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Investigation of Concerning Level of RSPM (PM10) Through AQI MAPPING in and Around Bengaluru

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Abstract

Pollutant concentration data for three important air pollutants have been collected from four prime locations in Bengaluru, Karnataka, India. These are analyzed for the period of 2016 and 2017, and represented in the form of standardized Air Quality Index (AQI) parameter. The obtained air quality values are further compared and interpreted on the basis of standard AQI values. Present study reveals that the AQI value at 'Central Silk Board' is the highest. This poor quality of air can possibly be due to two prime reasons – (1) dense on-going traffic; and (2) prolonged construction activities. On the other hand, Kajisomanahalli has shown the least AQI values from the present measurement. It is worth here to mention that in the selected places, the values of RSPM (Respirable Suspended Particulate Matter) (PM10) have been found to exceed the national limit of 60.0 μg/m^3. As a matter of high concern, the RSPM (PM10) levels are (160 - 180 μg/m^3), that is approximately three times more than the National Ambient Air Quality Monitoring (NAAQM) Standards.

Keywords: Air Pollution, Urbanization, Health hazards, Air Quality Index, Air Quality Management System, RSPM, NAAQM.

INTRODUCTION

Globally, air pollution has become an emerging concern for the public health. Recent studies have showed that the presence of various toxic pollutants is adversely affecting the quality of air, deteriorating the human health. Several factors are responsible for these increasing trends of air pollutant concentration in the developing countries. Countries that are more focussed on enhancing urbanization and industrial activity with high levels of energy consumption and improper infrastructure facilities are more prone to severe air quality. These factors will eventually inflate the vehicular growth. Vehicles have now become one of the prime sources of air pollution in urban India. As a matter of concern, this increase in the concentration of ambient air pollutants has tremendously affected the human population. Several epidemiological studies have already established a direct relationship between increasing air pollution and severe health hazards that ranges from morbidity to mortality. Hence there exists an inevitable relation between the poor air quality and poor public health.

Changes in the atmospheric composition, due to the introduction of harmful contaminants, is broadly referred as the air pollution. The increasing concentration of air pollutants depends on both the emissions from various sources, and the subsequent chemical and dynamical processes that will eventually take place in the atmosphere. These atmospheric emissions are in generic terms referred as Particulate Matter (PM), that consists of suspended particles in the air as a mixture of both solid and liquid particles [4]. This classification of suspended particles depends on the aero-dynamic diameter of the particles. A diameter of 10 µm (micro-meter), are commonly known as PM10 particles whereas diameter less than 2.5 µm are known as PM2.5. Further, PM10 particles are also known as Respirable Suspended Particulate Matter (RSPM). In this category, the major gaseous pollutants are Sulphur Dioxide (SO_2) and Nitrogen Dioxide (NO_2). Therefore, in order to have a proper control on these emissions, a detailed monitoring in terms of the ambient air quality is needed continuously. According to the National Ambient Air Quality Standards (NAAQS) as prescribed by Ministry of Environment, Forest & Climate Change, Government of India, the level of concern for the selected pollutants are given in Table-1.

Table 1: Ambient Air Quality Indian Standards for Selected Parameters (µg/m^3) [4]

Area	**Concentration of different Air Pollutants in (µg/m^3)**		
	RSPM (PM_{10})	**SO_2**	**NO_2**
Industrial, Residential Sensitive Areas	60	50	40

Bangalore (now known as Bengaluru), one of the fastest emerging cities of India, has recently showed evidences of rapidly deteriorating air quality. This has raised alarming concern both for the urban infrastructure management and local government authority. In this area, the major sources of both NO_2 and SO_2 pollutants are from combustion of fossil fuels and diesel exhausts. Poor quality of indoor settings like gas burning appliances, kerosene heaters and tobacco smoke also hugely contribute to the rising NO_2 levels. As per a recent study [5], the city has almost half of the running vehicles in diesel operation. This increased number of vehicles eventually triggers severe traffic congestions in the city, which contributes to further worsening of environment in prime locations. Due to these transportation activities only, last decade has seen a massive 70% degradation of AQI in Bangalore [2]. All these constraints result in the difficulty of expansion of the city, and *thus hindering its* development. This rising atmospheric pollutant concentration is mainly due to the urban lifestyle and management. Unnecessary use of private vehicles not only affects increasing commuting hours but also enhances poor traffic management, leading to congestion and high rate of fuel consumption. There have been quite a large number of studies on the impact of RSPM and other particulate matters on the environment and their resultant effects on the health of human beings, in Indian background. The studies [6-11] mostly concluded that concerning exposure of workers to RSPM of higher than recommended limit resulted in severe respiratory symptoms. It was also observed that high level of RSPM generated from vehicular emissions may cause acute and chronic impact on the human respiratory systems depending on the degree of exposure levels.

The main objectives of the present study is primarily focused on the assessment/ estimation of current levels of concerned pollutants namely, RSPM, NO_2 and SO_2 in four selected areas of Bangalore city (as shown in Table-2), which have recently been reported to exceed the national limit, exposing people to life-threatening health conditions.

Table -2: The Details of Study Locations

Sl.No	**Location**	**Feature**
1	Peenya Industrial area	Industrial Area
2	Central Silk Board	Heavy traffic area
3	AMCO Batteries	Commercial/ residential Area
4	Kajisomanahalli	Rural (Control station)

MATERIALS AND METHODOLOGY

In the present study, the ambient air quality monitoring was adopted as per the protocol of Central Pollution Control Board (CPCB) for four selected locations, see Table-2. The focus of the study is mainly on the pollutant parameters – RSPM (PM_{10}), SO_2, and NO_2. This data is further utilized to estimate the Air Quality Index (AQI) for the locations. The air samples are collected using large volume air sampler, that have been installed at each sampling stations, for the collection of different parameters.

The standard procedure [3] has been utilized to analyze the ambient air quality samples. This is the prescribed methodology as per the NAAQM (National Ambient Air Quality Monitoring) standard method (2016-17), monitored by the *Ministry of Environment, Forest and Climate Change, Government of India.* The air samples are collected for a period of 24 hours with a time interval of 8 hours. A flow rate through the glass fibre filter (GFA) Whatman make, of 0.8 m^3/min to 1.2 m^3/min has been measured for particulate matter. This collected amount of particulate matter per unit volume (with respect to the total drawn air volume) from the air samples are then calculated from the difference between initial and final weight of the filter paper. To estimate the gaseous pollutants i.e., for SO_2 and NO_2 sampling, the impinger was filled with specific absorbing solutions (Sodium Tetra Chloro Mercurate for SO_2, and NaOH (Sodium Hydroxide) solution for NO_2) and passed at 1 *litre per minute (lpm)* of ambient temp at 4 hours' time intervals for 24 hours, to get one sample in a day. A Spectrophotometer at a wavelength of 560 nano meter (nm) was used to measure and analyze the Sulphur Dioxide (SO_2) content, by employing West Gaeke method. Whereas for *measuring* the Nitrogen Dioxide (NO_2) parameter, the Jacob Hocheiser method was utilized to analyze using the same Spectrophotometer at a wave length of 540 nm.

