Using seasonal variations and air quality index for ambient air quality at govt polytechnique premises, Kherwadi in Mumbai

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Abstract
Air quality monitoring study at Govt. Polytechnique Premises, Kherwadi, Mumbai by Maharashtra Pollution Control Board (MPCB) was undertaken. The secondary data were collected from the MPCB web site from the period 1 Feb.-2013 to 17 Nov.-2014. Twenty-four hours air monitoring sampling was carried out by using continuous monitoring station (analysis Unit) and Reparable Suspended particulate matter sampler. Air Quality Index (AQI) and Time Series Analysis for Seasonal variation was employed for analysis of ambient air quality monitoring data. The criteria for pollutants included in the study were sulphur dioxide (SO$_2$), oxides of nitrogen (NOx) and Reparable suspended particulate matter (RSPM) below 10 micron partials. The results indicated that the RSPM extensively contribute toward air pollution at this location throughout study period.

Keywords: Time series analysis, Seasonal Variation, AQI and Rating scale.

INTRODUCTION
Decrease of air quality is a cause of concern since it affects the human health. The economic growth coupled with rapid urbanization, increased number of vehicles, industrial and human activities are responsible for the changes in the air quality. This has attracted attention of the Government and civil society. The air pollution costs society in terms of damage to human health, buildings, vegetation, lowered visibility and increased green house gases. Mumbai is the capital of Maharashtra state with a population of approximately 12 million people. It has tropical hot and humid climate with hot summers, moderately cold winters, severe monsoons and large diurnal variations in the wind speed. Mumbai being a financial capital of the country was earlier booming with industries and now has very large number of vehicle and most efficient public transport system in the country. Air quality index (AQI) is the key tool used for the assessment of ambient air quality. It was introduced by Environmental protection agency (EPA), USA to measure the levels of pollution due to major air pollutants. Air quality index has been used as an indication of the air pollution. The study was aimed to monitor the ambient air quality at Govt. Polytechnique Premises, Kherwadi in Mumbai, which is the east west corridor and caters to very heavy vehicular traffic in Mumbai city throughout the day and night. The air samples were collected to measure Sulphur dioxide and oxides of nitrogen for 24 hours and were analyzed by using Central Pollution Control Board guidelines for analysis for these gaseous pollutants. The RSPM was sampled by the gravimetric method at an interval of 8 hours, three samples were collected for 24 hours. Air Quality Index was then calculated with the concentration values using the following formula (Rao and Rao 1989),
\[
AQI = 1 / 3 [(SO_2)/ SSO_2 + NOx / SNOx + RSPM / SRSPM] x 100
\]
Where SO$_2$, NOx and RSPM represent the individual concentration and SSO$_2$, SNOx and SRSPM represents

the ambient air quality standard for SO\textsubscript{2}, NO\textsubscript{x} and RSPM respectively.

**METHODOLOGY**

Using the Thermo Environmental Instruments, Inc. Model 43C is designated by the United States Environmental Protection Agency (USEPA) used for sampling, for analysis of sulphur dioxide (SO\textsubscript{2}), oxides of Nitrogen (NO\textsubscript{x}). The sampling of ambient air was done during the period of first February 2013 to 17 November 2014 at Govt. Polytechnique Premises, Kherwadi in Mumbai city to detect air quality during three seasons in the year. The sampling was done using continuous ambient air quality monitoring station and Respirable dust sampling machine. The parameters monitored were sulphur dioxide (SO\textsubscript{2}), oxides of Nitrogen (NO\textsubscript{x}) and Respirable suspended particulate matters (RSPM). The sampling was carried out for 24 hours. The concentration of the pollutants was calculated in micrograms per cubic meter (µg/m\textsuperscript{3}).

**Analysis of rspm by gravimetric method**

Air is drawn into a covered housing and through a filter (Glass fibre filter) by means of high-flow-rate blower at a flow rate (1.13 to 1.70 m\textsuperscript{3}/min or 40 to 60 ft min) that allows suspended particles having diameters of less than 100m (Aerodynamic diameter) to pass to the filter surface. The mass concentration of suspended particulate in the ambient air (µg/m\textsuperscript{3}) is computed by measuring the mass of collected particulate and the volume of air sampled.

