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# Analysis of Pollution of Mandideep Region In Bhopal

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**ABSTRACT**

Most urban areas in India are encountering extreme air contamination because of quick financial turn of events and sped up urbanization. Long haul air contamination information with high transient and spatial goals are expected to help investigation into physical and synthetic cycles that influence air quality, and the comparing wellbeing hazards. Information on PM10, PM2.5, SO2, NO2, O3 and CO fixations in 23 surrounding air quality programmed checking stations and routine meteorological were gathered between August, September and October 2021 to decide the spatial and fleeting variety in these toxins and affecting elements in Mandideep. The yearly mean groupings of PM2.5 and PM10 surpassed the norm of Indian Ambient Air Quality and World Health Organization rules guidelines by any stretch of the imagination of the stations. The convergences of PM10, PM2.5, SO2 and CO diminished from 2014 to 2016, and the NO2 level was steady, while the O3 level expanded particularly during this period. The air contamination qualities in Mandideep showed at the same time high PM fixations and O3. High PM fixations were primarily seen in the center locale of Chengdu and may have been because of the joint impacts of modern and vehicle outflows. Ozone contamination was essentially because of vehicle outflows in the midtown region, and industry had a more significant impact on O3 in the northern region with less vehicles. The convergences of PM10, PM2.5, NO2 and CO were most elevated in winter and least in summer; the most elevated SO2 fixation was additionally seen in winter and was least in harvest time, while the O3 focus crested in summer. Dimness contamination can without much of a stretch structure sickly states of static breeze, low temperature and relative mugginess, and high surface strain inside Mandideep. Interestingly, serious ozone contamination is regularly connected with high temperatures.

**Keywords :** Air Pollutants; Exceeding Standard Levels; Spatiotemporal Distribution

## I. INTRODUCTION

Exposure to particulate matter PM2.5 and PM10 with an aerodynamic diameter less than 2.5 and 10 µm respectively is a global concern due to their adverse health effects. Prolonged exposure to these particles affects healthy people and seriously impacts those with existing diseases. It causes breathing discomfort for people with asthma and heart diseases. According to WHO, an increase in total PM by 10 µg/m3 per year increases mortality by 6 per cent. Most cities in India have been experiencing severe air pollution due to fast-paced urbanization and rapid economic growth. SPM primarily originating from gaseous pollutants is posing a grave threat to human health. Gaseous pollutants CO, SO2 and NO2 are reported in several studies to be leading to high PM levels.

The research presented here is an analysis of PM2.5 and PM10 concentrations from the industrial zone of Mandideep. The industrial development, initiated around 1950, triggered a population explosion in Mandideep. The population of Mandideep in the year 2018 as per estimated data was 2,02,331 (Population as per 2011). The city is studded with major industries mainly Hindustan Zinc Limited (HZL), Coromandel Fertilizers Limited (CFL), Mandideep Port Trust (VPT), Hindustan Petroleum Corporation Limited (HPCL), Bharat Heavy Plates and Vessels (BHPV), Hindustan Polymers Limited (HPL), Mandideep Steel Plant (SP), Coastal Chemicals (CC), Andhra Cement Company (ACC) and Simhadri Thermal Power Corporation (STPC).

**SOURCES OF AIR POLLUTION**

Pollutants are commonly classified into solid, liquid, or gaseous substances that are discharged into the air from a fixed or mobile source, then transmit through air, and contribute in chemo physical transformation, and eventually return to the ground. It is impossible to describe the full range of potential sources and actual damage caused by various sources of air pollution but few which are more vulnerable are discussed below:

- **Combustion of Fossil Fuel**
- **Industrial Emissions**
- **Agricultural Sources**

## II. Literature Review

**Rajveer Kaur and Puneeta Pandey (2021)** research paper reviewed concern over the Indian cities with significant impacts of both climate change and air pollution on human health. It even covered the increasing air pollution levels above the prescribed standards for most of the Indian megacities. The aerosols and PM concentrations have been explored and hazardous health impacts of particles that are inhaled by humans and enter the respiratory system. The air quality during COVID-2019 lockdown in Indian cities with its health impact was reviewed. Finally, the correlation between climate change, air pollution, and urbanizations were presented as air pollutants (such as aerosols) affect the climate of Earth both directly (by absorption and scattering) and indirectly (by altering the cloud properties and radiation transfer processes.

The conclusion stated that the use of advanced technologies such as satellite data with geospatial techniques can be of great help in monitoring and mapping of spatial-temporal distribution patterns of air pollution and climate change and associated health impacts. So, while focusing on building smart cities in developing nations like India, proper urban planning and sustainable measures should be taken for a sustainable urban environment to avoid adverse health impacts.

**Kuang Xiao et al (2018)** in the research paper, data on PM10, PM2.5, SO2, NO2, O3 and CO concentrations in 23 ambient air quality automatic monitoring stations and routine meteorological were collected between January 2014 and December 2016 to determine the spatial and temporal variation in these pollutants and influencing factors in Chengdu.

The results indicate that air pollution in Chengdu is caused by multiple pollutants, and the air pollution shows great divergence in different regions and different seasons. Region-oriented air pollution management plans are suggested.PM2.5, PM10, SO2, CO, and NO2 displayed the highest levels in winter and the lowest level in summer (SO2 lowest in autumn), indicating the combined impact of industrial sources and unfavorable weather conditions on air pollution dilution and dispersion. However, the O3 concentration peaked in summer, which was associated with the strong solar radiation. Meteorological conditions are important factors that affect the concentrations of air pollutants in excessive standard days. Haze pollution can be formed easily under the weather conditions of static wind, low temperature, high relative humidity, and high surface pressure inside Chengdu. In contrast, severe ozone pollution is often associated with high temperature.

