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***Research Article** (Open Access)*

MONITORING AIR QUALITY AND EXPLORING REAL-TIME AIR QUALITY USING AIR QUALITY INDEX (AQI)

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ABSTRACT
A major health concern nowadays is the quality of air we breathe. This leaves us with the option for Air Quality monitoring. The paper deals with air quality monitoring using the Air Quality Monitor stationed on campus. A full one month data (December 2022) has been analysed with respect to the following parameters – Particulate matter- PM_1, $PM_{2.5}$, PM_{10}, and levels of SO_2, NO_2, O_3, CO, along with Temperature and Humidity levels. Highest value was recorded for these parameters in the third week of December. Analysis of One year AQI data reveals good Air quality on campus. Also, explanation of AQI calculation, terms associated with air quality monitoring, interpretation of colour code for AQI and health impact has been indicated. The most polluted cities in India, the least polluted cities in India and world ranking have been highlighted. A reference to Exhaust Emission index is made as it is directly proportional to Air quality.

Keywords: *AQI, Air Quality Monitoring, AQI Ranking, Particulate Matter (PM)*

INTRODUCTION
The quality of Air we breathe is vital and due to pollution is a major concern these days. Occurrence of contaminant, or other agents in the air leads to air pollution. AQI – Air Quality Index is used to represent the quality of air present around us. The quality of air is indicated by a number standardised by the government and is referred to as AQI Air Quality Index. Air quality is an important criterion which reflects the health of the nation. A high AQI score shows an increased level of pollutants. (Shivangi Nigam et al 2015) Management of air pollution is imperative to health of the nation. In this paper AQI is evaluated as a good tool for assessment. The study area is Stella Maris College campus, where analysis of web-based data throws light on the AQI status. Real-time monitoring is also recommended to have several benefits in controlling and taking immediate intervention in localities that depict high AQI score. To calibrate AQI, at least three pollutants must be present, of which one should be either PM10 or PM2.5, The Indian government has laid AQI ranging from 0-500 with a color code for different categories and corresponding implications for health . Indian AQI range & probable impacts: Air Quality Index Parameters- Particulate Matter (PM10 & PM2.5)

1. ***Particulate Matter*** (PM10 & PM2.5) refers to particles along with liquid droplets and conforming to either 10 microns or 2.5 microns respectively to 2.5 microns. These particles, when inhaled, can penetrate deeper into the respiratory system and cause respiratory ailments such as asthma, coughing, sneezing, irritation in the airways, eyes, nose, throat irritation, etc. PM exposure has been known to cause an increase in related respiratory problems and diabetes. Ekpenyong *et al.*, 2012). As per the Indian CPCB, 0-60 ug/m3 is safe level for PM2.5 and within 100ug/m3 for PM10. Impact of pm2.5 pollution on environment includes haze production, soil fertility, nutrient cycling, plant photosynthesis, deposition of particulates in water bodies and disturbing ecosystems (Horaginamani, and Ravichandran, 2010).

2. ***Carbon Monoxide***

This gaseous pollutant is common in vehicular emissions and a level of 04mg/m3 is accepted as a safe level.

3. ***Ozone (O3)***

Ground ozone interferes with the plant's respiration process and enhances environmental stressor susceptibility. A range of 0-100 ug/m3 (8 hours) is the safe limit.

3. ***Nitrogen Dioxide (NO2)***

Nitrogen dioxide is also known to be hazardous. The Indian government and US-

EPA use Nitrogen dioxide as a parameter for calculating AQI. safe exposure is 0-80 ug/m3 (24 hours). Particulate matter (PM10) and NO2 may show synergistic action due to excessive rain and less photochemical reaction between pollutants (Analitis *et al.*, 2006).

