The Relationship Between the Frequency of fogging and Factory shutdown in Kinmen

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Abstract

This study mainly discusses the relationship between the number of foggy days and various air pollution values from 2018 to 2021. At the same time, we observe and analyze the chain effect of the decline in the number of foggy days in Kinmen due to the decline of production capacity in mainland factories over the past few years due to COVID-19.

Our experiment found that the PM2.5 value of pure water fog is also very high, indicating that the high value of PM2.5 measured during fogging is mainly the effect of water particles.

Research Questions

1. Analyze the relationship between the foggy days in Kinmen each year and the situation of air pollution.

2. Analyze the relationship between COVID-19 and the change in the situation of air pollution.

3. Understand the changes in the air pollution situation in each year.

Introduction and Review of Literature

In 2020, due to the impact of the new epidemic, factories around the world have been shut down on a large scale, traffic demand has also dropped significantly, and man-made PM2.5 and other pollutants have also decreased. The location of Kinmen is just right to measure the pollution emitted by the mainland. We also did experiments to understand the relationship between PM2.5 and fog, to see if aerosols were enough to serve as cloud condensation nuclei, and we began to study whether the frequency of fog on the ground was related to the shutdown of factories.

First, we focus on factory related emissions:

SO_2: Sulfur dioxide is a gaseous air pollutant composed of sulfur and oxygen. SO2 forms when sulfur-containing fuel such as coal, oil, or diesel is burned. Sulfur dioxide also converts in the atmosphere to sulfates, a major part of fineparticle pollution (https://www.lung.org/clean-air/outdoors/what-makes-air- unhealthy/sulfur-dioxide)

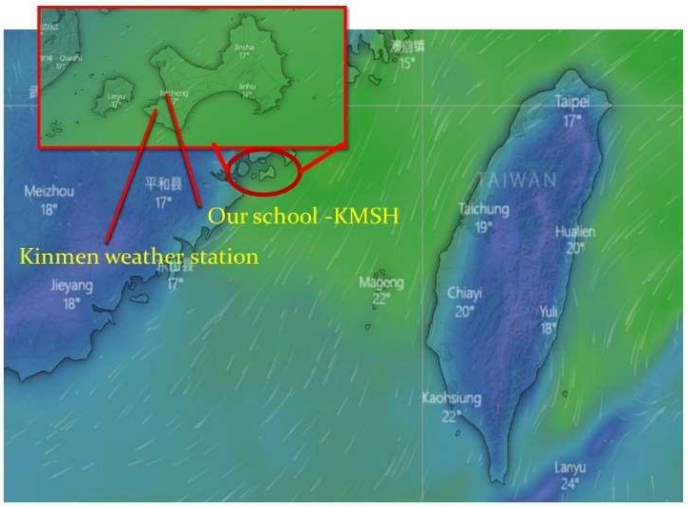
NOx: When the fuel of motor vehicles, thermal power plants and factory boilers is burned at high temperature, nitrogen oxides are generated due to the reactionof nitrogen compounds in the fuel with excess nitrogen and oxygen in the air. The higher the temperature, the more likely it is to be generated. (http://www.apis.ac.uk/overview/pollutants/overview_nox.htm)

CO: Incomplete combustion gas emitted by motor vehicles, and coking plants,calcium carbide plants, etc. are pollution sources.

PM10, PM2.5: Particulate matter (PM), also called particle pollution, is ageneral term for extremely small particles and liquid droplets in the
atmosphere . It is one kind of mostly combustion pollutants. PM10 are very smallparticles found in dust and smoke. They have a diameter of 10 micrometres (0.01 mm) or smaller. And PM2.5 is a kind of fine particles.
(https://www.epa.vic.gov.au/for-community/environmental-information/air- quality/pm10-particles-in-the-air)
(https://www.epa.gov/sites/default/files/2014-05/documents/huff-particle.pdf)

Second, we would like to introduce the location of Kinmen.

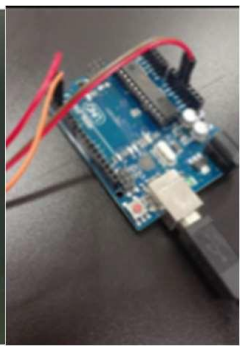
This is the location of Our city, Kinmen.In this image we can clearly point out that Kinmen is extremely close to Mainland China. As a result, the air quality is highly related to The factories in Mainland China.



