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Evaluation of seasonal study of ambient particulate and gaseous pollution in Jabalpur city during 2012–2019

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Abstract
In recent years, India has experienced severe air pollution problems. Air pollution and its control is a global issue demanding international cooperation. It caused by particulate pollutants as well as many gaseous pollutants. Ground level observations show that the concentrations of particulate matter and gaseous pollutants have become extremely high in India and world over recent decades. The PM (PM10 & PM2.5) and ground level O3 are the two essential sources which can fluctuates the quality of ambient air in the atmosphere. In this paper study of two seasonal averages (winter and summer) during the year 2012-19 shows higher fluctuating concentration during the winter season as compared to summer season for this study used AAQMS instrument for collecting the data of pollutants.

Keywords: gaseous pollutants (ozone), particulate pollutants, monthly and seasonal average, correlation, air quality, aaqms and bam instrument

Introduction

A progressive degradation quality of air has been observed in India and other developing countries due to urbanization, industrialization, increase in the number of motor vehicles, lack of awareness among people, use of fuels with poor environmental performance and ineffective environmental regulations. Previous studies have focused more on individual sectors when investigating the spatial impact of urbanization. This study uses geographically BAM (Beta Attenuation Monitor) and ozone analyzers to collect the data of particulate forms are: PM_{10} and $PM_{2.5}$ particulate matter and gases forms are: ozone (O_3). Monitoring of pollutants is a very important source of data. However, measurement of the air and particle pollutant concentrations, in comparison to monitoring of other elements in the environment, is the most difficult. The difficulties arise from the large dynamics of the atmosphere, causing that it constitutes the main route of pollution spreading and their transport between remaining environmental compartments and universal exposure for a large population without a chance for isolation, which is possible in the case of polluted waters and soil. Another problem is low concentration of air pollutants and their interaction with other gases.

Concern about urban air quality is not new. First complaints were recorded in the 13th century when coal was first used in London. Today the emphasis has shifted from the pollution problems caused by industry to the pollution in urban areas. A growing concern over the influence of different air pollutants on human health were the main driving force to develop and implement of air quality criteria and standards. In 1967, the US Congress enacted the Air Quality Acts, the first modern environmental law. Scientifically, O_3 shows tremendous fluctuation with other pollutants of ground level. One of them is suspended particulate matter which plays a vital role for the formation surface O_3 in ground level. Suspended particulate matters (SPM) are the one of the major pollutants in the developing countries. The SPM are mainly divided into two parts: $PM_{2.5}$ and PM_{10}. SPM which is less than or up to $2.5\mu/m^3$ in size comes under $PM_{2.5}$. This $PM_{2.5}$ has an adversely impact on human respiratory system. Thus, it is a part which causes air pollution.

