Assessment of indoor air suspended particulate matter in GLA University campus, Mathura

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Abstract: Indoor air quality represents the quality of air inside room. It affects the health and comfort of the residents. Hence it is very essential to measure the quality of air inside buildings and rooms. In this study, air quality of computer lab of GLA University has been assessed. Particulate matter (PM) is a common air pollutant, including of solid and liquid particles suspended in the air. Normally used indicators PM that are related to human well-being refer to the concentration of particles with a thickness of less than $10\mu m$. Therefore, for assessment of indoor air quality PM10, PM2.5 and PM1 has been monitored for one week. All observed diurnal data-sets have been represented by box plot. This research is very useful for policymakers of GLA University. Based on indoor air quality, classrooms and laboratories can be designed for good health of students.

Keywords: Air quality, Particulate matter (PM), GLA University, Health effect

1.0 Introduction

Air pollution has become a global public health problem, and is now regarded as a major environmental health hazard by the World Health Organization (WHO) and governments around the world. Poor air quality caused by high concentration of pollutants has become an increasingly global concern mainly in developing countries. The particles in the atmosphere are composed of various substances from many sources. Coarse suspended particles mainly come from suspended soil, dust, construction and demolition projects. The fine suspended particles come from combustion sources such as incineration, metallurgical processes, automobiles and household wood burning heaters, and some are produced by chemical reactions in the atmosphere. These particles have an adverse effect on human health, especially in urban areas.
Researchers have found a close relationship between particulate matter (PM) levels and mortality (Pope and Dockery, 2006). Studies have confirmed that better PM has the strongest impact on health (Borja-Aburto et al., 1998). In addition, PM in the air also causes some atmospheric activities, such as reduced visibility, acidification of clouds, rain and fog (Watson, 2002). The sources and characteristics of PM10, PM2.5 and PM1 (particles or fine particles with an aerodynamic diameter of less than 1 μm) are very different. The last two are more dangerous and are responsible for various short and long-term adverse effects, including increased respiratory diseases, premature death, decreased lung function and changes in lung tissue. The impact of PM on health is related to its specific chemical and physical (but mainly chemical) composition (Dockery et al., 1993). For deeper penetration into lung tissue, particle size is very important. The finer particles are carriers of organic compounds, toxic air pollutants and including heavy metals. Minimization of indoor pollutant emissions is usually insufficient, technically infeasible or economically infeasible (Luengas et al., 2015). Particulate matter is composed of solid particles suspended in the air and can enter the respiratory tract, mainly when the particle size is less than 2.5 mm. Fibers, such as glass fibers and asbestos, can also be included in this group (Leung, 2015; Royal College of Physicians, 2016).

Taking into account the opposing effects of finer PM on health, the United States Environmental Protection Agency (USEPA) stopped monitoring total suspended particulates (TSP) in 1987 and began monitoring PM10, followed by PM2.5 in 1999. Monitoring TSP includes the diameter of all particles up to 50 microns. Now, most developed countries have set the targets of PM2.5 and PM1 as monitoring and control. India and other developing countries have also expressed the need to monitor and research PM2.5 and PM1. The purpose of air quality monitoring is to study the air quality in a specific area. This type of monitoring helps to assess the level of pollution related to ambient air quality standards. Therefore, present study is about the monitoring of PM10, PM2.5 and PM1 concentration inside the computer lab of GLA University, Mathura.

2.0 Materials and Methods

2.1 Study area

GLA University located in Mathura, was selected for research. It is 14 kilometers away from Mathura city (Uttar Pradesh, India). The city is located on the bank of the Yamuna River. The socio-economic status of this city is uneven. It is located 145 kilometers southeast of Delhi, the capital of India, and about 55 kilometers north of Agra. Mathura is located between coordinates 27°41 and 39; latitude 77°41 and 39 north; longitude east. The temperature in summer ranges from 45°C to 30°C, and the temperature in winter ranges from 32°C to 14°C. The city's average annual rainfall is about 707 mm. Mathura has a population of approximately 4.42 Lacs (As per 2011 census) and an area of 3709 square meters. The population density of 761 people per square kilometer. The historical importance of this place is attributed to Lord Krishna's birth in Mathura. This city has been selected as one of the twelve heritage cities in the HRIDAY (Heritage City Development and Expansion Yojana) program of the government of India.
2.2 Sensor Configuration
Research has been conducted using the "purple air" real-time air quality monitoring instrument. This is a low-cost air quality monitoring instrument. It is based on a new generation of IoT (Internet of Things) sensors. The sensor uses a fan to draw air through the laser, causing particles in the air to reflect. It uses a laser optical particle counter to estimate the mass concentration of PM in the air, and then uses these reflections to count six types of particles with diameters between 0.3 and 10 microns. It provides real-time measurement of PM1.0, PM2.5 and PM10. The purple air sensor is easy to install and requires only a small power socket.

