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Air Quality Monitoring of some Gaseous Pollutants at selected points in Gullberg II, Lahore, Pakistan

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Abstract

The research study was based on air quality monitoring at selected point in Gullberg II, Lahore, Pakistan. Gaseous pollutants selected for Air quality assessment were Sulfur Dioxide, Nitrogen Dioxide, Carbon Monoxide and Ozone. Ambient HC Analyzer was used for monitoring of air quality and the data on the daily basis (24 Hours) for the period of four months (January –April, 2011) was collected. Results revealed that Nitrogen dioxide (NO_2) and Ozone (O_3) were found to be in concentrations higher than the NAAQS (National Ambient Air Quality Standards, Pakistan) at most of the selected points while Carbon Monoxide (CO) and sulfur dioxide (SO_2) were found to be within the permissible limits according to the standards. Highest Concentrations of NO_2, SO_2, CO, O_3 during four months of monitoring was 220µg/m^3, 118µg/m^3, 7.74 µg/m^3, 212 µg/m^3 respectively. These values were higher than NAAQS permissible limit which are 80µg/m^3, 120µg/m^3, 5 µg/m^3, 180µg/m^3 for 24 hours for NO_2, SO_2, CO, O_3 respectively. Concentration of different pollutants has fluctuation while the Nitrogen dioxide (NO_2) and Ozone (O_3) concentrations were found to be high throughout the monitoring period. The results of Air Quality Index about the air quality of Gullberg II shows that two months (March & April) showed unhealthy and Hazardous condition due to weather conditions enhancing (sunlight, high temperature, humidity etc.) the effects of gaseous pollutants.

Keywords: Ambient HC analyzer, urban air pollution, nitrogen dioxide (NO_2), ozone (O_3), carbon monoxide (CO), sulfur dioxide (SO_2), air quality index.

Introduction

Ambient air pollution is an important issue needed to be addressed on prior basis in context of urbanization and environmental health regionally and worldwide. A strong association between ambient air pollution and lung related problems like cough, asthma, lung irritation and exacerbation is evident from different studies on effects of air pollution on human health. Some recent studies also pointed out the links between high concentration of air pollutants and infant mortality, deficit in lung growth of children[1]. Anthropogenic activities largely affect Air quality in urban areas. Ambient air quality in cities has direct effects on the health of humans and also the ecosystems[2]. Nitrogen Dioxide (NO_2) is one of the predominant urban air pollutants. Other pollutants like CO, O_3 and SO_2 in high concentrations is also a matter of concern in big cities. Anthropogenic sources of air pollutants are land transportation, industrial emissions, and open burning sources. Land transportation and industrial sources are the major contributors of air pollution[3]. Clean air is the right of every citizen but in developing countries the problem of air pollution presents challenging situation to be handled in urban areas. Industrial sources and vehicular pollution has considerably deteriorated the air quality. Burning of fossil fuels for the energy production has dramatically increased the problem of ambient air pollution in cities which leads to serious health impairments and diseases. Air pollution is increasingly being cited as the main cause of lung related diseases such as throat irritation, asthma and lung cancer and the recent rate of incidences are reported to be increased twice as compared to 30 years ago[4].

Air pollution levels are still rising because of the use of private cars instead of public transport which is increasing the global number of cars by a factor of 10 since 1950. Also the rate of migration of people to urban areas has increased by a factor of 4[5]. Vehicular sources are the biggest contributor of air pollution. Recent trends of pollution from road traffic exhaust are regarded as the significant cause to affects the urban air quality in terms of human health and troposphere ozone production[6]. According to a report of WHO (2003) the urban air pollution affects the health of people living in urban areas, the report regarded Pakistan's road traffic as the significant threat and increasing an average annual rate of 14.1% during the 20-year period between 1985 to 2005. Respiratory diseases were regarded as the reason for 60 % of mortalities in terms of annual Disability Adjusted Life Years (DALYs) lost. A study investigated the impact of environmental pollution on the health of nearly 1,000 traffic policemen and the results showed that about 80% of them had chronic ear-nose-throat (ENT) problems and 40% showed signs of development of lung related problems[7]. About 50% of the anthropogenic NO_X in atmosphere comes from vehicular sources, 30% from the power plants and about 20% is produced by industrial process[8]. A number of studies pointed that children with long term exposure to air pollution have more chances of developing the respiratory symptoms, decreased lung function and increase in the incidence of chronic cough, bronchitis and conjunctives[9]. Ozone pollution is a common problem during the daylight hours in summers. High ozone days are likely to be affected by parameters as ground level temperature, upper air temperature, dew point temperature, wind speed, wind direction, solar radiation, cloud cover, relative humidity and precipitation[10]. The high concentration of O_3 was found to have influence on urban air pollution in summer, indicated by the increased average Ozone exposure according to research studies conducted by many scientists and found to exceed the permissible limits in urban areas worldwide[11].

Carbon monoxide is a colorless, odorless and tasteless gas and found to be the most abundant primary pollutant in ambient air. Carbon monoxide gas restricts the blood's ability to absorb oxygen when inhaled and can cause angina, impaired vision and poor coordination in exposed persons. Carbon monoxide is known to contribute to the green house effect and depletion of the Earth's protective ozone layer[9]. Sulfur dioxide is produced by burning of fossil fuels. Power stations and oil refineries release sulfur dioxide in the air. Other source is domestic open fires affecting the local concentrations[12]. Sulfur dioxide is colorless gas with a penetrating odor[13]. Sulfur oxides can cause a wide array of health and environmental impacts, particularly to vulnerable groups including people with asthma, the elderly, and people with heart or lung disease. High levels of SO_2 in ambient air are often responsible for causing the temporary breathing difficulty, asthma attacks and increased respiratory symptoms[14]. The mitigation measures to reduce urban air pollution is currently an environmental challenge and needed to be addressed on prior basis[15].

Objectives of the present study are to: i. Monitor the levels of Air pollutants (NO_2, SO_2, O_3, CO) in the study area. ii. Compare the measured values with the National Ambient Air Quality Standards. iii. Give recommendation to improve air quality.

Material and Methods

The present study was carried out to monitor the ambient air quality of Gullberg II, the exact locations were Gaddafi Road, Gaddafi Hockey Complex and Liberty, Lahore. HC analyzer was used for the purpose. The data of measurements was collected on daily basis (24 hours). The sampling duration for monitoring was about 4 months (January to April, 2011). All measure data was tabulated and compared permissible limits defined by the National Ambient Air Quality Standards (NAAQ's) of Environmental Protection Agency, Pakistan.