**RESULTS AND DISCUSSION**

The average values of concentration of three pollutants at Govt. Polytechnique Premises, Kherwadi in Mumbai are shown in table 1.

| Table 1: Govt. Polytechnique, Premises Kherwadi in Mumbai Monthly |

<table>
<thead>
<tr>
<th>Months</th>
<th>Avg. SO\textsubscript{2} Actual Observed values µg/m\textsuperscript{3}</th>
<th>Deviation from std. values for Residential area 80(µg/m\textsuperscript{3})</th>
<th>Avg. NO\textsubscript{x} Actual Observed values µg/m\textsuperscript{3}</th>
<th>Deviation from std. values for Residential area 80(µg/m\textsuperscript{3})</th>
<th>Avg. RSPM Actual Observed values µg/m\textsuperscript{3}</th>
<th>Deviation from std. values for Residential area 100(µg/m\textsuperscript{3})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb-13</td>
<td>17.56                                                             -62.44                                           56.30                                                             -23.70                                           155.81                                                             55.81</td>
<td></td>
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<tr>
<td>Mach</td>
<td>18.63                                                             -61.37                                           34.97                                                             -45.03                                           125.47                                                             25.47</td>
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<tr>
<td>April</td>
<td>19.53                                                             -60.47                                           27.30                                                             -52.70                                           108.87                                                             8.87</td>
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<tr>
<td>May</td>
<td>17.55                                                             -62.45                                           24.13                                                             -55.87                                           89.45                                                              -10.55</td>
<td></td>
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<td></td>
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<tr>
<td>June</td>
<td>19.76                                                             -60.24                                           17.04                                                             -62.96                                           70.21                                                              -29.79</td>
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<tr>
<td>July</td>
<td>18.10                                                             -61.90                                           19.17                                                             -60.83                                           75.76                                                              -24.24</td>
<td></td>
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<tr>
<td>August</td>
<td>19.21                                                             -60.79                                           19.46                                                             -60.54                                           73.04                                                              -26.96</td>
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</tr>
<tr>
<td>Sept.</td>
<td>17.31                                                             -62.69                                           36.11                                                             -43.89                                           50.10                                                              -49.90</td>
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<tr>
<td>Oct</td>
<td>16.77                                                             -63.23                                           54.90                                                             -25.10                                           79.10                                                              -20.90</td>
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<td></td>
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</tr>
<tr>
<td>Nov.</td>
<td>22.77                                                             -57.23                                           113.20                                                            33.20                                             151.63                                                             51.63</td>
<td></td>
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</tr>
<tr>
<td>Dec.</td>
<td>26.48                                                             -53.52                                           121.22                                                            41.22                                             155.56                                                             55.56</td>
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<td></td>
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<tr>
<td>Jan-14</td>
<td>31.29                                                             -48.71                                           78.71                                                             -1.29                                             141.32                                                             41.32</td>
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<td></td>
</tr>
<tr>
<td>Feb</td>
<td>23.15                                                             -56.85                                           38.70                                                             -41.30                                           140.89                                                             40.89</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>March</td>
<td>12.15                                                             -67.85                                           37.85                                                             -42.15                                           142.48                                                             42.48</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>April</td>
<td>10.57                                                             -69.43                                           42.32                                                             -37.68                                           151.57                                                             51.57</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>May</td>
<td>12.88                                                             -67.12                                           30.38                                                             -49.62                                           92.92                                                              -7.08</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>June</td>
<td>16.38                                                             -63.63                                           26.88                                                             -53.13                                           104.17                                                             4.17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>July</td>
<td>23.64                                                             -56.36                                           38.52                                                             -41.48                                           53.32                                                              -46.68</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>22.10                                                             -57.90                                           58.74                                                             -21.26                                           76.84                                                              -23.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Sept.</td>
<td>22.85                                                             -57.15                                           69.59                                                             -10.41                                           102.52                                                             2.52</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct</td>
<td>29.96                                                             -50.04                                           119.64                                                            39.64                                             147.29                                                             47.29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 Nov.-14</td>
<td>13.00                                                             -67.00                                           57.00                                                             -23.00                                           152.07                                                             52.07</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average for the period</td>
<td>19.62                                                             -60.38                                           51.01                                                             -28.99                                           110.93                                                             10.93</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Avg. data from Feb-2013 to 17 Nov-2014. (Source of data: MPCB website).
It is observed that the concentrations of sulphur dioxide (SO2) and Nox were within the permissible limit under NAAQS, except sometimes RSPM values were more sometime were high during the entire study period. When we observe RSPM monthly average values deviation from the national ambient air quality standard somewhere it is increased. And average values of sulphur dioxide (SO2), oxides of nitrogen (NOx) and Reparable suspended particulate matter (RSPM), within limit when compared with NAAQS values. It may be due to high traffic at surrounding the Govt. Polytechnique Kherwadi in Mumbai. The range of rating scale for calculated AQI values as shown below: Rating scale of AQI Values

