

# How Much Do You Know About The Air Pollution of Taichung?

Liu Yu Hsuan, Chen Yu Xuan

2019 International Virtual Science Symposium

## Abstract

The Taichung Power Plant was once the largest coal-fired power plant in the world, and the influence of the locals' health should never be underestimated. **The government must tackle the pollution problem by monitoring the first-level carcinogenic pollutants and work to curtail or eliminate their concentrations in the air. (Liaw Yung-po)** In this research, we utilized the observation from 1993 to 2018, which is provided from the Taiwan Air Quality Monitoring Network in the Environmental Protection Administration website. Through analyzing the differences among each of the general air quality monitoring stations (GAQM stations), and the impact of the pollutant source's distance, the differences of each seasons, also the yearly changes, we have the following discoveries:

1. The numeric of the pollutants in Taichung district shows an obvious seasonal change. It has a more serious air pollution problem in winter and spring. The air pollution problem in summer, by contrast, is comparatively lesser.
2. The numeric of the pollutants PM<sub>2.5</sub>, PM<sub>10</sub> and O<sub>3</sub> decrease with the increasing distances, it shows that the amount of the pollutants are highly related to the Taichung Power Plant.
3. Despite the increase of the coal consumption, the condition of the pollution in the central region of Taiwan is accidentally taking a turn for the better.
4. Except the amount of the O<sub>3</sub>, the concentration of the pollutants observed by the stations near the Taichung Power Plant have the lower yearly changing average, which means the pollutants amount always stay in a high position without going down. The amount of O<sub>3</sub>, however, keeps raising because of the coal consumption increase of the Taichung Power Plant.
5. Keywords: Taichung Power Plant, air pollution, PM<sub>2.5</sub>

## Research Questions

There're too many pollutions near us, for example, air pollution, water pollution or soil contamination. And we are always unconscious about the importance of the air pollution, as if the

“boiling frog” fable. This means people aren’t aware of the sinister threats that arise gradually rather than suddenly. The western Taiwan has the most serious problem of the air pollution in Taiwan. The Taichung Power Plant is now the second large coal-fired power plant in the world after being surpassed in 2017. And it also has the highest power generation among all of the Taiwan’s power station. In 2016, WHO reported that every billion kilowatt hour of energy which is provided through burning coals, would lead to the death of sixty people because of the air pollution. Through this research, we want to investigate the air quality in Taichung and the correlation between it and the Taichung Power Plant. We estimated that there may be a cause and effect between the Taichung Power Plant and the air pollution in Taichung.

## **Research Method**

At the beginning, we found many articles reported that the air pollution became so serious after the construction of the Taichung Power Plant. With the increasing amount of the hazardous purple ratings, people blame on the Taichung Power Plant, and request it to lessen its pollutants emission. Though the government keeps curtailing the outputs of the Taichung Power Plant, the sky in Taichung is still always dusky. Therefore, we first used the data of seven stations in Taichung in 2017 to start our research. After that, we used the data from 1993 to 2018, 26 years in total to observe whether the air pollution is related to the Taichung Power Plant.

### **1. Equipment**

- a. Recording and analyzing application
  - i. Word: recording data
  - ii. Excel: processing data, creating charts
  - iii. Google Map: Drafting diagram, observing the surroundings around the stations.
- b. Source of data

In this research, we use the hourly data of observation from 1998 to 2018. And all of the data are provided from the Taiwan Air Quality Monitoring Network in the

Environmental Protection Administration website. And the data of the coal consumption of the Taichung Power Plant came from the Taiwan Power Company.

### c. Graphs

By calculating the annual average, we drafted the broken-lined graphs of each pollutant. As for the way that how the bar chart shows the decrease of the CO's amount, we used the difference of the first and the last year of the data, and then divided the number by the amount of years.