Parameters Measured: i. Sulfur oxides SO_2 (μg/ m^3), ii. Nitrogen dioxide NO_2 (μg/ m^3), iii. Carbon monoxide CO (μg/ m^3), iv. Ozone O_3 (μg/ m^3).

Instrument: Ambient HC Air Analyzer: i. The APNA-370 for continuously monitoring the atmospheric NO_2 concentrations, ii. APSA-370 for continuous monitoring of SO_2, iii. The APMA-370 for continuously monitoring CO concentrations, iv. APOA-370 for measurement of Ozone level.

Sample Collection: Air quality sampling was conducted using fixed stations that measured daily mean concentrations of air pollutants in January, February, March and April 2011. The data was collected with the help of instrument named as Ambient HC analyzer monitor equipped by EPD, Punjab which routinely monitored the different sites of Gullberg across 3 to 4 km.

Data Analysis: The calculation for average, range and standard error of mean were made using standard procedure. All the results were analyzed statistically using Minitab (V13) software and presented in the form of bar graphs. The comparison was made with NAAQs limit for assessment and evaluation of pollution load. Air Quality Index was used to describe overall condition of gaseous air pollution in the area. AQI tells that how clean or polluted is the air of the area.

Air Quality Index= (/80) + (/120) + (/180) + (/5)/4 X 100

Results and Discussion

Ambient air quality monitoring was monitored at different sites of Gulberg II (Qadaffi stadium, National Hockey Stadium and Liberty round about). Data was collected and represented through an extension of simple bar diagram. Multiple bar graph comprising of eight bars, one of each day, for each pollutant make the comparison between the pollutants in different days. For each pollutant eight bars are drawn along this axis, one for each day to indicate the pollution extent. The bars are colored individually so that the different color coding for bars in graph showing the different values according to different days of the week. The very first bar having the black color representing the standard value of that pollutant according to National Ambient Air Quality standards. NAAQs permissible limit are 80μg/m^3, 120μg/m^3, 5 μg/m^3, 180 μg/m^3 in 24 hours for NO_2, SO_2, CO, O_3 respectively. Figure-1 to figure-14 are showing the concentrations of understudy gaseous pollutants from week 1 to week 14.

1st week, Maximum concentration of pollutants was: NO_2 70.23 μg/ m^3, SO_2 36.16 μg/ m^3 , O_3 72.37 μg/ m^3, CO 9.44μg/ m^3, 2nd week, Maximum concentration of pollutants was: NO_2 89.74 μg/ m^3, SO_2 63.82 μg/ m^3, O_3 89.04 μg/ m^3, CO 7.594μg/ m^3, 3rd week, Maximum concentration of pollutants was: NO_2 100.46 μg/ m^3, SO_2 51.4 μg/ m^3 , O_3 108.22 μg/ m^3, CO 8.73μg/ m^3, 4th week, Maximum concentration of pollutants was: NO_2 79.54μg/ m^3, SO_2 48.96μg/ m^3, O_3 100.2 μg/ m^3, CO 6.51μg/ m^3, 5th week, Maximum concentration of pollutants was: NO_2 73.5 μg/ m^3, SO_2 48.05μg/ m^3 , O_3 81.51μg/ m^3, CO 5.61μg/ m^3, 6th week, Maximum concentration of pollutants was: NO_2 64.92 μg/ m^3, SO_2 42.98 μg/ m^3, O_3 105.51 μg/ m^3, CO 1.65 μg/ m^3, 7th week, Maximum concentration of pollutants was: NO_2 82.59 μg/ m^3, SO_2 37.31μg/ m^3 , O_3 108.8 μg/ m^3, CO 2.93 μg/ m^3, 8th week, Maximum concentration of pollutants was: NO_2 64.9 μg/ m^3, SO_2 49.81μg/ m^3, O_3 187.62μg/ m^3, CO

2.32 µg/ m^3, 9^{th} week, Maximum concentration of pollutants was: NO_2 77.99 µg/ m^3, SO_2 63.1 µg/ m^3, O_3 185.86 µg/ m^3, CO 4.71 µg/ m^3, 10^{th} week, Maximum concentration of pollutants was: NO_2 82.8 µg/ m^3, SO_2 58.6 µg/ m^3, O_3 193.04 µg/ m^3, CO 6.12 µg/ m^3, 11^{th} week, Maximum concentration of pollutants was: NO_2 173.2µg/ m^3, SO_2 45.12 µg/ m^3, O_3 250.58 µg/ m^3, CO 3.52 µg/ m^3, 12^{th} week, Maximum concentration of pollutants was: NO_2 85.46 µg/ m^3, SO_2 67.07 µg/ m^3, O_3 168.06 µg/ m^3, CO 7.44 µg/ m^3, 13^{th} week, Maximum concentration of pollutants was: NO_2 89.93 µg/ m^3, SO_2 108.52 µg/ m^3, O_3 227.91 µg/ m^3, CO 4.97 µg/ m^3, 14^{th} week, Maximum concentration of pollutants was: NO_2 220.31 µg/ m^3, SO_2 117.23 µg/ m^3, O_3 212.56 µg/ m^3, CO 4.99 µg/ m^3

Air Quality Index for four months was calculated. Different color coding was used for bar to represent the category of Air Quality with respect to AQI value. This color coding is provided by EPA. The value which is between 0 and 50 falls under the category named as "Clean" with green color. The value which is greater than 100 falls under "Moderate" category which has yellow color. The air which has the value from 101 to150 is categorized "Unhealthy for sensitive people" which has orange color coding. The air which has value from 151 to 200 named as "Unhealthy" has the purple color. The AQI value which falls 201 to 300 known as "Very Unhealthy" air and it represents in red color. In last the AQI value which is greater than 300, that air has "Hazardous" air quality has maroon color for representation.

