ST306 Mini Project Report

S/18/843

January 30, 2024

0.1 Introuction

Air quality is really important for the health of our city and the people who live in it. That's why our project is all about looking closely at the air in London. We want to understand the patterns and changes in air quality throughout the city. We're using information collected from 36 special air monitoring spots in London, from January 1, 2022, to December 31, 2023.

The main bunch of data we're using is called "london local data 2022." It tells us about different pollutants in the air, like NO_2, NO_x, NO, O_3, SO_2, PM_{10}, and $PM_{2.5}$. But there's a little challenge, some of the data is missing. So, we need to be very careful in our analysis to make sure we get meaningful insights.

To get a good picture of how air quality is spread out across the city, we're adding more information from another dataset called "london local sites." This extra data gives us details about each monitoring spot, like its code, name, where it is on the map (latitude and longitude), and what substance it's measuring.

As we dive into this analysis, we're going to figure out how air quality changes over time and different places in London. It's like solving a puzzle to understand how things in the air change. By doing this, we hope to give useful information that can help with making smart decisions about city planning and taking care of the environment.

0.2 Literature review

In the past, many studies have shown that the air we breathe in cities is super important for our health and for keeping cities sustainable. Our project fits into this bigger picture because we want to take a really good look at how the air quality in London is changing over time.

Other studies have also focused on understanding air quality by setting up special monitoring spots in different parts of cities. These spots help collect data about different things in the air, like gases and particles. Our project is doing something similar by looking at data from 36 monitoring spots in London from 2022 to 2023.

In our study, we're paying close attention to various pollutants like NO_2, NO_x, NO, O_3, SO_2, PM_{10}, and $PM_{2.5}$, just like other researchers have done in the past. This helps us see what's in the air and how it might affect people's health.

One challenge we're dealing with is that some data is missing, like pieces of a puzzle. To tackle this, we're using smart methods to fill in the gaps and make our analysis more accurate.

To get a full picture of air quality in London, we're adding more information from another dataset. This extra data tells us about each monitoring spot, like its code, name, and where it is on the map. This helps us understand how air quality varies in different parts of the city.

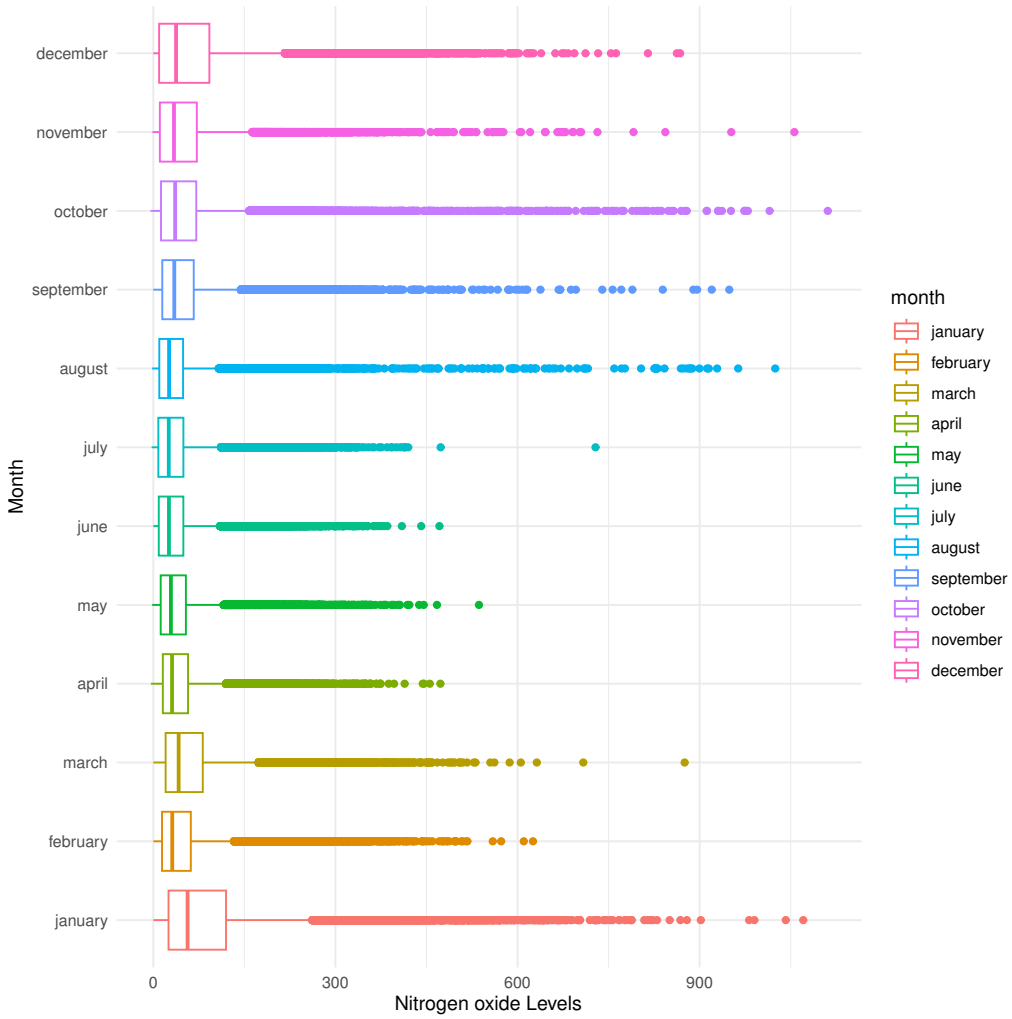
Looking at what others have done, it's clear that the air we breathe changes in complex ways across cities. People have used different techniques, from basic stats to advanced computer methods, to figure out these changes. Our project is part of this effort, aiming to provide useful information for city planning and taking care of the environment.