## 2. Selecting target

We found out seven GAQM stations near the Taichung Power Plant through the map. Then, we marked the seven stations and constructed three circles by using Google Map. Each circle present the distance of 10 kilometers, and the seven stations are divided into three grades.

- a. Stations within 10 kilometers (A station) : A1 (Xianxi) , A2 (Shalu)
- b. Stations within 20 kilometers (B station) : B1 (Xitun), B2 (Changhua), B3 (Zhongming)
- c. Stations within 30 kilometers (C station) : C1 (Dali), C2 (Fengyuan)

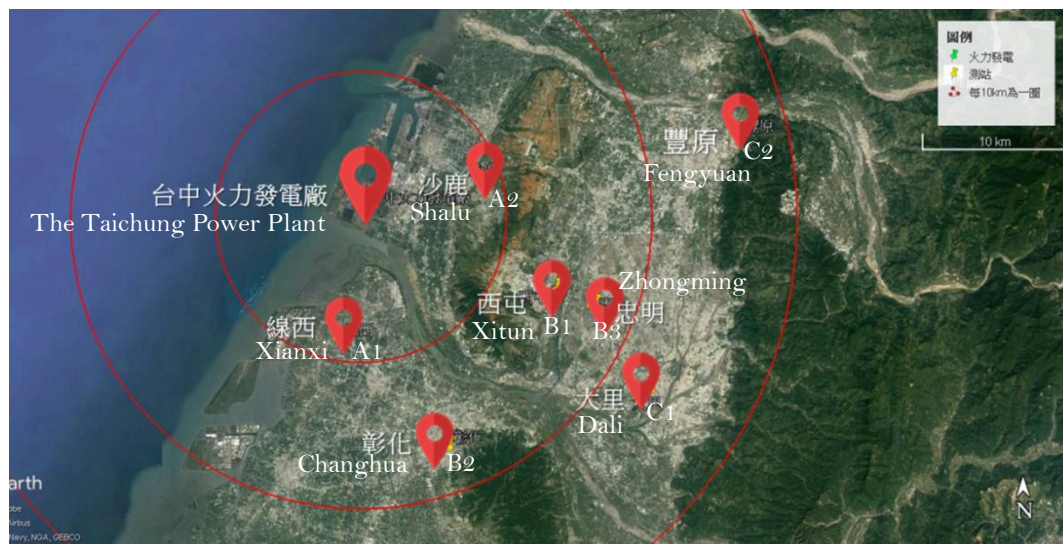


Fig.1 Locations of the seven stations, each of the red circle presents the distance of 10 km.

We downloaded eight pollutants including PM<sub>2.5</sub>, PM<sub>10</sub>, O<sub>3</sub>, CO, NO<sub>x</sub>, NO<sub>2</sub>, NO, SO<sub>2</sub> that

were observed by the seven stations from 1993 to 2018 from the Environmental Protection Administration. At first, we focused on the research for only a single year, 2017. We used the hourly data of every station to calculate the monthly average, and drafted those data into broken-lined graphs. After that, we did the research on the data from 1993 to 2018. This time, we used the hourly data to calculate the yearly average of each year and began our second research.

## Results and Discussion

### 1. Discussion of the observation data from the seven stations in Taichung in 2017

#### a. The seasonal change of the pollutants amount in 2017

We used the monthly average of eight different pollutants (PM<sub>2.5</sub>, PM<sub>10</sub>, O<sub>3</sub>, CO, NO<sub>x</sub>, NO<sub>2</sub>, NO, SO<sub>2</sub>) to analyze the relationship between season and pollution. Except SO<sub>2</sub> and NO, other pollutants have the common seasonal change. There is a low amount of pollutants in June and July, this phenomenon may cause by the strong convective heat transfer and the heavy rain. The amount of pollutants in March and April, in contrast, reach the climax of a year. This may be related to the pollutants transmit from Mainland China.