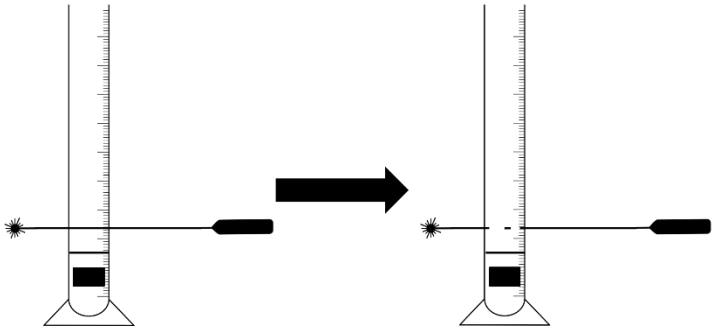
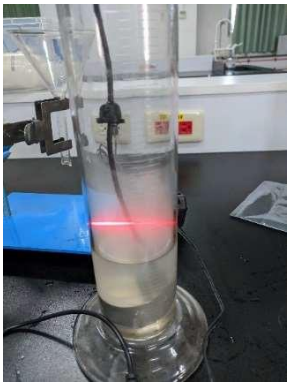
Research Methods

METHOD ONE

Step 1: We use an ultrasonic fogger (left picture) to artificially create a fog, which is convenient for experiments.


Step 2: After the fog is successfully generated, the PM detector will be used to obtainvarious data of the air pollutants at that time.

We also used laser light to observe the water mist and found that if there were salt impurities in the water, it takes more time for the fog to dissipate.

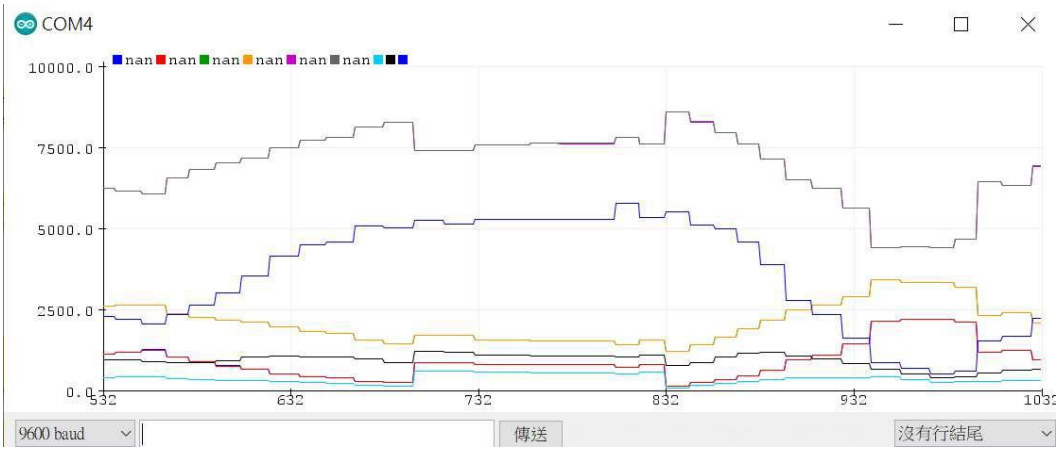
METHOD TWO

In addition to the experiment, we also capture the data of PM10, PM2.5, SO2, NOx, CO and the number of foggy days through the information of the Central Meteorological Bureau. After drawing a line chart for 2018-2021 based on the values, try to find the trend of both.

