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Assessment of PM$_{10}$ concentration in air at some prominent places of Akola (M.S.), India

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Air plays the vital role in our survival. Clean air is the foremost requirement to sustain healthy lives of humankind and those of the supporting ecosystems which in return affect the human wellbeing. Air quality monitoring at some prominent places of Akola city was performed in three slots during morning, afternoon and evening hours. Along with PM$_{10}$ concentration, the atmospheric temperature and humidity were also recorded at each sampling station. In Akola city, PM$_{10}$ concentration was found satisfactory i.e. in the range of 51-100. This PM$_{10}$ concentration may cause minor breathing discomfort to sensitive people and children. The time factor plays an important role in the air pollution level. At every location, it was observed that, PM$_{10}$ concentration is more during afternoon and evening as compared to morning hours.

Keywords: Air pollution, PM$_{10}$ concentration, Air Quality Index (AQI)

INTRODUCTION

Air is a non-homogeneous mixture of different gases. On an average, dry air mainly composed of 78% nitrogen and 21% oxygen. Remaining 1% accounts for gases like carbon dioxide (0.03%), argon (0.93%), and other gases in meagre amounts (Sharma, 2017). Air pollution is an important public health problem in developed and developing nations (Issever *et al.*, 2005). In India, with the advent of industrialization and urbanization, the levels of air pollution have increased manifold, making it an important environmental issue. Sources of air pollution include road traffic emissions, industrial emissions, domestic heating and formation of secondary pollutants etc. (Kassomenos *et al.,* 2006; Ogrin, 2007). The World Health Organisation (WHO) has released Air Quality Database 2022, which shows that almost the entire global population (99 %) breathes air that exceeds WHO's air quality limits. WHO's new guidelines recommend air quality levels for 6 pollutants, where evidence has advanced the most on health effects from

exposure. 6 classical pollutants include particulate matter (PM 2.5 and 10), ozone (O_3), nitrogen dioxide (NO_2) sulfur dioxide (SO_2) and carbon monoxide (CO). Among them, Particulate Matter (PM), particles of variable but very small diameter, penetrate the respiratory system via inhalation, causing respiratory and cardiovascular diseases, reproductive and central nervous system disfunctions and cancer (Manisalidis, *et al.* 2020). It is important to know about Air Quality Index (AQI) because unless and until the people know the worst impacts or hazards of air pollution, they will not become that much aware about the air pollution and try to reduce it. (Patil *et al.* 2020). This study is mainly focused on measurement of Particulate Matter (PM_{10}) concentration in air at some prominent areas of Akola city.

MATERIAL AND METHODS

Our study area was Akola city, which is located in Akola District of Maharashtra State, India (Fig-1a). It is one of the important developing cities of the Vidharbha region. The Akola district is geographically located at 20.17 to 21.16 North altitude and 76.7 to 77.4 East altitude. Prominent places of the Akola City like Bus stop, Railway station, MIDC area, Nehru Park, Dr. Punjabrao Deshmukh Krishi Vidyapeeth campus, Mahatma Gandhi Road, Bara Jyotirling temple of Ranpise Nagar and Shri R.L.T. College campus were selected for the study. Air quality monitoring at all these prominent places of Akola city was performed in three slots as - Morning hours during 7.00 a.m. to 9:00 a.m., Afternoon hours during 12.00 p.m. to 2:00 p.m. and Evening hours during 4.00 p.m. to 6.00 p.m.