**Objectives of the Study:**

- To determine the characteristics of PM 2.5 and PM10 concentration and to investigate when the high PM10 concentration occurs using time series plot.
- To compare the fitted distributions of Weibull, gamma and lognormal distributions on predictions of PM10 concentration during years with haze events and years without haze events.
- To use Gumbel and Frechet distribution to predict high PM10 concentrations.
- To monitor primary PM10 concentration using simple instruments and to compare with standard instruments used by the Department of Environment, India, in order to introduce a cheap and simple method of monitoring PM10 concentration.

## III. CASE STUDY

## IV. Material and Method

The real time hourly mass concentrations of PM2.5, PM10, CO, NO2 and SO2 are recorded by National Air Quality Index of Central Pollution Control Board compiled for each city under the Ministry of Environment, Forests and Climate Change, India. The instruments measuring the mass concentrations are located in the central point of the city. The mass concentrations of PM2.5 and PM10 are measured using beta attenuation method. The gas pollutants NO2, SO2 and CO are measured using the gas phase chemiluminescence method, ultraviolet fluorescence method and NDIR spectroscopy respectively.

The hourly mean variations of PM2.5, PM10, NO2, SO2 and CO in each season (Summer: March, April and May, Rainy: June, July, August and September, Autumn: October and November, Winter: December, January and February) during July 2021 - December 2021 at the present location were measured.

**MANDIDEEP**

Mandideep is a town with municipality in Goharganj sub-district of Raisen district in the Indian state of Madhya Pradesh. Mandideep is 23 km from Bhopal and is basically an Industrial township which came into existence in late 1970s. The Mandideep Municipality has population of 59,654 of which 32,390 are males while 27,264 are females as per report released by 2011 Census of India. Literacy rate of Mandideep city is 83.76 % higher than state average of 69.32 %. In Mandideep, Male literacy is around 89.33 % while female literacy rate is 77.04.

It has an Industrial area, just south of Bhopal capitalising on the proximity to Bhopal City. The major industries here are Hindustan Electro Graphite (HEG), Procter & Gamble, Eicher tractors Ltd, Lupin laboratories, and many more national and international level company have their manufacturing units at Mandideep.

