# London Air Quality Analysis

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## Contents

# 1 Introduction

Being healthy is very important in our lives. Then, breathing good quality air is a must. On account of that, monitoring air quality plays major role there. Also, it provides early warnings to reduce the risk of air pollution. Thus, air quality and its trends are dominant nowadays. This reports contains some air quality trends in London city based on the data collected from 36 air monitoring sites from 01/01/2022 to 31/12/2023. The parameters measured were $NO_2$, NO, $NO_x$, $PM_{10}$, $PM_{2.5}$, $O_3$ and $SO_2$. $NO_2$, NO, $NO_x$, $O_3$ and $SO_2$ are gases. $PM_{10}$ and $PM_{2.5}$ are particulate matter 10 and 2.5 micrometers or less than in diameter respectively.

## 1.1 Data Set Explanation and Missing Values

There are 2 data sets were given. One data set includes the details about air monitoring sites its locations, identification codes and parameters hourly measured in each sites (data set A). other data set includes measurements of above mentioned parameters, time and date and the site measured (data set B).

I have assumed that in a air monitoring site, parameters are in units of $\mu g/m^3$ in hourly manner when conducting the data analysis. These parameters are air pollutants.
In data set B, there are some missing values . Since not all parameters are measured in each and every monitoring site there is fair to have some NA values in the data sheet. Also, there might be some technical errors as well. First removed all empty columns and rows if any.Then, all NA values are replaced by value **0**. there are no any missing values in data set A.
Using data set A, geographical locations of sites can be shown in the map as follows.
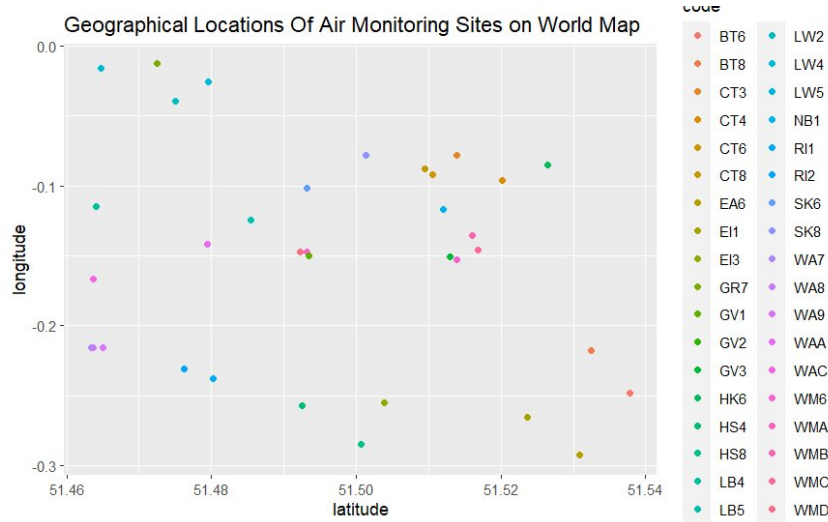


Figure 1:

According to the graph, all sites are well spread over the London city without being biasing to any part.

## 1.2 Air Quality Differs In London

Questions that are answered by the report.

1. How the concentration of pollutants differ with the time ?

2. What are the locations with higher total pollutants?

3. Does the London city have maintained AQGs by World Health Organization?

# 2 Literature review

According the World health Organization, there are quality indexes for each pollutant called **AQG**s in Oder to protect public health world wide (last update on 2021). If a values in specific area is less than or equal to that particular AQGs, then the air is not polluted.

| Pollutant | Averaging period | AQG ($\mu g/m^3$) |
|-----------|------------------|-------------------|
| PM10 | 1 day | 45 |
| PM2.5 | 1 day | 15 |
| NO2 | 1 hour | 200 |
| NO2 | 1 day | 25 |