AIR SAMPLE ANALYSIS USING AQI MEASUREMENTS

Air quality Index (AQI) may be considered as an effective way of indicating the overall quality of ambient or surrounding air in a particular place, which can be easily understood by the common people. In fact, through AQI the complex data in respect of surrounding air, which may contain different types of pollutants are expressed in terms of a single number or index value. Further, the various ranges of values of AQI are assigned with different category names and colours for indicating the severity and presence of pollutants in the ambient air. In India, as per the National AQI classification, surrounding/ ambient air with AQI values has been divided into six categories and each category has been assigned different colours. The above-mentioned categorization of ambient air based on range of AQI values and corresponding associated health impact on public are shown in Table-3 below.

In general, there are eight common pollutants in air namely, Respirable Suspended Particulate Matter (RSPM) also known as PM (Particulate Matter) 10, PM2.5, NO_2 (Nitrogen Dioxide), SO_2 (Sulphur Dioxide), CO (Carbon Monoxide), O_3 (Ozone), NH_3 (Ammonia) and Pb (Lead). Based on the concentration levels/ values of the pollutants in the ambient air, Air Quality Sub Index and corresponding health breakpoints can be developed for each of the above-mentioned pollutant. Thus, AQI may be considered as one of the powerful tools through which level of severity of pollutants present in the ambient air at critical places/ areas can be effectively measured and accordingly appropriate monitoring and corresponding mitigation measures can be developed/ suggested by the policy makers for the safeguards of public health.

Table-3: Category Wise Range of AQI Values and Corresponding Associated Health Impact [3].

Range of AQI Values	**Category**	**Colour Assigned**	**Associated Health Impact**
0 to 50	Good	Green	Minimal Impact
51 to 100	Satisfactory	Light Green	May cause minor breathing discomfort to sensitive people
101 to 200	Moderately polluted	Yellow	May cause breathing discomfort to the people with lung disease such as asthma and discomfort to people with heart disease, children and older adults
201 to 300	Poor	Orange	May cause breathing discomfort to people on prolonged exposure and discomfort to people with heart disease with short exposure
301 to 400	Very poor	Red	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases
401 to 500	Severe	Maroon	May cause respiratory effects even on healthy people and serious health impacts on people with lung/ heart diseases. The health impacts may be experienced even during light physical activity

In present study, data collection, analysis and monitoring of 3 major air pollutants namely, RSPM or PM10, SO_2 and NO_2 have been conducted at four different locations of Bengaluru city (as mentioned in Table.2), and have been shown in terms of corresponding observed Air Quality Indices (AQIs) over a certain period.

It is observed that Air Quality Index (AQI) may be considered to be a single value number indicating the status of ambient air quality of a place/ area and thereby ultimately representing its effect on public health in general. In a detailed way, AQI combines the concentration levels of various individual pollutants present in the ambient air, and a mathematical expression has been developed to arrive at a single number, that has been used in the calculation of AQIs in the present study. Thus, the mathematical expression for calculating AQI can be represented as follows [1]:

$$\mathbf{AQI = [((RSPM / SRSPM) + (SO_2 / SSO_2) + (NO_2 / SNO_2)) * 100] / 3}$$

Where,

RSPM = Observed value of Respirable Suspended Particulate Matter (RSPM)

SRSPM = Standard value of RSPM

SO_2 = Observed value of Sulphur Dioxide

SSO_2 = Standard value of Sulphur Dioxide

NO_2 = Observed value of Nitrogen Dioxide

SNO_2 = Standard value of Nitrogen Dioxide.

RESULTS AND DISCUSSION

The average values of Air Quality Indices (AQIs) at 4 selected places of Bengaluru city for the years 2016 and 2017 (as observed and calculated by using the formula shown in Section-III above) are shown in Table-4 below.

Table-4: Air Quality Index (AQI) Values at Selected Places of Bengaluru City.

Sl. No.	**Station name**	**2016**	**2017**
1	Peenya Industrial Area	92.54	85.28
2	AMCO Batteries	93.79	79.71
3	Central Silk Board	106.3	105.23
4	Kajisomanahalli	64.38	62.48

From the above table, it is evident that AQI value is highest in Central Silk Board, Hosur Road being a heavy traffic density area, falling in the category of '*Moderately Polluted*' as per the Central Pollution Control Board (CPCB) standards, thereby requiring implementation of necessary mitigation measures as per Air Quality Management System (AQMS) as prescribed by Central Pollution Control Board (CPCB). In other areas, AQI values (which being in the range of 51 to 100) are in the category of '*Satisfactory*'. It is also observed with concern that even in rural/ residential area such as Kajisomanahalli the AQI is not reaching the highest category of '*Good*' and therefore requiring necessary attention for further improving the same.

The year wise variation of average AQIs at selected 4 places of Bengaluru city during the years 2016 and 2017 is shown in Figure-1 below.

From Figure-1 it is observed that in general there has been a reduction in the values of AQIs at all 4 selected places of Bengaluru city between the years 2016 and 2017, thereby showing slight improvements in corresponding overall ambient air qualities as well as related meteorological parameters, possibly due to the intervention of State Pollution Control Board and/ or Bengaluru Metropolitan Development Authority.

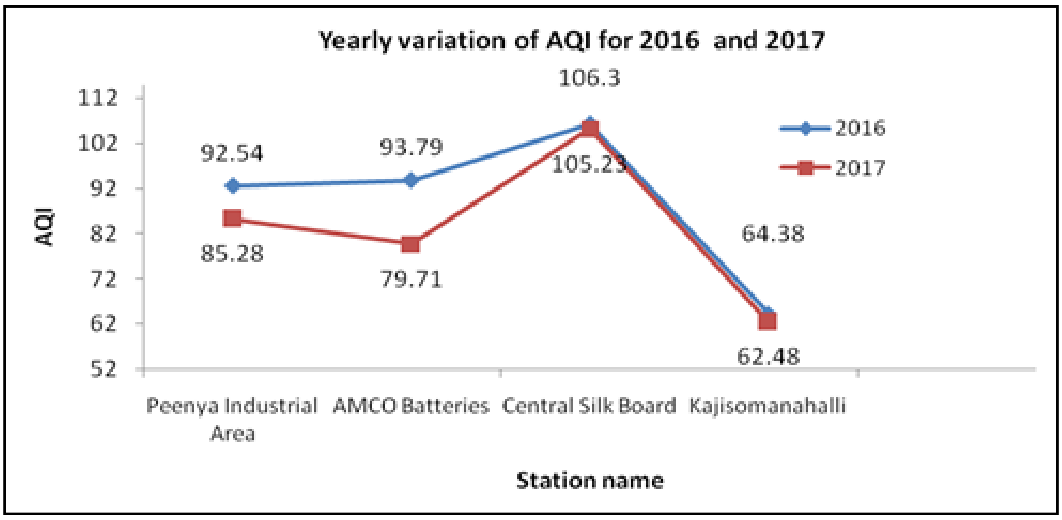

Figure-1: Year wise Variation of average AQIs at selected locations of Bengaluru city.