ARB staff reviewed the scientific literature and recommended revisions to the PM standards based on that review. There are so many research papers and works related to particulate matter and air quality have been reviewed in this work. Particulate matter and air quality is affected by meteorological parameter like-wind speed, temperature, humidity, rain fall and pressure. A variety of emission sources and meteorological conditions contribute to ambient PM_{10} and $PM_{2.5.}$ Air quality studies related to particulate matter have been done by various workers in India and in other counties. The concentration of O_3, $PM_{2.5}$ and PM_{10} were fluctuated during all the seasons because their concentration depends on the regional topography and climatic behavior. According to IMD (Indian Meteorological Department); India has designated into four seasons: winter and summer, winter occurred from November to February. Summer from March to June is the year. Mishra et al. (2011) [4] studied on modeling the effect of wind speed and win direction on RSPM concentrations in ambient air: a case study at urban areas in central India. They studied the impact of wind speed and direction on ambient RSPM concentration at three different urban sampling locations in Nagpur. They used statistical approaches of circular statistics in modelling the RSPM concentration using wind direction. The nonlinear model based on inverse relationship of RSPM concentration with wind speed and sine and cosine of wind direction is used to obtain one-step ahead forecast. They compared result with benchmark persistence model. Majumder *et al*. (2012) [5] published their findings on assessment of occupational and ambient air quality of traffic police personnel of the Kathmandu valley, Nepal; in view of atmospheric particulate matter concentrations (PM_{10}). In this study they conducted analysis during the period of 2008-09 and the purpose was to understand how the pollution trends are associated with the high density road traffic intersections considering the levels of particulate matter concentrations (PM_{10}), representing the occupational and ambient air quality of the traffic police personnel of the Kathmandu valley, Nepal. Correlation Analysis on Variation Characteristics of Surface Ozone Concentration and its Precursor Compounds in Chongqing was observed by Ping *et al*. (2013) [7]. As a result, ozone concentration shows significant diurnal variation and hourly changed positively correlation with solar radiation. VOCs (volatile organic compounds) are basically consistent with the variation of ozone whereas, good negative correlation with NOx. *Thakkar* (2013) Analyzed of air pollution parameters of fertilizer industries specially reference to G.S.F.C. Vadodara, Gujarat. He studied of air sample collected from around the factory G.S.F.C., Vadodara during 4 year of studies with the help of high volume sampler equipment. He measured different parameters and also analyzed the effect of seasonal variation on various parameters. The value of all the studies and their result concluded the value of SPM was higher in summer and winter least in rainy season. Moja *et al*. (2014) [6] studied determination of some polycyclic aromatic hydrocarbons (PAHs) associated with airborne particulate matter by high performance liquid chromatography (HPLC) method. In this study, polycyclic hydrocarbons associated with airborne particulate pollutants size 10µm measured for three month in 2010. Some PAHs are highly carcinogenic and could be more harmful when combined with inhalable PM_{10}. Yang *et al* (2018) [9], they reviewed different PM exposure assessment methods applied in epidemiological studies of adverse health effects of short-term and long-term exposure to PM components. Deep *et al* (2019) [1], Analysis of 'Air Quality Index (AQI)' variations indicates unhealthy atmospheric conditions near the major city centers and bus station. PM_{10} and SPM concentrations with maximum values of 203 ± 23 and 429 ± 49µg m^{-3}, respectively, during winter, are found to exceed the national standards by factors of 2 and 3. More observations in the region are highly desirable to understand the dispersion of the enhanced pollution in the Dehradun valley. Ma et.al (2019) [3] they measured particular matter (PM) including gaseous pollutants (SO_2, NO_2, CO, and O_3) over 130 cities in China from April 2014 to March 2015, the spatial and seasonal variations of air pollution. In contrary to PM pollution, gaseous pollution in China is overall quite trivial.

Significance of the study

The present study has been aimed to assess the seasonal variabilities in particulate and ozone pollutants as well as quality of air during the 7year study and comparison with previous year's air quality data during the same period. This study provides the useful information about the changes occurred in air quality data in 7years of study.

Material and Methods

The present study was aimed to study the PM and ozone pollution during 7 years study (2012-2019) in Jabalpur. The selected city Jabalpur is famous for its beauty and green belt. This is generally sub-tropical in nature because of its geography on Earth. It can be figure-out that, geographically Jabalpur is positioned at 23.17°N and 79.95°E. The district Jabalpur is located at the central point of India. It has an average elevation of 411 meters (1348 ft). The name of city Jabalpur is basically derived from Arabic word *Jabal* which means *"mounting pointing to the ancient trade connection with Arab countries"*. The name reflects the influence of the Arab traders who visited the city during the middle ages. Another belief is that a mythological figure known as Sage Jabali apparently lived in the area during the Ramayana era.

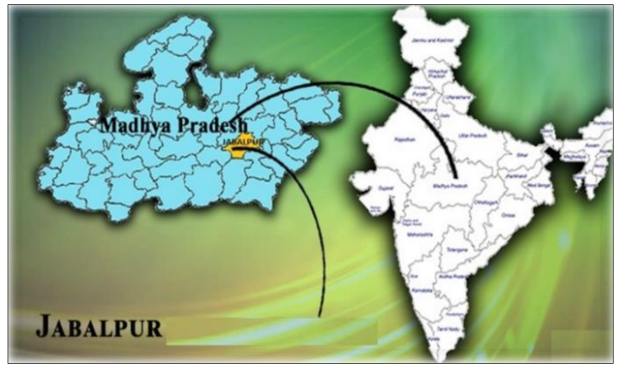

Fig 1: Location of Jabalpur city

Instrument

The locations for monitoring stations depend on the purpose of the monitoring. Most monitoring networks are designed with human health objectives in mind, and monitoring stations are therefore established in population centers. Ambient Air Quality Monitoring Systems (AQMS) monitored the level of pollutants – Particulate Matter (PM_{10} & $PM_{2.5}$), NOx, CO, CH_4, Ozone, etc. in the ambient atmosphere.

