3.1 Seasonality and Trends of AQ Pollutants in Urban Locations

Existing data from AQMS' can be accessed through OpenAQ [27] and this section has analysed data from various time points at the DEFRA AQMS in Newcastle city centre. This section shall use the existing data from that sensor to analyse trends and seasonality to draw any notable conclusions.

3.1.1 Weekly Data

Conclusive data from a DEFRA AQMS located in Newcastle's city centre (N54.97825, E-1.610528) was collected between 05/07/21 and 10/07/21 in an attempt to see trends in day to day AQ measurements. Figure 3 below graphs the results for the NO_2, O_3, $PM_{2.5}$ and PM_{10} pollutants.

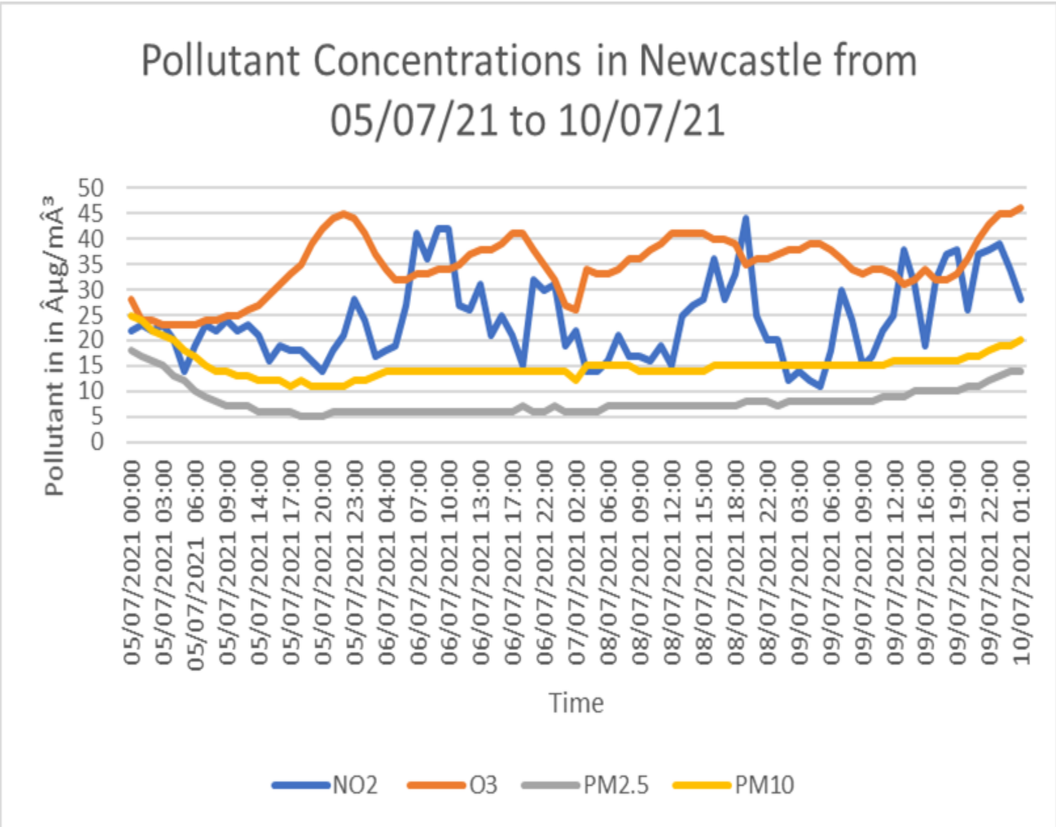

Figure 3.1: Pollutant Concentrations Over Short Time Period [27]

From figure 2.1 the daily trends can be observed.

For the NO_2 pollutant levels, a clear correlation between peak traffic times and pollutant level can be observed as the large spikes always occur between 7am and 9am and 4pm and 7pm. These times are 'rush hour' times in which the vast majority of commuters travel to and from work. Therefore, the amount of traffic as an impacting factor for NO_2 emission is reinforced by this data.

The O_3 pollutant level is interesting as it shows a negative correlation with the NO_2 pollutant, as the peaks in the O_3 line tend to be when the NO_2 levels are low. Obviously, this isn't a perfect fit due to the multifactorial causes of pollution but however, it is clear to observe a link between the two pollutants. Therefore, it can be reaffirmed that a lack of NO_2 in an area could cause an increase in O_3 pollution.