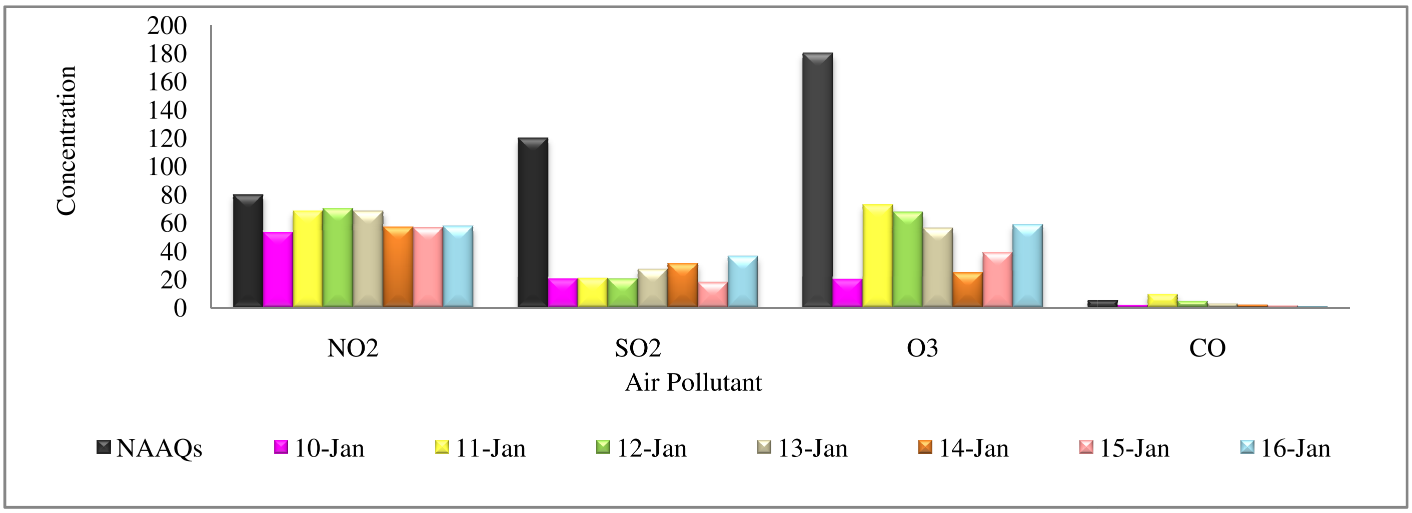

Figure-1
1^{st} week (10 January-16 January)

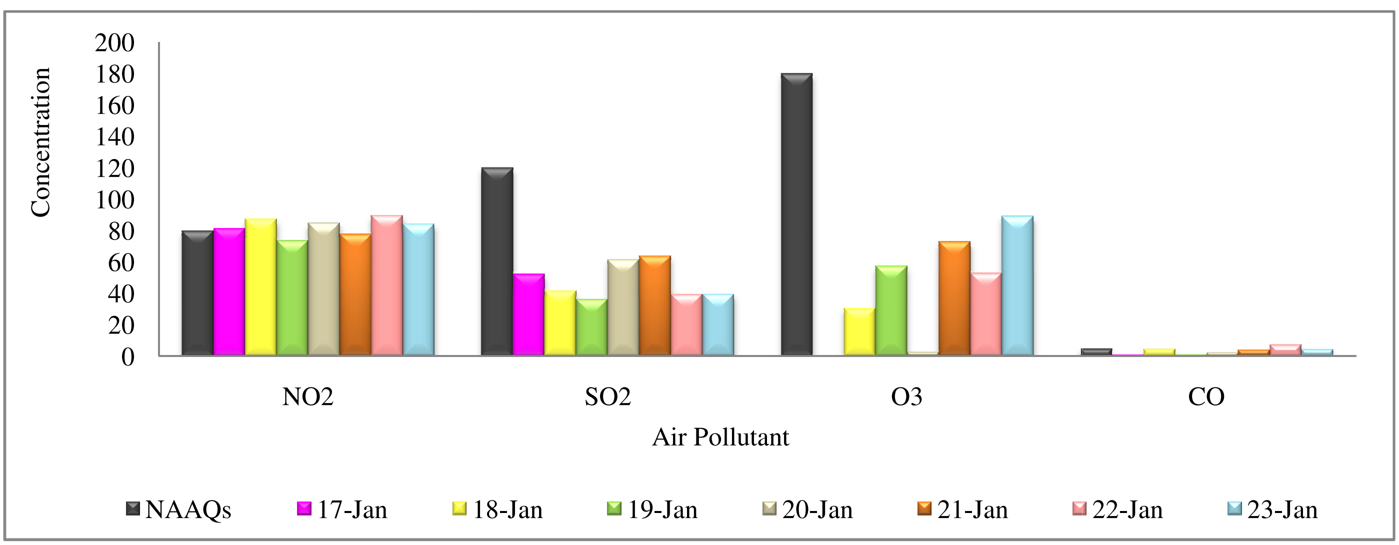

Figure -2
2^{nd} week (17 January-23 January)

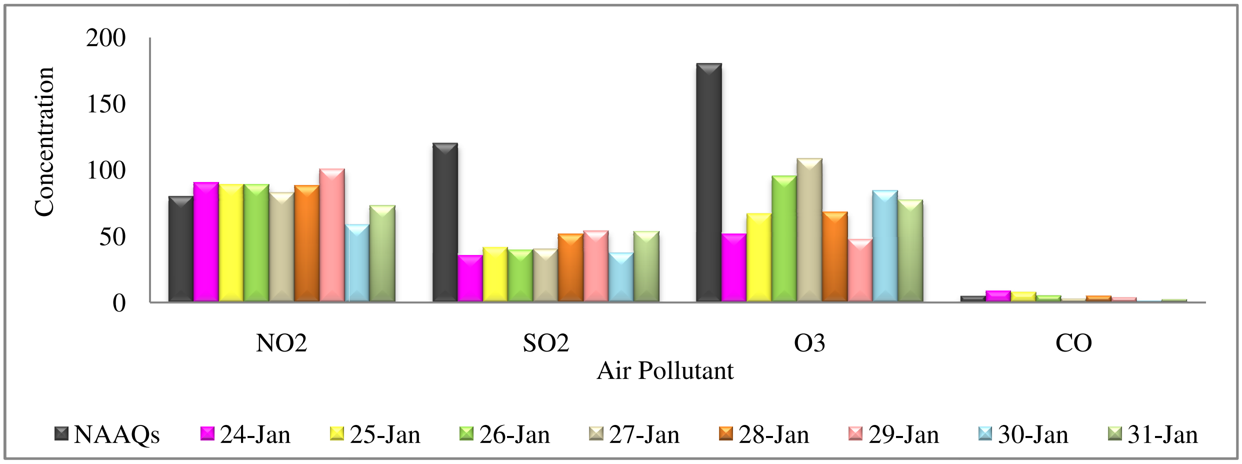

Figure -3
3rd week (24 Januart-31 January)