0.3 Results and Discussion

The following findings were obtained from our analysis of these datasets.

0.3.1 Trends of NO_x

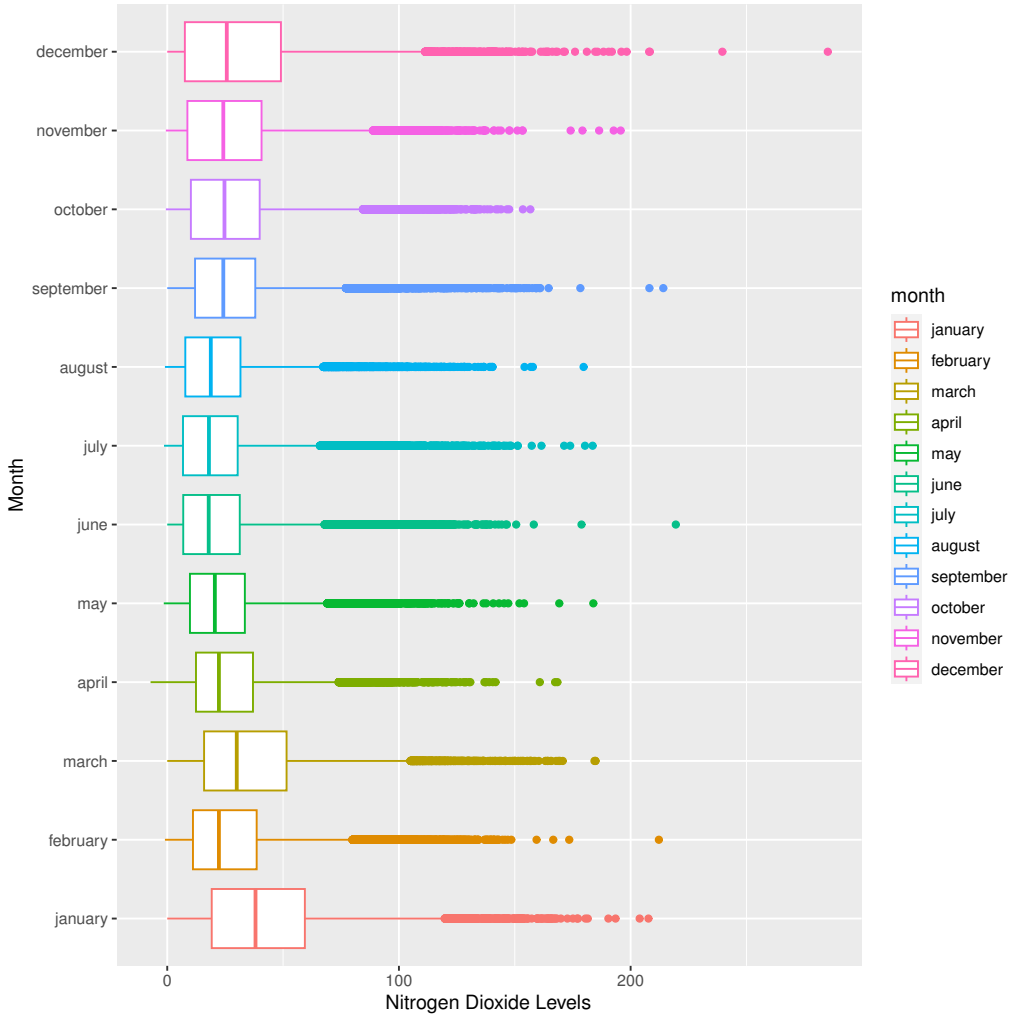
Figure 1: Boxplot for NO_x



When compared to other months, January's median line is higher. This suggests that January has a higher average concentration of NO_x. When compared to other months, July's median line is lower. This suggests that July has a lower average NO_x concentration. Consequently, July's air quality is better than January's.

