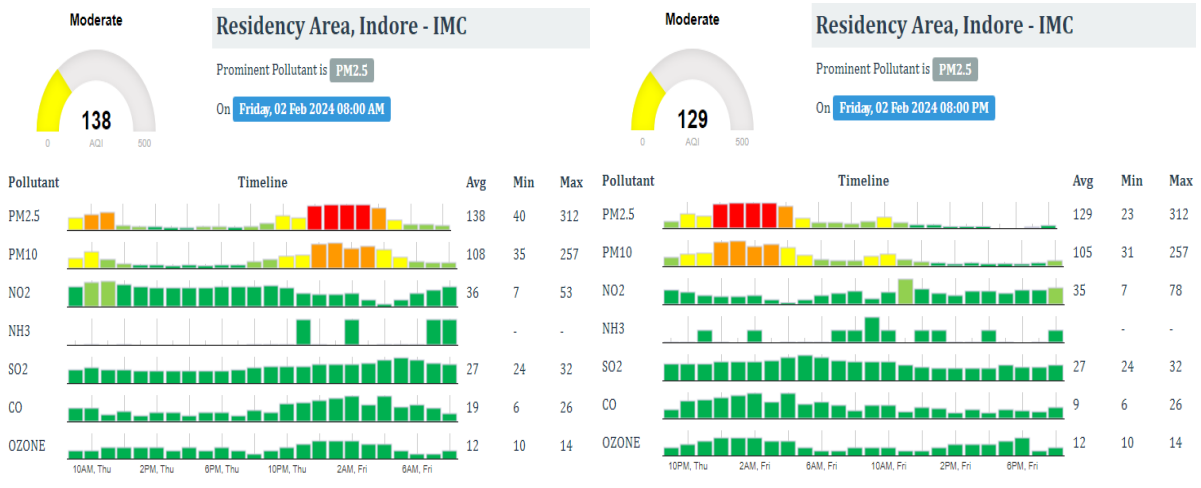

Figure 3: Analyzing the air quality in the morning and evening in Residency Area

AQI	Remark	Color Code	Possible Health Impacts
0-50	Good		Minimal impact
51-100	Satisfactory		Minor breathing discomfort to sensitive people
101-200	Moderate		Breathing discomfort to the people with lungs, asthma and heart diseases
201-300	Poor		Breathing discomfort to most people on prolonged exposure
301-400	Very Poor		Respiratory illness on prolonged exposure
401-500	Severe		Affects healthy people and seriously impacts those with existing diseases

Fig.4 Color Code: Possible Health Impacts

Table 3: AQI Value of different areas in Indore City

S.No.	State	City	Station Name	Current AQI Value	Status
1	Madhya Pradesh	Indore	Chhoti Gwaltoli, Indore - MPPCB	204.00	Poor
2			Regional Park, Indore - IMC	112.00	Moderate
3			Residency Area, Indore - IMC	129.00	Moderate

According to the findings, all of the locations that were chosen had Indian Air Quality Indexes, which classified them as moderately polluted in both seasons. It is noteworthy that Table (3) also displays the Figure of the air quality level during the day and night at a different location in Indore.

CONCLUSION

The public's perception of air pollution can be usefully assessed through the use of real-time air quality index (RT-AQI) measurements of air pollution. The present investigation shows that, out of all the parameters analyzed, it was determined that PM 2.5, PM10, SO2, NO2, O3, and CO were within permissible limits. However, according to the Indian NAAQS 2009,

the concentrations of PM2.5 and PM10 were found to be higher at all three locations than the standard levels. Usually, government agencies urge people to stay inside during these periods or to minimize their time spent outdoors. Additionally, using cotton masks or N95 face masks might be suggested.

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