However, the level of air pollution is maximum in Central Silk Board, Hosur Road, which is a heavy traffic area and the overall improvement in AQIs at this place between the years 2016 and 2017 is very marginal.

This fact clearly indicates that pollution due to vehicular traffic is substantially contributing to the overall degradation of ambient air quality in Bengaluru city, in comparison to industrial area such as Peenya and commercial area such as AMCO Batteries, Mysore Road. Further, in respect of overall level of pollution, there is not much difference between Peenya industrial area and AMCO Batteries commercial area. Off course, in Kajisomanahalli residential/ rural area, the overall level of pollution is least as compared to other 3 selected areas, due to obvious reasons.

The monthly variation of Air Quality Indices (AQIs) at 4 selected locations of Bengaluru city during the year 2016 is shown in Figure-2 to 5 below. It is clearly observed from the same that in general during the year 2016 the AQI values are high during summer season (April – May) and low during rainy season and the same again rises slightly during pre-winter period (October) and then again falls during winter season. This phenomenon is indicating the combined effects of various meteorological parameters such as, wind precipitation, wind speed and wind direction, etc. Further, the average level of pollution is highest in Central Silk Board area, which is followed by AMCO Batteries area, Peenya Industrial area and Kajisomanahalli area in decreasing order. Figure-4 indicates that during 2016 the level of pollution in commercial area (namely AMCO Batteries) has been greater than that of industrial area (namely Peenya).

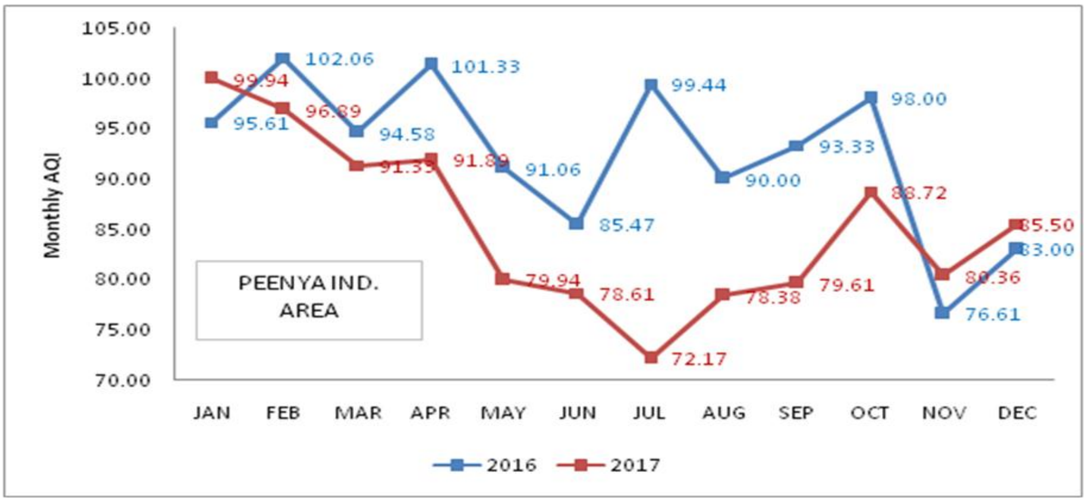

Figure-2: Monthly variation of AQIs during 2016-2017 at Peenya Industrial Area.

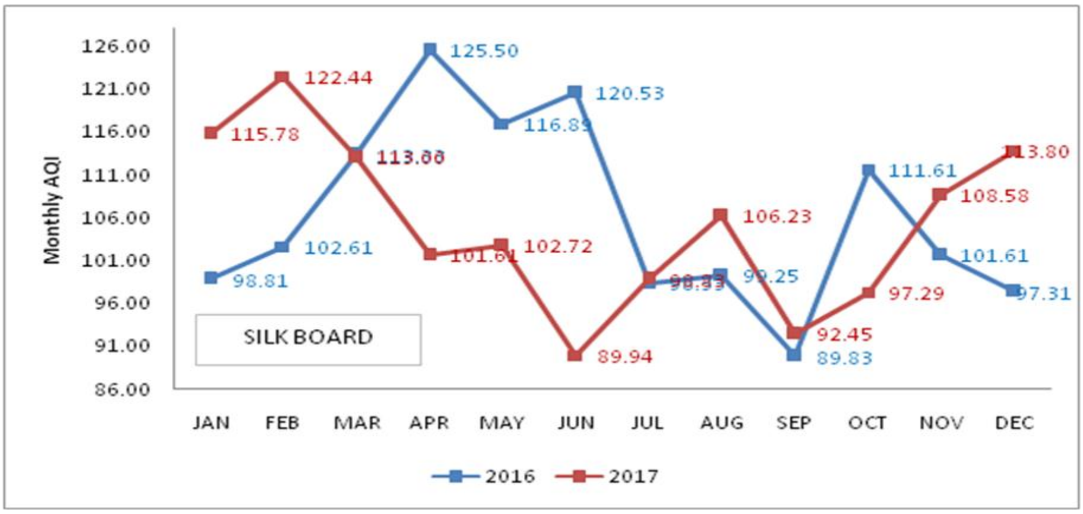

Figure-3: Monthly variation of AQIs during 2016-2017 at Silk Board Junction.

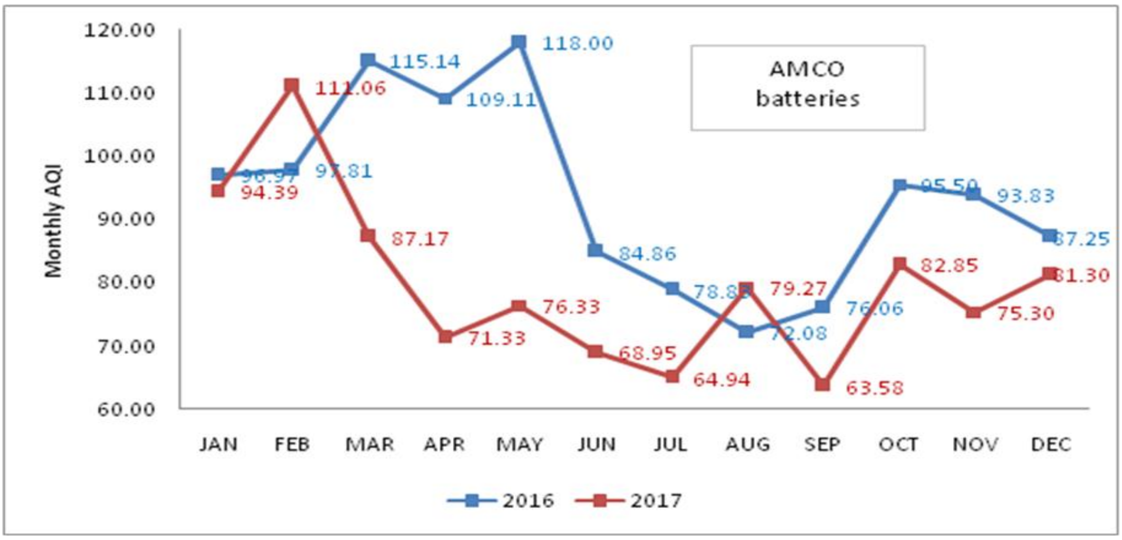

Figure-4: Monthly variation of AQIs during 2016-2017 at AMCO Batteries Area.