Table 1: AGQs in 2021

# 3 Results and Discussion

## 3.1 Question 01

Using of below displaying graphs , differing of each pollutant with time can be analyzed. Here data only from January of 2022 to January of 2023 is used.
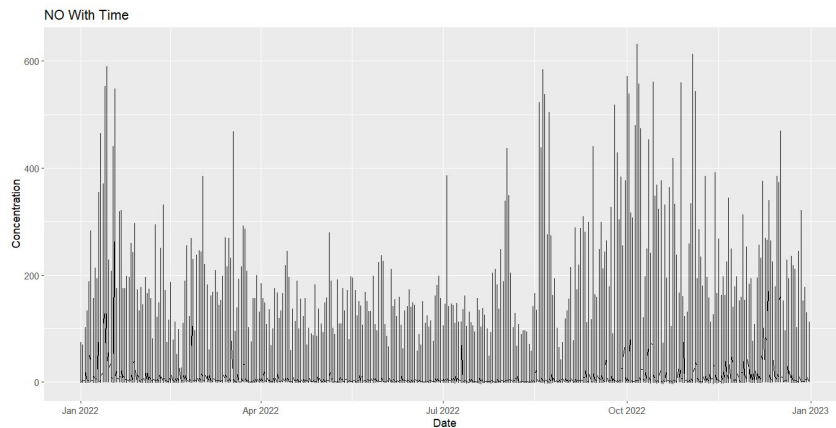


Figure 2: NO with Time

During from Octomber of 2022 to January of 2023, higher concentrations are observed while at the middile of the year it is less. At most of year concentrations of NO revolve around 75 to 200.
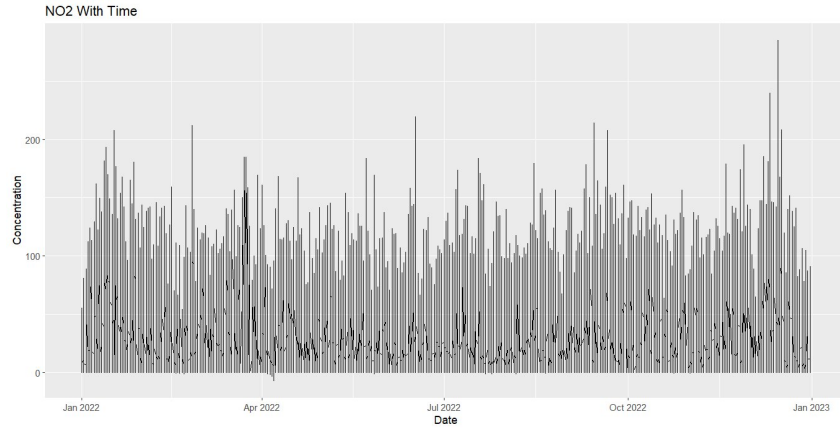


Figure 3: $NO_2$ with Time

At most of year concentrations of NO2 revolve around 50 to 150. There are no significant differences between values during the year.But as a summary it stats with lower value and end with lower values as well.
Concentrations are lower than in NO. Only 8 numbers of days, the values goes higher than $200\mu g/m^3$.
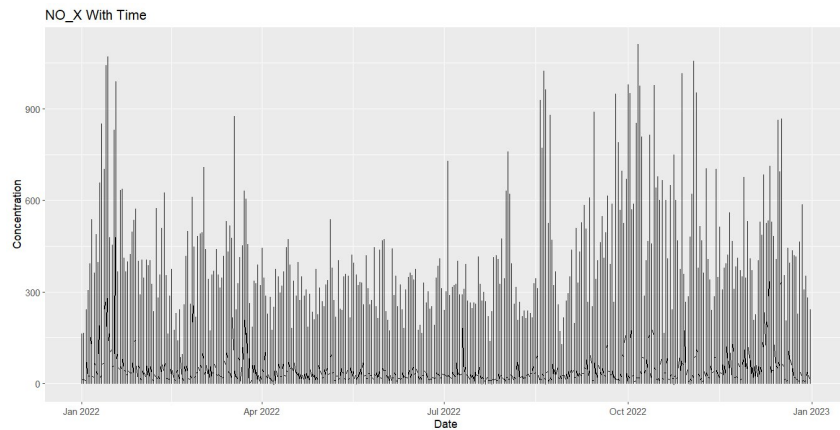


