Queen's University Belfast

ELE8096 Wireless Sensor Systems

Coursework1 Group: 5

Part II: Group Task – Data Set and Basic Statistics

1 Identifying a Data Set

Belfast is the most populous city in Northern Ireland. The monitoring site is close to residential areas, and the detection results are of great reference significance to the lives of urban residents. It can reflect the level of NO_2 pollution in cities and towns more truly. Thus, the Belfast Westlink Roden Street (Belfast - Northern Ireland Air) is chosen as the monitoring site. And the data source is from the UK AIR Air Information Resource, it can be check with some steps from this link: The Data Source [1].

2 Background on the importance of pollutant and legislation on thresholds

Nitrogen Dioxide (NO_2) is one of a group of highly reactive gases known as oxides of nitrogen or nitrogen oxides (NO_x). Other nitrogen oxides include nitrous acid and nitric acid. NO_2 is used as the indicator for the larger group of nitrogen oxides [2].

The main source of NO_2: NO_2 primarily gets in the air from the burning of fuel. NO_2 forms from emissions from cars, trucks and buses, power plants, and off-road equipment.Nitrogen dioxide by anthropogenic is mainly released from high-temperature combustion processes, such as motor vehicle exhaust and boiler exhaust emissions. NO_2 is mainly derived from the oxidation of NO, producing approximately 568×106 tons per year. The various nitrogen oxides emitted by human activities mainly come from the combustion process of various fuels, among which industrial kilns and automobiles are the most important. NO_x generation pathway during fuel combustion: Nitrogen in the air is oxidized at high temperature. The NO_x generated in this way is called thermally induced NO_x. The amount of NO_x generated is a function of flame structure and temperature. The higher the temperature, the greater the concentration of oxygen in the combustion zone, and the greater the amount of NO_x produced [3].

Health effects of NO_2: Breathing air with a high concentration of NO_2 can irritate airways in the human respiratory system. Such exposures over short periods can aggravate respiratory diseases, particularly asthma, leading to respiratory symptoms (such as coughing, wheezing or difficulty breathing), hospital admissions and visits to emergency rooms. Longer exposures to elevated concentrations of NO_2 may contribute to the development of asthma and potentially increase susceptibility to respiratory infections. People with asthma, as well as children and the elderly are generally at greater risk for the health effects of NO_2. NO_2 along with other NO_x reacts with other chemicals in the air to form both particulate matter and ozone. Both of these are also harmful when inhaled due to effects on the respiratory system.
Nitrogen dioxide is one of the causes of acid rain and has a variety of environmental effects, including effects on competition and changes in composition between wetland and terrestrial plant species, reduced atmospheric visibility, acidification of surface water, eutrophication (lack of oxygen due to algal blooms rich in nutrients such as nitrogen and phosphorus in the water) and increased levels of toxins in the water column that are harmful to fish and other aquatic organisms [4].

Legislation on threshold: The Air Quality Standards Regulations 2010 require that the annual mean concentration of NO_2 must not exceed 40 $\mu g/m^3$ and that there should be no more than 18 exceedances of the hourly mean limit value (concentrations above 200 $\mu g/m^3$) in a single year [5].

3 Basic statistics on the data set

12 months average duiring this year

The figure of 12 months average duiring this year is shown in Figure 1.
The Figure 1 shows the variation of Nitrogen dioxide (NO_2) concentration during Dec 2020 to Nov 2021. It is obvious that the graph keeps fluctuating from the end of Dec 2020 to the beginning of Sep 2021 in the range of about 38 $\mu g/m^3$ to 22 $\mu g/m^3$. Then a significant drop of NO_2 is illustrated from Sep 2021 to Oct 2021, following a similar magnitude of increasing of that until the beginning of Nov 2021.
As mentioned above, the NO_2 mainly be produced through the gas released from vehicle and charcoal burning for heating. Then, the ascending trend from Dec 2020 to Jan 2021 and Oct 2021 to Nov 2021 could be explained as the demand of heat increased due to the approaching of winter. For the descending trend from Sep 2021 to Oct 2021, a possible explanation could be the strike of lorry drivers during this period [6], their strike leads to decreasing of vehicle tail gas. Despite that, the average value of NO_2 concentration in the air is about 30 in approximation.

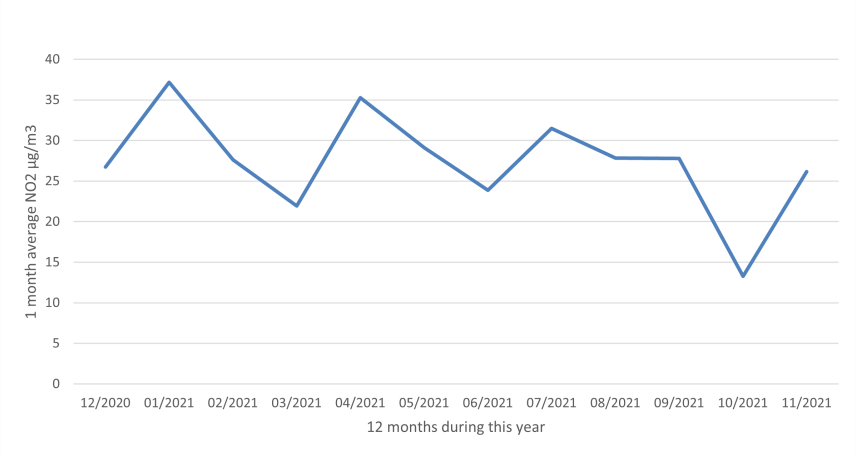

Figure 1: 12 months average duiring this year

4 season 15th comparison

The figure of 4 season 15th comparison is shown in Figure 2.
The Figure 2 shows the nitrogen dioxide concentration comparison on January 15th, April 15th, July 15th and October 15th. Because of the winter central heating, the night's nitrogen dioxide concentration in January and April is significantly higher than the same time in July and October. Motor vehicle emissions is the mainly reason why the nitrogen dioxide concentration is the highest from 7:00 to 10:00 in January and April. Paradoxically, overall nitrogen dioxide concentration were the lowest in October. One of the main reason is truckers strike in Britain.