The air quality detector instrument from Innovation and Incubation Centre of Shri R.L.T. College of Science, Akola, was used for measurements (Fig.-1b). It is a portable digital hand-held air monitor to measure the air pollutant, especially PM_{10} concentration. Analysis was performed with Arduino IDE software Version 1.8.19 (Fig.-1c). Particulate Matter (PM_{10}) value have been identified for random monitoring at various locations during March 2023 to April 2023. Along with PM_{10}, the atmospheric temperature and humidity were also recorded. Several readings were taken at each sampling station.
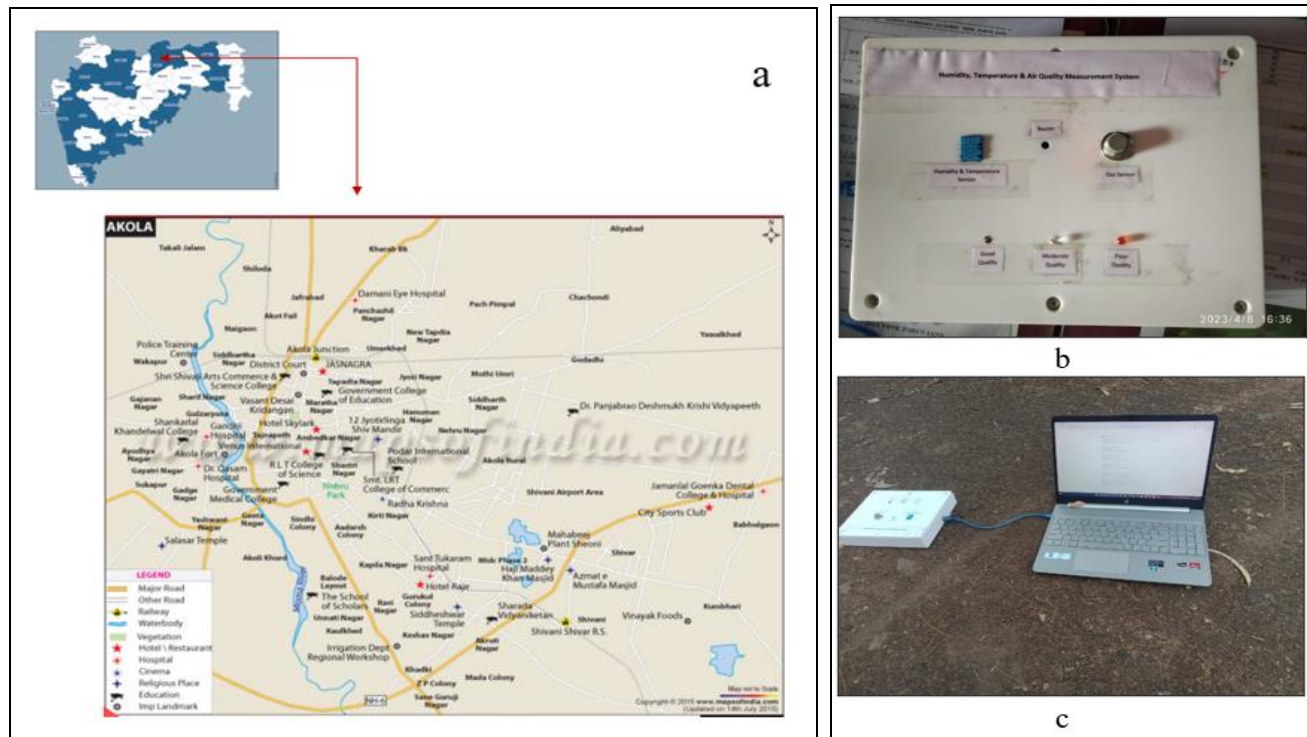

Fig.-1: Study area and equipment used
a. Map showing study area; b. The air quality detector instrument
c. The air quality detector instrument with laptop attachment

RESULTS AND DISCUSSION

For healthy and good air quality, PM_{10} concentration should be ranging between 00 to 50, which shows minimal impact on health. Levels of ambient air pollution at various prominent areas of Akola city vary considerably. During morning hours, PM_{10} concentration, the highest daily mean level was found at the Bara Jyotirling temple of Ranpise Nagar, which is located near the main traffic road. Also, there is a huge crowd of devotees towards the temple. Bus stop, Railway station, Mahatma Gandhi Road and MIDC area also showed high PM_{10} concentration. All of these sites are characterized by high traffic movement. Nehru Park and inner area of Dr. Punjabrao Deshmukh Krishi Vidyapeeth (PDKV) campus showed comparatively low concentration of PM_{10} (Fig.- 2a). Relatively more humidity was recorded at Nehru Park and inner area of Dr. PDKV campus.