Figure 4: $NO_x$ with Time

At most of year concentrations of NOx revolve around 150 to 450.There are significant differences between values during the year. There are much highr values in the beging and end of the year. NOx has the higher concentrations than other pollutants.
Concentrations are higher than in NO2. Only 3 numbers of days, the values goes higher than $1050\mu g/m^3$.
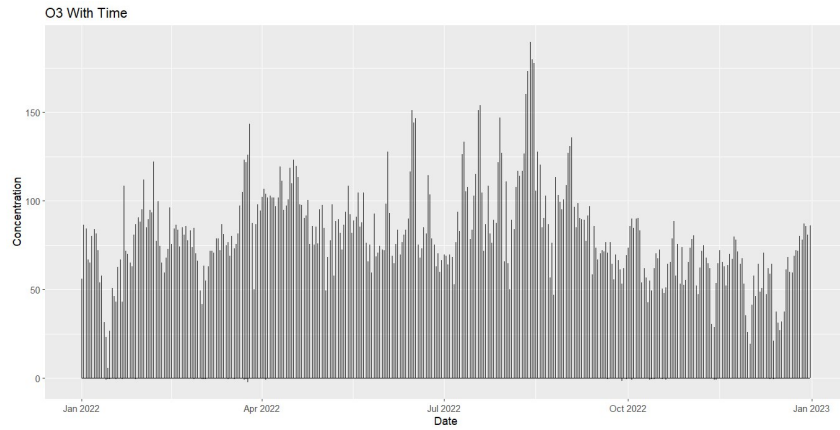
Figure 5: $O_3$ with Time

At most of year concentrations of O3 revolve around 25 to 75.There are some significant differences between values during the year. In the middle of the year, most of higher values can be observed while in other time, comparatively lower values are observed. Concentrations are lower than in NOx. Only 3 numbers of days, the values goes higher than $175\mu g/m^3$.
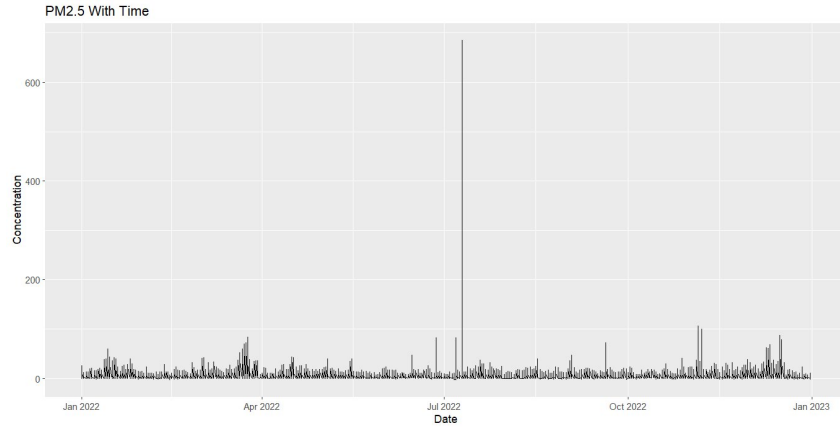
Figure 6: $PM_{2.5}$ with Time

At most of year concentrations of PM2.5 revolve around 10 to 50.PM2.5 has the lowest concentrations comparing to other parameters.
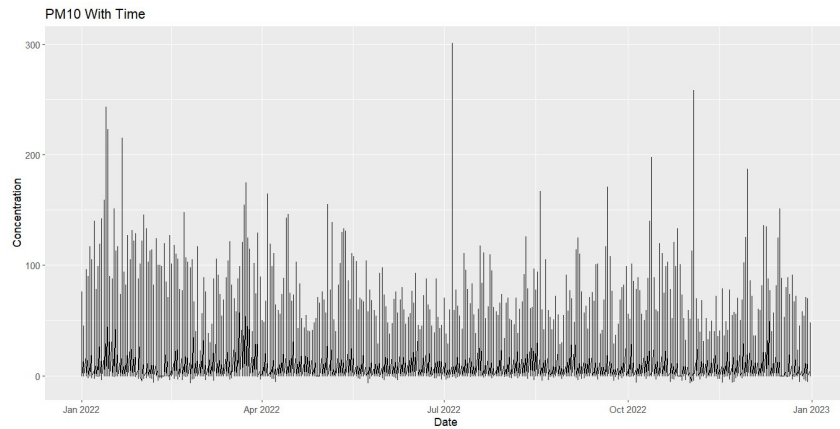Concentrations are higher than in O3. Only one day, the values goes higher than $100\mu g/m^3$.