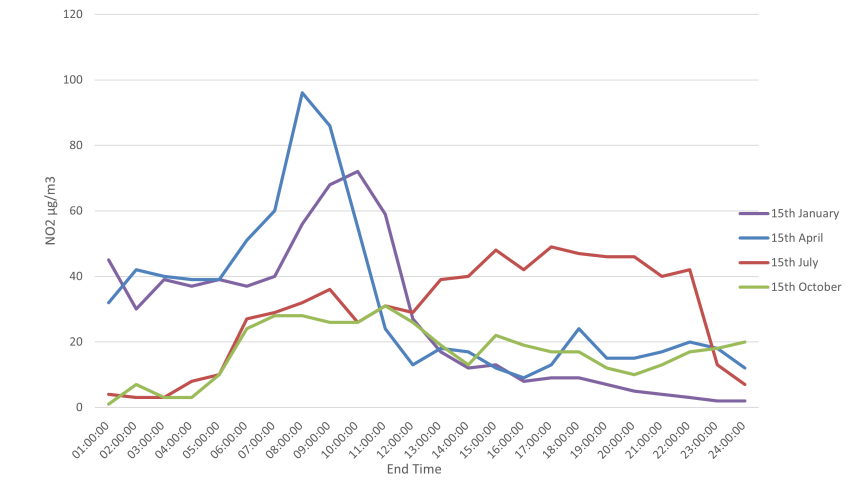

Figure 2: 4 season 15th comparison

Data distribution of NO_2 concentration

Data distribution of NO_2 concentration is shown in Figure 3.

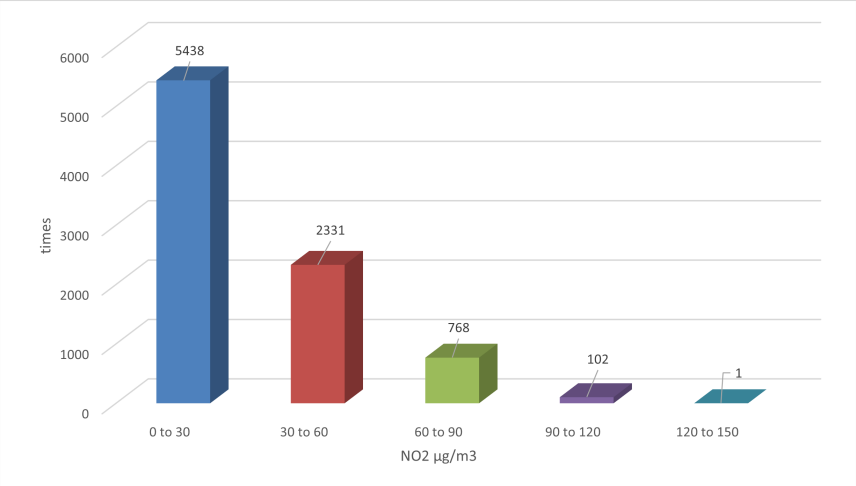

Figure 3: Data distribution of NO_2 concentration

The maximum value of the NO_2 is 144 $\mu g/m^3$ and the minimum value of the NO_2 is 0 $\mu g/m^3$, so the range of the value is approximately 0 to 150 $\mu g/m^3$. In order to facilitate data analysis and comparison, 30 $\mu g/m^3$ is used as the sampling interval in this figure. From Figure 3, it is clear that the maximum times which is the concentration of NO_2 appearing between 0 to 30 $\mu g/m^3$ is shown. According to the government's legislation on threshold for pollutant concentration, the histogram shows that NO_2 concentration has no effect on people's health.

4 Summary

In conclusion, the value of each months duiring this year are below the 40 $\mu g/m^3$, hence the average value of whole year is below the 40 $\mu g/m^3$ which satisfy the requirement of legislation on threshold. And the hourly mean maximum value is 144 $\mu g/m^3$ which is below the limit value (concentrations above 200 $\mu g/m^3$) in a single year. Combining all of the results, the overall NO_2 concentration of Belfast is lower than the harmful concentration required by the government.

References

[1] A. I. Resource, "Data selector," https://uk-air.defra.gov.uk/data/datawarehouse, 2021.

[2] U. E. P. Agency, "Basic information about no2," https://www.epa.gov/no2-pollution/basic-information-about-no2#Effects, 2021.

[3] Baidu, "nitrogen oxides pollution," https://baike.baidu.com/item/%E6%B0%AE%E6%B0%A7%E5%8C%96%E7%89%A9%E6%B1%A1%E6%9F%93/12599363, 2021.

[4] ——, "nitrogen dioxide," https://baike.baidu.com/item/%E4%BA%8C%E6%B0%A7%E5%8C%96%E6%B0%AE/1403762?fr=aladdin, 2021.

[5] D. for Environment Food and R. Affairs, "Concentrations of nitrogen dioxide," https://www.gov.uk/government/statistics/air-quality-statistics/ntrogen-dioxide, 2021.

[6] G. Davies, "Lorry driver strikes are not the answer, haulage group warns unite," https://www.telegraph.co.uk/news/2021/10/15/lorry-driver-strikes-not-answer-haulage-group-warns-unite/, 2021.