0.3.2 Trends of NO_2

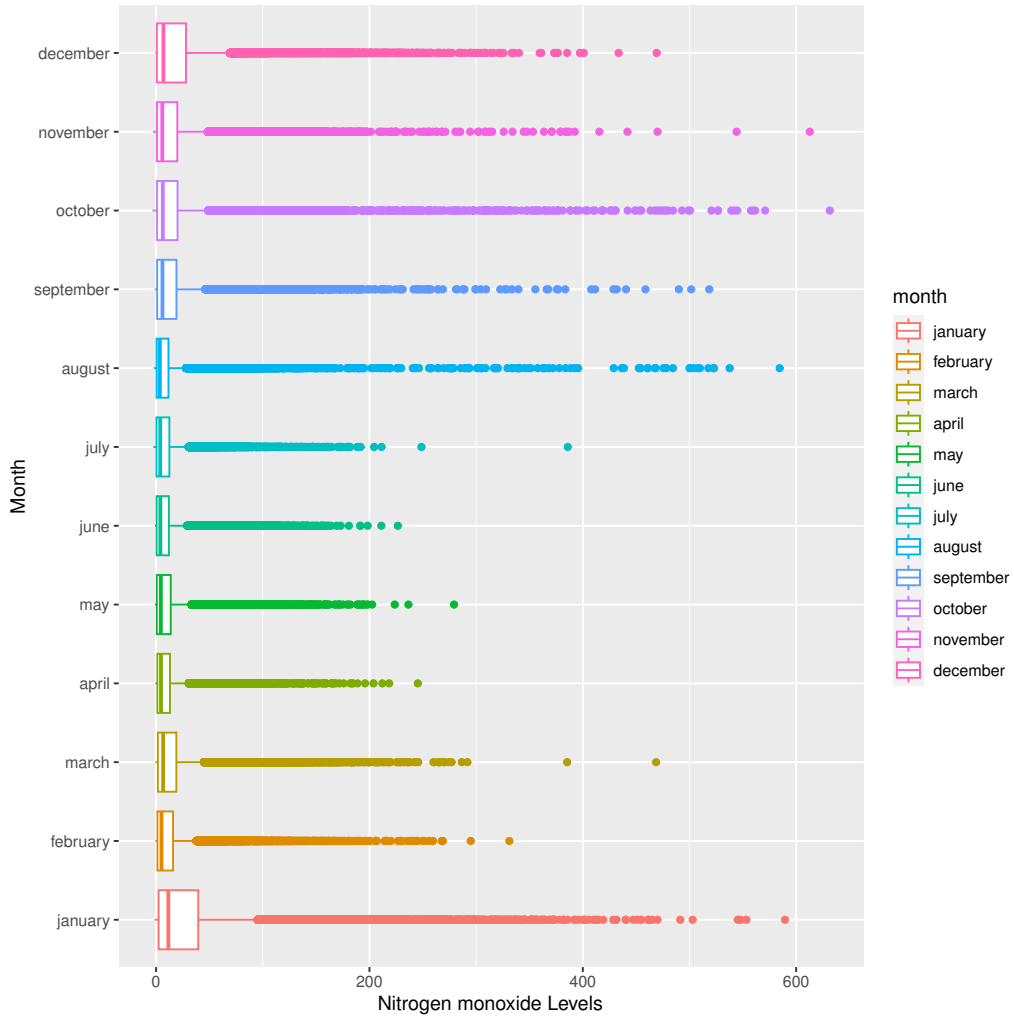
Figure 2: Boxplot for NO_2



When compared to other months, January's median line is higher. This suggests that January has a higher average NO_2 concentration. June and July have a lower median line than the other months. This suggests that June and July have lower average NO_2 concentrations. As a result, June and July have better air quality than January.