Figure 7: $PM_{10}$ with Time

At most of year concentrations of PM10 revolve around 10 to 50.There are significant differences between values during the year.
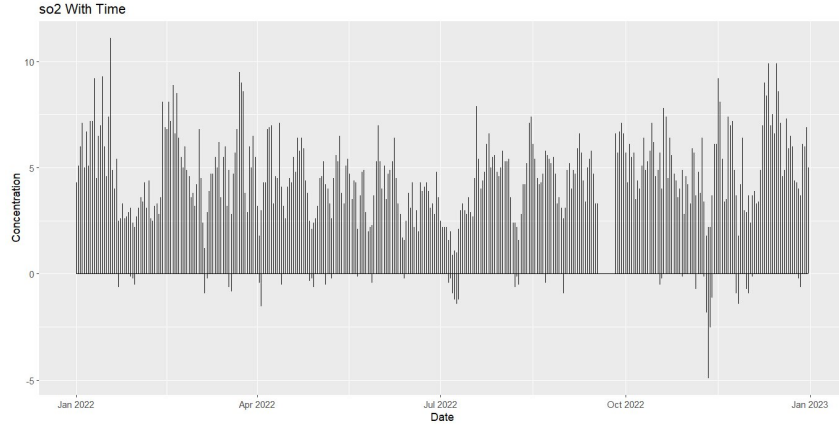Concentrations are higher than in PM2.5. Only 5 numbers of days, the values goes higher than $200\mu g/m^3$.

Figure 8: $SO_2$ with Time

At most of year concentrations of PM10 revolve around 1 to 5. There are significant differences between values during the year.

Concentrations are lower than in PM10. Only 1 day , the values goes higher than $10\mu g/m^3$.

## 3.2 Question 02

To get the locations with higher amount of pollutants, the sums of parameters are used. since $NO_2$, NO, $NO_x$, and $PM_{10}$ are measured at most every site, only those pollutants are considered. From that only highest 10 values and its locations with codes are given below table.

| Code | Sum of Pollutant |
|------|------------------|
| LB4  | 2355163.5        |
| EA6  | 2313841.5        |
| CT6  | 1755353.6        |
| LW4  | 1711118.6        |
| El1  | 1322689.2        |
| WMB  | 1296355.5        |
| CT4  | 1196247.3        |
| WM6  | 1154628.1        |
| LB5  | 1136960.7        |
| HS8  | 1109840.6        |

Here LB4 has the highest values. EA6 bit lower than LB4. Also, CT6 and LW4 are having kind of equal values.

## 3.3 Question 03

The means of each and every pollutant was calculated only considering the values without 0. By comparing the resulting means and AQGs stands, we can check whether London city has suitable air to breath or not. Only some of gases are considered to avoid complicity of computations.
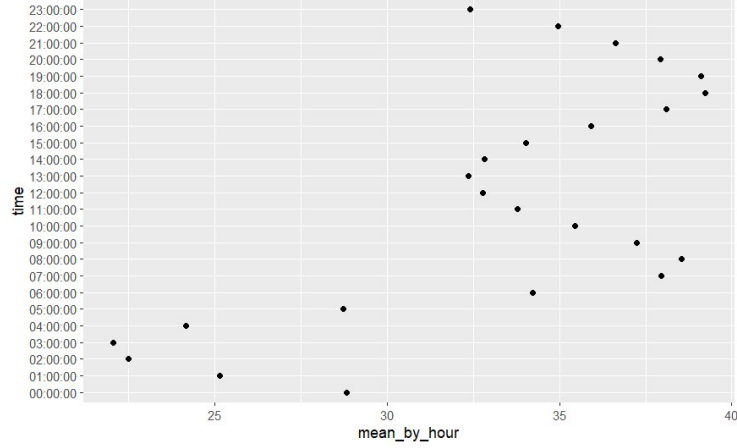