Collection of Data

The data is collected with the help of AQMS (air quality monitoring system) through WINAQMS Software and that shows every five minute data and installed in the Laboratory.

Win Ambient Air Quality Monitoring Station (Win AAQMS)

Win AQMS is a Windows based system which provides full control over the entire system (remote and onsite) enabling automatic calibrations to be performed and system errors to be monitored. Win AQMS interfaces to analyzers via a RS232 multi-drop serial link, through a USB link or via TCP/IP network link. This allows it to collect data directly from the instruments in digital format thus eliminating digital to analog and analog to digital conversion errors. The bi-directional interface also allows a remote central computer, running Ecotech's WinCollect software, to access full control and diagnostics of the analyzers used and data to be collected remotely.

Particulate Matter Measurement Used Beta Attenuation Monitor Analyser (BAM)

The Met One instruments model BAM-1020 automatically measures and records airborne particulate concentration levels using the principal of beta ray attenuation. This method provides a simple determination of concentration in units of milligrams or micrograms of particulate per cubic meter of air. A small ^{14}C (carbon 14) element emits a constant source of high-energy electrons known as beta particles. These beta particles are detected and counted by a sensitive scintillation detector. An external pump pulls a measured amount of dust-laden air through a filter tape. After the filter tape is loaded with ambient dust, it is automatically placed between the source and the detector thereby causing an attenuation of the beta particle signal. The degree of attenuation of the beta particle signal is used to determine the mass concentration of particulate matter on the filter tape, and hence the volumetric concentration of PM in ambient air.