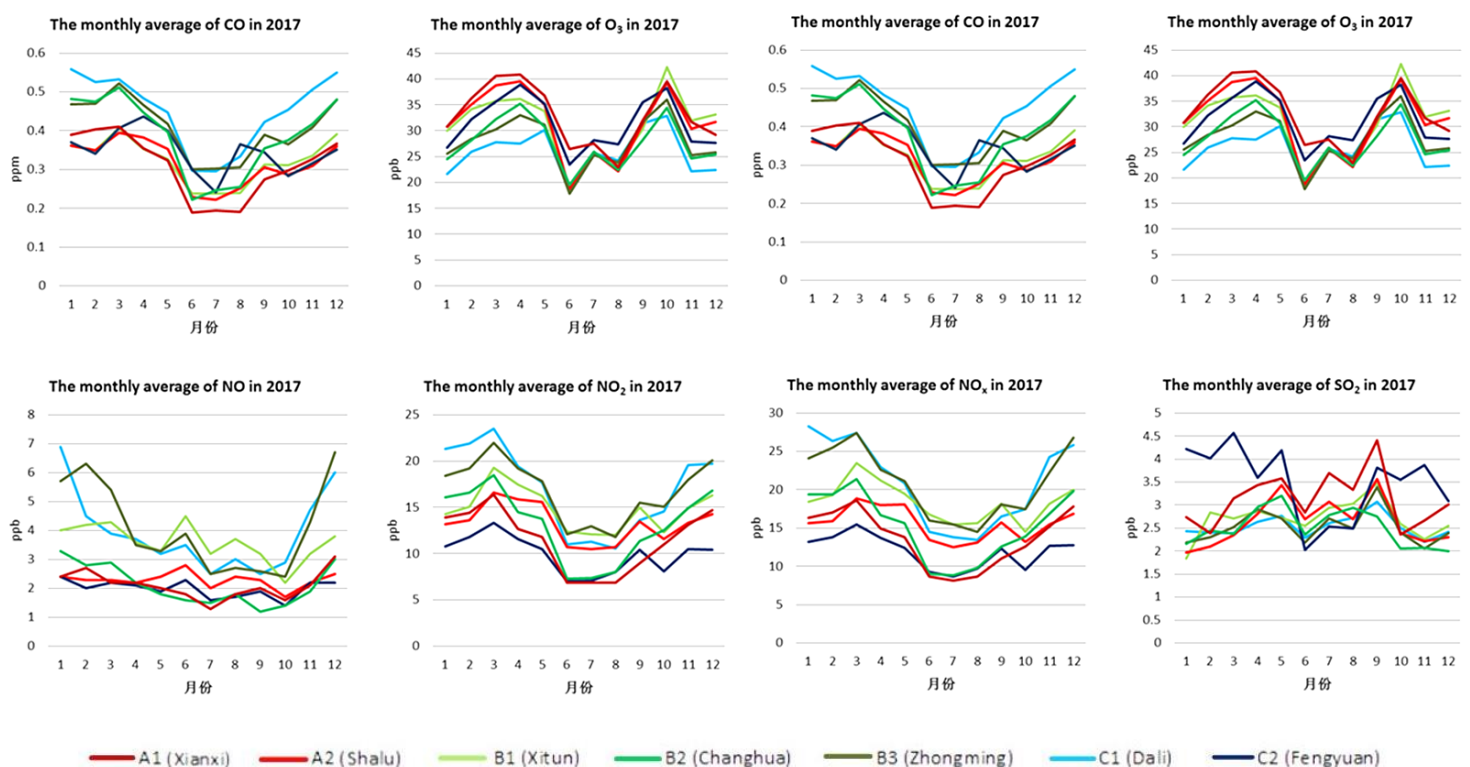


Fig.2 Broken-lined graphs of the monthly average of different pollutants observed by seven stations in 2017.

b. The variation of the pollutants amount with the distance changes

Taichung doesn't have a flat landform. Instead, there's a Bagua Plateau between A1 and A2. As it shows in Fig. 2, A1, B3, C1 and C2 stations are all located in the Taichung Basin. Therefore, the air quality of all stations is related to distances with the power plant and the fact of landform.