0.3.3 Trends of NO

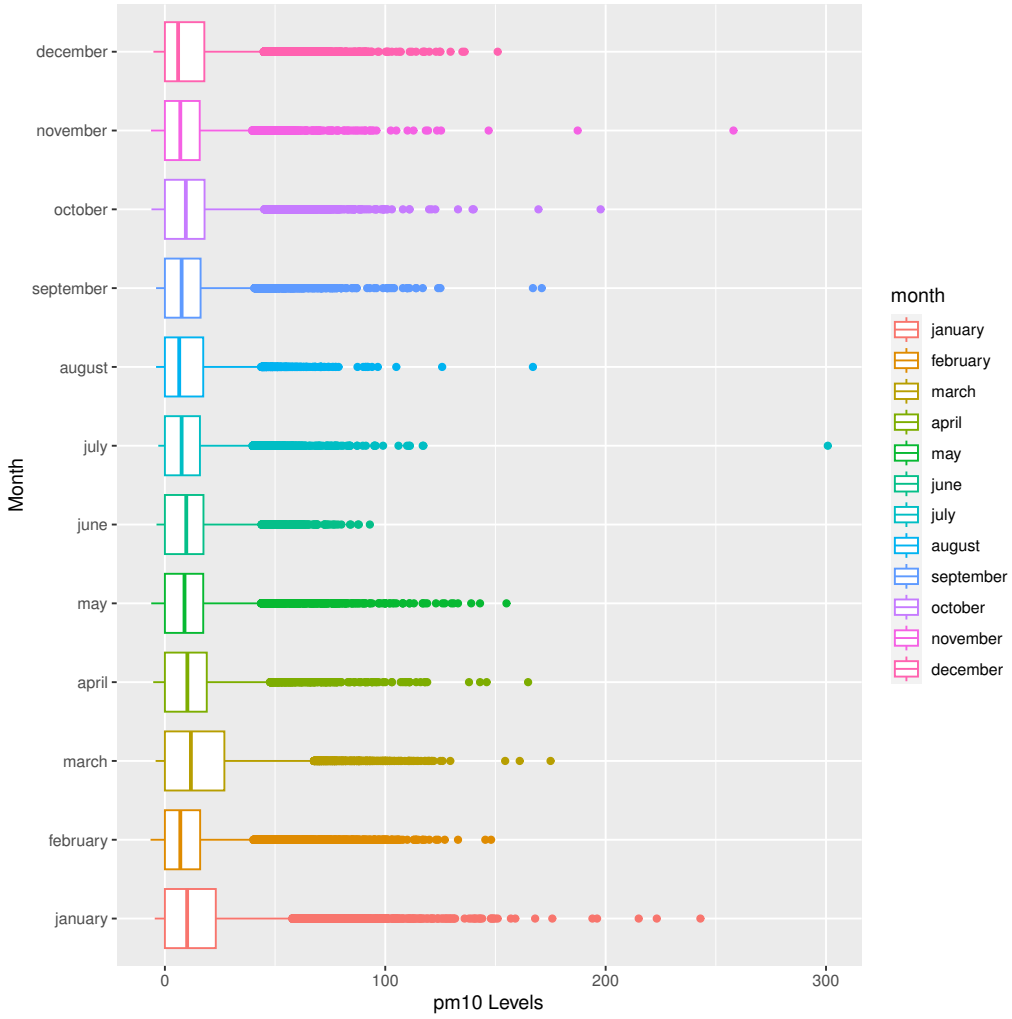
Figure 3: Boxplot for NO



January has a higher median line than the other months. This suggests that January has an average higher NO concentration. April's median line is lower than it is in previous months. This suggests that April's average NO concentration is lower. Consequently, compared to January, April's air quality is better.

0.3.4 Trends of PM_{10}

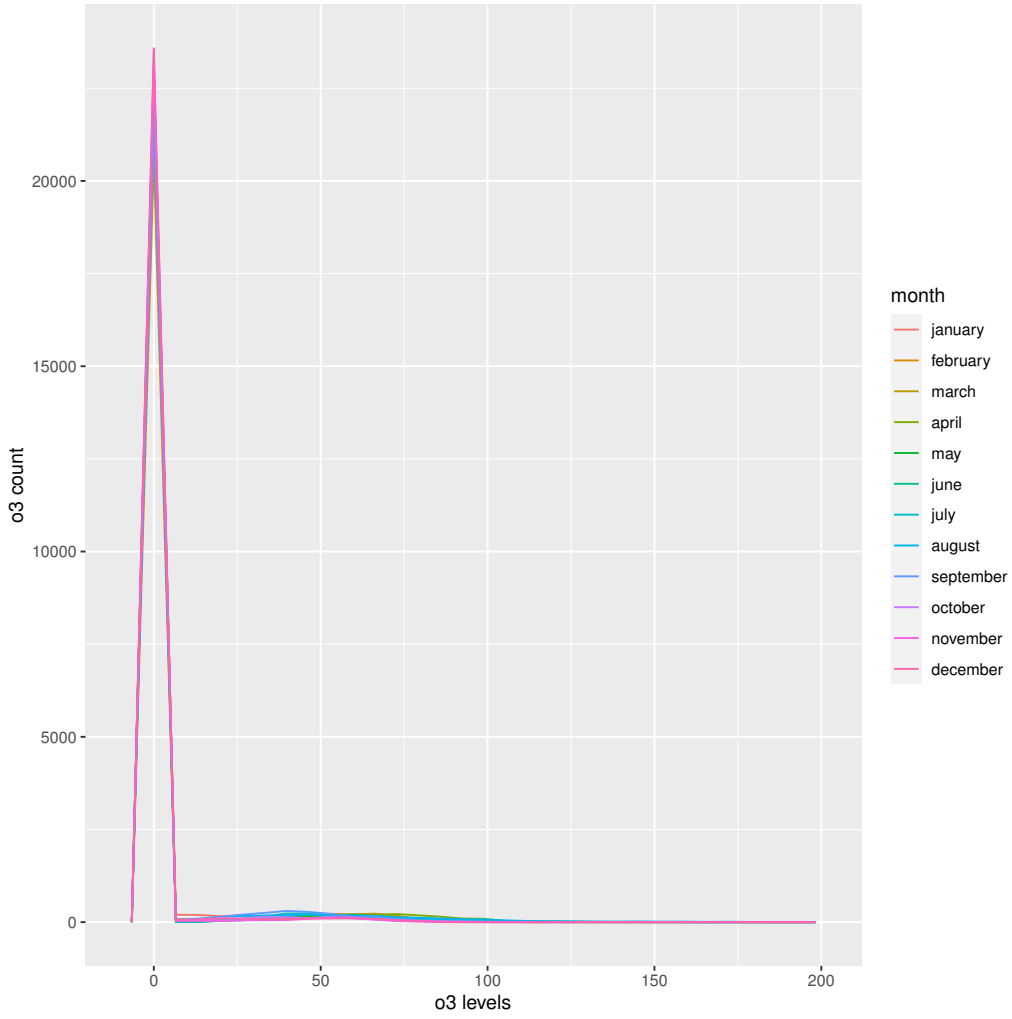
Figure 4: Boxplot for PM_{10}



In comparison to previous months, March has a higher median line. This suggests that March has a higher average PM_{10} concentration. In comparison to other months, December has a lower median line. This suggests that December has a lower average PM_{10} concentration. As a result, December has better air quality than March.