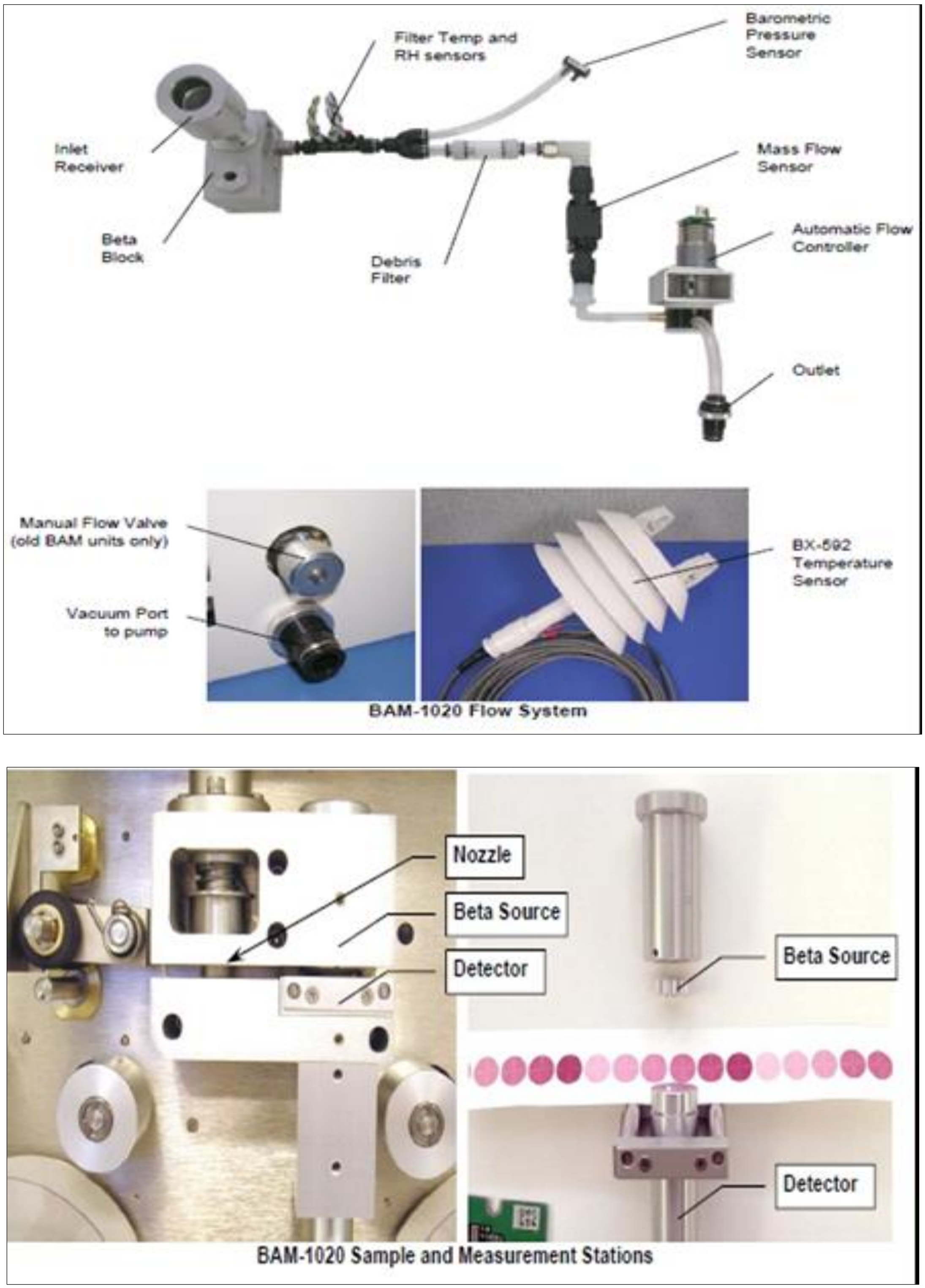

Fig 2: Flow Diagram with Measurement Cycle of BAM

EC9810 Ozone Analyzer

The ozone analyzer determines ozone concentrations by measuring the amount of ultraviolet light that the ozone absorbs.

Ozone exhibits strong absorption in the ultraviolet spectrum around 250 nanometers (nm). The EC9810 ozone analyzer exploits this absorption feature to accurately measure ozone concentrations to less than 0.5 ppb. A stream switched, single beam photometer serves as the basis for the EC 9810. The ultraviolet light is detected by a photodiode that only responds to ultraviolet energy. The photodiode converts ultraviolet light to electrical signal that is proportional to ultraviolet light detected.

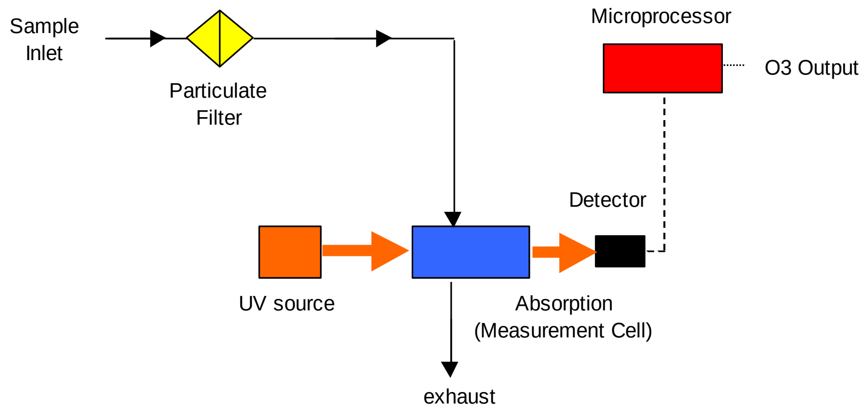

Fig 3: Flow diagram of O_3 analyzer

Observation Table and result and discussion

This study determined the effects of seasonality on particulate and ozone pollution in a tropical city of Jabalpur, MP. This was with a view to acquiring data that would be useful in policy formulation and planning for proper management of ailments that result from seasonal variation of particulate and ozone pollution in the study area. Analysis of two season (summer and winter for the study covered a period of seven months, between winter (March 2012-June 2013 and March 2018-June 2019) and summer (November 2012- February 2013 and November 2018- February 2019). Air pollutants, taken into consideration, include particulate matter (PM2.5 and 10µg/m^3) and Ozone (O_3). Particulate matter was measured using a Bam analyzer, while O_3 was measured with an ozone analyzer (EC9810). Collecting the data from AAQMS monitoring station which is installed in Govt. Science College, Jabalpur were selected based on automatic technique, which represented five minutes data. Sampling was continued carried out 24hours. Sampling height was 5 meters above ground level. The student Pearson correlation was used to determine significant differences in seasonal mean concentration of air pollutants across dry and wet seasons.