By comparing the amount of PM<sub>2.5</sub>, PM<sub>10</sub> and O<sub>3</sub>, we discovered that their amount have the highest relation to the distances between the Taichung Power Plant and each station. And for the other pollutants, the amount may be influenced by the factor of landform.

First of all, according to figure 2, B1 (Xitun), B3 (Zhongming), C1 (Dali) are situated at the lower reaches of the Dadu River while the Taichung Power Plant is located in the upper reaches of the river. The serious pollution in these areas may due to this reason.

Furthermore, the landform of Taichung Basin is a factor that can't be neglected. B1 (Xitun), B3 (Zhongming), C1 (Dali) are all located in this basin, and all of them have a more serious pollution problem than other four stations. It means that the pollutants may influx along the Dadu River to the interior region of the basin and accumulate in these areas. It leads to the obvious differences among them and the other four stations.

The above reasons may be possible to raise the amount of pollutants in B1 (Xitun), B3 (Zhongming) and C1 (Dali). It shows that the landform is a significant factor in the amount change of the pollutants.

2. Discussion of the observation data from the seven stations in Taichung from 1993 to 2018

a. Coal consumption of the Taichung Power Plant

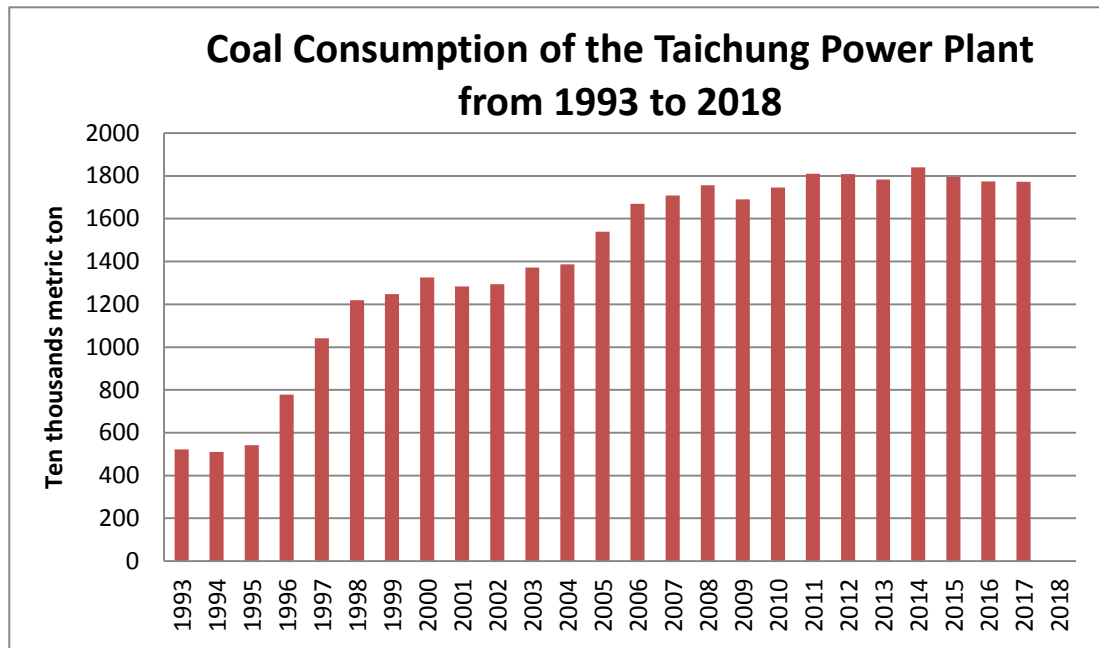


Fig.3 Bar chart of the coal consumption of the Taichung Power Plant from 1993 to 2018.