There was little fluctuation in both of the PM pollution levels with both lines having a very small gradient which suggests that there aren't any clear daily trends for those pollutants. However, it interesting to note that both lines had an almost identical gradient at all times suggesting that the factors that impact the levels of $PM_{2.5}$ and PM_{10} are the same.

3.1.2 Annual Seasonality

To analyse an annual seasonality I plotted the levels of each pollutant from the same sensor in Newcastle from 01/01/19 to 01/01/20. The reasoning behind using data from 2019 was to avoid using anomalous data from the COVID-19 pandemic, in which Government 'lockdowns' had a huge effect on pollution levels. Therefore data from 2019 better represents seasonality in a typical urban setting.

N02 Annual Seasonality

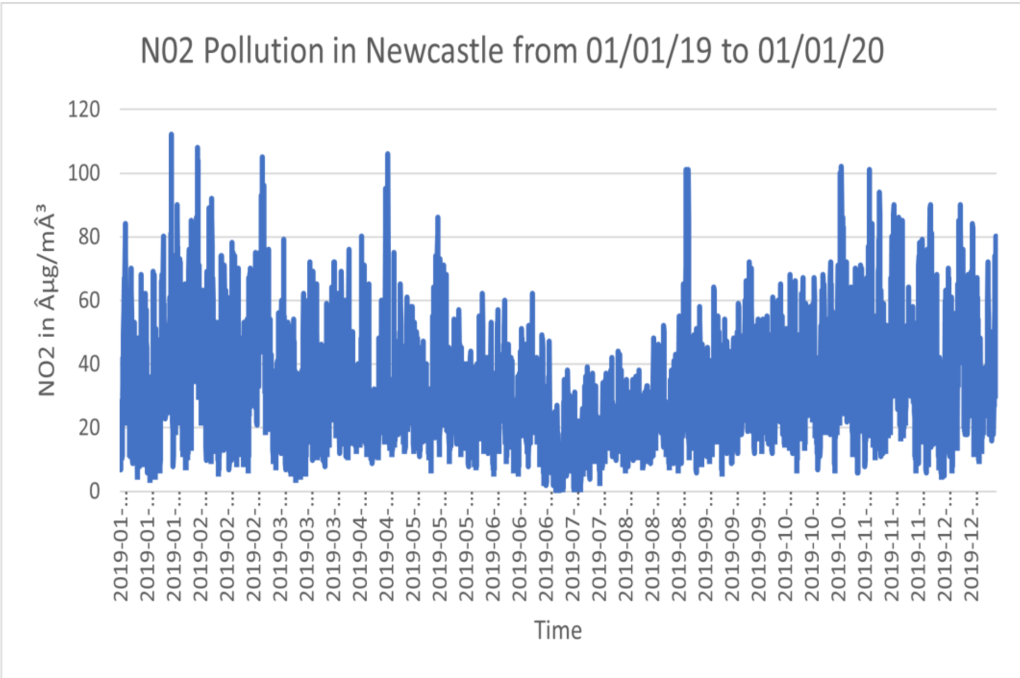

Figure 3.2: NO2 Concentrations Over a Year [27]

From figure 2.2 the seasonality of NO_2 pollution can be observed. This data reinforces claims from section 2.3.1 that there is less NO_2 in warmer summer months as from the graph it can be noted that the levels of pollution is much lower in June, July and August, which are the warmest months in the UK. Also, the converse of this claim can also be observed as there is more NO_2 pollution in winter, with the levels of pollution being highest in January, February, March, November and December.

There is a uncharacteristically large spike on 25/08/2019 from 7pm to 10pm and from investigation I believe that this large spike may have been caused by an increase in people and traffic in the area. This increase in people was due to the 25th being the crux of a bank holiday weekend with multiple different events taking place in Newcastle that evening.