Table 1: Result of Seasonal Correlation of $PM_{2.5}$, PM_{10} and O_3 concentration of 2012-19

Year	2012-13		2018-19	
Season	**Winter**	**Summer**	**Winter**	**Summer**
$PM_{2.5}$ (µg/m^3)	66	34	60	38
PM_{10} (µg/m^3)	106	88	126	114
O_3 (ppb)	67	59	52	52

The results revealed the summer season with mean values of 34, 88 particle counts for particles counts PM2.5 and 10µg/m^3 and 59ppm O_3 concentration in 2012-2013 and 38, 114 particle counts for PM2.5 and 10µg/m^3 and 52ppm O_3 concentration in 2018-19. Winter season with mean values of PM are 66, 106 particle counts for PM2.5 and 10µg/m^3 and 67ppm O_3 concentration in summer season in 2012-13 and 60, 126 and 52ppm O_3 concentration in 2018-19 and 66, 106 and 67ppm O_3 concentration (Table-1) it was characterized by higher concentration of pollutants, while the winter season as compare to summer season. The study concludes that seasonality significantly influences the concentration of pollutants in the city.

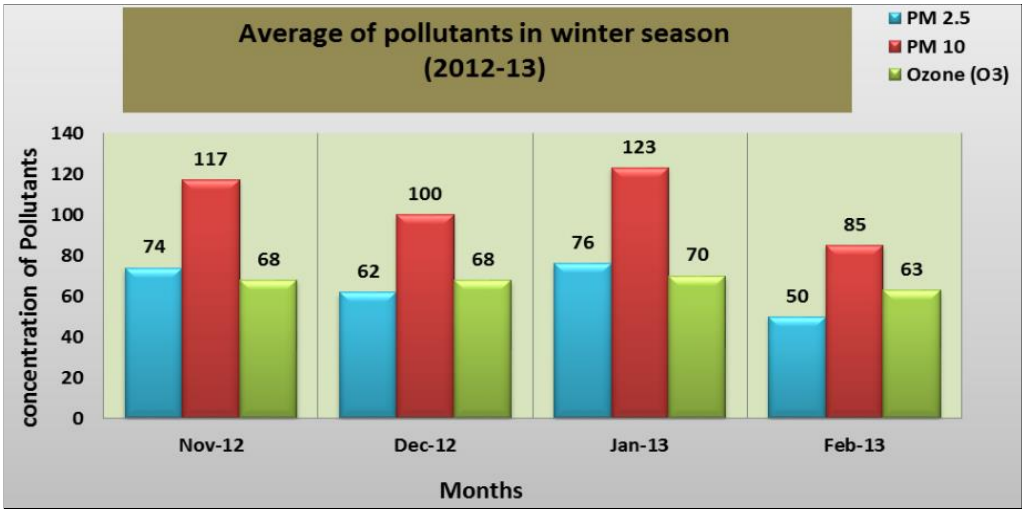

Fig 4: Average value of $PM_{2.5}$ & PM_{10} and O_3 concentration in winter season (2012-13)