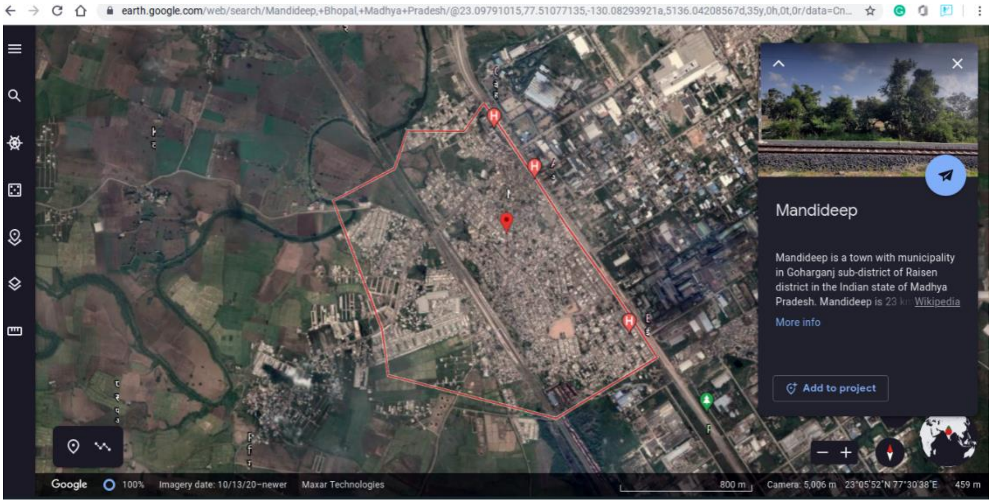



Fig 1: Satellite view of mandideep area

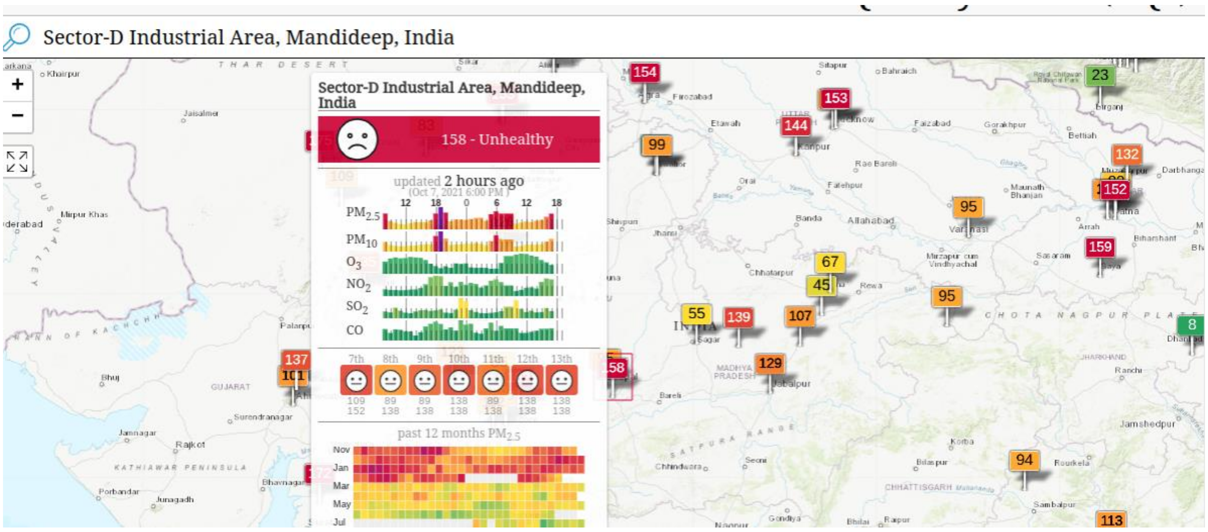



Fig 2: pollution status of mandideep on working hours

In Mandideep, the wet season is oppressive and overcast, the dry season is mostly clear, and it is hot year round. Over the course of the year, the temperature typically varies from 54°F to 105°F and is rarely below 47°F or above 110°F.

## METHODOLOGY

## RESPRIABLE DUST SAMPLER

The Respirable Dust Sampler is meant for monitoring the Total Suspended Particles (TSP) in ambient air conditions. It also simultaneously used for sampling the pollutant gases like $SO_2$, NOX, $CL_2$ $H_2S$, and $CS_2$. These gases are analyzed to determine the concentration of specific pollutant.

- **Particle Collection :** The sampler serves as particle collector that collects the particles less than 10 microns on filter paper and bigger than 10 microns in a sampling bottle with the helps of a cyclone separator.

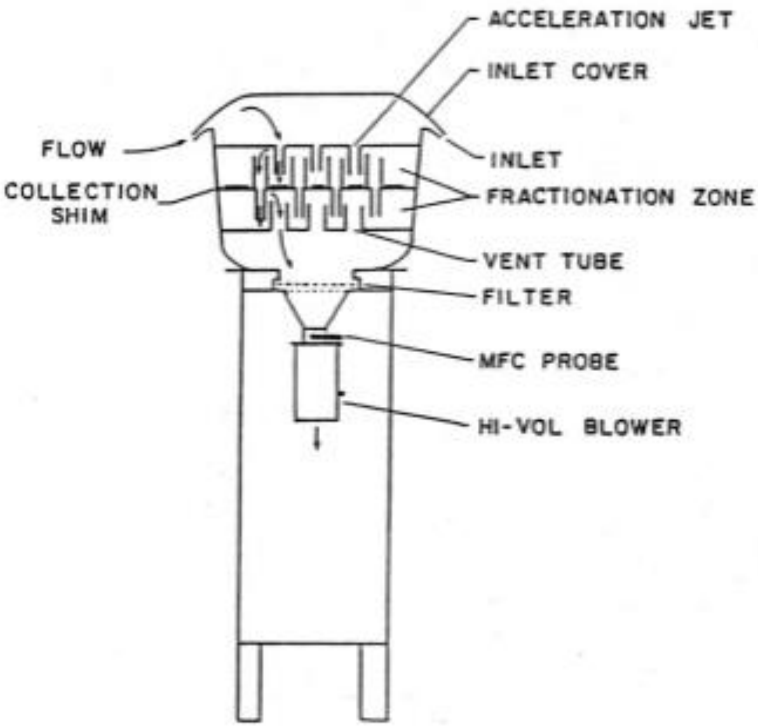
- **Bower Motor :** The sampler features bower motor instead of high speed blower. This is a brushless and noiseless motor with no carbon brushes.
- **Programmable Timer & Relay :** The sampler possess programmable relay that helps in setting ON time and protects the motor in case of high or low voltage conditions.

## SAMPLE COLLECTION

The methodology for the collection and mass determination of particulate matter is rather simple. Air is drawn through a size-selective inlet and through some sort of filter media. Particulates with aerodynamic diameters less than the cut-point of the inlet are collected on the filter media. The mass of these particulates is determined by the difference in filter weight before and after sampling. The concentration of the suspended particulate matter in the designated size range is calculated by dividing the weight gain of the filter by the volume of the air sampled. Due in large part to the smaller filter and lower flow rates, PM2.5 samplers can be equipped with a variety of size selective inlets. The smaller filter used in PM2.5 samplers allows for advanced automation whereby a filter can be used and a replacement filter automatically put into position for another sampling period.In addition, PM2.5 samplers can be equipped with an automatic weighing system for continuous real time analysis. The sample flow passes through the filter where the particulate matter collects, and then continues through the hollow tapered element on its way to an electronic flow control system and vacuum pump. As more mass collects on the filter, the tube's natural frequency of oscillation decreases. A direct relationship exists between the tube's change in frequency and mass on the filter. This inertial methodology is a more fundamental means of measuring mass than the use of gravity. The tapered element technology enables highly precise and accurate mass determinations and rivals the resolution obtained from conventional microbalances.

### High Volume PM10 Sampler with Mass Flow Control

The major components of the High Volume PM10 sampler, Model 321B, are shown in below. As ambient air is drawn into the inlet, it is evacuated from the buffer chamber where the particulates larger the 10 μ are impacted onto a greased collection shim. The air is then accelerated through an additional 16 jets into a second impaction chamber. The acceleration nozzles have critical diameters to provide the necessary velocity to effect correct particulate size fractionation within the impaction chamber. The airflow finally exits the inlet through nine vent tubes onto a micro-quartz fiber filter.