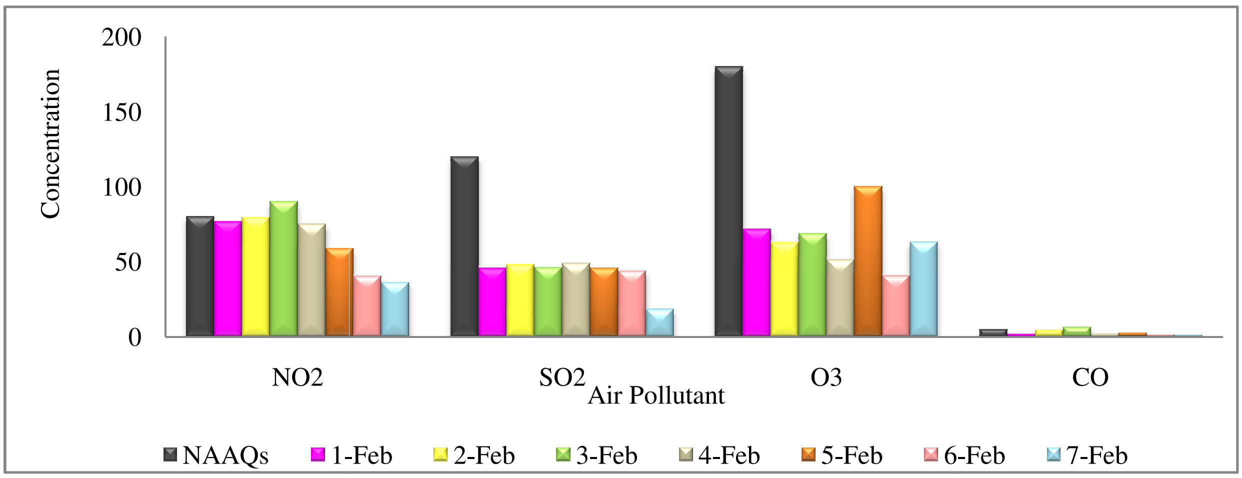

Figure- 4
4th week (1February-7february)

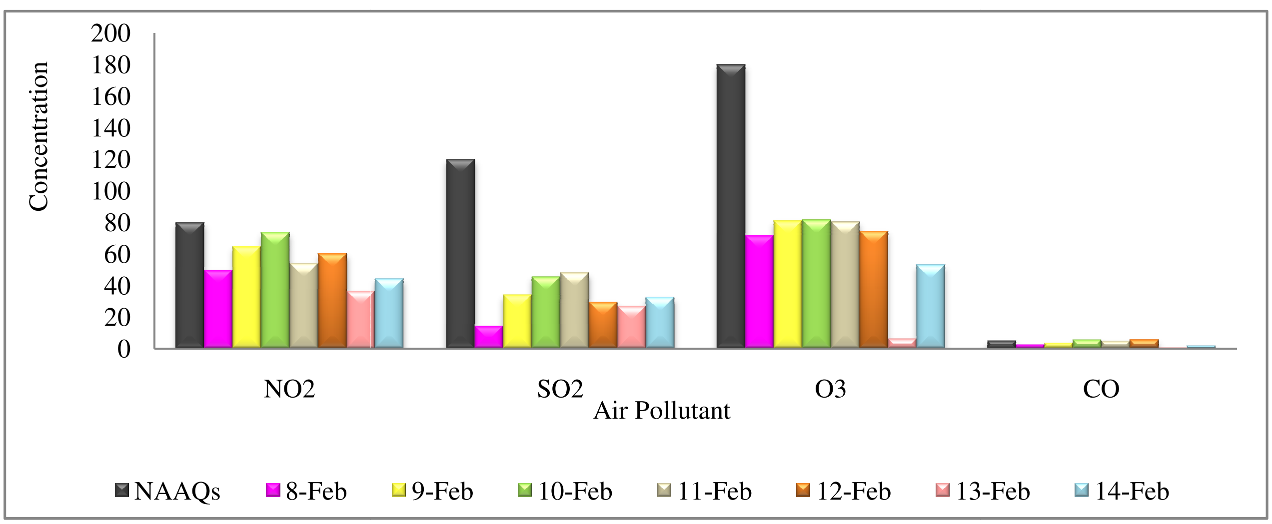

Figure-5
5th week (8 February-14 February)

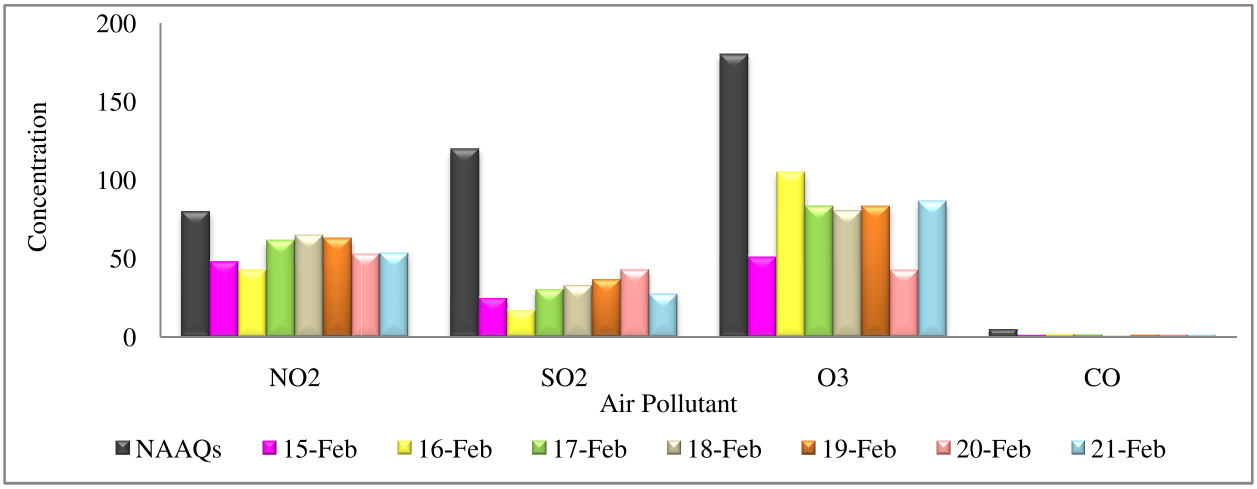

Figure -6
6th week (15 February -21 February)