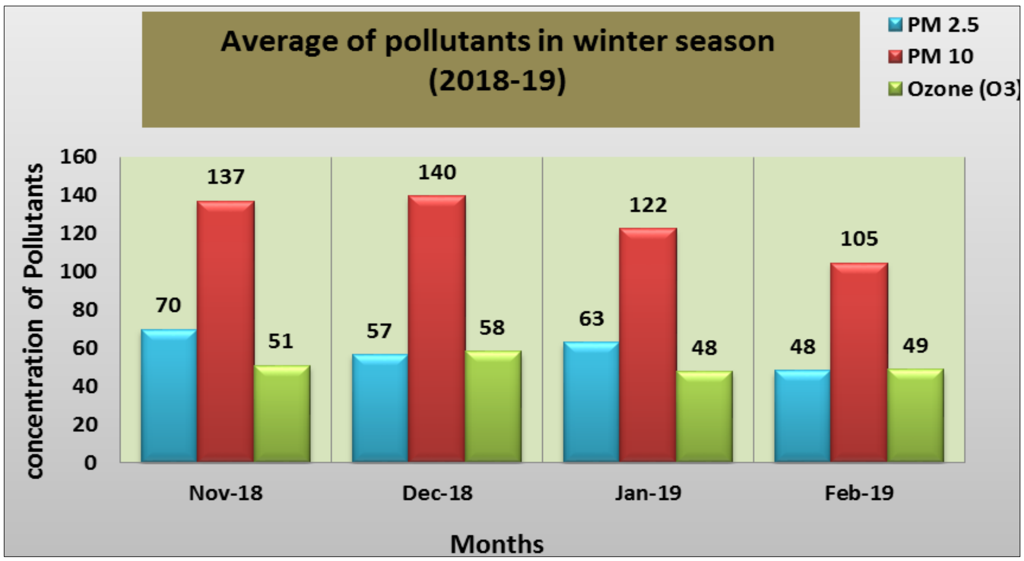

Fig 5: Average value of $PM_{2.5}$ & PM_{10} and O_3 concentration in winter season (2018-19)

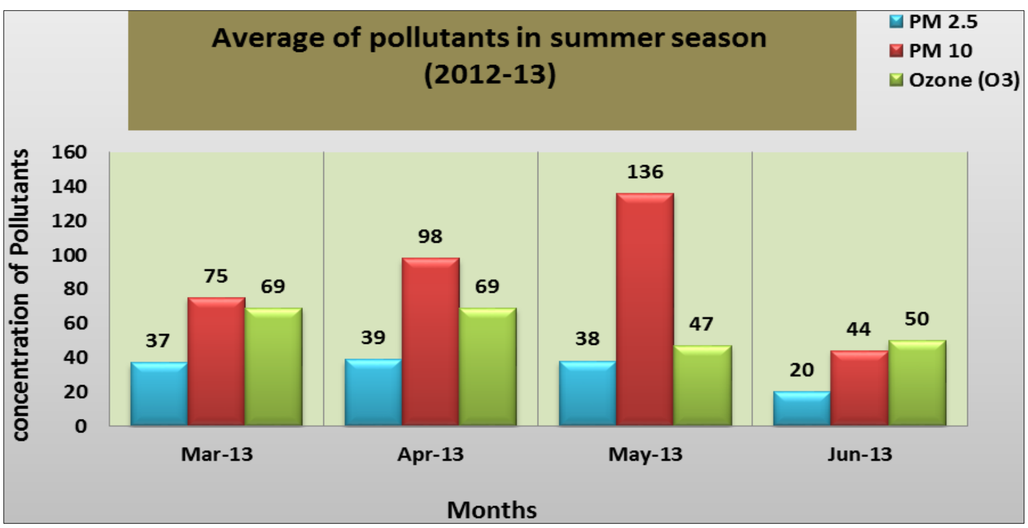

Fig 6: Average value of $PM_{2.5}$ & PM_{10} and O_3 concentration in summer season (2012-13)

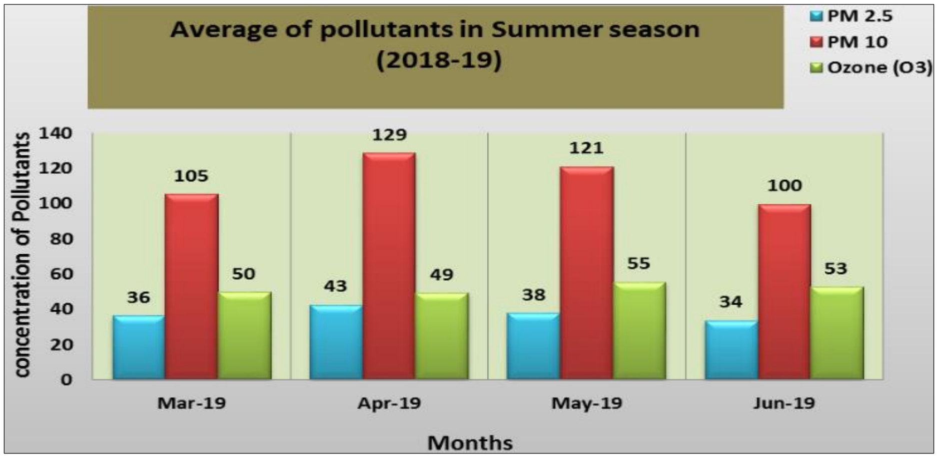

Fig 7: Average value of $PM_{2.5}$ & PM_{10} and O_3 concentration in summer season (2018-19)

