

# **PASSION PROJECT FINAL REPORT**

## *The Math of Air Pollution*

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**Word Count: 1998**

## **Introduction**

My goal for this passion project is to investigate on the application of mathematics in air pollution and give a report for what I learned, as well as a photo gallery for further public awareness.

Air pollution has been a serious problem in China since 2013, damaging the environment and meanwhile torturing every Chinese citizen physically and mentally.

I have been wondering about what causes the air pollution, and want to find some trend in the air pollution. Also, I am really passionate about mathematics and interested in its application. I believe the collision of mathematics, photography and environmental science can help us gain an insight to this long-standing concern, and might help us to come up with better measures to deal with it.

## **Methods & Materials**

### **Overview of the methods & materials used to and achieve my goal(s)**

One of the main methods I used is reading literature. In the first month of my project, since all the knowledge required in this project is not taught in school, I first read a large collection of literature in the area of environmental to gain some basic knowledge of the topic I am looking into. The books I read includes: Michael Allaby's *Dangerous Weather: Fog, Smog and Poisoned Rain* (Allaby), which mainly focuses on the formation and effects of various weathers, including various types of air pollution and different approaches to address the issues; also, I read Cao Junyi's *PM2.5 and the Environment in China* (Cao). This book was full of complicated terminology and formulae, when I did investigate into it however, it turned out to gave me an overview of how to scientifically analyze a set of data and present it in a formal way; I then proceed to read *Toward a Low-Carbon Development: China and the World* by Research Group of Chinese Economists 50 (Research Group), a book quite different from others in that it viewed air pollution in a political and economy perspective, and offers advices on policies for improving the environment; I read

afterwards the *Blue Book of Low carbon Development--Annual Review of Low-Carbon Development in China (2014)* (Blue Book, which was more practical with review of the air pollution and its management along with several case studies.

Second, I did data collection, I have been collecting all the data concerning the air pollution every day in Changshu for later analysis in my report since the day our project started. The data include the concentration of different chemicals and the official AQI index from China's national website of meteorology.

(<http://106.37.208.233:20035/>)

The third method I took is field trip. I visited the Wujiang meteorological station, and learned practically about the meteorological devices used to measure AQI and other properties of air quality.

The fourth method I took is photo taking. Through taking photos of hazy conditions and creating phot collections, I may arose further public awareness.

### **Steps I took**

1. In the first month, I first read a large collection of literature in the area of meteorology, environmental science and advanced mathematics to gain some basic knowledge of the topic I am looking into.
2. After I have an overall understanding of this area, I visited the Wujiang Meteorological Station to learn further about practical knowledge on air pollution during the Chinese New Year.
3. At the meantime, I have been collecting all the data about the air pollution every day during the whole process in Changshu for later analysis since the project started.
4. Data analysis and formation of the report.
5. I am taking photos these days in order to make my final product, which will be a photo gallery that exhibit the current lives of people under the haze.

## **Findings & Analysis**

### **1. Data analysis and report**

#### **1.1. Background information of Suzhou city**

Suzhou is a city in Jiangsu, China, located 31.30 latitude and 120.60 longitude. It is a major economic center and the second largest city in the province. (Where is Suzhou)

**Climate:** As one in subtropical zone, Suzhou has monsoon maritime climate, with mildly cold, cloudy, damp winter and hot, humid summer. The annual temperature of Suzhou is around 15.7°C.

#### **Population**

Suzhou has a population of 4.33 million in its city proper, and a total resident population (as of 2013) of 10.58 million in its administrative area. (Suzhou Wikipedia)

#### **Transportation**

Suzhou possesses developed transportation network.

Besides the four railway stations and four long-distance bus terminals in Suzhou, there are 3.5million private cars in the city, ranking 5<sup>th</sup> in the whole country.

(2017 苏州统计年鉴)

### **Surroundings:**

Suzhou is located at Yangtze River Delta, surrounded by Cities like Shanghai, Nanjing, Hangzhou, etc. It is one of the most developed areas in China, with a huge population and high level of urbanization and industrialization.

## 1.2.AQI measure in Suzhou over the last quarter

### 1.2.1. Overall trend

From over one hundred data sets of Suzhou that I collected throughout the quarters, we finally plotted a graph as below.