During afternoon hours, highest PM_{10} concentration was noted at Mahatma Gandhi Road. Bus stop, Railway station, MIDC area, Bara Jyotirling temple also showed higher level of PM_{10} and lower level of humidity (Fig.- 2b). Outer area of PDKV campus is more polluted than inner area. PM_{10} level of Shri R.L.T. College campus is more than required. Similar observations were recorded during evening hours also (Fig.- 2c). Comparison of PM_{10} concentration during morning, afternoon and evening hours showed progressive increase in level of PM_{10} at all the nine selected locations (Fig.- 2d).
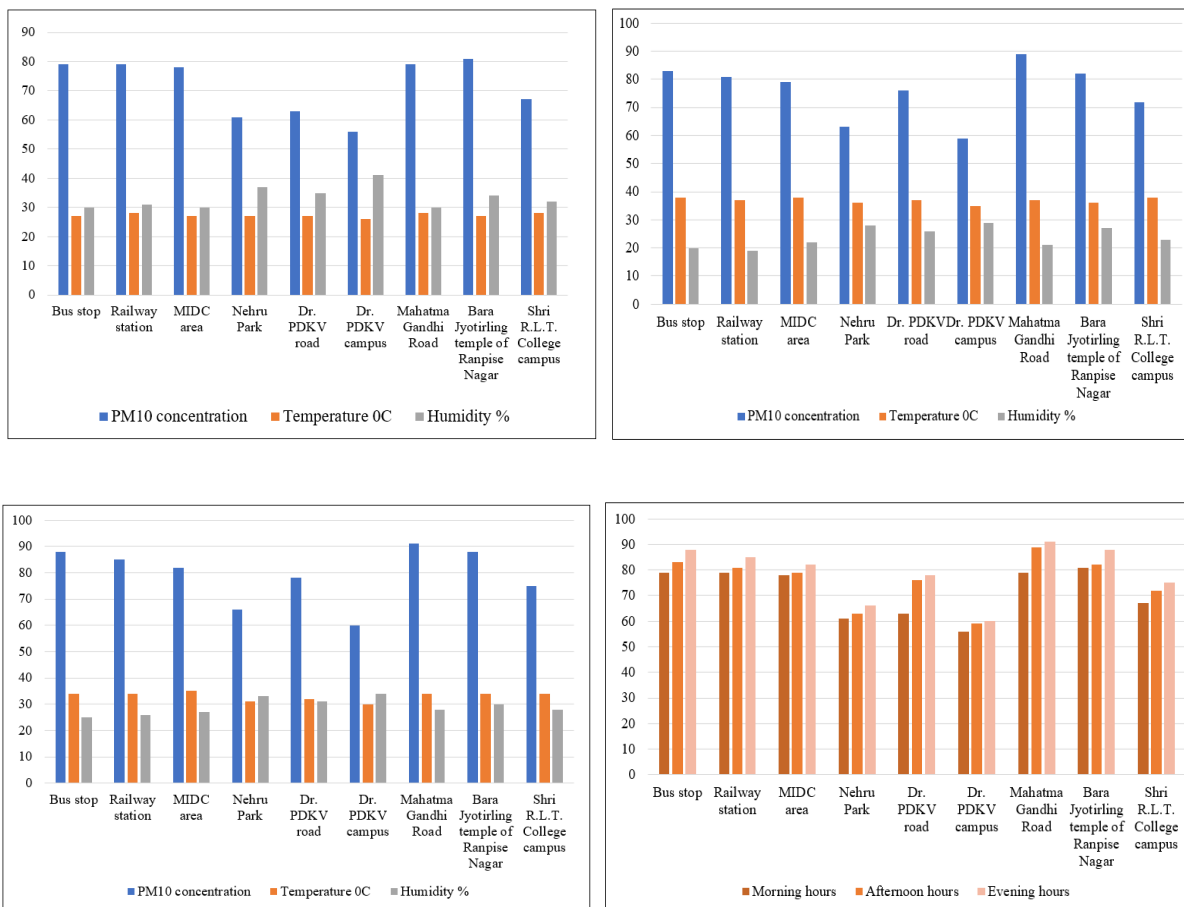
Fig.-2: a. Air quality assessment during morning hours; b. Air quality assessment during afternoon hours; c. Air quality assessment during evening hours; d. Comparison of PM_{10} concentration during morning, afternoon and evening hours.