These figures have revealed that the nature of monthly variation of AQIs during 2017 at 4 selected places of Bengaluru city is almost similar as observed during 2016, with some differences.

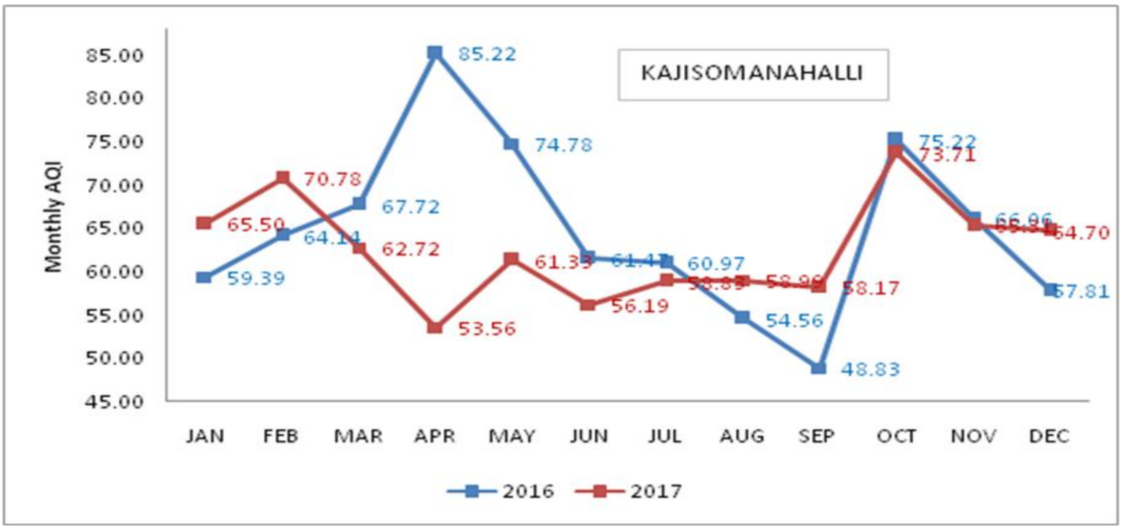

Figure-5: Monthly variation of AQIs during 2016-2017 at Kajisomanahalli Area.

However, in general during the year 2017 the AQI values are highest during February and low during rainy season and the same again rises slightly in August and thereafter falls in September and then rises once again in October and falls subsequently. However, in case of Central Silk Board area, where the pollution level is highest it has shown continuously increasing trend from the month of October onwards and up to December unlike the pollution level trends of other 3 selected areas of Bengaluru city.

Major Pollutantwise Observations:

Figures - 6 to 9 show the month wise observed trends of different major pollutants namely, SO_2 (Sulphur Dioxide), NO_2 (Nitrogen Dioxide), RSPM (Respirable Suspended Particulate Matter) and Overall AQI values, separately for the years 2016 and 2017 in respect of all the 4 selected areas of Bengaluru city. These trends are discussed below in detail and individual figure wise.

(A) Figure – 6 to 9: Shows the month wise observed trends of concentration levels of major pollutants (namely SO_2, NO_2, RSPM and values of AQIs) during the year 2016 for the four selected sample locations.

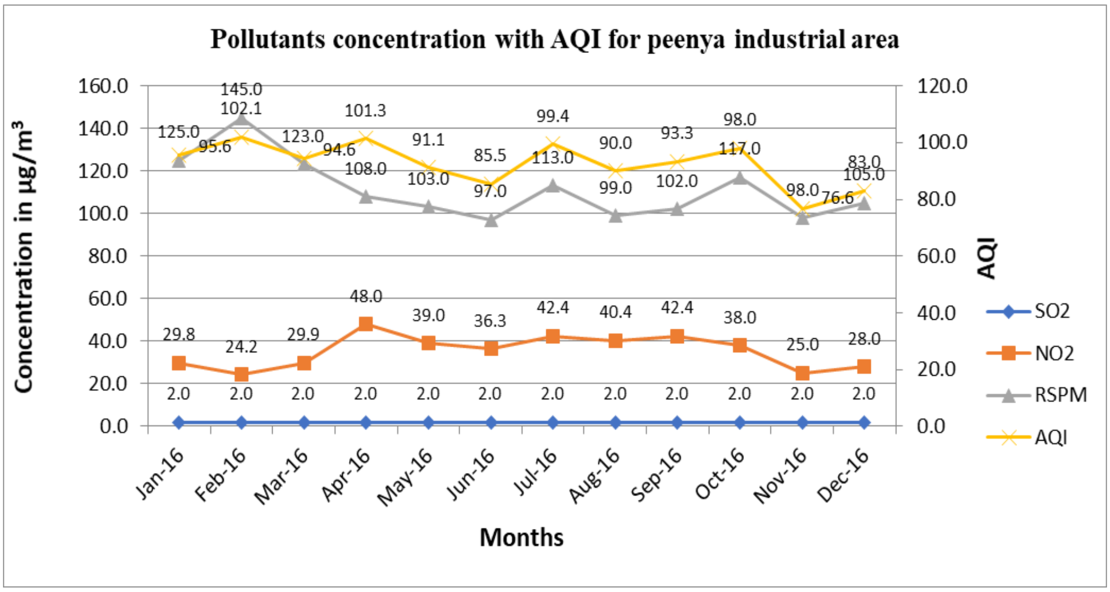

Figure-6: Monthly Pollutants Concentration Levels along with AQI values during 2016 for Peenya Industrial Area.

From Figure-6 the various relevant observations are as follows:

(i) The concentration level of SO_2 pollutant has remained constant in all the 12 months of the year 2016 at the least level of 2.0 µg/ m^3 (micro gram per cubic meter).

(ii) The concentration level of NO_2 pollutant has shown ups and downs during the year 2016 with its values ranging from a minimum level of 24.2 µg/ m^3 in February 2016 to a maximum level of 48.0 µg/ m^3 in April 2016. This trend also indicates that the concentration level of NO_2 reaches higher level values during summer, rainy and pre-winter seasons (April to October) and gradually reduces to low values in winter months (November to February).

(iii) The concentration level of RSPM pollutant is always at the maximum level (amongst all pollutants) with its values ranging from a minimum level of 97.0 µg/ m^3 in June 2016 to a maximum level of 145.0 µg/ m^3 in February 2016.