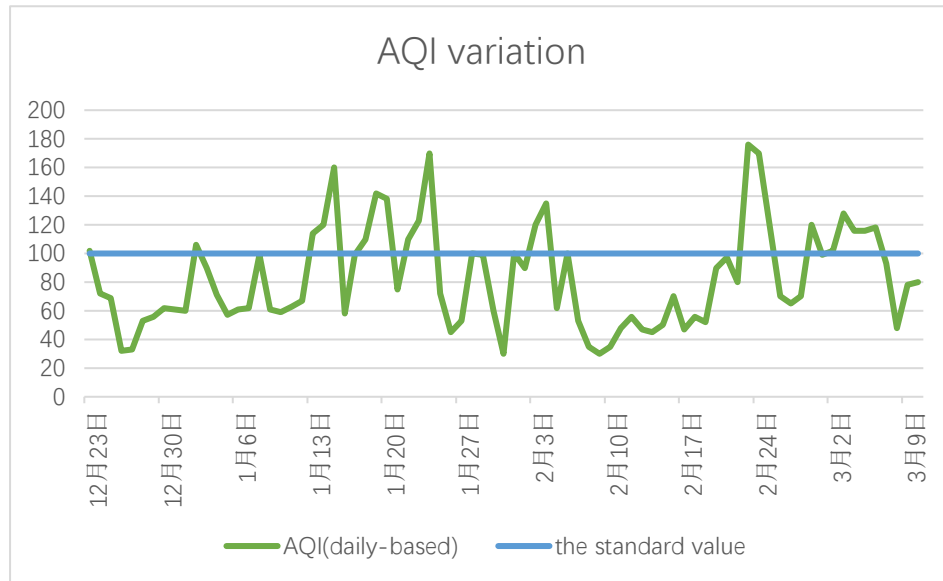


Table 1. AQI in Suzhou over the last quarter.

The graphs shows the variation of AQI value in Suzhou over the last quarter, with an average AQI of 83, and standard deviation of 35.

### 1.2.2. Variation between different months

In order to show a clearer presentation and find a patter, by categorizing relative data into four months, we managed to get this graph that summarizes the variation of AQI on monthly basis.



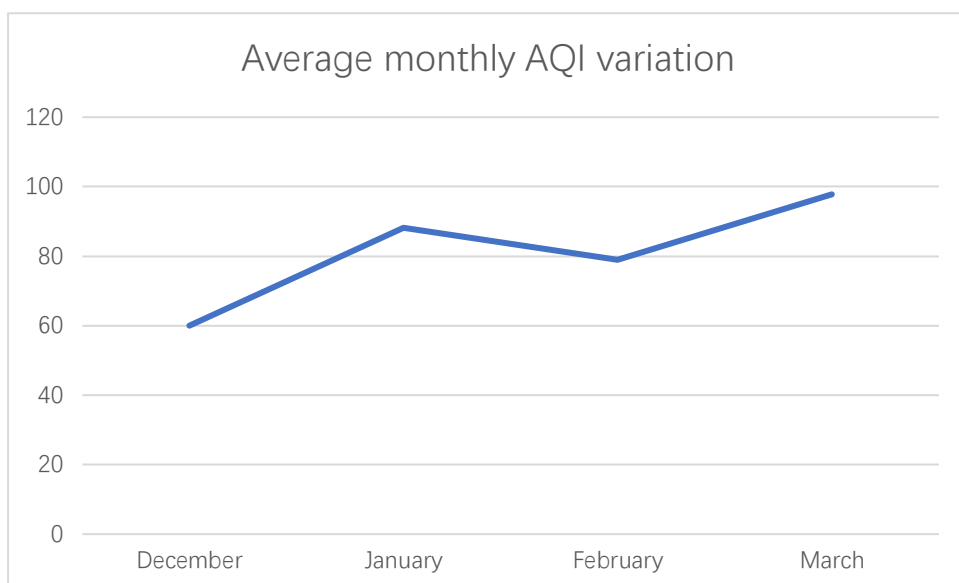


Table 2. Average monthly AQI variation

As the graph shows, all the average value is below 100, the national standard value. However, the trend keeps increasing over the four months, implying a not quite optimistic future trend.