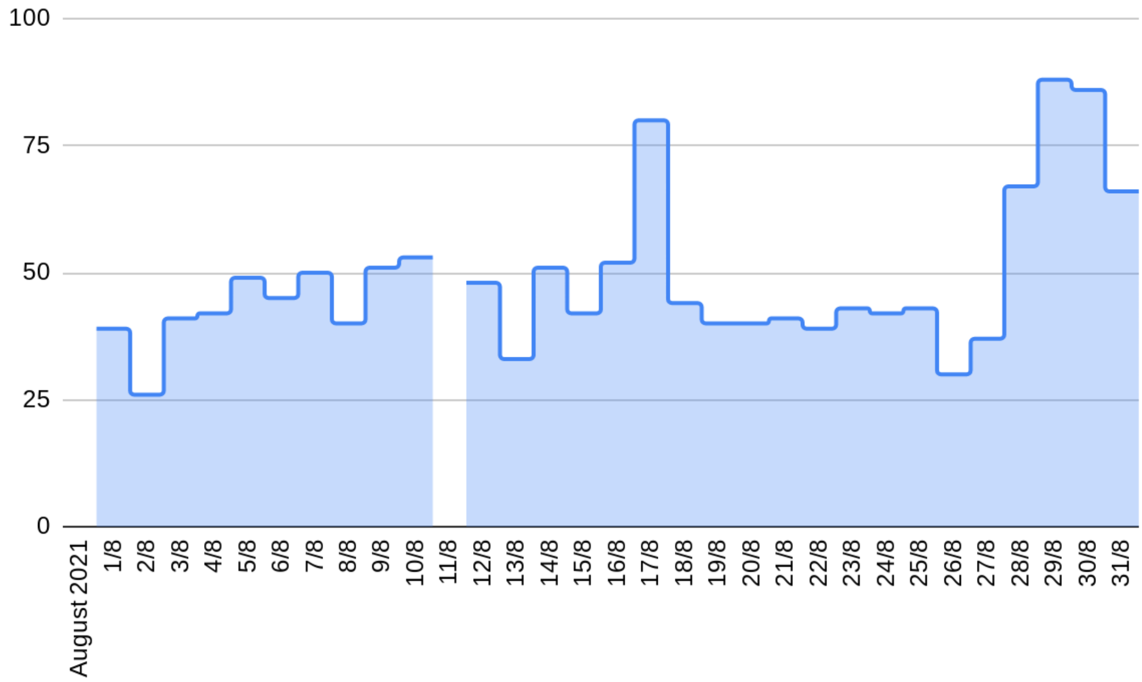

## CALIBRATION PROCEDURES

Particulate size discrimination is dependent upon the air velocity through the acceleration jets. There are no field calibration standards for particulates, therefore an indirect method must be used. Calibration is very critical for proper instrument performance and requires the following equipment:

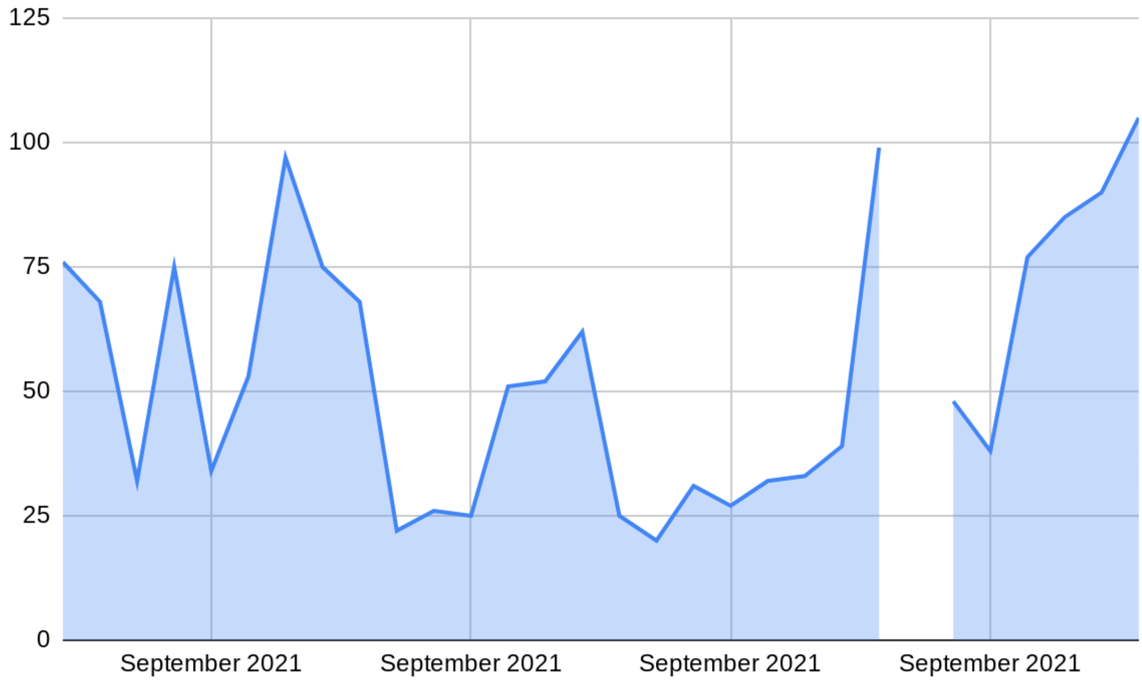
1. An orifice device for measuring flow rate that has been previously calibrated against a standard of known accuracy. The Streamline FTS from Rupprecht and Patashnick and the Vari-Flo from Andersen are two examples. Each of these orifice devices comes with a calibration relationship determined by plotting orifice pressure drop verses actual flow rate to find the slope (m) and intercept (b).
2. A manometer with a range from 0 to 16 inches of water and a minimum scale division of 0.1 inch.
3. A thermometer with a verified accuracy. All temperatures must be expressed in degrees Kelvin.
4. A barometer or other local verified source for barometric pressure. Pressures must be expressed in mm Hg and must not be corrected to sea level (station pressure).