4. ***Sulfur Dioxide (SO2)***

Sulfur Dioxide is used by the Indian government and US-EPA as a parameter for Air Quality Index (AQI) calculation. Within 80 ug is the safe limit. Prana air-- https://www.pranaair.com/blog/what-is-air-quality-index-aqi-and-its-calculation/

REAL-TIME AIR QUALITY DATA – refers to current levels of pollutants such as particulate matter, ozone, nitrogen dioxide, sulfur dioxide, carbon monoxide and ozone gathered through use of air quality monitoring equipment. The pollution over time can be tracked by using this web facility. (Amaann *et al.*, 2017). Several benefits ensue from this such as early warning, Informed decisions, environmental policy identifying sources of pollution, targeted intervention, public engagement, planning smart cities, research and analysis. Prana air https://www.pranaair.com/blog/what-is-real-time-air- quality-and-its-benefits/It should be noted that with rapid urbanization, economic development, increase in commercial, construction and industrial activities during the last decades have increased the vehicular population by several folds in and around cities (Praveen and Jegan Josephraj 2018). AQI can be used as a valuable tool for development of EIA, Environment Impact Assessment. Exhaust Emission Index – this index reflects the emission status of a vehicle and is a related measure to control air pollution. Formulated by the researchers at Delhi Technological University, it is a new concept to measure or assess the performance of petrol cars and other vehicles along the lines of an air quality index (AQI). Determining the EEI will help in bringing emissions under control and for vehicles to comply with EEI.

MATERIALS AND METHODS

Continuous Ambient Air Quality Monitoring System is installed at Stella Maris College with sensors to detect the concentration of pollutants. The technology is Beta Attenuation Monitor. The operation is remotely via the Web. The measured pollutants are PM 10, PM 2.5, Gaseous pollutants- SO^2, NO^2, CO and O^3. Specifically for Particulate Matter (PM10 and PM 2.5) -Type of sensor: Optical 90˚ Light Scattering. For measurement of Toxic gases -(CO, O3, NO2, and SO2) Electrochemical Sensors are used. The data is shown on a dashboard and provides round the clock (24 hrs) access to results. Also, it is significant that the real-time data is given in 30 seconds with great accuracy. The advantage of this equipment is that it does not involve after-purchase expenses like filter change and has Wi-Fi connectivity. The data is easily accessible from AQI website and StellaMaris dashboard. Power requirement is 120 VAC.

RESULTS AND DISCUSSION

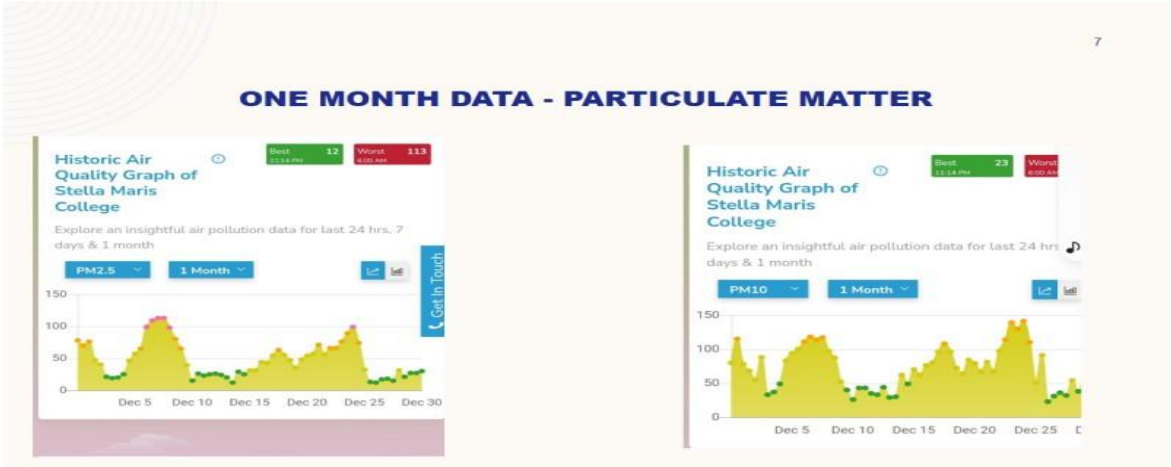

Figure 2: showed SO^2 - Highest value was recorded in the second and third week of December with a value of 10 µg /m^3.