We notice that during February, which is Chinese New Year, the air quality improves a lot. That might contribute to the growing government control of fireworks during holidays; also, all the factories are off during the New Year, so that shall be less pollutant released in the air, and thus improve the air quality. However, when it comes to March, workers go back for work and the pollution starts to rise again.

1.2.3. Concentration and Composition of air pollution

I manually collected many sets of data in different areas in Suzhou over the three months, including PM2.5, PM1.0, SO2, NO2, O3, CO.

1.2.3.1. Variation with different substances

Since there are not sufficient data for a daily-based presentation of data, the data below are averages of different times within the certain month.

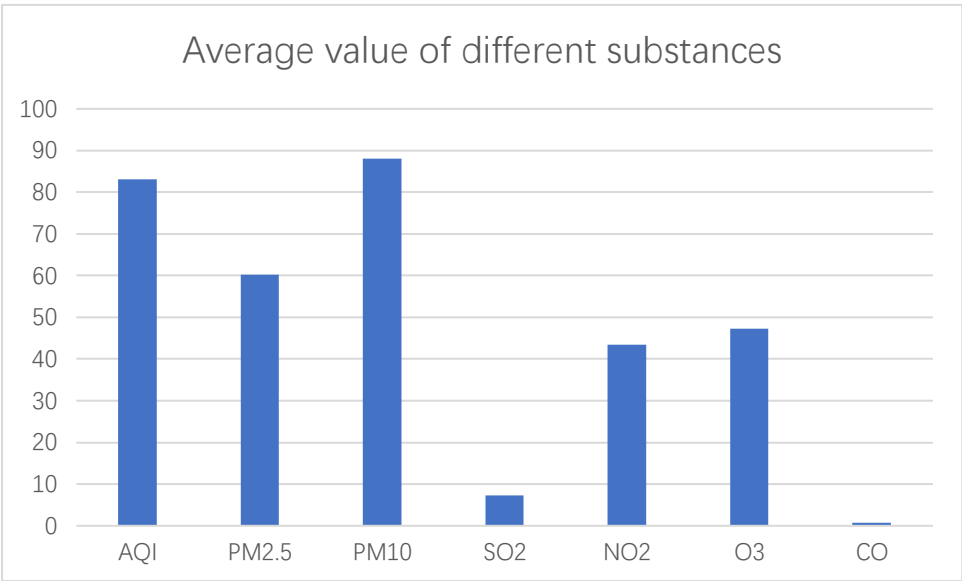


Table 3. average value of different substances.

We first compare PM2.5 with PM1.0 and find that PM1.0, even though seems to be less well-known by the general public compared with PM2.5, actually has higher values and thus implying a larger impact on air quality.

Also, comparing SO<sub>2</sub> with NO<sub>3</sub> and O<sub>3</sub>, it has relatively low volume and thus less impact.

#### 1.2.4. Variation with location

There 8 locations being chosen to collect the data, and the 8 places are Xiangchen

District 相城区, the steel mill 轧钢厂, Suzhou Industrialized Park 苏州工业园

区, Caixiang 彩香, Suzhou New District 苏州新区, Northern Gate 南门,

Wuzhong District 吴中区 and Shangfang mountain 上方山.

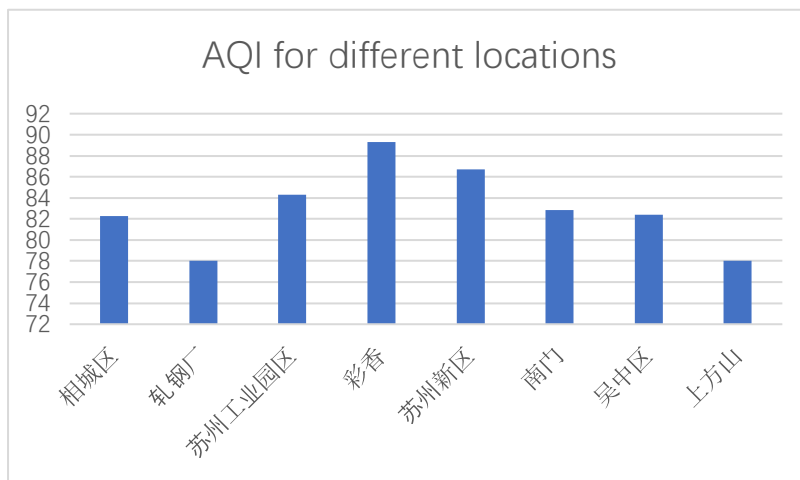


table 4. AQI for different locations

From the graph, we learned that the AQI is highest for Caixiang, while lowest for

steel mill. It is surprising to see that yet a possible explanation is the government's

increasing strict regulations for factory gas emission, which strictly decrease the pollution level in factory areas.