0.3.5 Trends of O_3

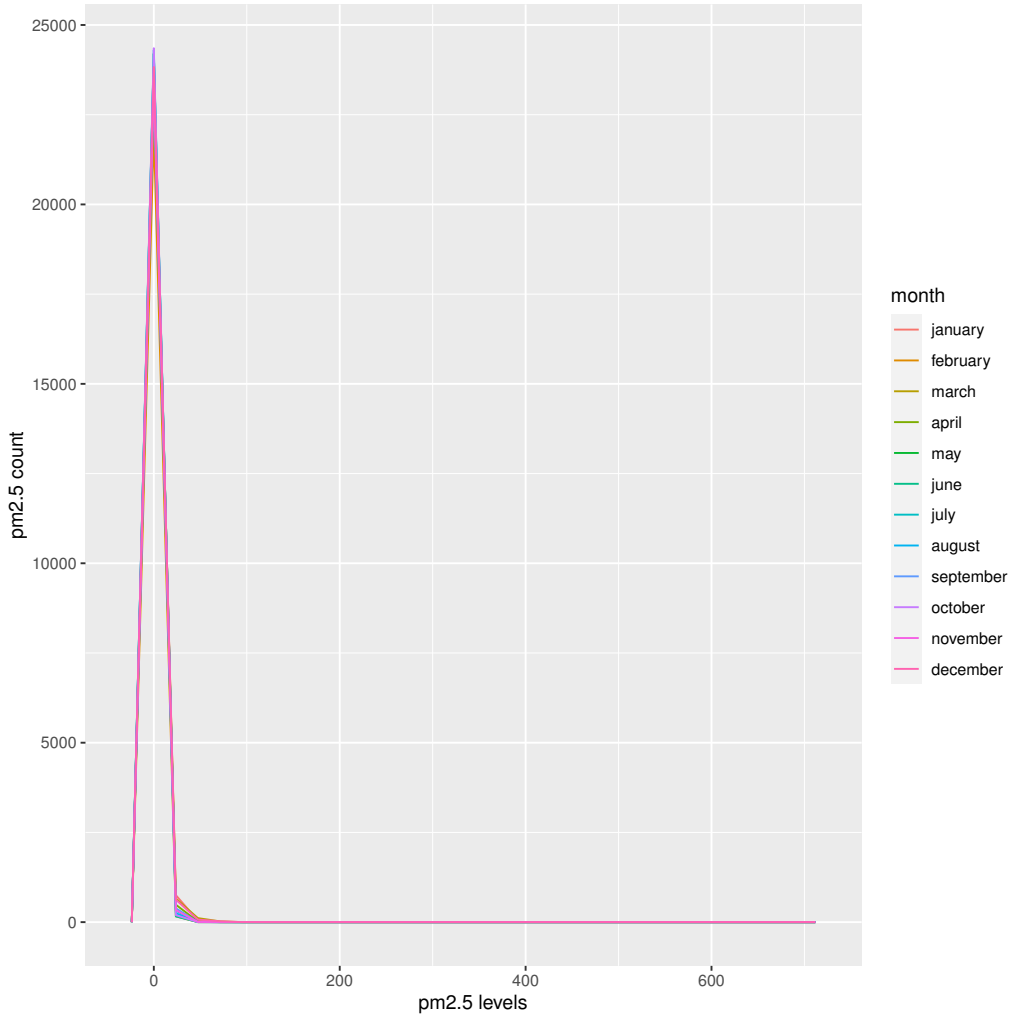
Figure 5: frequency polygon for O_3



There is the polygon's peak when looking at the O_3 graph. This concentration level, which signifies the month of December and the central tendency of O_3 concentrations, has the highest frequency. This indicates that December has poor air quality. There aren't any noticeable gaps or spikes. It displays concentrations that do not differ significantly from the majority.

0.3.6 Trends of $PM_{2.5}$

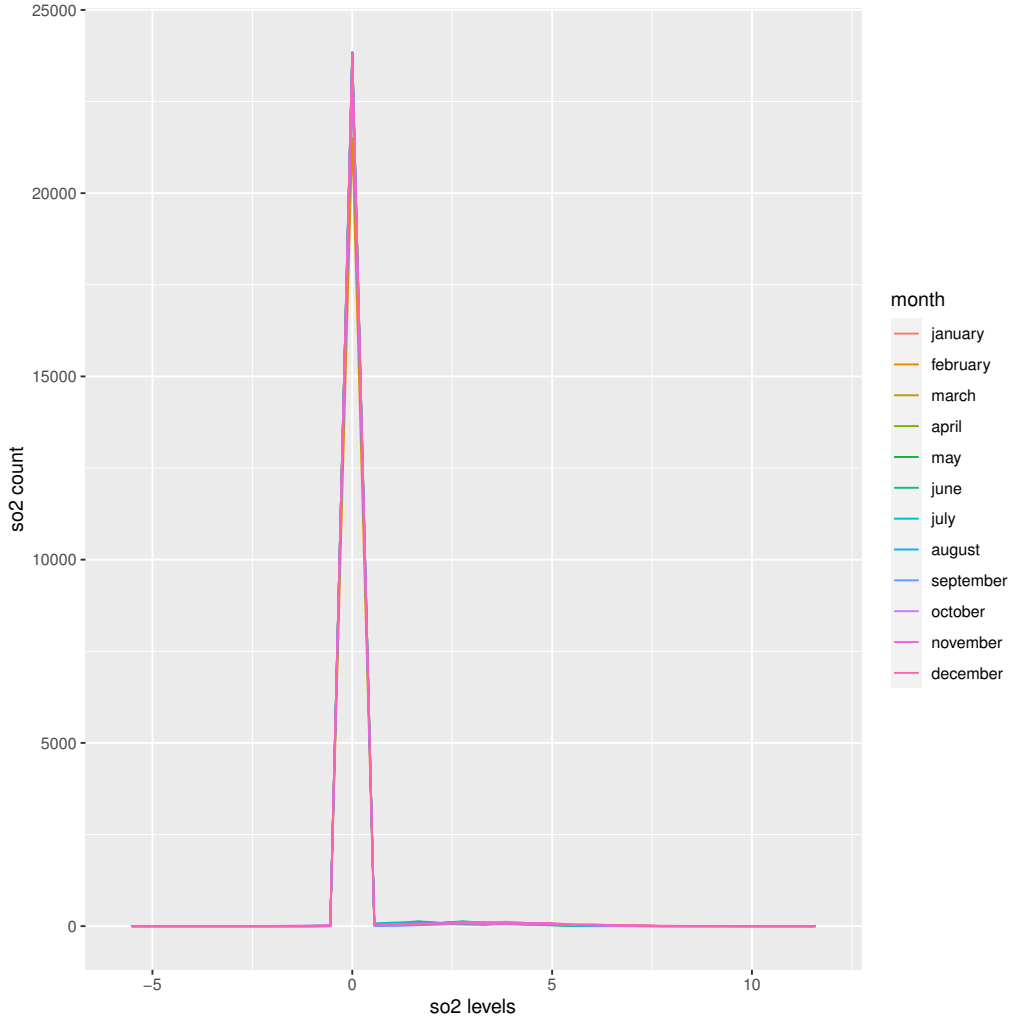
Figure 6: frequency polygon for $PM_{2.5}$



