# Temporal Analysis of Air Pollution Over Mumbai Metropolitan City

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***Abstract*— Mumbai (18.97˚N, 72.82˚E) with over 10 million population is one of the most populous city in India and ranks fifth among the most populous cities of the world. With considerable industrial activity and vehicular presence, air pollution is a key issue affecting the human health. Continuous air quality monitoring is being done to identify the patterns in key indicators like SOx, NOx and RSPM (respirable suspended particulate matter). We have analyzed the pattern in the changes in these species using air quality data at Sion (19.04˚N, 72.86˚E) from 2004 to 2014 and Bandra (19.05˚N, 72.84˚E) from 2007 to 2014. . In time series analysis of this 10 years data at Sion we are able to get considerable decay in SOx from 30 to 10µg/m3 and in RSPM from 250 to 150µg/m3because industries are displaced from locality, not much change is seen in NOx from 110 to 100µg/m3. Whereas in case of Bandra there is little increase in SOx concentration from 18 to 20µg/m3while decay in concentration of NOx from 65 to 50µg/m3and in RSPM from 140 to 110µg/m3. The paper attempts to analyze the causes for these pattern changes in terms of industrial activity, changes in vehicular pollution norms and other anthropogenic factors.**

***Keywords—Air Pollution, Particulate Matter, Vehicular Pollution, Anthropogenic Factors, Industrial Activity.***

## I. INTRODUCTION

Mumbai was formed through reclamation of seven islands in the course of time. It is covered with Western Ghat (WG) Mountains from east side and the Arabian Sea from the west side. Even the city itself has large hydrological resources like lakes, dams and rivers and forest Reservoir. Mumbai is the commercial capital of India therefor it always guarantees the mass employment in the town[8]. Always there is migration from every part of India for the employment in the Mumbai, which is responsible for continues population growth in the town. Currently Mumbai has a population more than 20 million, which is about 1.2% population of the whole country. Due to its commercial value for the India and its unique geographical situation makes this city as ideal city. As increasing population and development of the city is contributing greatly to pollution in flux too[3,8]. In past years, it's climate has changed significantly, which is one of the reasons to be getting alerts for this elegant city. Continuous monitoring of pollution concentration of this city will be helpful for decision maker and city planner for its betterment. Pollution studies is not only important for climatological variation, but also its directly make an impact on human health. In this paper, we had studied pollution concentration for the past 10 years for two different observation station, which is housed in the heart of the island. This paper gives a variation of various pollution components like, $NO_x$, $SO_x$, and Repairable Suspended Particulate Matter (RSPM), which plays an important role in human health as well in environmental issues like global warming scenarios. Air pollution cause problems like eye irritation, asthma, bronchitis, etc., which invariably reduce efficiency at work. There are the different types of air pollutants, suspended particulate matter (SPM),especially Repairable Suspended Particulate Matter (RSPM), is known as the most important in terms of health effects[2,3,4]. The air pollution has significant impact on health, it is important that it be explicitly accounted for economic planning. This requires, however, economic valuation of the benefits of remedial measures taken to reduce air pollution and its impacts. In most of the urban cities of India the pollution levels are much above the international and domestic safety standards. Therefore, in recent years there has strong movement to introduce environmental policy changes that can improve air quality[3]. For this purpose continues observation and analysis of its temporal trend. We had present time serious variation as well as seasonal variation in concentration of said gases, also we had discussed about possible reasons for its variations in the course of time.

## II. DATA SAMPLING AND RESULT

The data for the present study was obtained through Maharashtra State Pollution Control Board's (MPCB) pollution monitoring station at Sion and Bandra as primary data. MPCB provides every day's daily mean concentration of NOx, SOx and RSPM for said stations. We took data from the year 2004 to 2014 and averaged into monthly and seasonal mean values FOR Sion station and year 2007 to 2014 for Bandra station. We had identified whole year into four seasons pre-monsoon (March, April and May), monsoon (June, July and August), post monsoon (September, October and November) and winter (December, January and February). Since monsoon washed of all the trace gases (pollution) from the atmosphere, therefore we had considered a period before and after monsoon for the study of trace gas concentration.

Fig. 1 (a) shows variation in concentration of RSPM, NOx and SOx, annual average is plotted on temporal scale for the year 2004 to 2014 and in Fig. 1 (b) seasonal means are plotted on a temporal scale at Sion station.