(iv) The AQI value is ranging from a minimum value of 76.6 in November 2016 to a maximum value of 102.1 in February 2016.

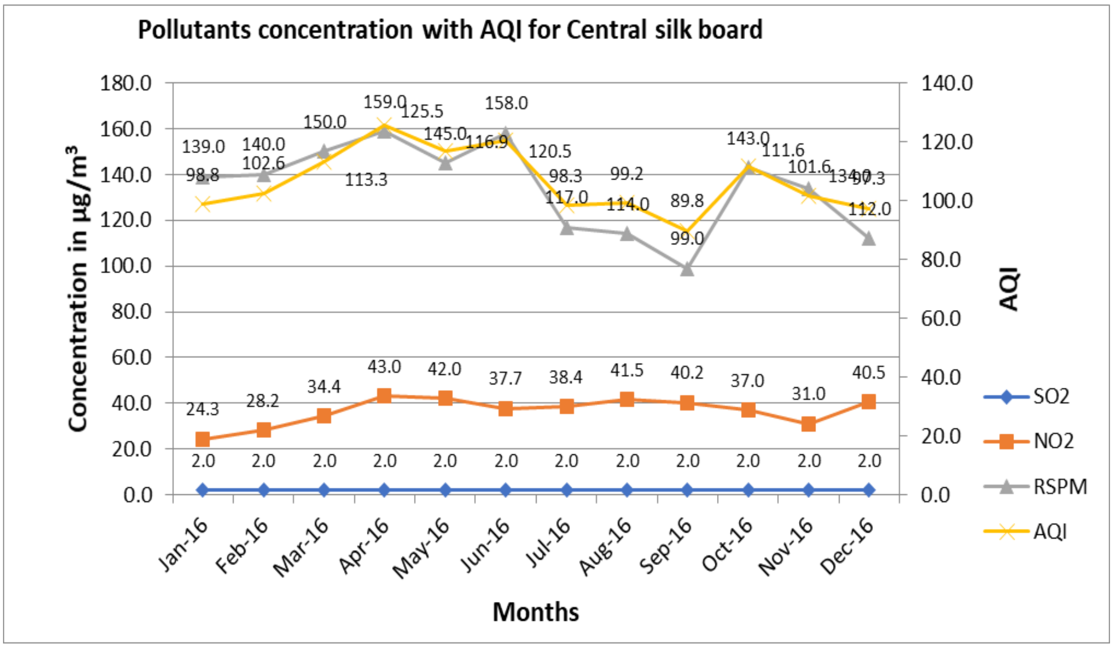

Figure-7: Monthly Pollutants Concentration Levels along with AQI values during 2016 for Central Silk Board Area.

From Figure-7 the various relevant observations are as follows:

(i) The concentration level of SO_2 pollutant has remained constant in all the 12 months of the year 2016 at the least level of 2.0 µg/ m^3 (micro gram per cubic meter).

(ii) The concentration level of NO_2 pollutant has shown ups and downs during the year 2016 with its values ranging from a minimum level of 24.3 µg/ m^3 in January 2016 to a maximum level of 43.0 µg/ m^3 in April 2016. This trend also indicates that the same reaches high level values during summer, rainy and pre-winter seasons (April to October) and gradually reduces to low values in winter months (November to February).

(iii) The concentration level of RSPM pollutant is always at the maximum level (amongst all pollutants) with its values ranging from a minimum level of 99.0 µg/ m^3 in September 2016 to a maximum level of 159.0 µg/ m^3 in April 2016.

(iv) The AQI value is ranging from a minimum value of 89.8 in September 2016 to a maximum value of 125.5 in April 2016.

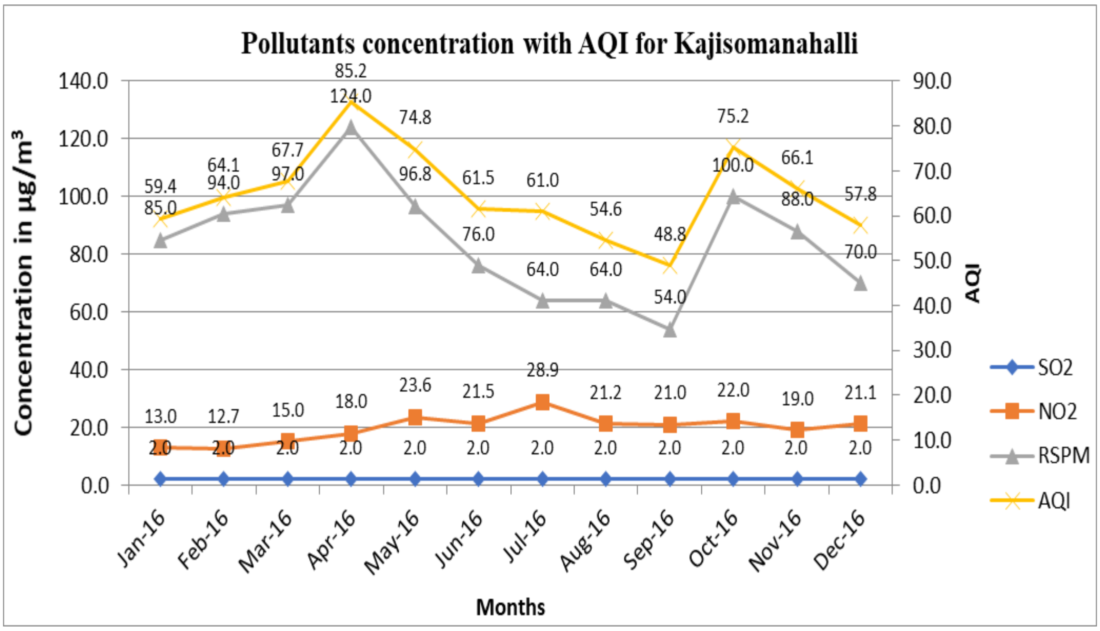

Figure-8: Monthly Pollutants Concentration Levels along with AQI values during 2016 for Kajisomanahalli Area.

From Figure-8 the various relevant observations are as follows:

(i) The concentration level of SO_2 pollutant has remained constant in all the 12 months of the year 2016 at the least level of 2.0 µg/ m^3 (micro gram per cubic meter).

(ii) The concentration level of NO_2 pollutant has shown ups and downs during the year 2016 with its values ranging from a minimum level of 13.0 µg/ m^3 in January 2016 to a maximum level of 28.9 µg/ m^3 in July 2016.

(iii) The concentration level of RSPM pollutant is always at the maximum level (amongst all pollutants) with its values ranging from a minimum level of 54.6 µg/ m^3 in September 2016 to a maximum level of 124.0 µg/ m^3 in April 2016.

(iv) The AQI value is ranging from a minimum value of 48.8 in September 2016 to a maximum value of 85.2 in April 2016.