When looking at the $PM_{2.5}$ graph, the polygon has a peak. This concentration level is the most frequent; it corresponds with the months of November and December and shows the general pattern of $PM_{2.5}$ concentrations. This indicates that November and December have poor air quality. There isn't a noticeable increase. It displays concentrations that are noticeably identical to the majority.

0.3.7 Trends of SO_2

Figure 7: frequency polygon for SO_2

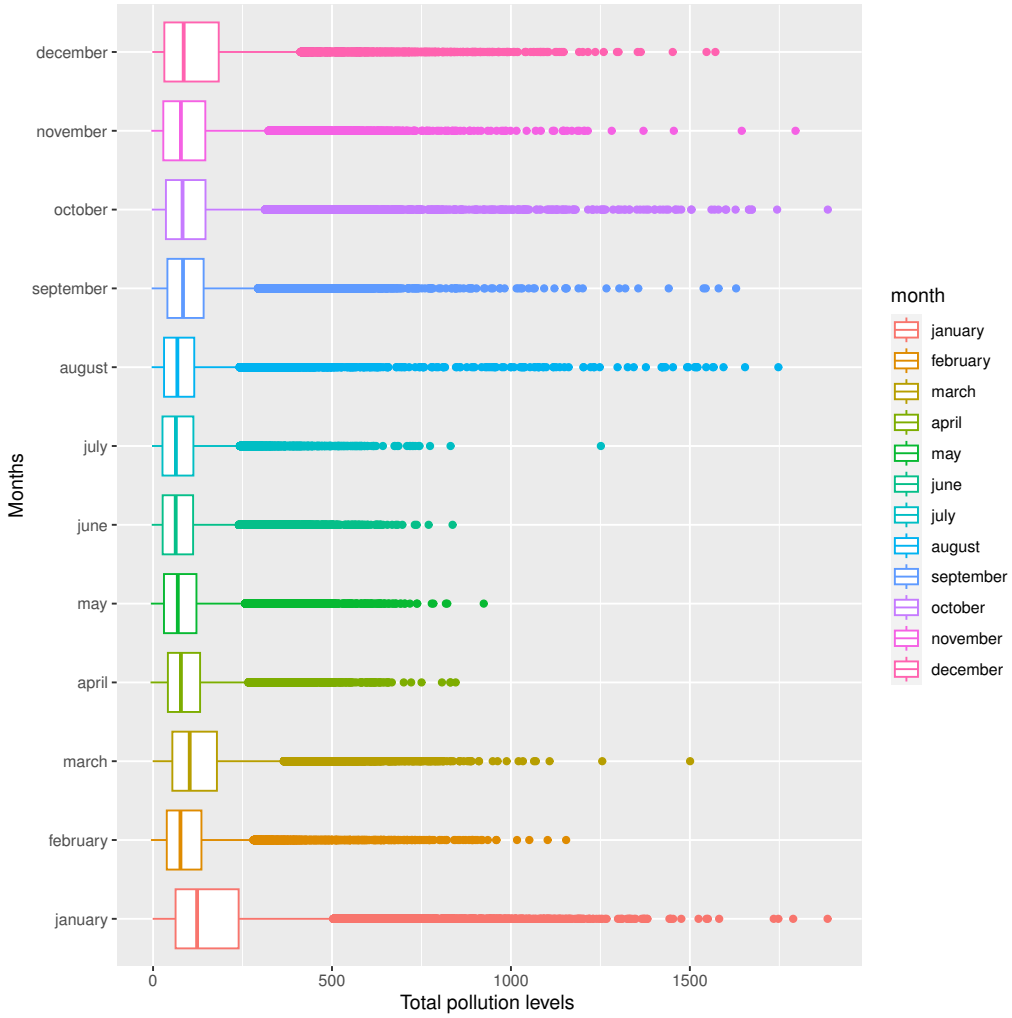


The polygon's peak can be seen when looking at the SO_2 graph. This concentration level is the most frequent; it is indicative of the months of November and December and shows the general trend of SO_2 concentrations. In other words, November and December have poor air quality. No notable gaps or spikes are present. It displays concentrations that do not differ appreciably from the majority

0.3.8 Total Pollution

This graph displays the total pollution when all seven pollutants are added.