Particulate matter **Figure 1** indicates Pm2.5 data for one month revealed poor AQI status in the first week of December and uniformly good in the second week of December (within the range of 0- 50). PM 10 Highest AQI showing poor air quality status was observed in the third week of December (147 / µg /m^3**).** Second week of December it was uniformly good in the range of (0-50). The ambient air concentration observed with regard to PM10 and PM 2.5 was found to be well within the prescribed limits. With regards to **NO^{2-}** highest value was recorded as 10 µg/ m^3 in then third week of December Gaseous pollutants SO^2 and NO^2 show decreased value and reflects good air quality in the study area of Stella Maris college campus**.**

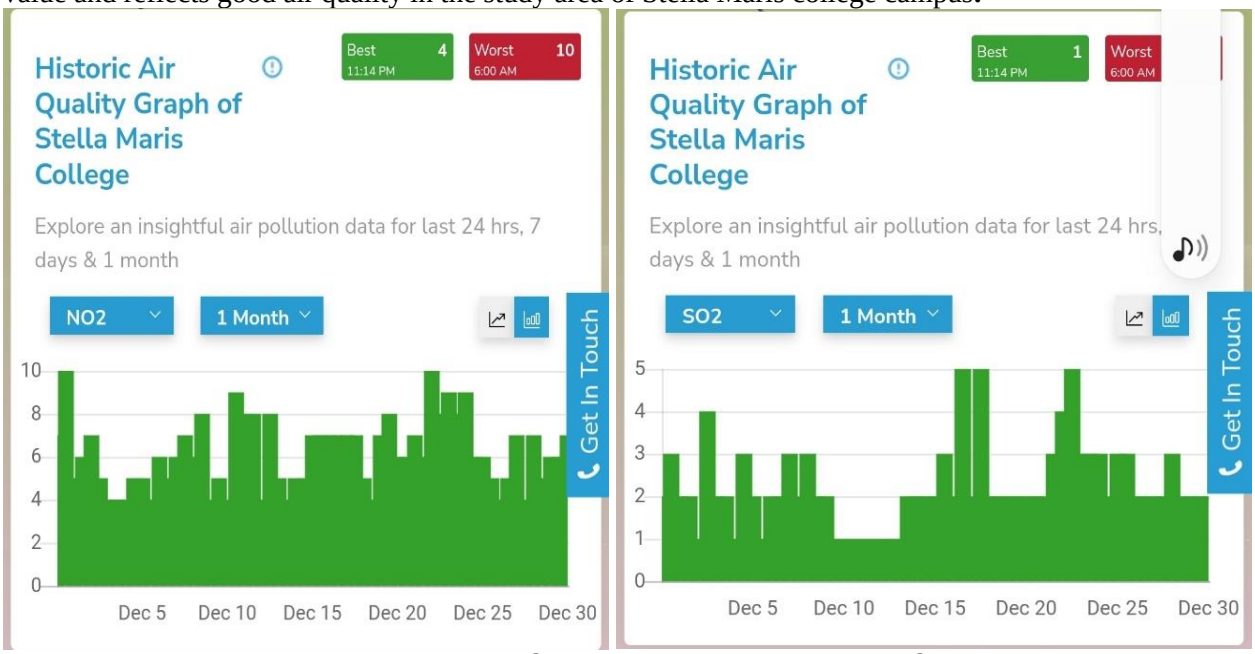

Figure 3: CO – Highest value of 310 mg/ m^3 and lowest value of 100 mg/ m^3 was observed during the entire month of December

O_3 -The level of ozone was observed as 12 µg/ m^3 in the fourth week of December and least value of 1 µg/ m^3in the third week of December.