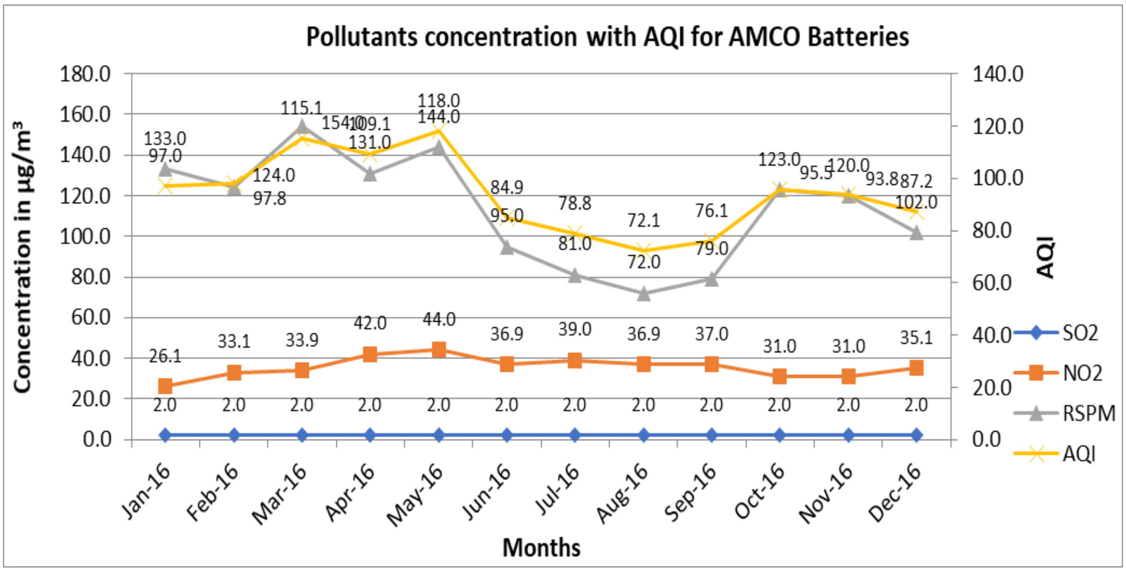

Figure-9: Monthly Pollutants Concentration Levels along with AQI values during 2016 for AMCO Batteries Area.

From Figure-9 the various relevant observations are as follows:

(i) The concentration level of SO_2 pollutant has remained constant in all the 12 months of the year 2016 at the least level of 2.0 µg/ m^3 (micro gram per cubic meter).

(ii) The concentration level of NO_2 pollutant has shown ups and downs during the year 2016 with its values ranging from a minimum level of 26.1µg/ m^3 in January 2016 to a maximum level of 44.0 µg/ m^3 in May 2016.

(iii) The concentration level of RSPM pollutant is always at the maximum level (amongst all pollutants) with its values ranging from a minimum level of 72.1µg/ m^3 in August 2016 to a maximum level of 154.0 µg/ m^3 in March 2016.

(iv) The AQI value is ranging from a minimum value of 72.0 in August 2016 to a maximum value of 118.0 in May 2016.

(B) Figure-10 to 13: Shows the month wise observed trends of concentration levels of major pollutants (namely SO_2, NO_2, RSPM and values of AQIs) during the year 2017 for the four selected sample locations.

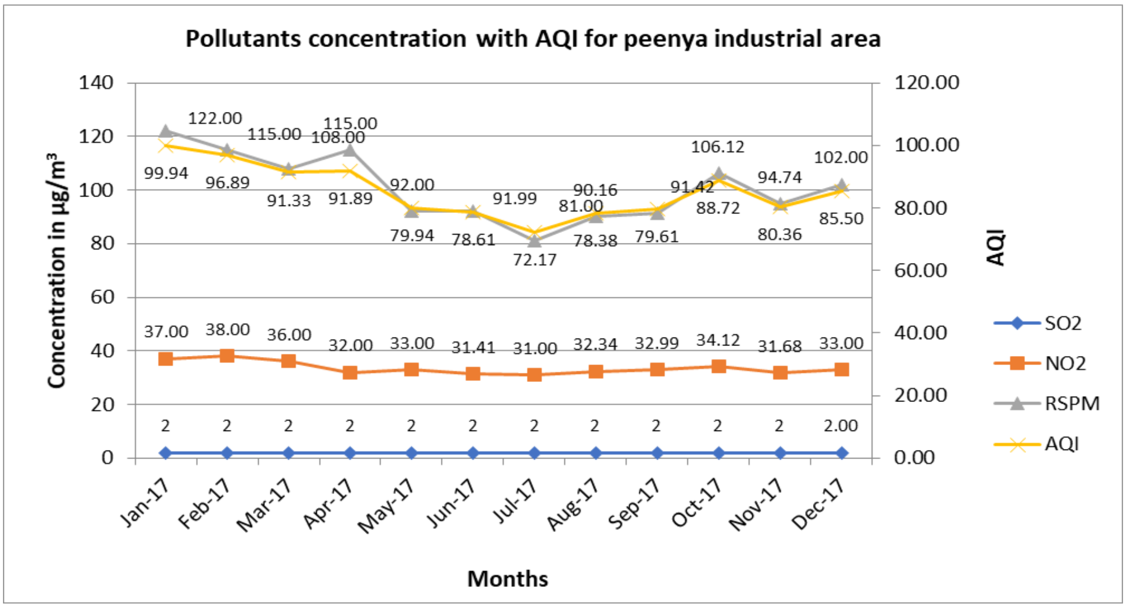

Figure-10: Monthly Pollutants Concentration Levels along with AQI values during 2017 for Peenya Industrial Area.

From Figure-10 the various relevant observations are as follows:

(i) The concentration level of SO_2 pollutant has remained constant in all the 12 months of the year 2017 at the least level of 2.0 µg/ m^3 (micro gram per cubic meter).

(ii) The concentration level of NO_2 pollutant has shown ups and downs during the year 2017 with its values ranging from a minimum level of 31.0 µg/ m^3 in July 2017 to a maximum level of 38.0 µg/ m^3 in February 2017.

(iii) The concentration level of RSPM pollutant is always at the maximum level (amongst all pollutants) with its values ranging from a minimum level of 81.0 µg/ m^3 in July 2017 to a maximum level of 122.0 µg/ m^3 in January 2017.

(iv) The AQI value is ranging from a minimum value of 72.17 in July 2017 to a maximum value of 99.94 in January 2017.