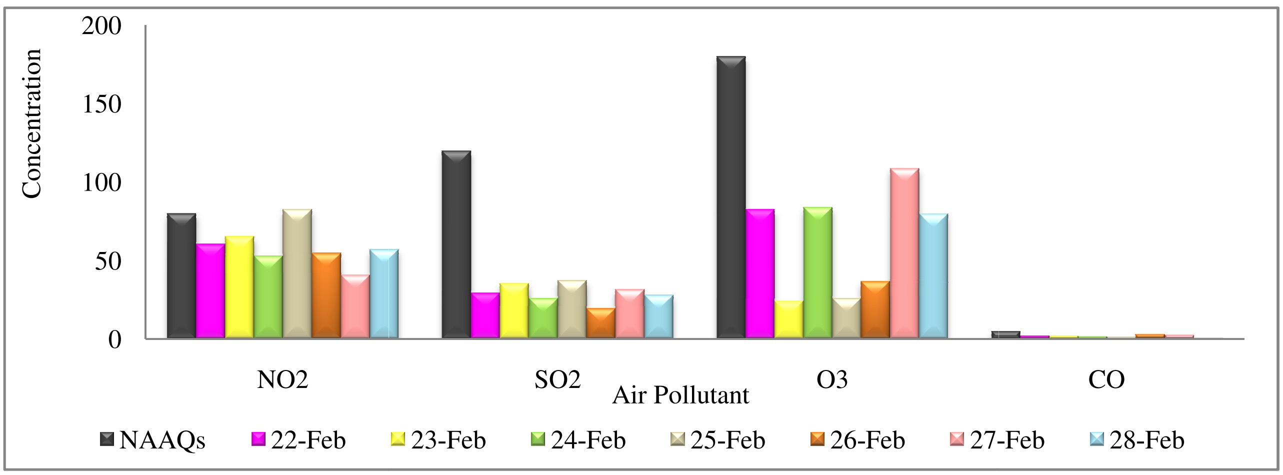

Figure-7
7th week (22 February -28 February)

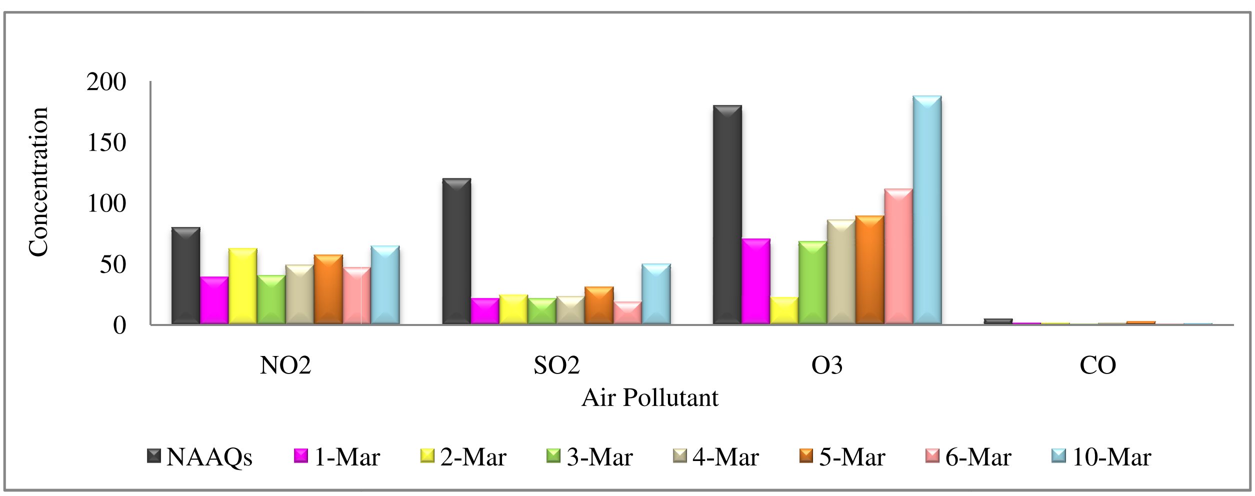

Figure-8
8th week (1 March-10March)

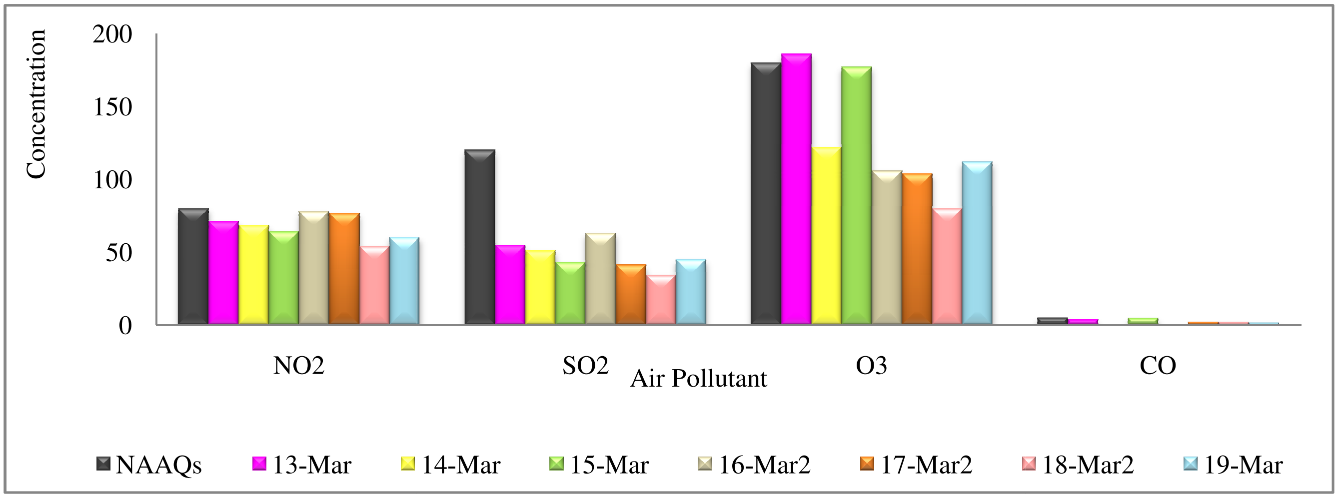

Figure-9
9th week (13 March-19 March)

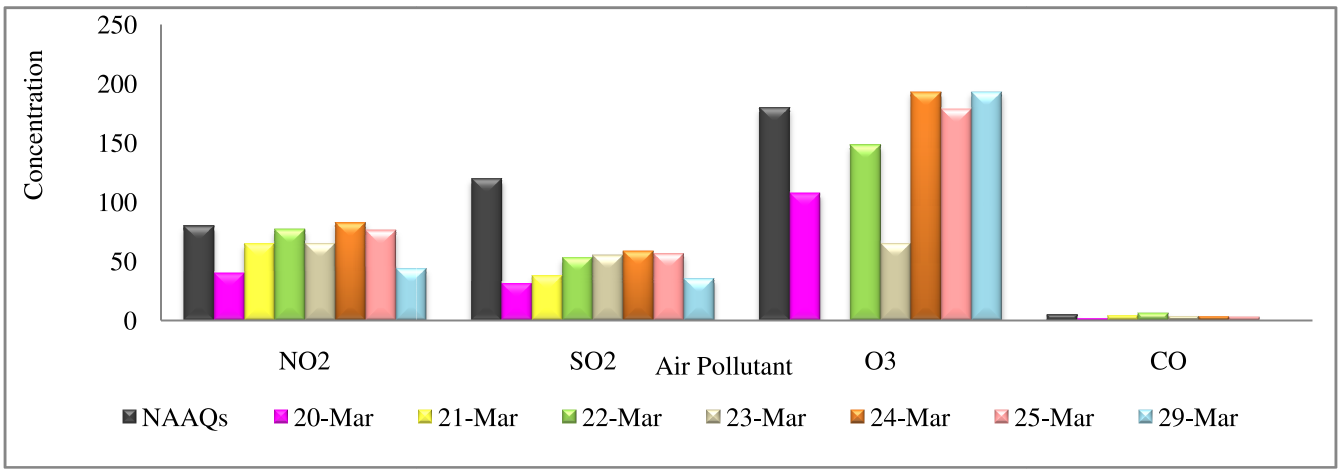

Figure-10
10th week (20 March - 29 March)