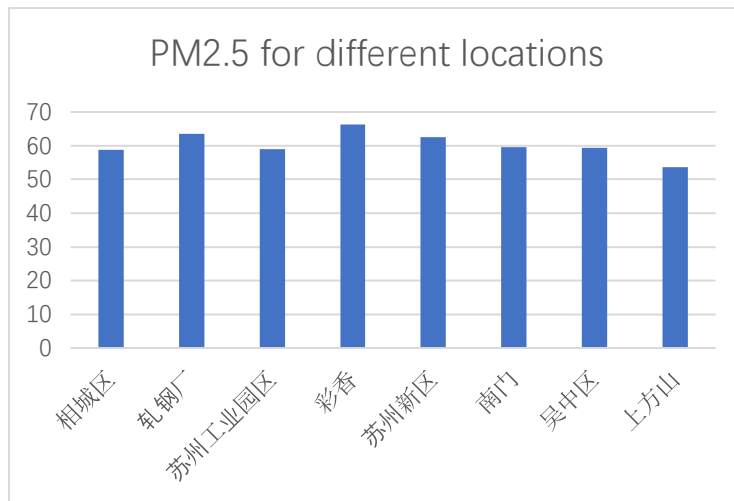


table 5. PM2.5 for different locations.

PM2.5 for all these places are almost equal, indication that PM2.5 may not be largely affected by that and the spread of PM2.5 is really fast and covers a huge area, which is in correspondence with what I learned through literature phase.

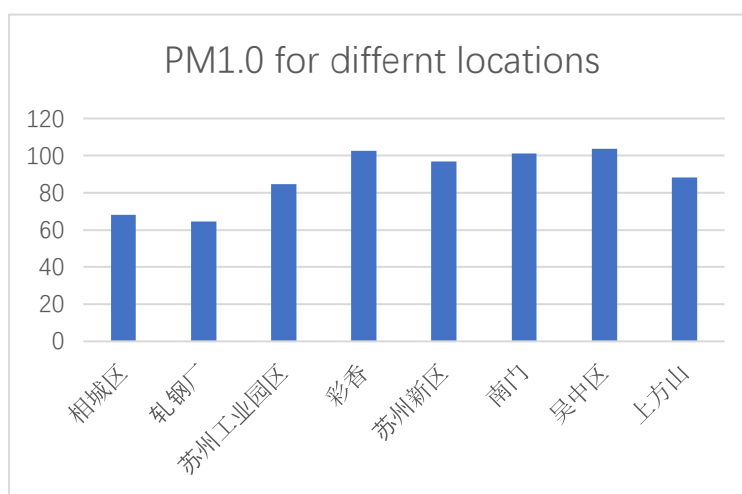


Table 6. PM1.0 for different locations

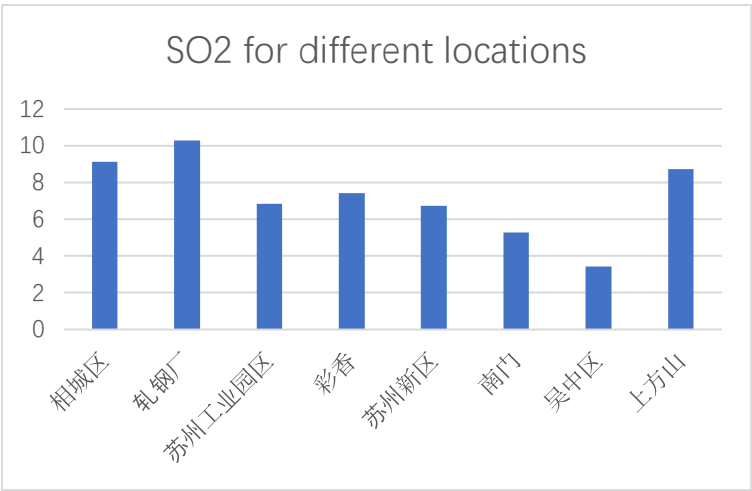


Table 7. SO2 for different locations

SO2 is highest for the steel mill, and relatively low for other places. Because SO2, as a toxic gas, should be rarely produced in daily life except for car emission and other little gas outputs; while it is the main component of factory emissions and thus results in a graph just like above.