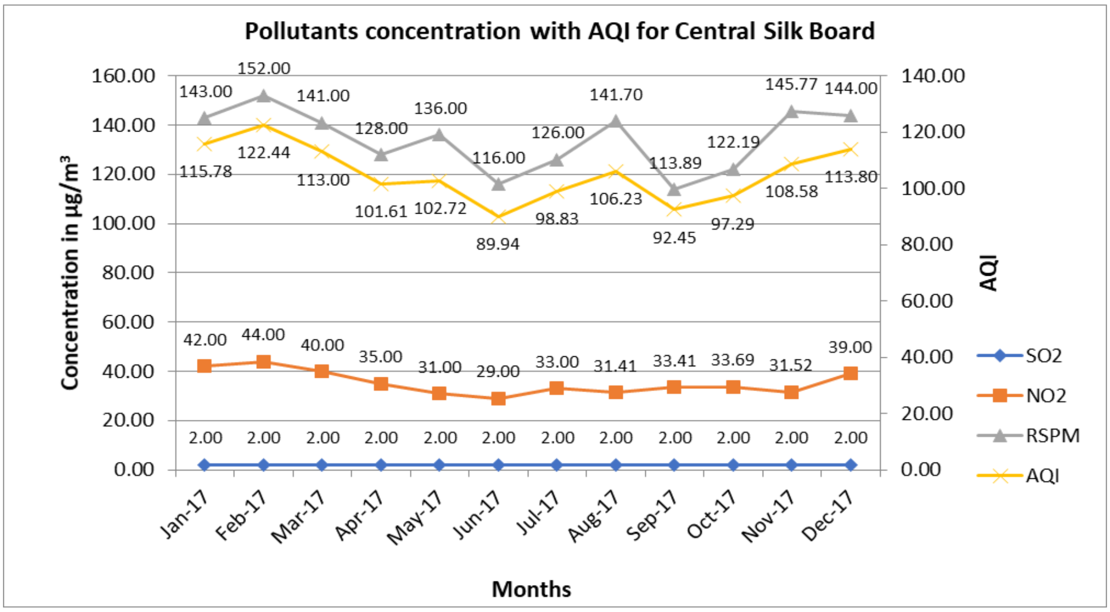

Figure-11: Monthly Pollutants Concentration Levels along with AQI values during 2017 for Central Silk Board Area.

From Figure-11 the various relevant observations are as follows:

(i) The concentration level of SO_2 pollutant has remained constant in all the 12 months of the year 2017 at the least level of 2.0 µg/ m^3 (micro gram per cubic meter).

(ii) The concentration level of NO_2 pollutant has shown ups and downs during the year 2017 with its values ranging from a minimum level of 29.0 µg/ m^3 in June 2017 to a maximum level of 44.0 µg/ m^3 in February 2017.

(iii) The concentration level of RSPM pollutant is always at the maximum level (amongst all pollutants) with its values ranging from a minimum level of 113.89 µg/ m^3 in September 2017 to a maximum level of 152.00 µg/ m^3 in February 2017.

(iv) The AQI value is ranging from a minimum value of 89.94 in June 2017 to a maximum value of 122.44 in February 2017.

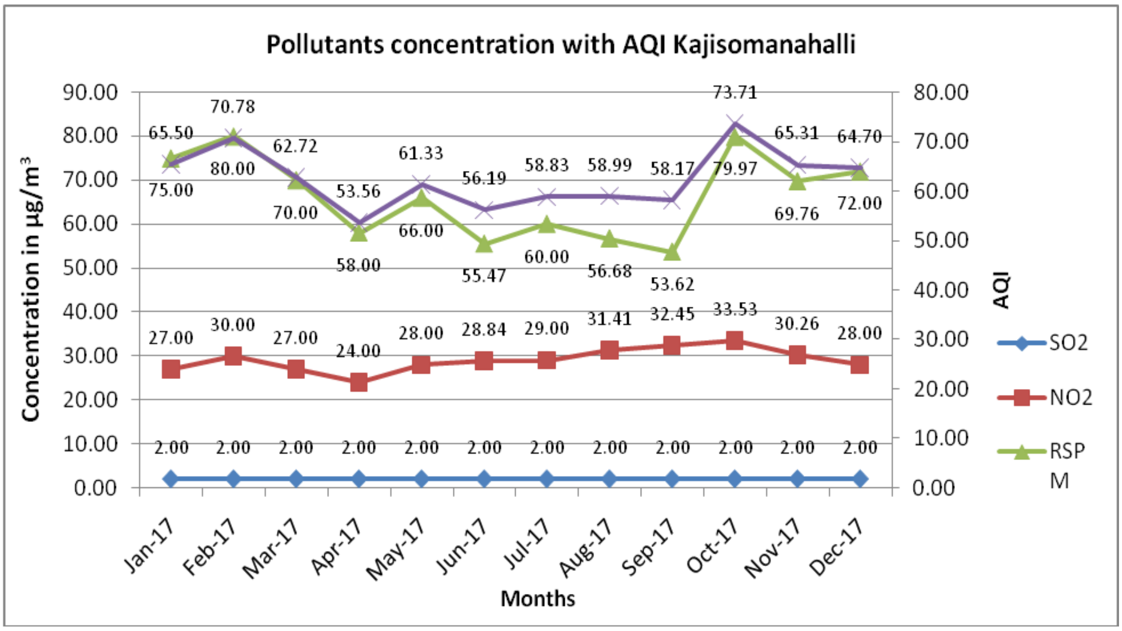

Figure-12: Monthly Pollutants Concentration Levels along with AQI values during 2017 for Kajisomanahalli Area.

From Figure-12 the various relevant observations are as follows:

(i) The concentration level of SO_2 pollutant has remained constant in all the 12 months of the year 2017 at the least level of 2.0 µg/ m^3 (micro gram per cubic meter).

(ii) The concentration level of NO_2 pollutant has shown ups and downs during the year 2017 with its values ranging from a minimum level of 24.0 µg/ m^3 in April 2017 to a maximum level of 33.53 µg/ m^3 in October 2017.

(iii) The concentration level of RSPM pollutant is always at the maximum level (amongst all pollutants) with its values ranging from a minimum level of 53.62 µg/ m^3 in September 2017 to a maximum level of 80.00 µg/ m^3 in February 2017.

(iv) The AQI value is ranging from a minimum value of 53.56 in April 2017 to a maximum value of 73.71 in October 2017.