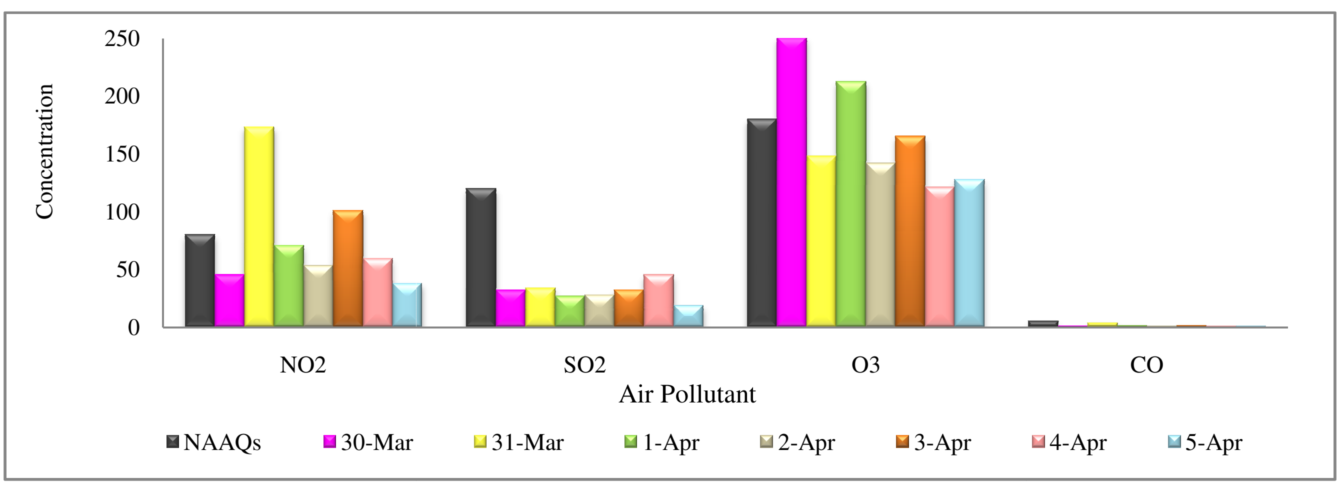

Figure-11
11th week (30 March -5 April)

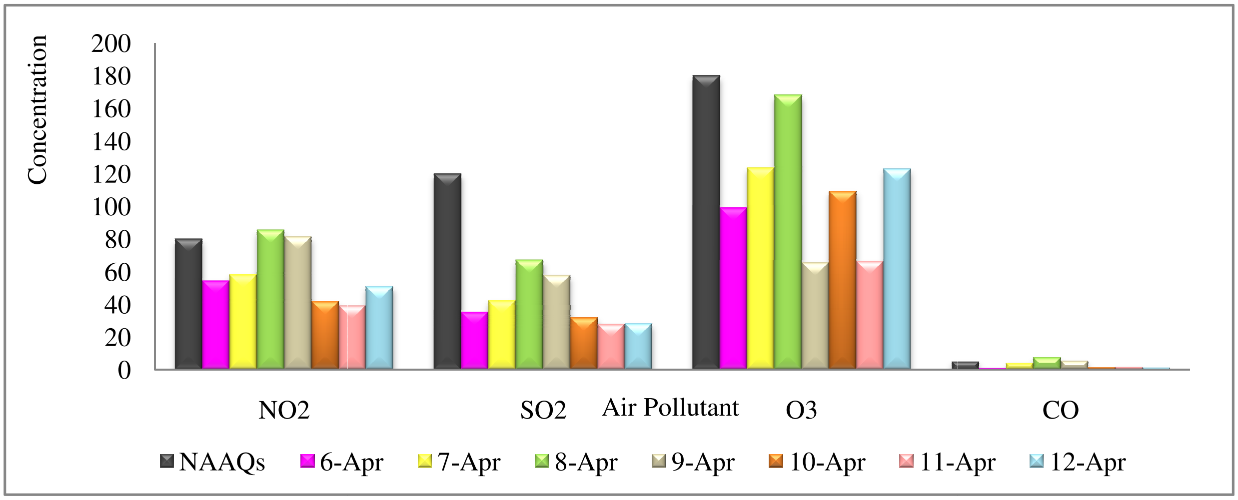

Figure-12
12th week (6 April -12 April)

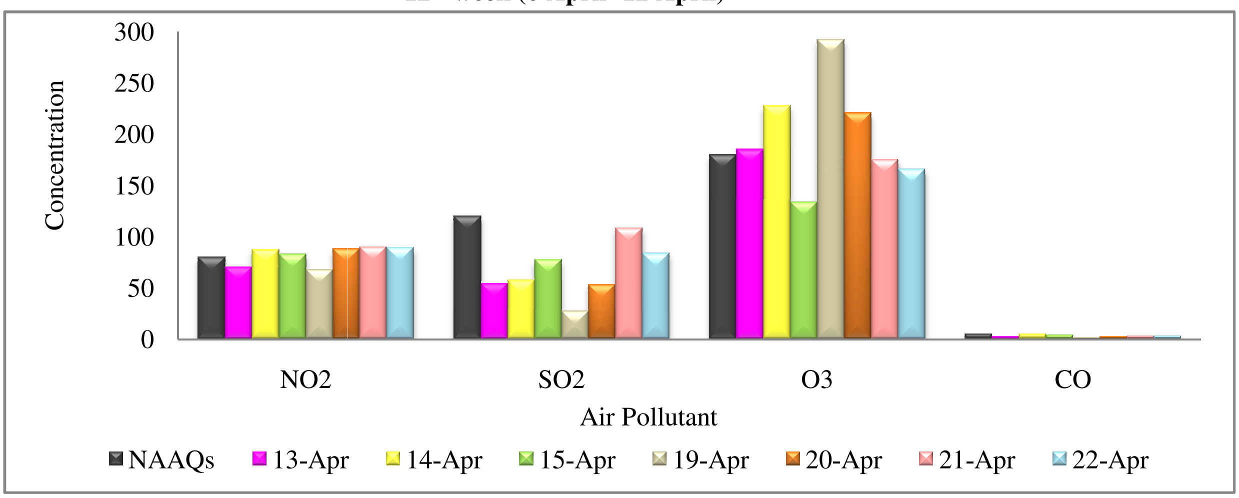

Figure -13
13th week (13 April -22 April)