Figure 8: Boxpot for Total Pollution



When compared to other months, January's median line is higher. This suggests that January has a higher average total pollution concentration. June has a lower median line than the other months. This suggests that June has a lower average total pollution concentration. Consequently, June's air quality is better than January's.

By combining these data, we can create the following table, which shows the pollution for each month broken down into its seven constituent pollutants.

Table 1: Pollution for each month

Month	**NO**	**NO_2**	**NO_x**	**PM_{10}**	**O_3**	**$PM_{2.5}$**	**SO_2**
January	833924.2	1014988.0	2293633.5	359324.3	67610.8	25070.6	2431.3
February	311137.5	612346.4	1089415.4	228271.1	84327.5	10755.0	2342.3
March	394539.4	869004.0	1472031.3	413958.3	84646.8	24516.0	2411.5
April	256342.2	626266.1	1020617.8	273625.0	116097.3	15558.0	2061.4
May	279166.3	581897.9	1011325.4	260697.4	78287.8	13570.0	1968.3
June	245196.5	525196.5	902577.8	247300.9	82322.3	7603.0	1727.0
July	252477.3	537435.4	924698.2	231688.8	99910.3	14055.0	1732.5
August	273363.6	547810.3	966785.3	244676.9	131430.5	10208.0	2305.4
September	377109.7	646310.1	1224609.0	234722.9	93935.9	13055.0	1924.8
October	461804.3	664809.9	1373085.6	273280.0	46950.7	8922.0	2464.5
November	401433.1	645584.7	1261436.3	223239.3	32976.5	12900.0	1920.9
December	596718.0	757814.6	1672765.0	268571.1	40538.2	21490.0	2789.8

Additionally, we could make the following table, which displays each site's level of pollution.

Table 2: Pollution for each site

Site	**NO**	**NO_2**	**NO_x**	**PM_{10}**	**O_3**	**$PM_{2.5}$**	**SO_2**
Brent - ARK Franklin Primary Academy	123532.9	249455.8	438862.4	134196.4	0.0	0.0	0.0
Brent - John Keble Primary School	100689.6	240072.4	394464.3	141583.0	0.0	0.0	0.0
City of London - Beech Street	142089.1	348783.9	566653.3	138721.0	0.0	0.0	0.0
City of London - Sir John Cass School	43668.4	197502.7	264457.8	118784.0	0.0	0.0	0.0
City of London - Upper Thames Street	0.0	0.0	0.0	251.0	0.0	0.0	0.0
City of London - Walbrook Wharf	344236.0	441655.6	969462.0	0.0	0.0	0.0	0.0
Ealing - Acton Vale	28217.6	85825.0	129099.8	47284.1	0.0	0.0	0.0
Ealing - Hanger Lane Gyratory	501426.1	448518.0	1217362.4	146535.0	0.0	0.0	0.0
Ealing - Western Avenue	196365.7	305669.0	606755.2	213899.3	0.0	0.0	0.0
Greenwich - Blackheath	105906.2	224899.4	387277.6	141581.1	0.0	0.0	0.0
Hackney - Old Street	128745.2	255258.2	452667.5	135142.0	294381.4	8706.6	0.0

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Site	NO	NO_2	NO_x	PM_{10}	O_3	$PM_{2.5}$	SO_2
Hounslow Chiswick	157236.9	255846.3	496943.4	153551.4	0.0	85764.0	0.0
Hounslow Gunnersbury	192881.8	218607.7	514355.8	183995.2	0.0	0.0	0.0
Lambeth - Bondway Interchange	129468.6	251098.2	449608.9	306785.0	0.0	0.0	26079.7
Lambeth - Brixton Road	434015.4	548169.9	1213652.7	159325.5	0.0	0.0	0.0
Lewisham - Deptford	43381.8	166212.0	232732.1	0.0	0.0	0.0	0.0
Lewisham - Loampit Vale	347381.4	330724.8	863372.4	169640.0	0.0	0.0	0.0
Lewisham - New Cross	93819.6	185738.4	331326.4	74953.0	0.0	0.0	0.0
Richmond Upon Thames - Barnes Wetlands	11112.8	77169.1	94210.9	122697.9	229146.0	0.0	0.0
Richmond Upon Thames - Castelnau	59160.2	163372.3	254088.3	119616.6	0.0	0.0	0.0
Southwark - Elephant and Castle	39775.6	177134.0	238127.1	132062.8	435507.2	0.0	0.0
Southwark - Tower Bridge Road	180412.0	260558.8	537185.8	0.0	0.0	0.0	0.0
Wandsworth - Battersea	71003.2	178738.5	287618.7	175535.4	0.0	0.0	0.0
Wandsworth - Lavender Hill (Clapham Jct)	32004.0	65123.0	114150.0	156128.8	0.0	0.0	0.0
Wandsworth - Putney	12555.0	33029.8	52280.0	124186.0	0.0	0.0	0.0
Wandsworth - Putney High Street	83545.6	74911.5	203009.5	162901.5	0.0	0.0	0.0
Wandsworth - Putney High Street Facade	169633.9	271945.3	532045.4	0.0	0.0	0.0	0.0
Westminster - Cavendish Square	136015.4	285758.9	494311.6	0.0	0.0	0.0	0.0
Westminster - Duke Street (Grosvenor)	73049.0	264656.0	376660.0	0.0	0.0	0.0	0.0
Westminster - Ebury Street (Grosvenor)	55989.0	198435.3	285298.0	0.0	0.0	0.0	0.0
Westminster - Elizabeth Bridge	155140.7	294012.3	531886.0	0.0	0.0	83232.0	0.0
Westminster - Oxford Street	199643.3	324434.4	630550.4	0.0	0.0	0.0	0.0
Westminster - Oxford Street East	224801.7	363432.6	708121.2	0.0	0.0	0.0	0.0
Westminster - Strand (Northbank BID)	66308.3	242714.8	344383.8	0.0	0.0	0.0	0.0