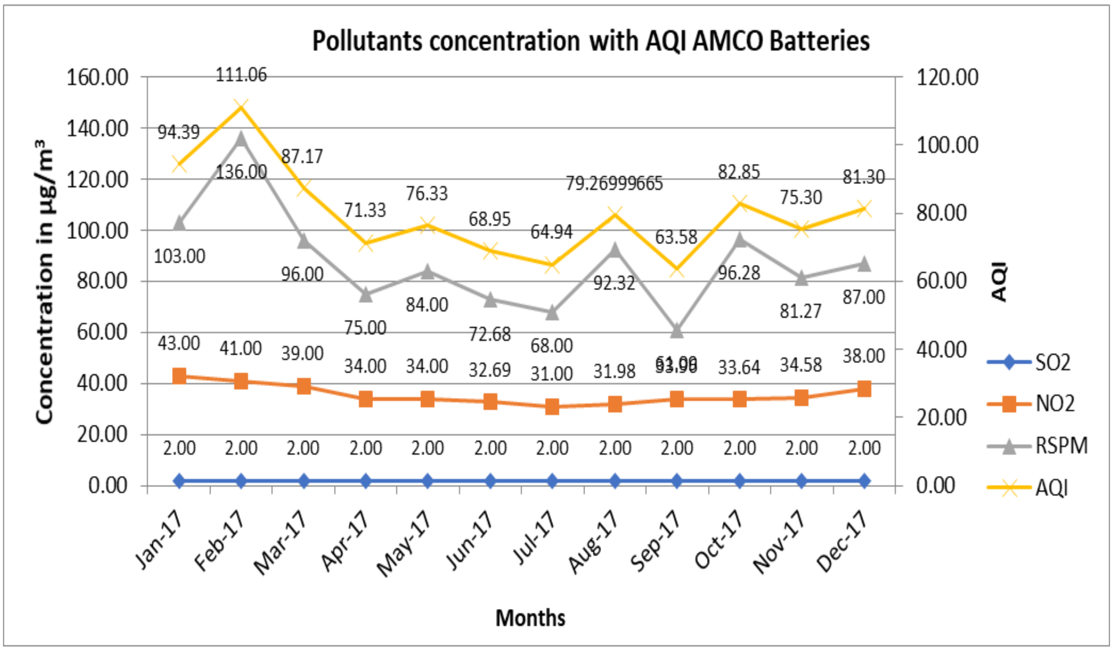

Figure-13: Monthly Pollutants Concentration Levels along with AQI values during 2017 for AMCO Batteries Area.

From Figure-13 the various relevant observations are as follows:

(i) The concentration level of SO_2 pollutant has remained constant in all the 12 months of the year 2017 at the least level of 2.0 µg/ m^3 (micro gram per cubic meter).

(ii) The concentration level of NO_2 pollutant has shown ups and downs during the year 2017 with its values ranging from a minimum level of 31.00 µg/ m^3 in July 2017 to a maximum level of 43.00 µg/ m^3 in January 2017.

(iii) The concentration level of RSPM pollutant is always at the maximum level (amongst all pollutants) with its values ranging from a minimum level of 61.09 µg/ m^3 in September 2017 to a maximum level of 136.00 µg/ m^3 in February 2017.

(iv) The AQI value is ranging from a minimum value of 63.58 in September 2017 to a maximum value of 111.06 in February 2017.

CONCLUSION

The above graphs (Figures – 6 to 13) clearly indicate that the average level of AQI at Central Silk Board is highest, when compared to the other locations. The same can be attributed to large numbers of vehicular movements, construction activities, metro and flyover construction activities. Kajisomanahalli (control station) has shown least AQI values, when compared to the other stations.

The result of air quality monitoring, indicates that the pollutants concentration was highly variable at different stations, depending on the source i.e., stationery and density of mobile pollution sources. Particulate matter concentration i.e., RSPM has exceeded the values in most of the stations, due to high level of vehicular traffic and construction activities. The present study also shows that the values of RSPM have exceeded the threshold limit. The AQI values indicate that the air quality is *"Unhealthy for sensitive group"* at high traffic junctions and nearing *"Unhealthy for sensitive group"* in industrial and commercial areas, which needs high attention of policy makers to evolve appropriate strategies for mitigation of the same.

The results have also revealed that even though the AQI values for residential area is now "moderate", it is showing an increasing trend in the recent past, due to huge construction activities, which have been undertaken in the respective locations.

Air Quality Index (AQI) parameter is one of the prime indicators of air pollution of any specific area and is very useful in defining the status of air in relative terms. However, there has not been much progress in establishing a relation between the AQI value and health of the locality till date. Although these AQI values do not provide any definitive inferences about the air quality category but it has the advantage of self-consistency in the form of combining the synergistic effects of all the criteria of the pollutants. The present investigation through a detailed AQI mapping reveals that the air quality has become severely unhealthy at high traffic junctions in industrial and commercial areas. These observations suggest that high attention is required from the policy makers in the studied localities, who need to evolve appropriate strategies for mitigation of the same.

The study also reveals that the AQI values for the 'Residential Area' is presently moderate, but it has a definitive increasing trend. This increasing trend of AQI can be attributed to high level of construction activities, which have been undertaken in the studied locations.

Further, it can be concluded from the analysis and findings that presence of high concentration of RSPM in all the four selected places in Bengaluru city is mainly responsible for the increasing level of pollutions in these areas. Hence, urgent appropriate mitigation measures for the same need to be initiated and continuously monitored in a focussed manner by the policy makers of the city, namely, Karnataka State Pollution Control Board and Bengaluru Metropolitan Development Authority in the forthcoming period.

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REFERENCES

[1] Harinath S. and Murthy, Usha N. (2010). “Air Quality Index in Industrial Areas of Bangalore city – A case study, India”, *Journal of Industrial Pollution Control*, 2010,26(2), pp. 235-237.

[2] Karnataka State Pollution Control Board. (2017). Annual Report, 2016-17.

[3] NAQI (url: https://cpcb.nic.in/National-Air-Quality-Index/)

[4] National Ambient Air Quality Standards Central Pollution Control Board (CPCB) Notification (url: https://cpcb.nic.in/uploads/National_Ambient_Air_Quality_Standards.pdf)

[5] Harish, M. (2012). “A study on air pollution by automobiles in Bangalore city”, *Management Research and Practice*, Volume 4, Issue 3, 2012, pp: 25-36

[6] Singh, Lakhwinder Pal, Bhardwaj, Arvind and Deepak, K.K. (2011). “Respirable Suspended Particulate Matter (RSPM) and Respiratory Symptom among Casting Industry Workers: An Exploratory Study in Northern India”, *International Journal of Advanced Engineering Technology*, Volume II, Issue I, January-March 2011, pp. 251-259

[7] Reddy, Yanumula Bala Rami, Reddy, Singampalli Mutta and Reddy, Challa Bala Sekhara. (2015). “Determination of Respirable Suspended Particulate Matter, Non-Respirable Suspended Particulate Matter and Total Suspended Particulate Matter in Piduguralla Industrial Area India”, *International Research Journal of Environment Sciences,* Volume 4, Issue 6, pp. 1-5, June 2015.

[8] Abdelbagi, Abdelrazig Mohamed. (2018). “Assessment of Contribution of Suspended Particulate Matter (SPM and RSPM) Levels in Ambient Air Pollution”, *International Journal of Applied Environmental Sciences*, Volume 13, Number 2 (2018), pp. 135-143.

[9] Mehta, Umangi. (2020). “Statistical Analysis of Suspended and Respirable Suspended Particulate Matter (PM10 and PM2.5): Concentrations in Urban Region of Ahmedabad, India”, International Journal of Science and Research, Volume 9 Issue 2, February 2020, pp. 605-609.

[10] Kale, Uma Santosh and Sawant, P. H. (2017). “A Study Effect of RSPM on Spirometry to Identify an Occupational Hazard in Traffic Police”, *International Journal of Applied Environmental Sciences,* Volume 12, Number 4, 2017, pp. 633-642.

[11] Araújo, Ingrid P. S., Costa Dayana B. and Moraes, Rita J. B. (2014). “Identification and Characterization of Particulate Matter Concentrations at Construction Jobsites”, *Sustainability,* Volume 6, November 2014.