Bus station and Railway station are the main transportation hubs. Air quality inside these stations is a concern as so many buses and trains are scheduled to run daily. Measurement results showed that coarse PM inside the bus station and Railway station was resuspended by the movement of large numbers of passengers. The fine and ultrafine PM in the station concourse were also from outside vehicles (Cheng, *et al.,* 2011). Workers at the Bus station and Railway station might be risk to get respiratory illnesses due to occupational particulates exposure.

MIDC area showed PM_{10} concentration ranging between 78 to 82. An industrial application might affect air pollution levels in the urban area of city. Roads in MIDC area is continuously used for hauling raw materials. During afternoon hours, highest PM_{10} concentration was noted at Mahatma Gandhi Road. PM_{10} concentration at Mahatma Gandhi Road ranging in between 79-91. It is highest at evening time. This is the highly crowded market area, located at the heart of the city. This is heavy-traffic roads with a high concentration of traffic-related air pollution. Their origin is associated with road dust, vehicle emission and the erosion of building products. Gaseous pollutants are emitted directly from the tailpipe of cars, while PM is produced as a result of friction of its tires with the street, or indirectly due to the excitation of street dust (Elsharkawy, 2013). Nehru Park and inner area of Dr. Punjabrao Deshmukh Krishi Vidyapeeth campus showed comparatively good quality air than other assessment stations, which mean that, this area is the most convenient place for health. Lower concentration of $PM_{10.}$ were recorded here. Green zone in Dr. Punjabrao Deshmukh Krishi Vidyapeeth (PDKV) campus is the lung of Akola city. Though, pollen grains, mould spores, plant and insect parts contributed to PM concentration, these natural causes have little effect on air pollution. Outer area of Dr. PDKV campus is more polluted than inner area. The high PM_{10} concentrations on outer area of Dr. PDKV campus are likely to be attributable to the generation of windblown dust. PM_{10} level of Shri R.L.T. College campus is more than required i.e. 67 to 75. Location of college is adjacent to main road. Dominant factors for the increase of PM_{10} includes high occupancy rate in the classroom (Matic *et al.,* 2017) as well as in college campus. In some classrooms, dust from the blackboard increases concentrations of particles inside classrooms.

The time factor plays an important role in the air pollution level. At every location, it was observed that, PM_{10} concentration is more during afternoon and evening as compared to morning. Magnitude of all activities is less during morning hours. The various meteorological or environmental factors such as temperature, relative humidity, wind, wind speed, pressure and geographical location regulate the spatiotemporal variation of PM_{10} and $PM_{2.5}$. These factors like high temperature with relative humidity and strong wind influence to disperse the particulate matters (Bera, *et al.,* 2022). Particulate Matter having diameter less than 10μ and 2.5μ etc. is very important because impact of these factors on human health becomes severe (Patil *et al.,* 2020). Children are particularly vulnerable to air pollution, especially during their development. It causes asthma, bronchitis, and pneumonia in older people. Air pollution has adverse effects on our lives in many different respects. Diseases associated with air pollution have not only an important economic impact but also a societal impact due to absences from productive work and school (Manisalidis, *et al.* 2020).

CONCLUSION

At prominent locations in Akola city, PM_{10} concentration was satisfactory i.e. in the range of 51-100. This PM_{10} concentration may cause minor breathing discomfort to sensitive people. In Akola city, the main sources of particulate matter are anthropogenic activities like construction work, industrialization, agriculture, residential and traffic activity etc. Natural sources like pollen grains, minute plant and insect parts, windblown dust etc. adds particulate matter in air. Particles can also be formed directly in the atmosphere by physico-chemical reactions between pollutants already present in the atmosphere. The growth in urban population and extensive development activities have further added to the increased level of air pollution in the city.

RECOMMENDATIONS

For overcoming air pollution problem in Akola city, the local government bodies, non-government organizations, education institutions should follow given recommendations and undertake following action plan.

1. Proper management of traffic. During road construction works, divert some of the traffic for another subway.
2. Should encourage the use of battery -powered and human-powered transportation methods.
3. Increase use of clean and green renewable energy sources.
4. Reduce waste by recycling.
5. Air quality monitoring by local government agencies and non-government entities may help to overcome the lack of air quality information and awareness in community.

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