Results

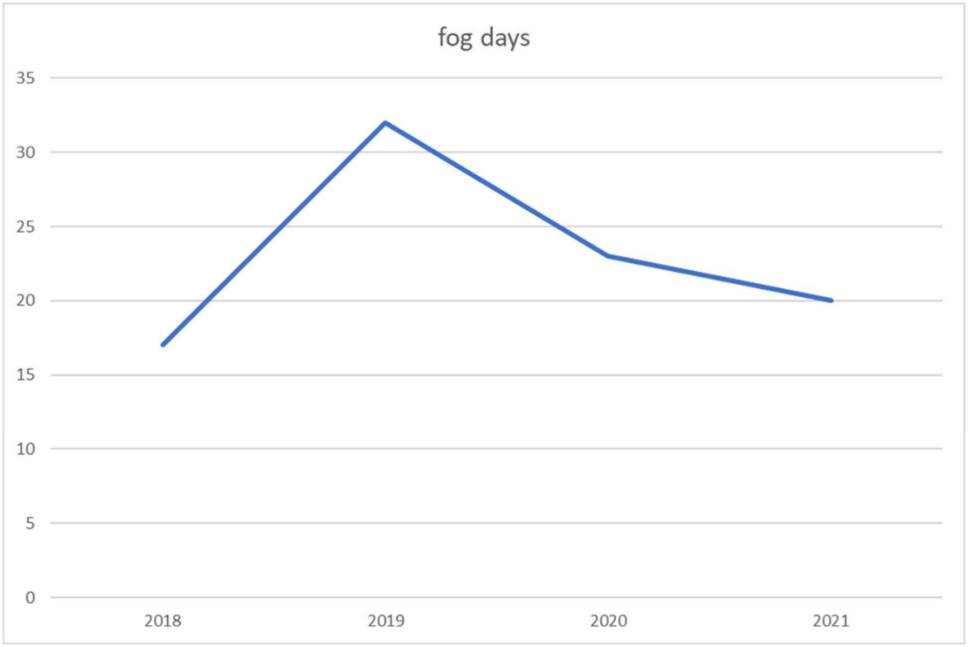
METHOD ONE

The figure below is detected by the detector, the gray line represents PM10, and the dark blue is PM2.5.



The PM2.5 sensor was used to measure the value of water fog, and the fluctuation was very large. However, the experimental results for all concentrations clearly show that the values of tiny particles are high, and the graphs of different fogs are similar in that all values are high at the same time when the fog is generated, even with pure water.

Method TWO



The number of foggy days from 2018 to 2021

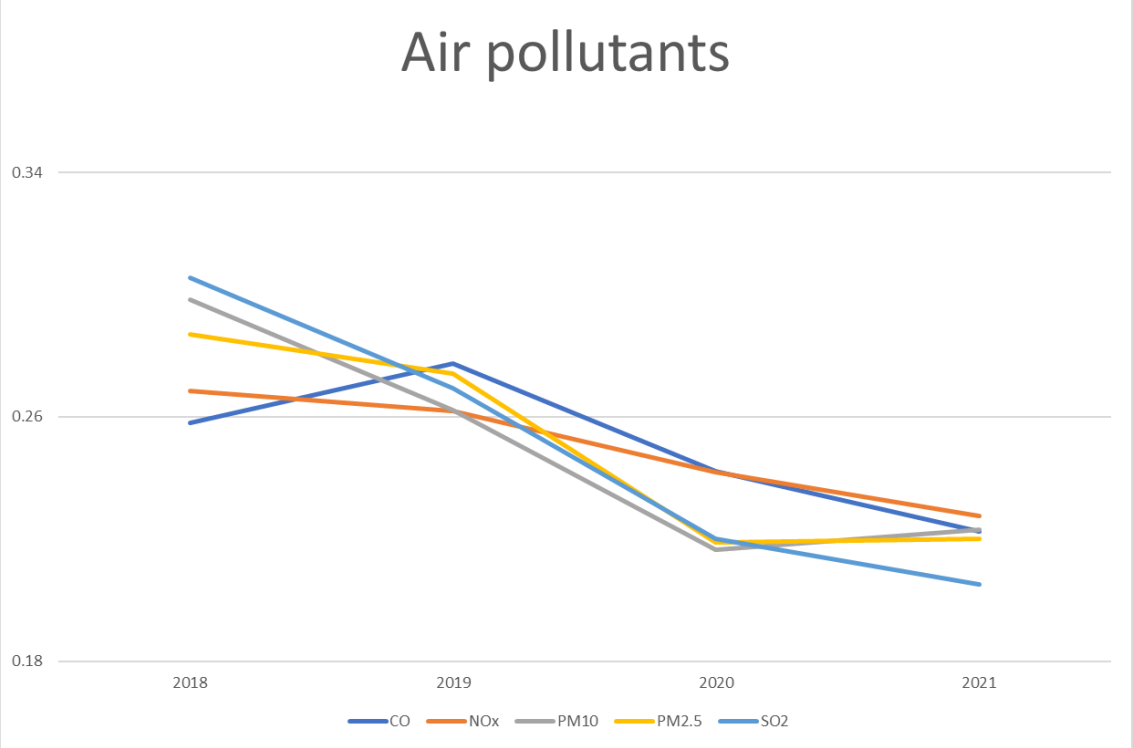
During these four years, the number of foggy days in Taiwan has slowly decreased.