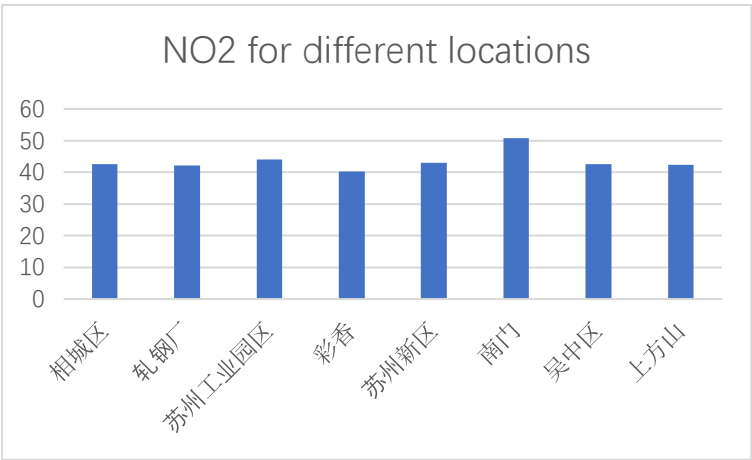


Table 8. NO2 for different locations.

NO2 is almost evenly distributed around Suzhou area because of its high motibility.

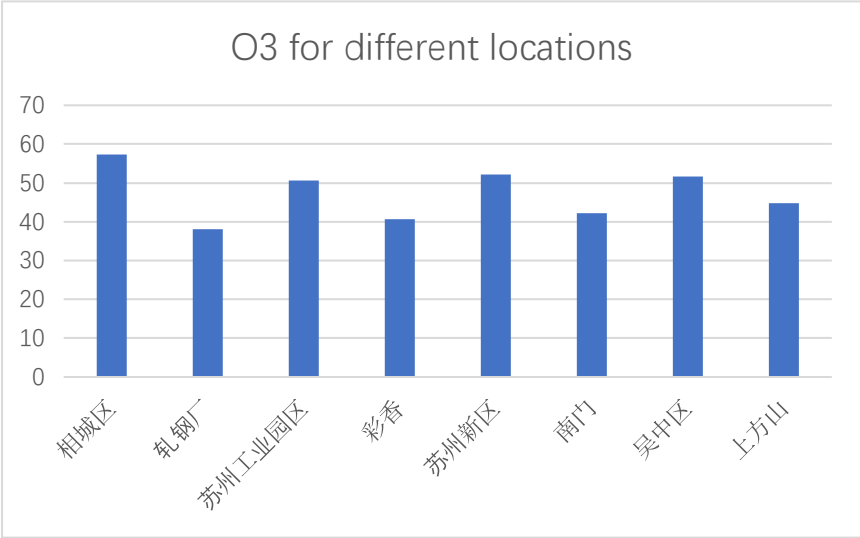


Table 9. O3 for different locations

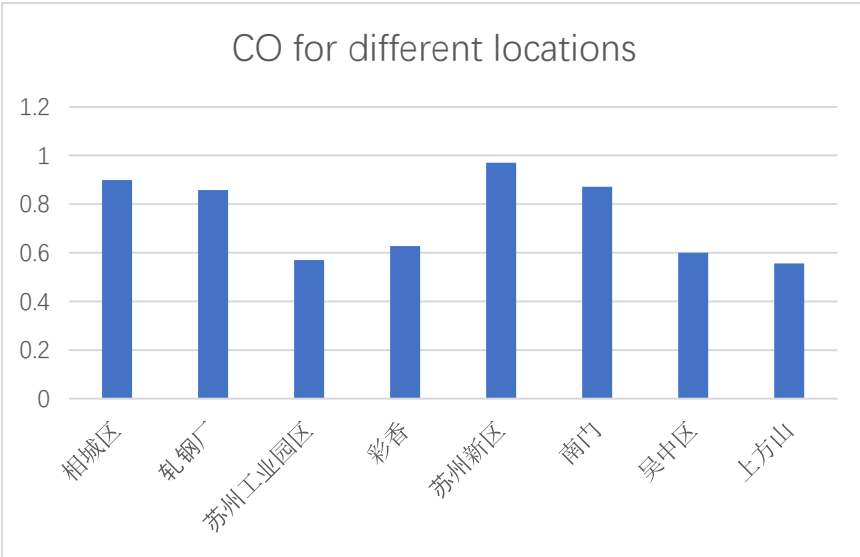


Table 10. CO for different locations

CO, similar to SO<sub>2</sub>, is a toxic gas that can be largely produced in industrialized areas like steel mill and Xiangcheng District. However, we find the most urbanized and industrialized area, Industrial Park District, has the lowest CO emission, one possible reason for which can also be the extremely strict government intervention.

## **2. Photo collection**

I took some photos in Shengze, Suzhou. As Shengze is known as a town full of factories and produces a huge amount of toxic pollutants. The photos were taken at different places and various times. The photos are attached at Appendix I.

## **Conclusion**

From the data analysis, the conclusion can be drawn that (1 the variation of air pollution is not linear, so there cannot be simple prediction of the trend and instead requires complex mathematical models that is far beyond high school level; (2 different pollutants have different effect as well as spread around a certain area, and the specific features still need further investigation; (3 some government measures of preventing air pollution is effective as we can see from the pattern of some toxic chemicals.

Overall, I came across many challenges while doing the project. The first one is the many changes of project and how I should approach the topic. I initially aim to write a full report. Later, however, I found that it might be way more impactful and useful to have a photo collection taken by myself rather than a report that is hard to read; also, I overestimated my own ability and it will be extremely hard for me to write a detailed and decent report like others written by college students.

Also, it is a really long and tough time for me to collect data every day. I missed several days in the beginning. Thus, I even set an alarm everyday for reminding.