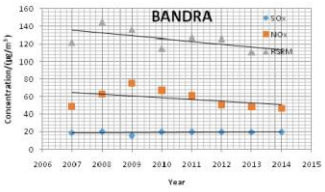


Fig.1(a)

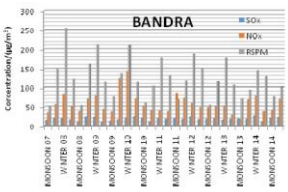


Fig.1(b)

From the Fig. 1 (a) we are able to observe declination of RSPM concentration for more than 250µg/m$^3$ to less than 150µg/m$^3$ in the past 10 years at the Sion observation station. Concentration of $SO_x$ significantly reduced from 30µg/m$^3$ to about 10µg/m$^3$.Variation in concentration of $NO_x$ is about negligible in past years, i.e. from 110µg/m$^3$ to 100µg/m$^3$.

From the Fig. 1 (b) we are able to recognise concentration of $SO_x$, $NO_x$ and RSPM is remains low in Monsoon in comparison with pre-monsoon and post-monsoon periods season and peak is observed in winter for every year at the Sion observation station.

Fig. 2 (a) shows variation in concentration of RSPM, $NO_x$ and $SO_x$ annual average is plotted on temporal scale for the year 2007 to 2014 and in Fig. 2 (b) seasonal means are plotted on a temporal scale at Bandra station.

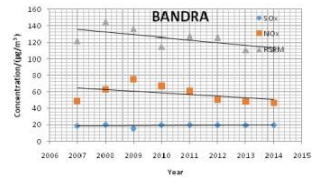


Fig.2(a)

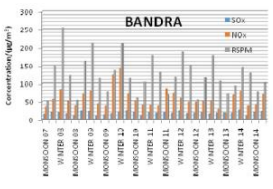


Fig.2(b)

From the Fig. 2 (a) we are able to observe declination of RSPM concentration from 140µg/m$^3$ to less than 110µg/m$^3$ in past years at the Bandra observation station. Concentration of $SO_x$ increased slightly from 18µg/m$^3$ to about 20µg/m$^3$.Variation in concentration of $NO_x$ is about negligible in past years, i.e. from 65µg/m$^3$ to 50µg/m$^3$.

From the Fig. 2 (b) we are able to recognize concentration of $SO_x$, $NO_x$ and RSPM, which remains low in Monsoon season in comparison with pre-monsoon and post-monsoon period and peak is observed in winter for every year at the Bandra observation station.

## III. DISCUSSION

Fig. 1 (a) considerable decrease in concentration of RSPM and SOx at Sion observation station. As Sion was surrounded by Industrial area, concentration records were slightly higher in this region. Industrial activity loads the SOx particle in the environment and in the past ten years, most of the manufacturing industries had moved out of the town, which will be one of the possible reasons for decreasing concentration of the SOx and RSPM at Sion. Change in NOx concentration is observed negligible. NOx is a mainly outcome of vehicular motion and in the past ten year's number of vehicles are increasing drastically in the town. As our new vehicles are more fuel efficient and environmental friendly therefore it's increased number had a neutral effect on NOx concentration in Sion locality.

Fig. 2 (a) shows small but significant decrease in the RSPM and $NO_x$ concentration at Bandra observation station, this area was surrounded by residential and commercial complex, which does not have any significant modification in the term of pollution control in past years. Due to this reason we are not able to find out much change in concentration of RSPM and Nox. There is small increase in the concentration of $SO_x$ over the region is observed. This region is surrounded by Asia's biggest slum Dharavi which holds many small scale and illegal industries which contributes great in $SO_x$ concentration.
Beside this increasing Municipal awareness and traffic rules has also contributed in term of pollution control on a small scale.

Different seasons play different role, in the ambient concentrations of different trace gases. Fig. 1 (b) and 2 (b) shows seasonal variation of different pollutants $SO_x$, $NO_x$ and RSPM. In our study, we are able to observe continues fall in the concentration of all the pollutants in the monsoon seasons compare to pre and post monsoon periods, due to windy atmospheric condition and regular rains wash away different anthropogenic pollutants and helps in the stop dispersion of particles in the locality.
On the other hand, in winter season high pressure zone increases the stability of the atmosphere, RSPM and other trace gases are retained in the locality. Therefor we are able to observe the high concentration of pollutant in winter season. In summer or the pre - monsoon season atmospheric temperature is high, due to convection activity pollutant lifted high in the atmosphere. Which makes the lower part of atmosphere cleaner than the winter and the post monsoon period.
Fig. 1 (b) and 2 (b) are in great agreement with the above statement. For both the observation statement Sion, and Bandra, it is observed that major pollutants ($SO_x$, $NO_x$ and RSPM) are present in high concentration in winter period compared to pre-monsoon and monsoon period. Therefor respiratory and eye infections are frequent and obvious in winter.

## IV. CONCLUSION

In the past ten years, migration of industries had made quite an impact on air quality of the city. Increasing population and thus increase in the number of private vehicles are contributing to the concentration of trace gases. A continuous monitoring will help to understand the impact of pollution on human health and take timely decisions to handle the pollution in town.

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