## RESULTS AND DISCUSSION

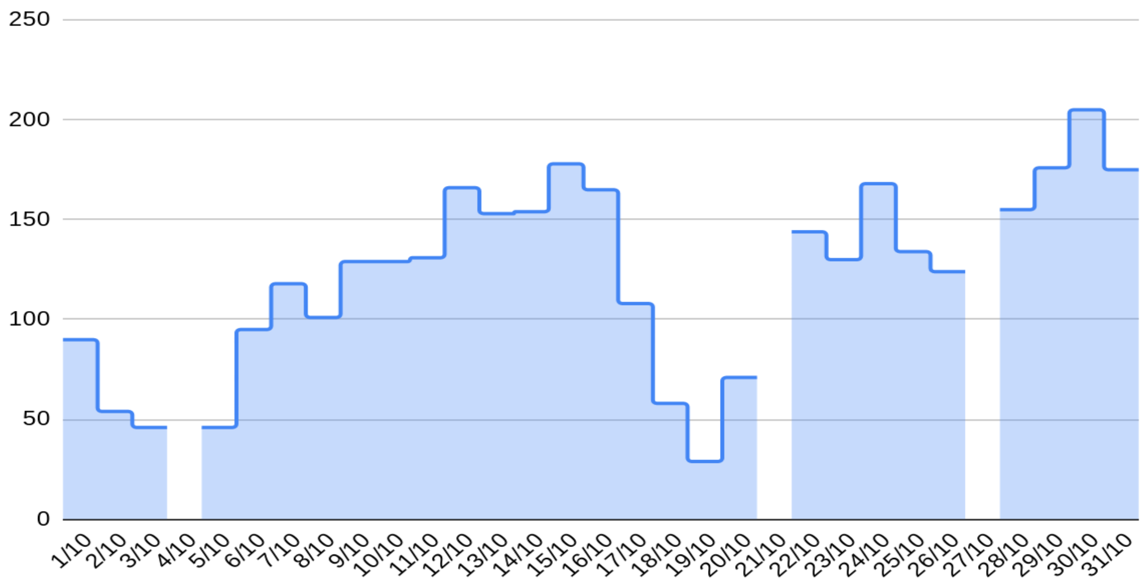
### Mean values of AQI and prominent gaseous pollutants for August 2021