The above graphical representation of each month shows the variation in the concentration of pollutants. The time interval of 1hrs within the 24hrs of in each day of each month performs the seasonal average. To establish the seasonal differences in particulate matter and ozone, it was monitored in terms of different size fractions which were separated into winter (November-February) and summer (March-June) in Fig. 4 & 5 shows the concentration of pollutants during 2012 to 2019. In January 2012-2013 all pollutants was highest as compare to other months but in 2018-19 December was highest because of boundary layer and other climatic factor was involved for responsible to increases the pollution level. In fig. 6 & 7 shows highest concentration of particulate pollution in April and May months but ozone concentration was low.

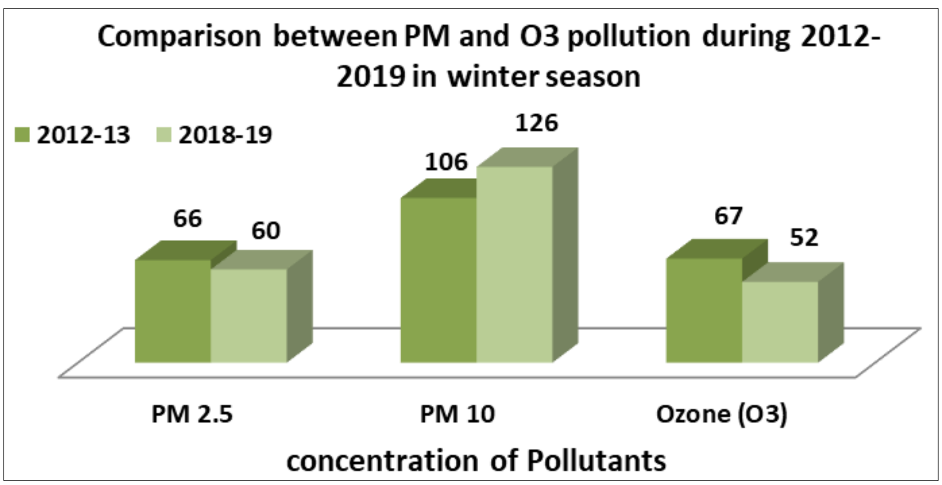

Fig 8: Comparison between PM and O3 pollution during 2012-2019 in winter season

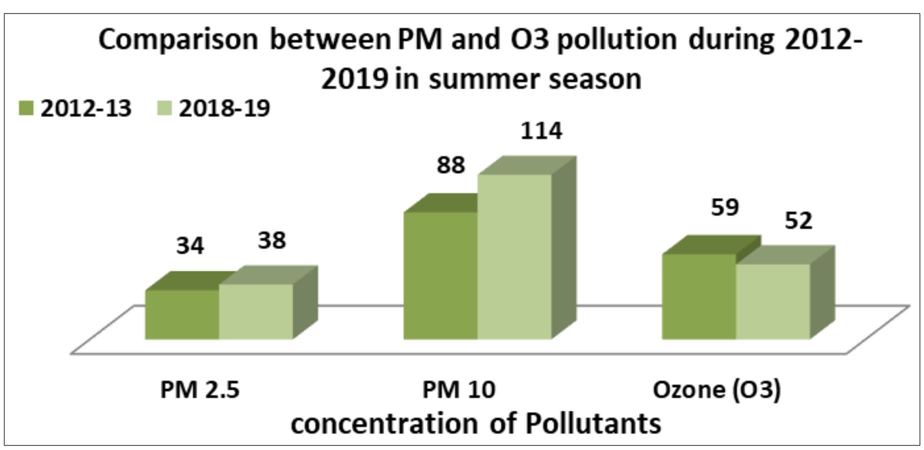

Fig 9: Comparison between PM and O3 pollution during 2012-2019 in winter season

The seasonal monitoring of $PM_{2.5}$, PM_{10} and O_3 with respect to shows a trend line fluctuation in all the weathers. This may be affected with other meteorological parameters present in the atmosphere. It observed that, PM_{10} was high and $PM_{2.5}$ and O_3 was low (fig. 8 & 9) concentration was highly affected during the autumn season due to high humidity. The particulate matter (PM_{10} and $PM_{2.5}$) and meteorological parameter (Tem.) were analyzed during 7 year study found that the particularly.