Ozone Pollution Annual Seasonality

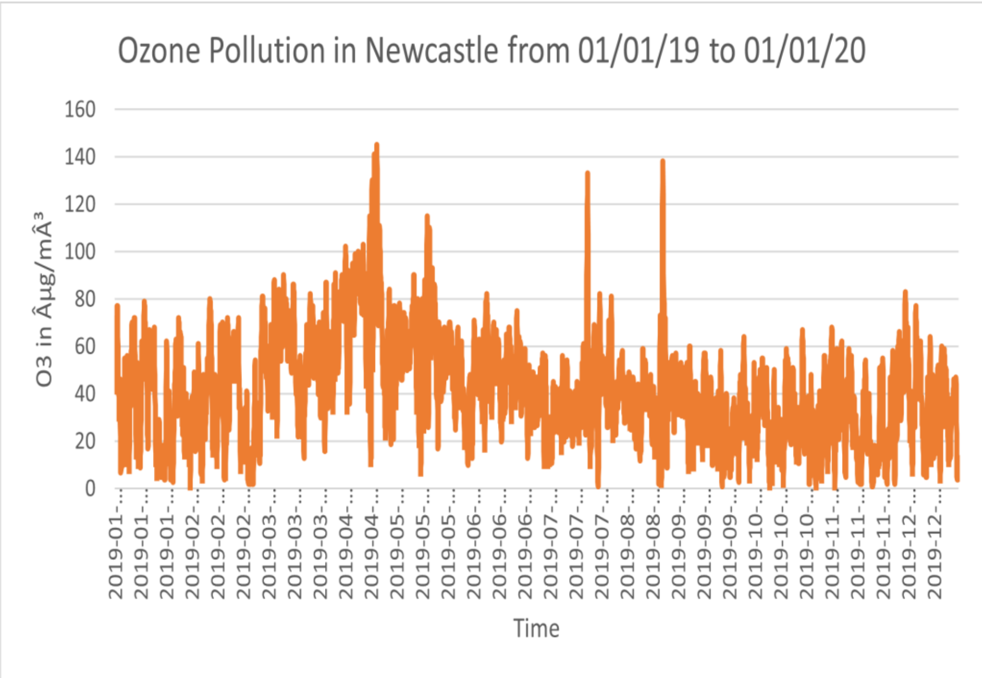

Figure 3.3: 03 Concentrations Over a Year [27]

Figure 3.3 demonstrates the ozone pollution levels over a year. Initially it can be noted that ozone levels are not as volatile as the NO_2 pollution, as although there is evidence of some seasonality, it doesn't have as great an effect as NO_2 pollution.

However, this graph demonstrates that ozone levels are higher in the warmer summer months than winter months with April, May, June and July being the months with the highest levels of ozone.

There were two great spikes on 25/07/2019 and 25/08/2019 and I believe these were due to a great increase in temperature with the temperature on 25/07/2019 setting a record for the warmest day in July and 25/08/2019 also setting a record for the warmest bank holiday in the UK. This therefore suggests that sharp increases in warm weather can cause sharp ozone spikes. Also, as the ozone spike occurred on the same day as the NO_2 spike, it could be noted that high temperature for Ozone and increased amount of traffic for NO_2 is greater than the link between the two pollutants.