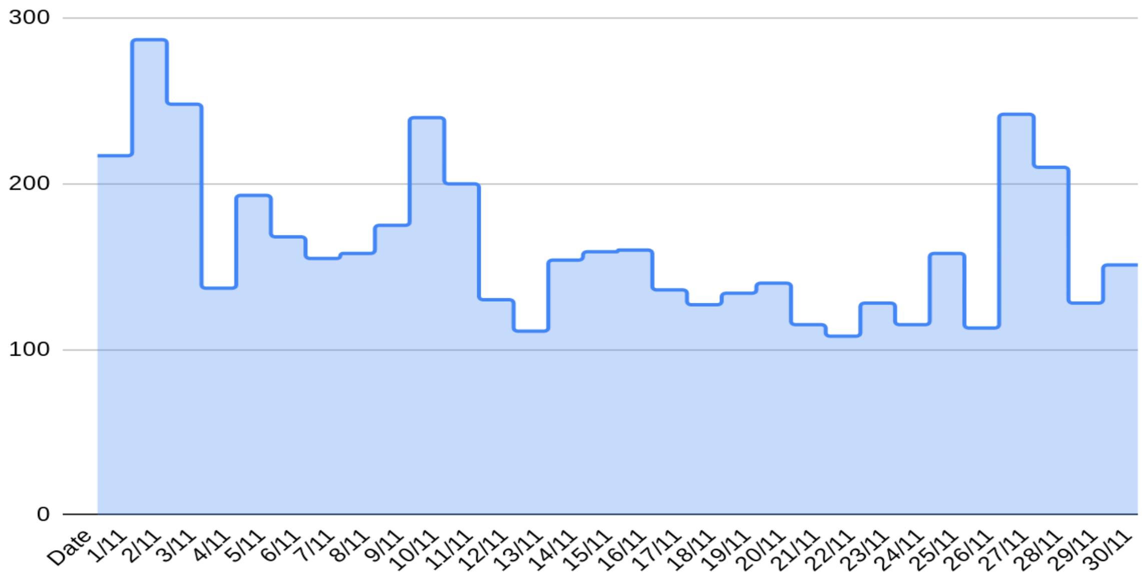

### Mean values of AQI and prominent gaseous pollutants for September 2021



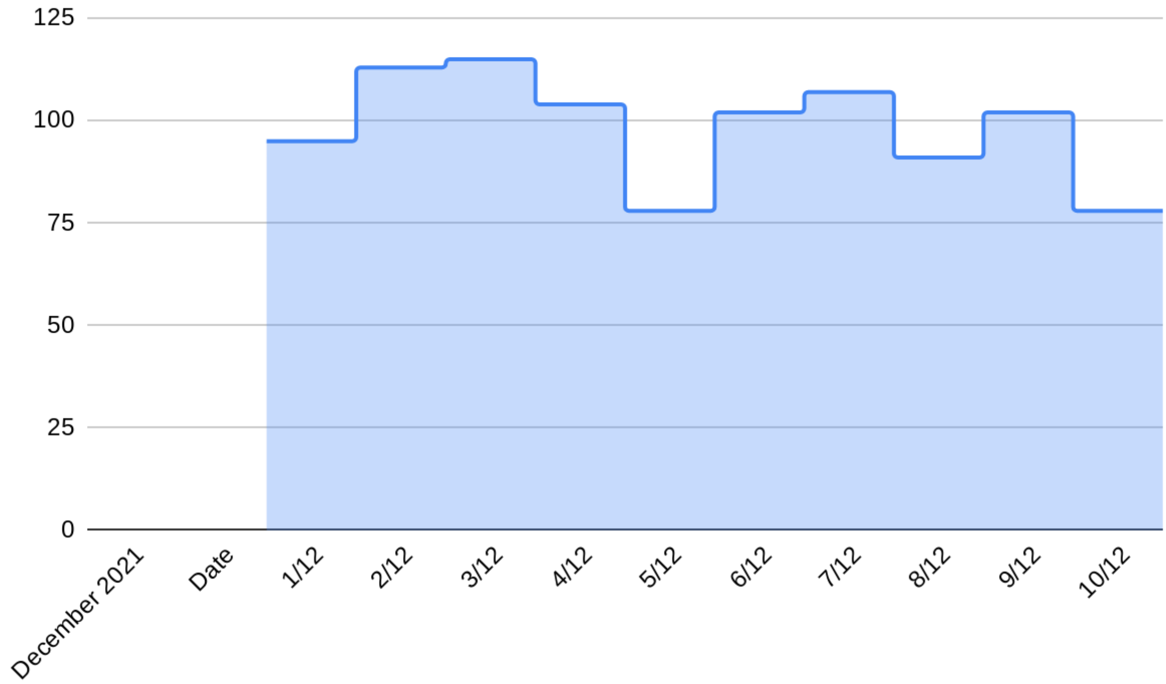
**Mean values of AQI and prominent gaseous pollutants for October 2021**