Type	CO	NOx	PM10	PM2.5	SO2
2018	0.272599	11.02463	50.44337	23.78116	3.425338
2019	0.29299	10.75144	44.34165	22.7172	3.021647
2020	0.255833	9.925833	36.63333	18.13333	2.466667
2021	0.235	9.344167	37.73333	18.23333	2.3
average	1.056422	41.04606	169.1517	82.86503	11.21365

(μg/m³)

We want to compare iteasy, so using Type/average as follow

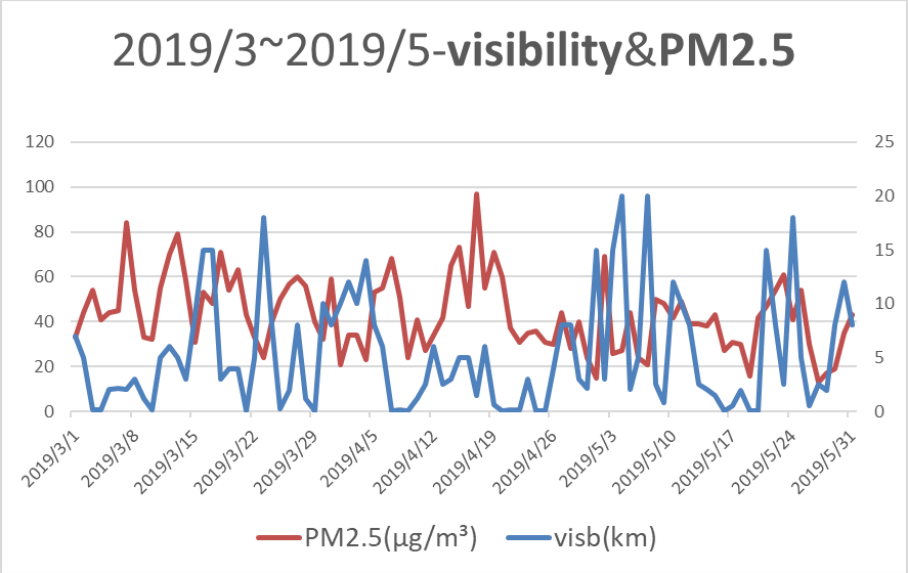
Type/average	CO/average	NOx/average	PM10/average	PM2.5/average	SO2/average
2018	0.25804	0.268592	0.298214	0.286987	0.305461
2019	0.277342	0.261936	0.262141	0.274147	0.269461
2020	0.24217	0.241822	0.216571	0.21883	0.21997
2021	0.222449	0.227651	0.223074	0.220037	0.205107