Conclusion

In the past decade, many studies have reported an association between air pollution and daily deaths resulting from either respiratory or cardiovascular causes. In particular, exposure to particulate pollution was found to be associated with increased cardiopulmonary deaths. Although the mechanisms responsible for this association remain unclear, it is commonly explained by alteration in the autonomic nervous system, change in blood coagulability or inflammation said by choi *et al.* (2007) [2]. As a result of the observations that exposure to particulate ($PM_{2.5}$ and PM_{10}) and ozone air pollutants is associated with an altered autonomic recorded data. Results from the study have shown that seasonality significantly varies with air pollutant concentration. The mean variation for particulate matter and ozone concentration between the dry and winter seasons was highest value as compare with Indian standards; values for PM2.5-10µm and ozone have categorized the environments of all the land use classes in the study area as the "moderately dirty". This study analysis that in 2012 to 2019 pollution level was slightly increases.

Acknowledgement

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References

1. Amar Deep, Chhavi P Pandey, Hemwati Nandan, Purohit, Narendra Singh K D, Jaydeep Singh, Srivastava AK, *et al*. Evaluation of ambient air quality in Dehradun city during 2011–2014. Journal of Earth System Science. 2019; 128:9. ttps://doi.org/10.1007/s12040-019-1092-y.
2. Ji Ho Choi, Qing Song Xu, So Yeon Park, Jin Hee Kim, Seung Sik Hwang, Kwan Hee Lee, *et al*. Seasonal variation of effect of air pollution on blood pressure. J Epidemiol Community Health. 2007; 61(4):314-318. doi: 10.1136/jech.2006.049205
3. Ma X, Jia H, Sha T, An J, Tian R. Spatial and seasonal characteristics of particulate matter and gaseous pollution in China: Implications for control policy. Environ Pollut. 2019; 248:421-428. doi: 10.1016/j.envpol.2019.02.038. Epub 2019 Feb 15.
4. Mishra Sargam, Chauhan Chanchal, Chelani Asha, Kumar Animesh, Rao CV Chalapati. Modelling the effect of wind speed and win direction on RSPM concentrations in ambient air: A case study at urban areas in central India. IJEP. 2011; 1(3):9-14 www.ijep.org ○C World Academic Publishing.
5. Majumder AK, Nazmul Islam KM, Roshan Man Bajracharya, William S Carter. Assessment of occupational and ambient air quality of traffic police personnel of the Kathmandu valley, Nepal; in view of atmospheric particulate matter concentrations (PM_{10}). Atmospheric Pollution Research. 2012; 3:132-142.
6. Moja Shading J, Mtunzi Fanyana, Mnisi Jeremiah S. Determination of some polycyclic aromatic hydrocarbons (PAHs) associated with airborne particulate matter by high performance liquid chromatography (HPLC) method. African Journal of Environmental Science and Technology. 2014; 8(4):210-218.
7. Ping L, Chongzhi Z, Jiayan Y, Lei B, Wei H. Correlation analysis on variation characteristics of surface ozone concentration and its precursor compounds in Chongqing. Environmental Science and Management. Chongqing Environmental Monitoring Center, Chongqing, 2013 401147,
8. Thakkar Atul. Analysis of air pollution parameters of fertilizer industries specially reference to G.S.F.C. Vadodara, Gujarat. International Journal of Theoretical & Applied Sciences. 2013; 5(2):109-113(2013).
9. Yang Yang, Vivian C Pun, Shengzhi Sun, Hualiang Lin, Tonya G Mason, Hong Qiu. Particulate matter components and health: a literature review on exposure assessment. J. Public Health Emerg. 2018; 2:14. doi: 10.21037 / jphe. 2018. 03. 03. http://dx.doi.org/10.21037/jphe.2018.03.03