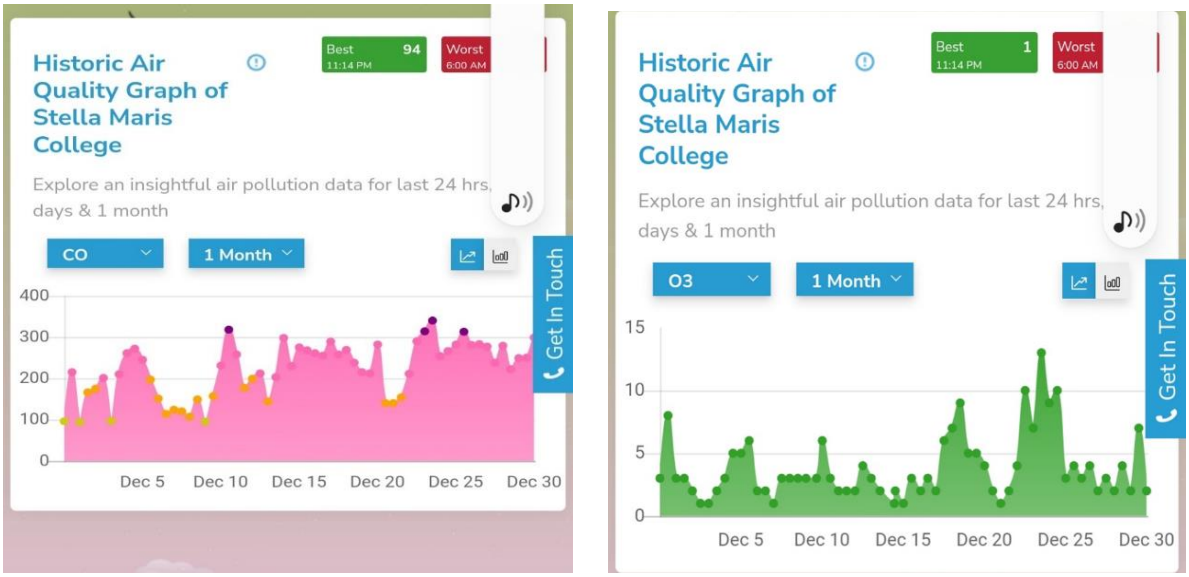

Figure 4: Temperature - Lowest temperature (22 c) was recorded in the first week of December and highest value in the third week of December.

Humidity was highest (95%) in the third week of December. From the data observed for one full month it can be inferred that with regard to other parameters like **SO^2, NO^2, CO and O_3** that poor air quality status was found in the third week of December. The College campus though situated in an urban area shows overall good AQi score which may be attributed to the good vegetation cover maintained within the campus along with use of ecofriendly measure taken such as avoiding burning plastics by recycling them, maintaining a biogas plant, segregation of waste at source and other green initiatives practiced which promoted sustainable growth.