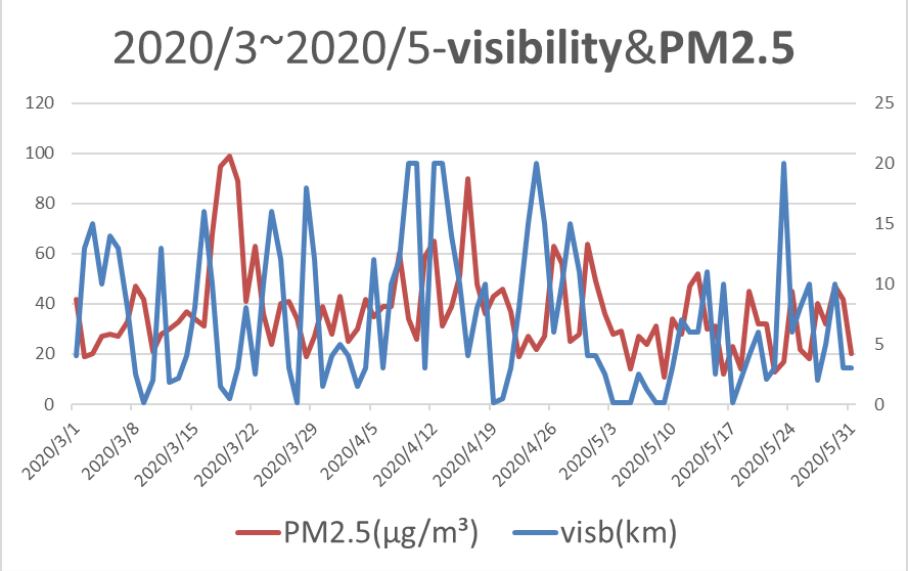


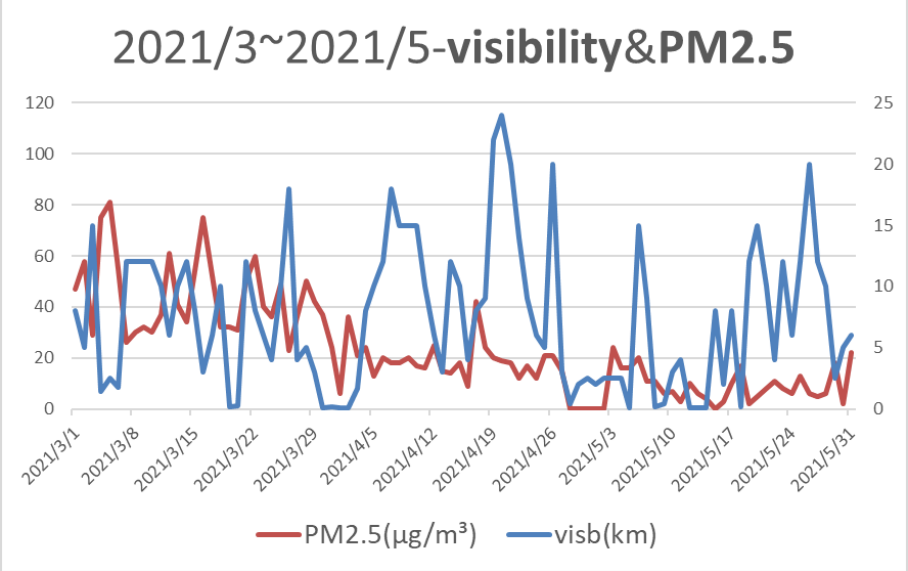
Analyzing the above charts, we can see that since the outbreak of infectious diseases, the amount of air pollutants has decreased. PM10 and PM2.5 have fallen more in 2020, but they will rebound in 2021.

Discussion

1. Comparison of visibility and PM2.5 on fog days in 2019 to 2021







The y-axis is the visibility (km) and pm2.5 (μg/m³) value, x-axis is the date

In some fog days visibility is still possible, you can know that the haze does not mean the fog, but the fog will usually be combined with the haze.

From February to April 2020, the air pollution sources in the Kinmen area decreased due to the better air quality in mainland China (BBC NEWS in Chinese). And compare with 2019 and 2021. 2020 fog and PM2.5 relation is more strong. Therefore, it is reasonable to assume that the PM2.5 exceedances in the March and April data above are highly correlated with the foggy days in Kinmen. It is presumed that the increase of airborne particles at this time is the reason.

Main pollutions from Jan to Apr in 2020 in China

Taken from BBC NEWS Chinese

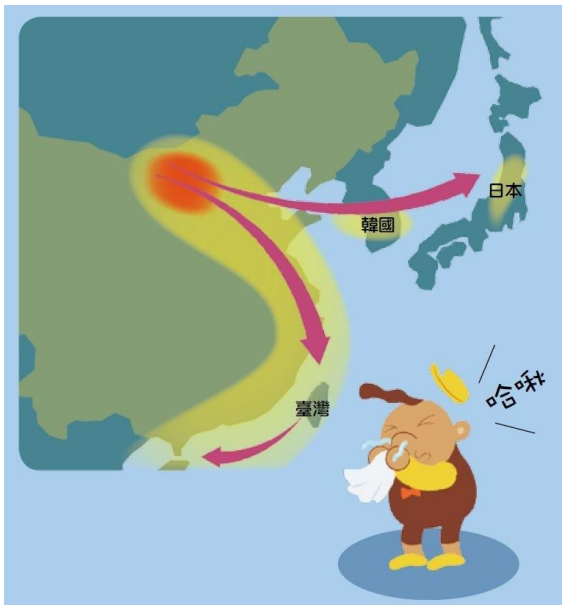
	2019~2021
CO	0.99
NOx	0.98
PM10	0.93
PM2.5	0.97
SO2	1.00

By the way, we analyzed the correlation coefficients between various pollutants and fog from 2019 to 2021, in which all indicators show a high correlation between both.

Meteorological data

After comparing the data with other non-foggy data, we know that the difference between Condensation nuclei that produce fog and PM2.5 is not distinguishable by the PM 2.5 measuring instruments, so when the PM 2.5 instruments measure water particles in the air, they are forcibly included in the calculation of PM 2.5 in the spring data. Therefore, when the PM 2.5 value increases, it may not necessarily be due to the particles from the plant, but also due to the increase in water content in the air when spring arrives.

The northeast monsoon is caused by high pressure from the mainland, which brings water and dust from local factories, while the southwest wind comes from the Indian Ocean and does not bring much pollution other than water.



Taken from Parent-Child World (2018)　　Kinmen Weather Station (2019)

According to the relevant data, the foggy days in Kinmen are usually the days when the south wind blows, and if PM2.5 is not caused by fog, perhaps it is really the suspended particles from the mainland.

Of course, to determine whether the PM2.5 value in Kinmen is due to fogging or the influence of industrial substances blown from the mainland, However, from the above data, we can find that PM2.5 values usually rise even when fog is present, and with our experimental results, we can see that PM2.5 may not be able to distinguish between water particles and air pollution particles of PM2.5.

Conclusion

According to the data we analyzed, under the influence of the COVID-19, the air pollution situations have decreased.

We found that PM2.5 values usually increase even when fog is presenting, and with our experimental results, we know that PM2.5 may not be able to distinguish between water particles and air pollution particles of PM2.5.

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