**Mean values of AQI and prominent gaseous pollutants for November 2021**

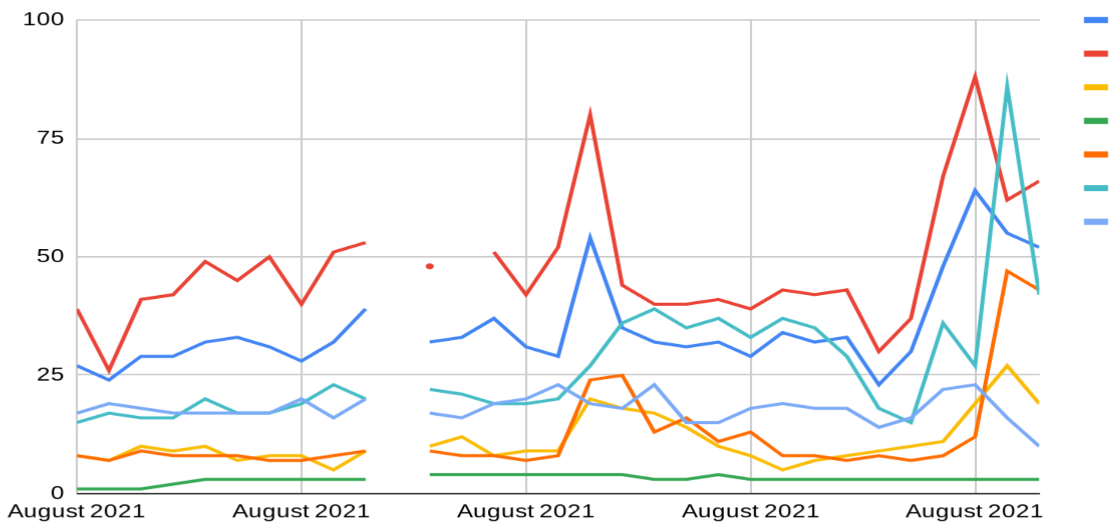


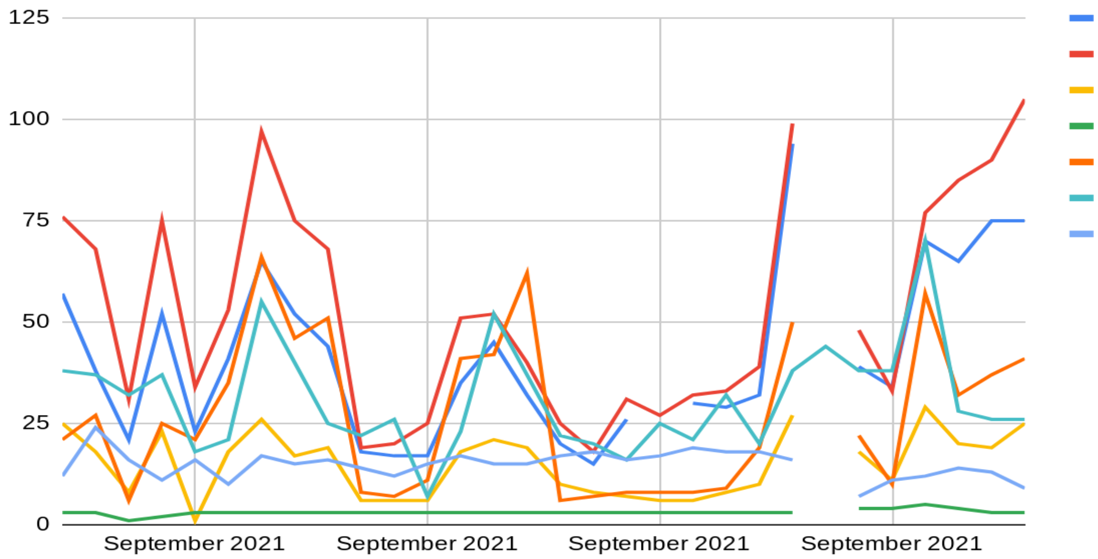
**Mean values of AQI and prominent gaseous pollutants for December 2021**




Daily

**Calculation of Pollutants :**

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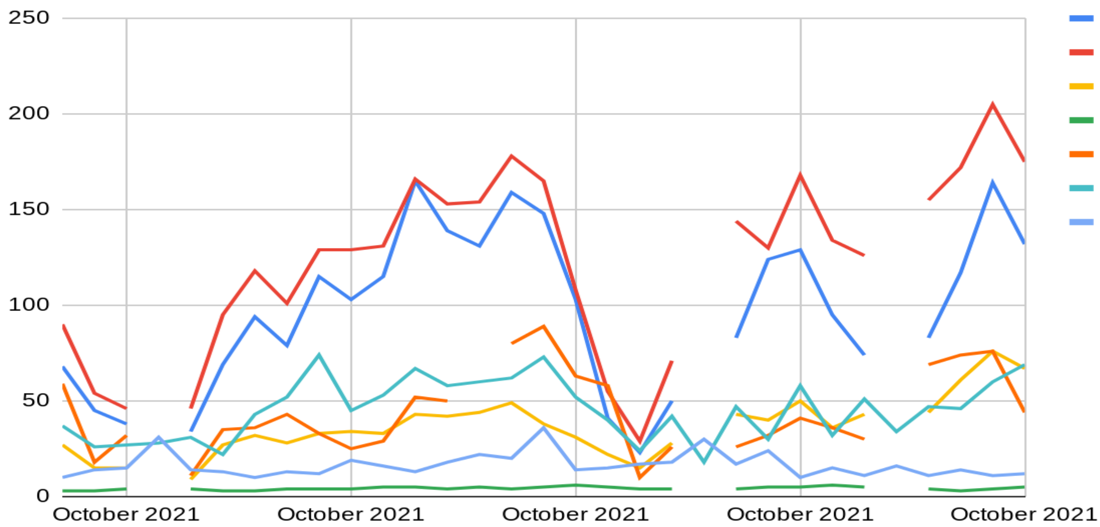
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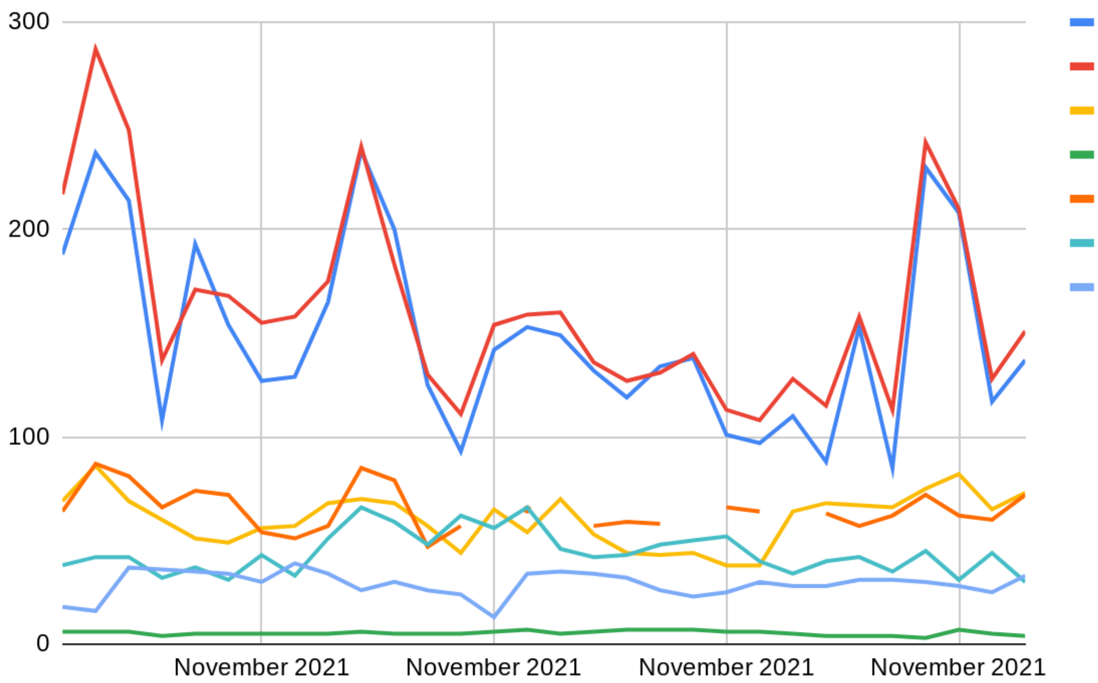