3.0 Results and Discussion
The concentration of PM inside the room mainly depends on generation of PM in the room, concentration outside the room, the air exchange rate and the deposition characteristics of the particles (Thatcher TL, 1995). A recent Greenpeace report shows that more than 80% of cities in India have PM10 levels that exceed the PM10 limit of 60 μg/m3 specified in the National Ambient Air Quality Standard.
Therefore, it is necessary to clarify the composition and source of indoor PM. There are limited data available on the monitoring of PM inside the university premises. In the present study, concentration of PM1, PM2.5 and PM10 has been observed. Data has been collected from computer lab during the period 21 November 2019 to 26 November 2020. Diurnal variation of PM1, PM2.5 and PM10 has been shown in figure 2.1, figure 2.2, and figure 2.3 respectively. Statistical summary of whole one-week data has been given in table 1.

Generally, University environments lack typical indoor PM sources, such as smoking and cooking, and many students spend several hours in a limited space. There is evidence that PM concentrations in classrooms are higher (Stranger et al., 2007). This is mainly due to insufficient ventilation in the university (especially in winter), infrequent and improper cleaning of indoor surfaces, a large number of pupils related to the area and volume of the room, and constant re-suspending particles from the surface of the room. However, since the source and composition of PM in indoor air may be different from that in outdoor air, these high concentrations do not necessarily pose a higher health risk to students (Schwarze et al., 2006).

PMs comprises microscopic solids or liquid droplets. Major components of PM include SO42-, NO3-, NH3, Na+, K+, Mg2+, Cl-, metals, and PAH. Allergens and microbial compounds are other major components of PM. The physical and chemical properties of PM vary with location. PM with a diameter between 0.1 μm and 1 μm can remain in the atmosphere for several days or weeks, and therefore will undergo long-distance transboundary movement in the air. It has been observed that PM2.5 accounts for 50-70% of PM in Europe. PM10 and PM2.5 contain inhalable particles small enough to penetrate the alveolar area of the respiratory system. The health effects of PM are well known. Both short term and long-term exposure causes health hazard and primarily responsible for respiratory and cardiovascular problems, such as aggravation of asthma and respiratory symptoms acute condition may result in lung cancer.
Fig. 2(b) Variation of concentration of PM2.5

Fig. 2(c) Variation of concentration of PM10
### Table 1(a): Descriptive statistics of PM1

| Metric               | Value  |
|----------------------|--------|
| Mean                 | 74.33  |
| Standard Error       | 0.53   |
| Median               | 75.13  |
| Mode                 | 75.89  |
| Standard Deviation   | 22.22  |
| Sample Variance      | 493.89 |
| Kurtosis             | -0.46  |
| Skewness             | 0.02   |
| Range                | 101.20 |
| Minimum              | 22.00  |
| Maximum              | 123.20 |

### Table 1(b): Descriptive statistics of PM2.5

| Metric               | Value  |
|----------------------|--------|
| Mean                 | 125.63 |
| Standard Error       | 1.01   |
| Median               | 124.02 |
| Mode                 | 120.96 |
| Standard Deviation   | 42.07  |
| Sample Variance      | 1769.76|
| Kurtosis             | -0.31  |
| Skewness             | 0.26   |
| Range                | 185.91 |
| Minimum              | 43.00  |
| Maximum              | 228.91 |
Table 1(c): Descriptive statistics of PM10

| PM10               |        |
|--------------------|--------|
| Mean               | 138.41 |
| Standard Error     | 1.10   |
| Median             | 134.73 |
| Mode               | 70.87  |
| Standard Deviation | 45.88  |
| Sample Variance    | 2104.86|
| Kurtosis           | -0.26  |
| Skewness           | 0.42   |
| Range              | 206.71 |
| Minimum            | 50.00  |
| Maximum            | 256.71 |

4.0 Conclusions

In many places, monitoring of PM10 and PM2.5 needs to be improved to assess population exposure and assist local authorities in formulating plans to improve air quality. There is evidence that reduced levels of particulate air pollution after continued intervention can provide health benefits. Using currently available cleaning technologies, particulate pollution in the air can be greatly reduced.

The reduction of indoor PM requires concerted action by university authorities. The responsible agencies responsible for air pollution management include coordination between the environment, transportation, classroom and laboratory programs, student health and the promotion of renewable energy. Comprehensive policies on classroom and laboratory design can improve indoor air quality by changing personal behavior and encouraging walking and biking between employees and students, it encourages cleaner transportation. These policies help clean the air while promoting physical exercise and to a large extent benefit public health.

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