PM2.5 Pollution Annual Seasonality

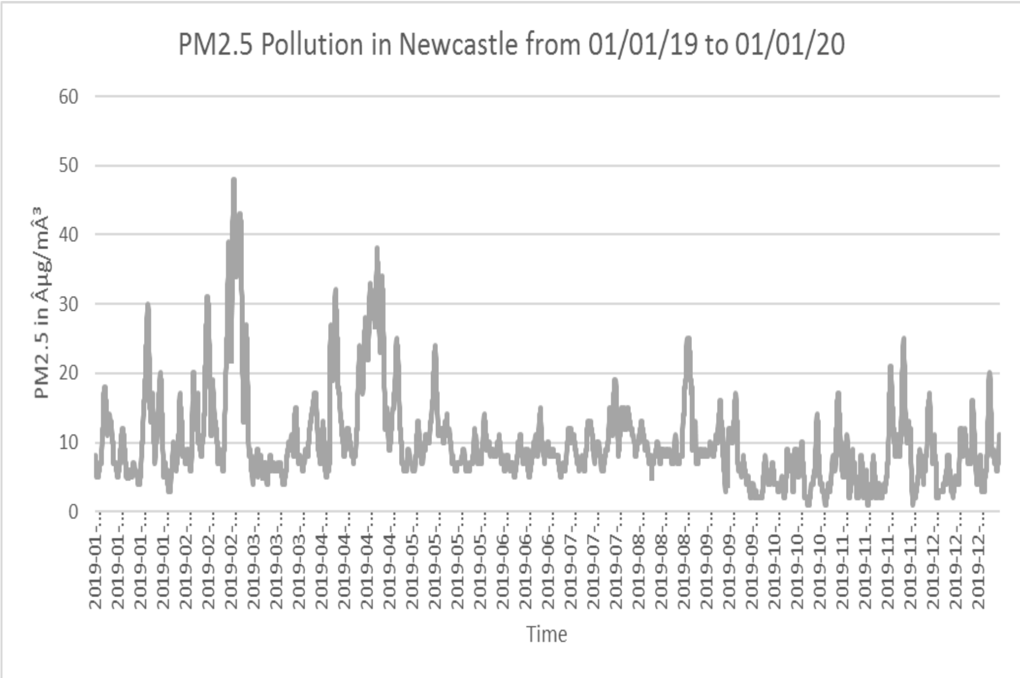

Figure 3.4: PM2.5 Concentrations Over a Year [27]

From figure 3.4 it can be observed that PM2.5 pollutant levels were slightly higher and more volatile in winter and spring months and lower in autumn and summer months, which is similar to what was noted from section 2.3.1. There are a few large spikes which are typically in February and March. This could be due to an increase in traffic and construction in the vicinity of the sensor as roadworks were taking place during those months on St Mary's

Place (the location of the sensor).

PM10 Pollution Annual Seasonality

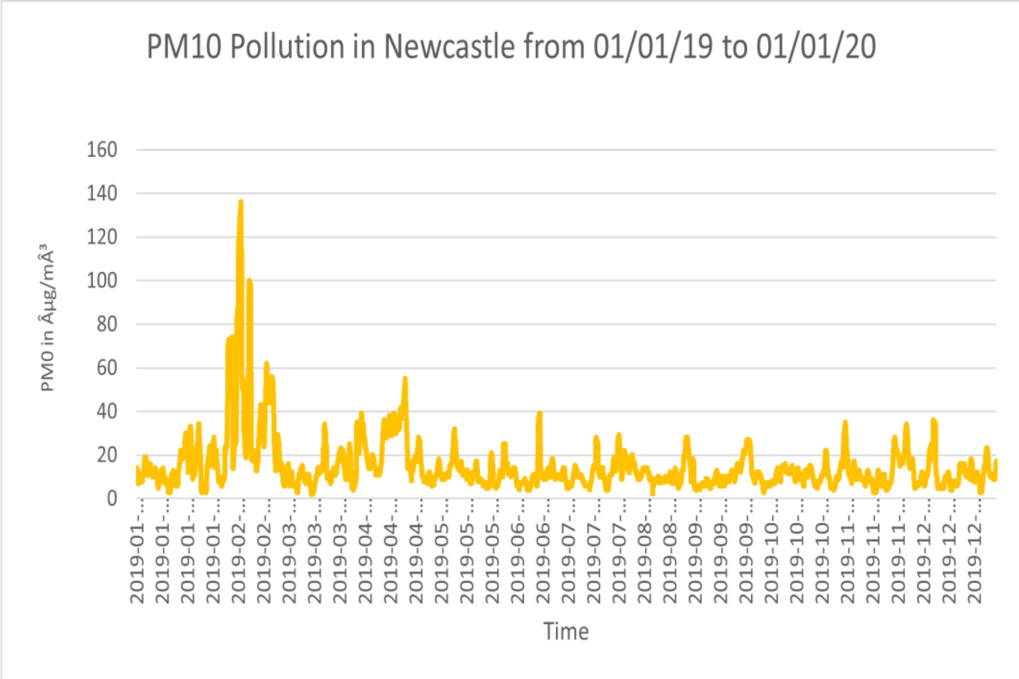

Figure 3.5: PM10 Concentrations Over a Year [27]

From figure 3.5, it can be noted that for 11 months of the year the levels of PM10 pollution was very consistent and stable. This would suggest that there isn't a link between the season and the amount of PM10 pollution.

However there is a major spike in the amounts of PM10 pollution around the 15/02/19, which is similar to the increase that occurred for the PM2.5. This reinforces the findings from section 3.1.1 that both PM2.5 and PM10 follow very similar trends.