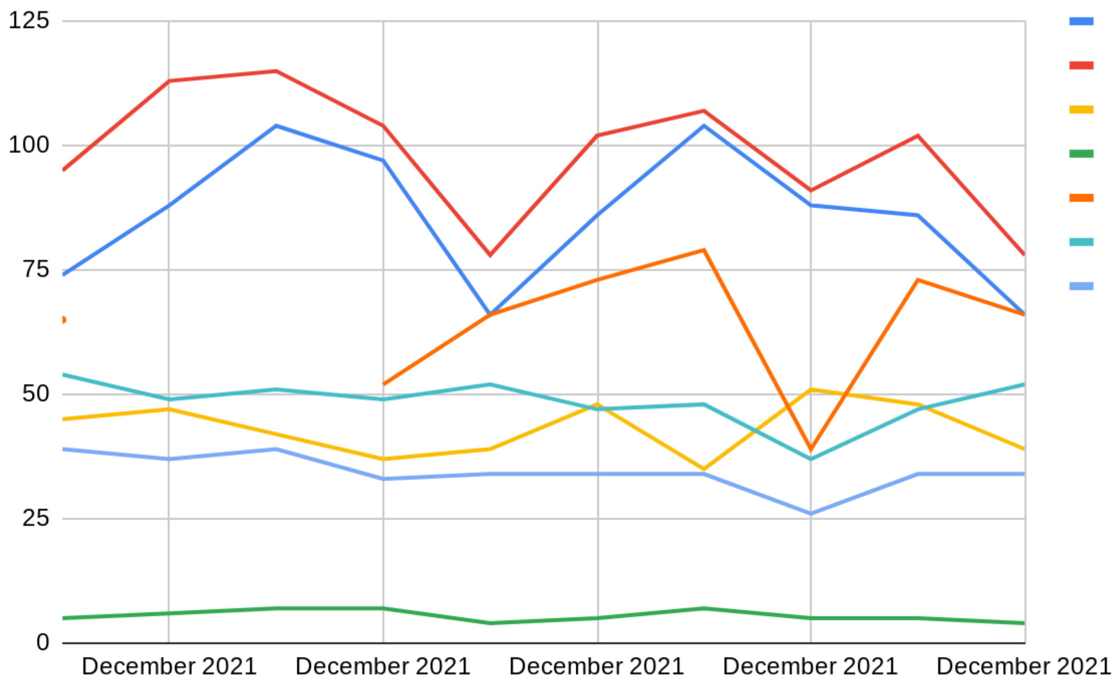


## V. CONCLUSION

This study has demonstrated how ambient PM10 and PM2.5 concentrations can be mapped on city-wide scales using portable particulate monitors in combination with a GPS. The approach presented in this paper has the potential to identify areas of elevated PM concentrations that might not have been detected when employing modelling approaches alone.

It is observed that the annual averaged PMs exceeded the WHO standards (10μg/m3 ) in all seasons. The PM concentrations showed a remarkable seasonal variability, highest during winter and lowest during the summer. The winter maximum is due to temperature inversion and stagnant weather. The diurnal variations of PM concentrations and gaseous pollutants were analysed. The concentration of PM and air pollutants showed significant correlation. The major contributing factors are NO2, a tracer for vehicle emissions and SO2, a tracer for combustion. It is clear from the study that high health risk is evident associated with fine particulate matter pollutants to the people living in Mandideep city.

Average PM concentrations in the region exceeded the World Health Organization guideline values, which indicated a serious impact on humans and the environment in Mandideep Province.

Results showed that 20% of all summer days had higher concentration of PM2.5, exceeding standards, and 33% of days were for PM10. PM10 concentrations were practically similar for entire industrial area and varied in the range of 60–70 μg/m3; it was indicated that PM pollution was a regional problem due to construction projects and industrial base. There is no clear distinction between working days and holidays in the concentrations of seven pollutants that indicate a weak influence of weekly human activities.

Data revealed that particulate aerosol concentration and their metallic content tend to fluctuate with the change in meteorological conditions i.e. lower concentration in winter season and higher concentration in summer season. Alarming vehicular and population growth rate, frequent traffic jams and overall poor infrastructure has lead to a significant rise in the aerosols such as PM10, and PM2.5 level. The ascending order of aerosol pollution level in sensitive zones in Mandideep industrial area city is the commercial complex > Industrial Plants > Manufacturing Units. Although vehicles and industries are the two most important contributors to aerosol level in outdoor atmosphere, comparatively less level in indoor atmosphere at selected monitoring locations. Other pollution sources, such as roadside dust, trans-boundary migrations, solid waste and local sources are also reasons for aerosol pollution in the ambient atmosphere of sensitive zones of Mandideep, Madhya Pradesh.

The primary reasons for air pollution in mandideep industrial area is due to the textile and cement industries situated there and the heavy transportation adds to the emissions.

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