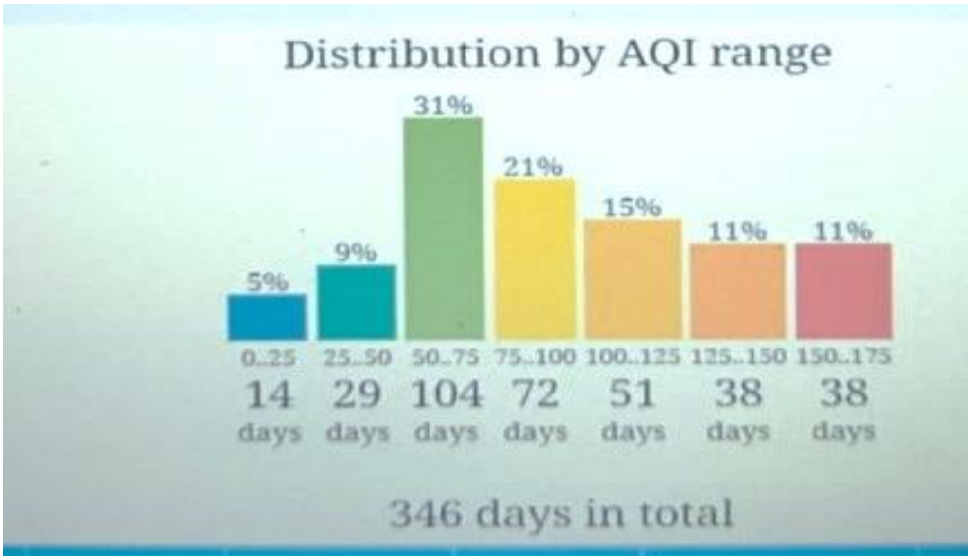

Figure 5: **Histogram showing AQI for the year 2021**

Analysis of Air quality data for the year 2021 clearly indicates the distribution of AQI range throughout the year falls in the category of Good AQI score (0-50) for a total of 43 days, Moderate AQI (51-100) for 176 days, Unhealthy for sensitive groups ((101-150) for 89 days, and Unhealthy AQI score for Normal people for a period of 38days. It can be inferred that overall the AQI for the entire year has been predominantly Good. This was well within the stipulated standards.

Table 3: Least Polluted cities in India

Rank	City	AQI-IN
1	Kulgam	8
2	Handwara	8
3	Rajori	9
4	Sopur	12
5	Kulu	13
6	Baramula	15
7	Bandipura	15
8	Mandya	16
9	Channarayapatna	17
10	Srinagar	18

From the above table it is clear that Kulgam and Handwara cities in India had a least AQI score of 8 and 18 AQI score in Srinagar with regard to first 10 ranks in India.

Table 4: Highest Polluted cities in India

Rank	City	AQI-IN
1	Rajgir	607
2	Muzaffarpur	524
3	Patna	516
4	Begusarai	514
5	Kulu	13
6	Baramula	15
7	Bandipura	15
8	Mandya	16
9	Channarayapatna	17
10	Srinagar	18

Rajgir in India showed a maximum score of 607 which is aver high hazardous value and Deo city recorded a score of 380 in India.

Table 5: World Ranking – Most polluted countries

Air Quality Index (AQI) 0-50 Good | 51-100 Moderate | 101-200 Poor | 201-300 Unhealthy | 301-400 Severe | 401-500(+) Hazardous | Search

RANK	CITY	2022 AVG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	Bangladesh	172	326	289	262	115	128	106	66	44	96	126	202	304
2	Kuwait	155	114	106	179	212	288	236	234	130	119	97	74	61
3	Chad	142	230	231	333	174	130	70	40	31	41	90	108	230
4	United Arab Emirates	117	88	77	74	87	207	169	136	234	163	78	53	40
5	India	96	141	117	134	106	98	78	43	44	57	85	121	133
6	Iraq	95	61	56	72	104	135	161	124	97	88	126	58	52
7	Pakistan	91	149	118	76	80	70	67	37	63	42	116	116	157
8	Sudan	85	72	81	117	147	193	101	43	101	44	46	40	39
9	Bahrain	79	0	85	99	101	147	124	158	149	83	0	0	0
10	Nepal	75	93	85	60	41	32	32	27	8	12	104	187	214

In the year 2022 the average AQI score showed India holding 5th Rank amongst global scenario. The average AQI score was 96. Bangladesh had a score of 172 while Nepal ranks tenth with a AQI score of 75 amongst other nations. According to a recent 2021 repor released by Swiss organization, 22 Indian cities hold the rank among the 30 most polluted cities in the World.

Table 6: Comparison of AQI of Metro cities of India

S. No.	Cities	Year -2019	Year - 2023
1	New Delhi	156	179
2	Ahmedabad	173	149
3	Bangalore	66	84
4	Mumbai	164	141
5	Pune	171	89
6	Chennai	115	88
7	Hyderabad	74	88
8	Kolkata	143	127

This table clearly indicates the AQI status of metro cities in India. Comparing the results acquired in the year 2019 and 2023 shows marked improvement in Ahmedabad, Mumbai, Pune, Chennai and Kolkata.
The results obtained are in corroboration with the work done by Priyanka Das et al 2022. Both national and regioal lockdown resulted in a dramatic improvement in air quality.
Wheras there is an increase in the AQI score in other cities like New Delhi,Bangalore and Hyderabad. This is a clear indication how AQI calculation and monitoring has helped to control pollution and maintain good air quality when rigorous measures are taken in both public and private sectors thereby promoting sustainable development.

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