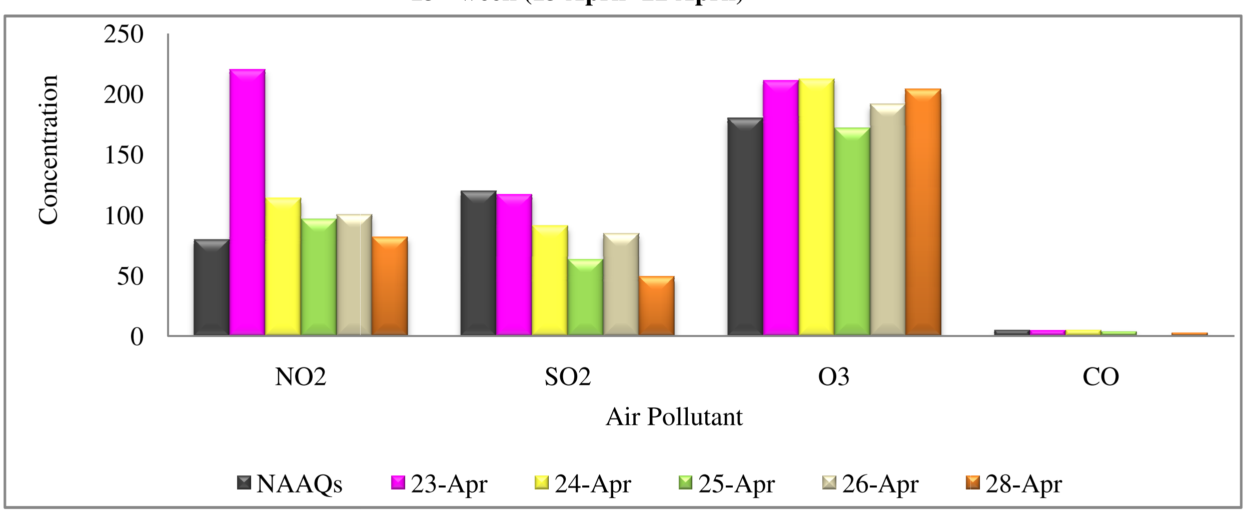

Figure -14
14th week (23 April -28 April)

Air Quality Index for four months was calculated. Different color coding was used for bar to represent the category of Air Quality with respect to AQI value. This color coding is provided by EPA. The value which is between 0 and 50 falls under the category named as "Clean" with green color. The value which is greater than 100 falls under "Moderate" category which has yellow color. The air which has the value from 101 to150 is categorized "Unhealthy for sensitive people" which has orange color coding. The air which has value from 151 to 200 named as "Unhealthy" has the purple color. The AQI value which falls 201 to 300 known as "Very Unhealthy" air and it represents in red color. In last the AQI value which is greater than 300, that air has "Hazardous" air quality has maroon color for representation.

AQI of 1st month of January is shown in the Figure- 15. This graph represents that in 1st week of Jan the AQI was 189 which means that air quality was "Unhealthy" and it has purple color. The second bar for second week of January has red color with value of 249 which means the air quality was "very Unhealthy". The last was also 274. This trend shows that the air quality remained "very Unhealthy" in the whole month of January.

Figure- 16 is showing AQI of 2nd month of Feb is shown in this graph represents that in 1st week of February the AQI was 209 which means that air quality was "Very Unhealthy" and it has red color. The second bar for second week of February has purple color with value of 189 which means the air quality was "Unhealthy". The third bar represents that the air quality was "Unhealthy" with the value of 163. The last bar also represents that the air quality remained "Unhealthy" with the value of 169. This trend shows that the air quality remained "Unhealthy" in the whole month of February, which has better quality than January.

Figure-17 is showing AQI of 3rd month of March, graph represents that in 1st week of March the AQI was 163 which means that air quality was "Unhealthy" and it has purple color. The second bar for second week of Jan has red color with value of 262 which means the air quality was "very Unhealthy". The last also represents that the air quality remained "very Unhealthy" with the value of 262.This trend shows that the air quality remained "very Unhealthy" in the whole month of March, due to high traffic load and its smoke and unburnt carbon particles. AQI of 4th month of April is shown in the Figure-18. This graph represents that in 1st week of April. The AQI was 210 which mean that air quality was "Very Unhealthy" and it has red color. The second bar for second week of Feb has red color too with value of 229 which means the air quality was "Very Unhealthy". The third bar represents that the air quality was "Hazardous" with the value of 326. The last bar also represents that the air quality remained "Hazardous" with the value of 403. This trend shows that the air quality remained "Hazardous" in the whole month of Jan, which had worst condition; the level of pollution was very high due to high level of ozone and nitrogen dioxide. This represents that the air quality remained "very Unhealthy" throughout this month.

Table-1
Air Quality Index

AQI	0 – 50	51 – 100	101 – 150	151 – 200	201 – 300	>300
Air Quality	Clean	Moderate	Unhealthy for sensitive people	Unhealthy	Very Unhealthy	Hazardous