After the data was analyzed, a detailed table was created that shows the monthly total pollutant levels in descending order, giving an overview of the monthly pollution trends.

Month	Total Pollutant Level
January	4596983
December	3360687
March	3261107
October	2831317
September	2591667
November	2579491
February	2338595
April	2310568
May	2226913
August	2176580
July	2061997
June	2011924

Table 3: Total Pollutant Levels for Each Month (Descending Order)

January had the highest total of 4,596,983 units in the monthly pollutant assessment, followed by December with 3,360,687 and March with 3,261,107. Notable pollution levels were also observed in October and September, which added to the overall decreasing pollution order during the study period. Pollutant levels were comparatively lower in August, July, and June (2176,580 units in August, 2,061,997 units in July, and 2,011,924 units in June.

The total pollution for each site could also be displayed in descending order in the following table.

Table 4: Total Pollutant Levels for Each Site (Descending Order)

Site	Total Pollutant Level
Lambeth - Brixton Road	2355163.5
Ealing - Hanger Lane Gyratory	2313841.5
City of London - Walbrook Wharf	1755353.6
Lewisham - Loampit Vale	1711118.6
Ealing - Western Avenue	1322689.2
Westminster - Oxford Street East	1296355.5
Hackney - Old Street	1274900.9
City of London - Beech Street	1196247.3
Lambeth - Bondway Interchange	1163040.4
Westminster - Oxford Street	1154628.1
Hounslow Chiswick	1149342.0
Hounslow Gunnersbury	1109840.6
Westminster - Elizabeth Bridge	1064271.0
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Site	**Total Pollutant Level**
Southwark - Elephant and Castle	1022606.7
Southwark - Tower Bridge Road	978156.6
Wandsworth - Putney High Street Facade	973624.6
Brent - ARK Franklin Primary Academy	946047.5
Westminster - Cavendish Square	916085.9
Brent - John Keble Primary School	876809.3
Greenwich - Blackheath	859664.3
Westminster - Duke Street (Grosvenor)	714365.0
Wandsworth - Battersea	712895.8
Lewisham - New Cross	685837.4
Westminster - Strand (Northbank BID)	653406.9
City of London - Sir John Cass School	624412.9
Richmond Upon Thames - Castelnau	596237.4
Westminster - Ebury Street (Grosvenor)	539722.3
Richmond Upon Thames - Barnes Wetlands	534336.7
Wandsworth - Putney High Street	524368.1
Lewisham - Deptford	442325.9
Wandsworth - Lavender Hill (Clapham Jct)	367405.8
Ealing - Acton Vale	290426.5
Wandsworth - Putney	222050.8
City of London - Upper Thames Street	251.0

The table illustrates the notable differences in overall pollution levels among the different locations. Lambeth - Brixton Road has the highest concentration, 2,355,163.5 units, while City of London - Upper Thames Street has the lowest, 251.0 units. This thorough analysis helps identify high-impact areas for focused environmental interventions by offering insightful information on the distribution of pollution.

0.4 Conclusion

Based on information gathered at 36 air monitoring sites, we conducted an analysis of trends in London City's air quality from January 1, 2022, to December 31, 2023. We found significant patterns for seven pollutants: NO_2, NO_x, NO, O_3, SO_2, PM_{10}, and $PM_{2.5}$.

The highest NO_x, NO_2, and NO concentrations were seen in January, indicating lower air quality during this month. On the other hand, July continuously showed lower concentrations, indicating better air quality. There is a seasonal variability in the NO concentrations; March had the lowest and December the highest levels of PM_{10}. Over the course of the monitoring period, the concentrations of O_3, $PM_{2.5}$, and SO_2 stayed consistently low.

When total pollution was analyzed, June showed the lowest levels, indicating better air quality in June than in January. January had the highest levels. Upon closer examination of the overall pollution levels for each month, it was found that January had the highest concentrations, followed by December and March, and June had the lowest.

When individual sites were examined, Upper Thames Street in the City of London had the lowest concentrations of pollution and Lambeth's Brixton Road had the highest overall. Together, these results add to a thorough understanding of the dynamics of London City's air quality and highlight the necessity of focused interventions to address particular pollutants and seasonal variations.