Moreover, it is a challenge for my photographic skills. I had never tried to take photos on a hazy day because of the limitation of sunlight. I read some photography books and websites and learned how to control the diaphragm and ISO so that they can fit the gloomy weather.

Regardless of all the challenges and obstacles, I reached my aim to collect all the data, analyze them based on my current mathematical knowledge, and create a photo collection on hazy days. I wish my project could have a positive effect on environmental protection on people around me. I wish to further investigate into this topic and do something more powerful and impressive and change the severe environmental situation in China as well as the rest of the world.

### **Works Cited Page**

Allaby, Michael, *Dangerous Weather: Fog, Smog and Poisoned Rain*, translated by

Haitao Deng, Shanghai Scientific and Technology Literature Press, 2014.

Cao, Junyi, *PM2.5 and the Environment in China*, Science Publisher, 2014

全国城市空气质量实时发布, <http://106.37.208.233:20035/>

“Where Is Suzhou, China?” WorldAtlas, 15 Oct. 2015,

[www.worldatlas.com/as/cn/32/where-is-suzhou.html](http://www.worldatlas.com/as/cn/32/where-is-suzhou.html).

Research Group of Chinese Economists 50, *Toward a Low-Carbon Development:*

*China and the World-- Forum*, edited by Gang Fan, China Economic Publishing

House, 2010.

Qi, ye, et al, *Blue Book of Low carbon Development--Annual Review of Low-Carbon*

*Development in China (2014)*, Social Science Academic Press, 2014.

Wang, Lichun, et al, *环境仪器分析*, China Railway Publishing House, 2014.

*Suzhou: A Brief Introduction*,

[www.china.org.cn/english/features/woeld\\_heritage/99110.htm](http://www.china.org.cn/english/features/woeld_heritage/99110.htm).

“Suzhou.” *Wikipedia*, Wikimedia Foundation, 5 Mar. 2019,

[en.wikipedia.org/wiki/Suzhou](http://en.wikipedia.org/wiki/Suzhou).

2017 年苏州统计年鉴, [www.yearbookchina.com/navibooklist-n3018021805-1.html](http://www.yearbookchina.com/navibooklist-n3018021805-1.html).

## Appendix I