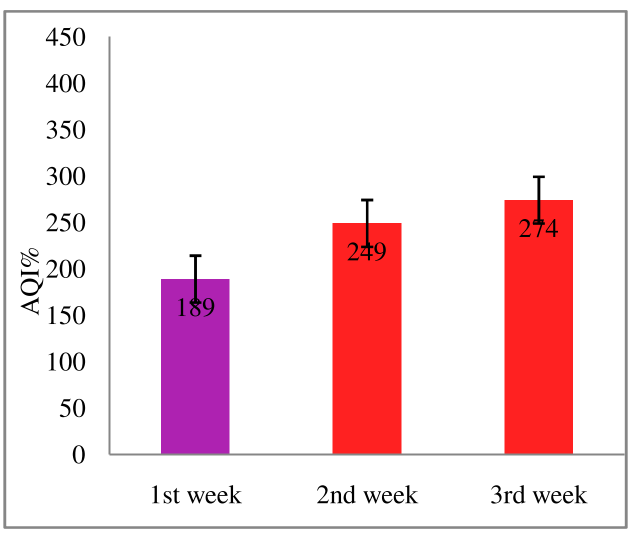

Figure-15
Graph showing the AQI of 1st to 3rd week

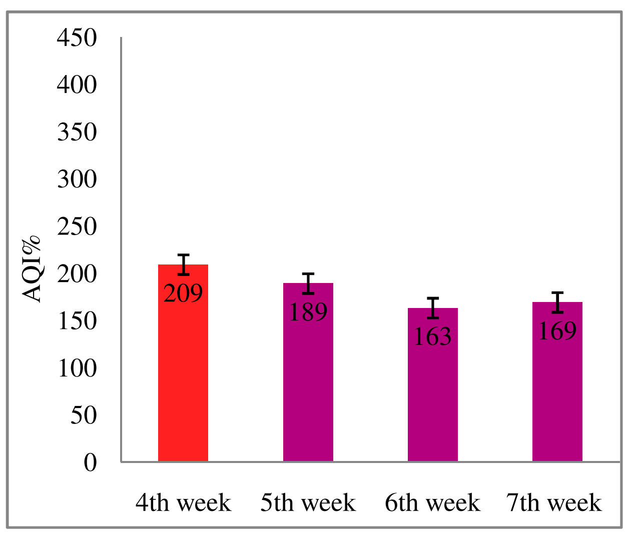

Figure-16
Graph showing the AQI of 4th to 7th week

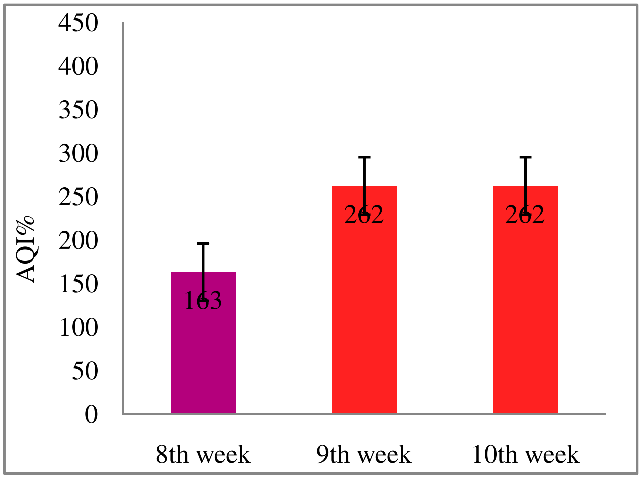

Figure -17
Graph showing the AQI of 8th to 10th week

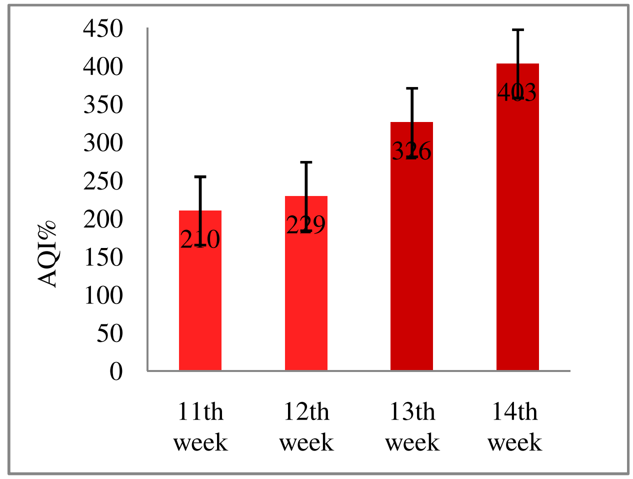

Figure-18
Graph showing the AQI 11th to 14th week

Discussion: Major sources of air pollution were heavy traffic load, smoke and dust. After tabulating all the data, data was represented in an appropriate manner for which the different types of graphs were used. Air quality monitoring of the area revealed potentially serious situation in context of environmental health. Concentrations of Ozone and Nitrogen Dioxide were considerably high in the months of March and April. Gaseous air pollutant showed high enough values to harm people. Gulberg II is the central commercial area of Lahore and high concentrations of air pollutants pose high risk of development of lung diseases. The largest source of air pollution in the area was heavy traffic load use of generators for electricity production in commercial plazas and shops during load shedding hours. Most o the people in the area use to drive their own vehicle instead of public transport whic multiplies the air pollution load. The personal automobile is regarded as the single greatest polluter, as emission from millions of vehicles on road add up. Driving a private car is a typical citizen's most polluting daily activity according to USEPA, 2001.

Nitrogen oxides react with oxygen in the air to form nitrogen dioxide, a foul-smelling brown gas. NO_2 concentration in four months from January to March reveals that this time period experienced air which had high NO_2 that was about 75µg/m^3 which was within the permissible limit but towards the higher side. SO_2 has relatively low concentration than NO_2. Nitrogen Dioxide often produce brown smog by combining with water vapours in the month of January and cause low visibility in night and early morning. NO^2 pollution is a growing threat to human health because of its photo toxic nature. The air pollution level is often high during the day time because of more use of vehicle to move from one place to the other for work. In the day time sun light increase the problem due to formation of smog. Concentration of ground level Ozone also present potentially hazardous environment and its often a day time phenomena. Sunlight plays a critical role in formation of Ozone in the summers months that's why ozone concentration was recorded to be high in the months of March and April. Ground level Ozone is produced by the action of sunlight and Nitrogen Dioxide combines with Hydrocarbons to produce the Ozone. Hydrocarbons and Nitrogen Oxides are the compounds released as byproducts of fuel consumption from vehicular sources power production through generators, wherever gasoline, diesel fuel, kerosene, oil, or natural gas is combusted. This area with heavy traffic exhibits higher values of ground level ozone affecting the human health. The Ozone significantly exceeded from National Ambient Air Quality limit. When Air Quality Index (AQI) was in orange, red, purple, or maroon, the quality of air was very bad and dangerous to health. In first two months of Jan and Feb, the value of AQI was "Unhealthy". In third month of March Air Quality was worst and that was "Very Unhealthy'. In last month of monitoring the Air Quality Index was exceeded and more than all three months and regarded as "Hazardous". The average AQI was in red color which shows that Air quality was unhealthy for the people of the area.

Conclusion

As air pollution is a serious problem in urban areas like Lahore, it needs special attention and strong mitigation. Levels of Ozone and Nitrogen Dioxide were comparatively high than other pollutants such as carbon monoxide and sulfur oxides. On-road traffic is the major source of air pollution in urban areas likewise emissions from motor traffic are the largest contributor of the air pollution is the area of study and its management is an environmental challenge. Effective engineering ant traffic planning is required to address the problem in the area and measures should be taken on policy level and also by awareness of individual citizens.

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