Figure 9: How the concentration of $NO_2$ vary within day

During 2am to 3am there is lowest concentration is observed. from 7am to 8am and 5pm to 6pm are the peak hours. (6pm to 11pm) , (12am to 7am) and (9am to 6pm) are significant varing of NO2 concentrations.
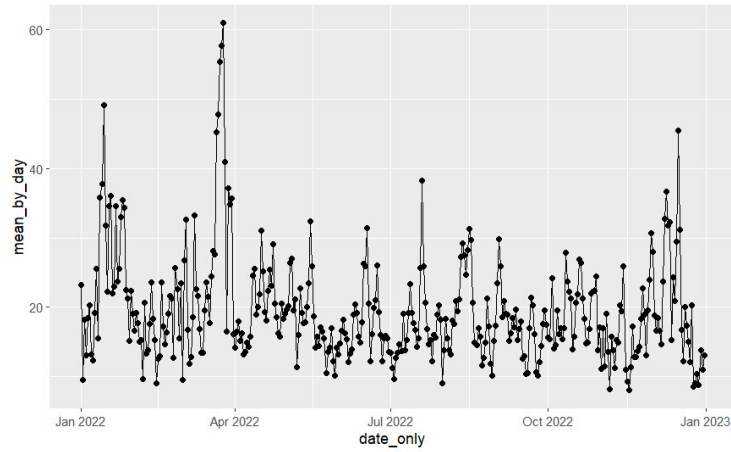


Figure 10: How the concentration of $PM_{10}$ vary within a year

Only data between January2022 and January20223 is considered. There are significant ups and downs during whole year. The highest can be observed between March2022 and April2022. Most of mean values of PM10 revolves around 30 and 10.

8

Figure 11: How the concentration of $PM_{2.5}$ vary within a year

Only data between January2022 and January20223 is considered.There are significant ups and downs during whole year. The highest can be observed between March2022 and April2022. Most of mean values of PM10 revolves around 30 and 10.
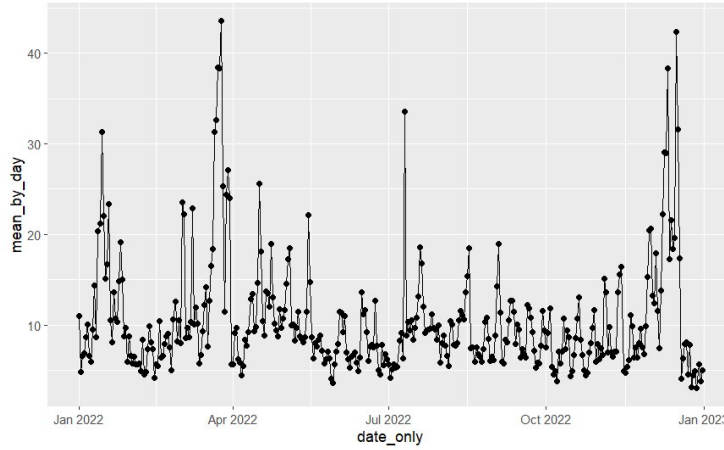
As a summary both means of $PM_{10}$ and $PM_{2.5}$ behave likely around the year even though there are some differences between values.
The below mentioned are values needed to compare with respective AQGs.

1. Mean value of $NO_2$ by averaging time as 1 hour is $33\mu g/m^3$.

2. Mean value of $PM_10$ by averaging time as 1 day is $19\mu g/m^3$.

3. Mean value of $PM_2.5$ by averaging time as 1 day is $10\mu g/m^3$.

# 4 Conclusion

Lambeth - Brixton Road aera (LB4) is the highest polluted area in London city. Ealing - Hanger Lane Gyratory (EA6) , City of London - Walbrook Wharf (CT6), Lewisham - Loampit Vale (LW4) and Ealing - Western Avenue (El1) has taken the places from $2^{nd}$ to $5^{th}$. Further, using the graphs for each pollutants with time the highest found pollutant is $NO_x$. Considering the AGQs ,Mean values of $NO_2$ and $PM_10$ are less than the standards and while for $PM_2.5$, it is near around the AGQ. As , a conclusion London city air quality is good for human health but there might not in the future.
I suggest it would be better if could collect the data about carbon monoxide $CO$; another one of main pollutants.

# 5 References

1. "Particulate matter (PM10 and PM2.5)",30 June 2022, Australian Government Department of Climate Change, Energy, the Environment and Water from https://shorturl.at/cwENY

2. "WHO Global Air Quality Guidelines",22 September 2021, World Health Organization https://shorturl.at/yBFT0