<table>
<thead>
<tr>
<th>Index values (µg/m3)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 25</td>
<td>Clean air (CA)</td>
</tr>
<tr>
<td>26 - 50</td>
<td>light air pollution(LAP)</td>
</tr>
<tr>
<td>51 - 75</td>
<td>Moderate air pollution(MAP)</td>
</tr>
<tr>
<td>76 - 100</td>
<td>Heavy air pollution (HAP)</td>
</tr>
<tr>
<td>&gt; 100</td>
<td>Severe air pollution (SAP)</td>
</tr>
</tbody>
</table>

We calculated month wise AQI and rating scale values are shown in table 2 as below:

**Table 2: AQI and Rating scale for AQI values at Govt. Polytechnique Premises, Kherwadi in Mumbai from Feb-2013 to 17 Nov.-2014.**

<table>
<thead>
<tr>
<th>Months</th>
<th>Air quality index (AQI) values</th>
<th>Rating scale (R.S.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>February-2013</td>
<td>82.71</td>
<td>HAP</td>
</tr>
<tr>
<td>March</td>
<td>64.16</td>
<td>MAP</td>
</tr>
<tr>
<td>April</td>
<td>55.80</td>
<td>MAP</td>
</tr>
<tr>
<td>May</td>
<td>47.18</td>
<td>LAP</td>
</tr>
<tr>
<td>June</td>
<td>38.73</td>
<td>LAP</td>
</tr>
<tr>
<td>July</td>
<td>40.78</td>
<td>LAP</td>
</tr>
<tr>
<td>August</td>
<td>40.46</td>
<td>LAP</td>
</tr>
<tr>
<td>September</td>
<td>38.96</td>
<td>LAP</td>
</tr>
<tr>
<td>October</td>
<td>56.23</td>
<td>MAP</td>
</tr>
<tr>
<td>November</td>
<td>107.20</td>
<td>SAP</td>
</tr>
<tr>
<td>December</td>
<td>113.40</td>
<td>SAP</td>
</tr>
<tr>
<td>January-2014</td>
<td>92.94</td>
<td>HAP</td>
</tr>
<tr>
<td>February</td>
<td>72.73</td>
<td>HAP</td>
</tr>
<tr>
<td>March</td>
<td>68.33</td>
<td>MAP</td>
</tr>
<tr>
<td>April</td>
<td>72.56</td>
<td>MAP</td>
</tr>
<tr>
<td>May</td>
<td>49.00</td>
<td>LAP</td>
</tr>
<tr>
<td>June</td>
<td>52.74</td>
<td>MAP</td>
</tr>
<tr>
<td>July</td>
<td>43.67</td>
<td>LAP</td>
</tr>
<tr>
<td>August</td>
<td>59.30</td>
<td>MAP</td>
</tr>
<tr>
<td>September</td>
<td>72.69</td>
<td>MAP</td>
</tr>
<tr>
<td>October</td>
<td>111.43</td>
<td>SAP</td>
</tr>
<tr>
<td>17 Nov-2014</td>
<td>79.86</td>
<td>HAP</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>66.40</strong></td>
<td><strong>Moderate air pollution(MAP)</strong></td>
</tr>
</tbody>
</table>

From the above table it is observed that the Moderate and Heavy air pollution from the month of Feb-2013 to 17 Nov-2014, And average value of rating scale shows that moderate air pollution. The graphical representation of
this AQI values against months, the graphical representation shown below:

From the table 2, we distributed months in terms of seasons and the average values of every season shown in table 3, SO2, NOx and RSPM respectively as shown below:

**Table 3:** The concentration of various pollutants at Govt. Polytechnique Premises, Kherwadi in Mumbai in all seasons

<table>
<thead>
<tr>
<th>Years</th>
<th>Seasons</th>
<th>Months</th>
<th>SO2 (Avg)</th>
<th>S.D.</th>
<th>C.V. (%)</th>
<th>NOx (Avg)</th>
<th>S.D.</th>
<th>C.V. (%)</th>
<th>RSPM (Avg)</th>
<th>S.D.</th>
<th>C.V. (%)</th>
<th>AQI Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mean</td>
<td></td>
<td>Mean</td>
<td></td>
<td></td>
<td>Mean</td>
<td></td>
<td></td>
<td>Mean</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>Summer</td>
<td>Feb-13</td>
<td>18.33</td>
<td>2.41</td>
<td>13.15</td>
<td>35.15</td>
<td>28.82</td>
<td>82.00</td>
<td>118.73</td>
<td>44.32</td>
<td>37.33</td>
<td>62.46</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TO May-13</td>
<td>18.59</td>
<td>3.15</td>
<td>16.93</td>
<td>22.91</td>
<td>13.04</td>
<td>56.91</td>
<td>67.23</td>
<td>22.51</td>
<td>33.48</td>
<td>39.73</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Jun-13</td>
<td>24.27</td>
<td>7.09</td>
<td>29.21</td>
<td>90.85</td>
<td>53.50</td>
<td>58.89</td>
<td>130.94</td>
<td>40.58</td>
<td>30.99</td>
<td>92.44</td>
</tr>
<tr>
<td></td>
<td>Rainy</td>
<td>Sep-13</td>
<td>14.67</td>
<td>7.47</td>
<td>50.93</td>
<td>37.43</td>
<td>15.06</td>
<td>40.24</td>
<td>132.51</td>
<td>37.69</td>
<td>28.45</td>
<td>65.66</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oct-13</td>
<td>21.36</td>
<td>4.72</td>
<td>22.10</td>
<td>49.61</td>
<td>27.05</td>
<td>54.53</td>
<td>83.95</td>
<td>31.32</td>
<td>37.30</td>
<td>57.1</td>
</tr>
<tr>
<td>2014</td>
<td>Rainy</td>
<td>Jun-14</td>
<td>24.31</td>
<td>9.96</td>
<td>40.98</td>
<td>98.76</td>
<td>57.52</td>
<td>58.24</td>
<td>148.88</td>
<td>23.66</td>
<td>15.89</td>
<td>39.75</td>
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<tr>
<td></td>
<td></td>
<td>Sep-14</td>
<td>17 Nov. 2014</td>
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</tbody>
</table>

From the above table 3, As regards year 2013, variability of SO2 was more in winter (29.21%) and less in Rainy season (16.93%). It was more stable in summer season (13.15%). In the year 2014, in Summer more (50.93%) and less in winter (40.98%). It was more stable in Rainy season (22.10%). As regards Nox, in the year 2013, the variability was maximum in summer (82%) and less in Winter (58.89%), In Rainy season it was 56.91. In the year 2014, Winter (58.24%) and Rainy(54.53%) season. It was more stable in summer season (40.24%). In case of RSPM in the year 2013, the stability was in Rainy season (3.83%) and it was maximum 92.44% in Winter season and less in Summer season (62.46). In the year 2014, more in Summer season (65.66%) and less in season (57.1%). It was more stable in Winter season (39.75%). When we consider AQI and rating scale for Nox and RSPM of Summer and winter seasons the air pollution at Govt. Polytechnique Premises, Kherwadi in Mumbai is moderate and heavy air pollution.

CONCLUSIONS

Here it is concluded that RSPM extensively contribute towards air pollution at this location throughout study period. When Govt. When we observe RSPM monthly average values deviation from the national ambient air quality standard somewhere it is increased. And average values of sulphur dioxide (SO2), oxides of nitrogen (NOx) and Reparable suspended particulate matter (RSPM) ,within limit when compared with NAAQS values. It is observed that the Moderate and Heavy air pollution from the month of Feb-2013 to 17 Nov-2014. And average value of rating scale shows that moderate air pollution. When RSPM parameter is considered, there is moderate and heavy air pollution. It may be due to high traffic at surrounding the Govt. Polytechnique Kherwadi in Mumbai. When we consider AQI and rating scale for Nox and RSPM of Summer and winter seasons the air pollution at Govt. Polytechnique Premises, Kherwadi in Mumbai is moderate and heavy air pollution. For reducing this, a systematic traffic management, expansion of greenery or green belt and category wise distribution of vehicles split up on other routes in reducing the air pollution.

REFERENCES


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Conflict of Interest: None Declared