After the bar chart (Fig.3) was made, we found that the coal consumption of the Taichung Power Plant keeps rising. Therefore, we expected that the amount of the pollutants would have a positive correlation with the coal consumption.

b. Annual average of different pollutants in seven stations from 1993 to 2018

After the broken-lined graphs were done (Fig.4), we accidentally discovered that all of the pollutants except  $O_3$ , have a negative correlation with the coal consumption of the Taichung Power Plant. From the above graphs, we can see that the B stations almost have the highest average of the seven pollutants (except  $O_3$ ) in the 26 years. On the other hand, their amount of pollutants is always the highest among the seven stations.

However, the graphs also show that the nearest stations of the Taichung Power Plant, A1 and A2 usually have the lowest amount of pollutants. It means distances are not the direct influence to the amount of pollutants. And from this discovery, we can know that maybe the influence caused by the basin landform is greater than distances.

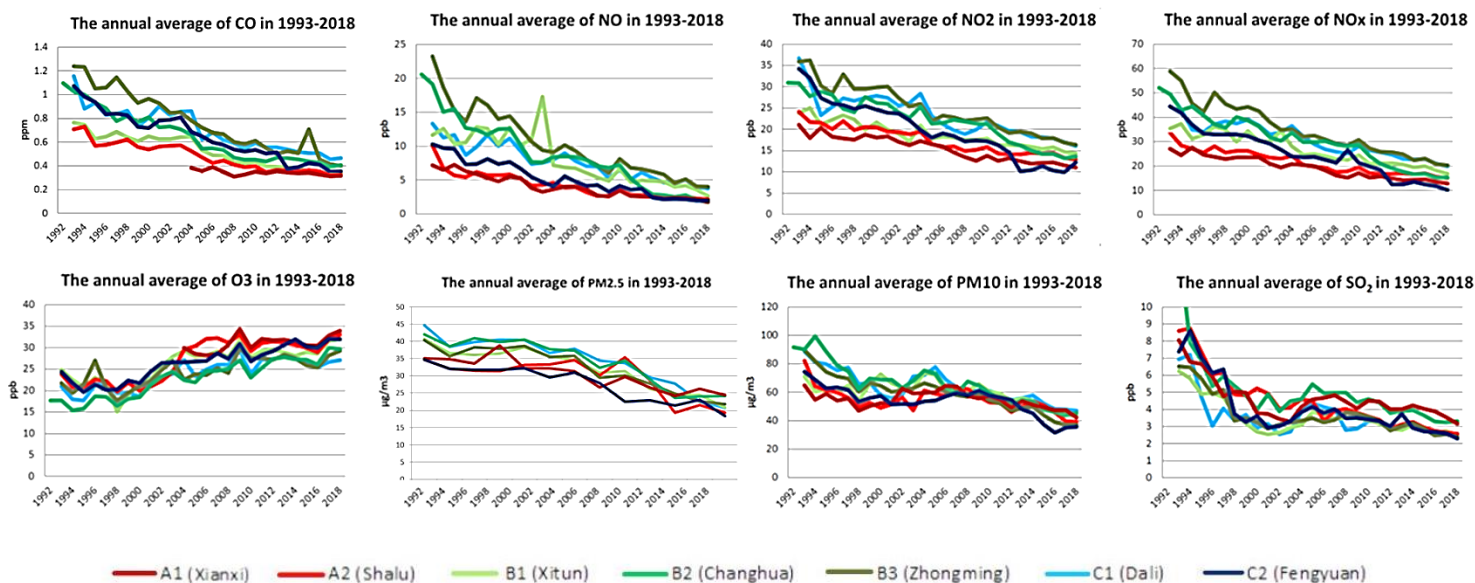


Fig.4 Broken-lined graphs of the annual average of different pollutants observed by the seven stations in 1993–2018.

c. Amount decreased of different pollutants in seven stations from 1993 to 2018

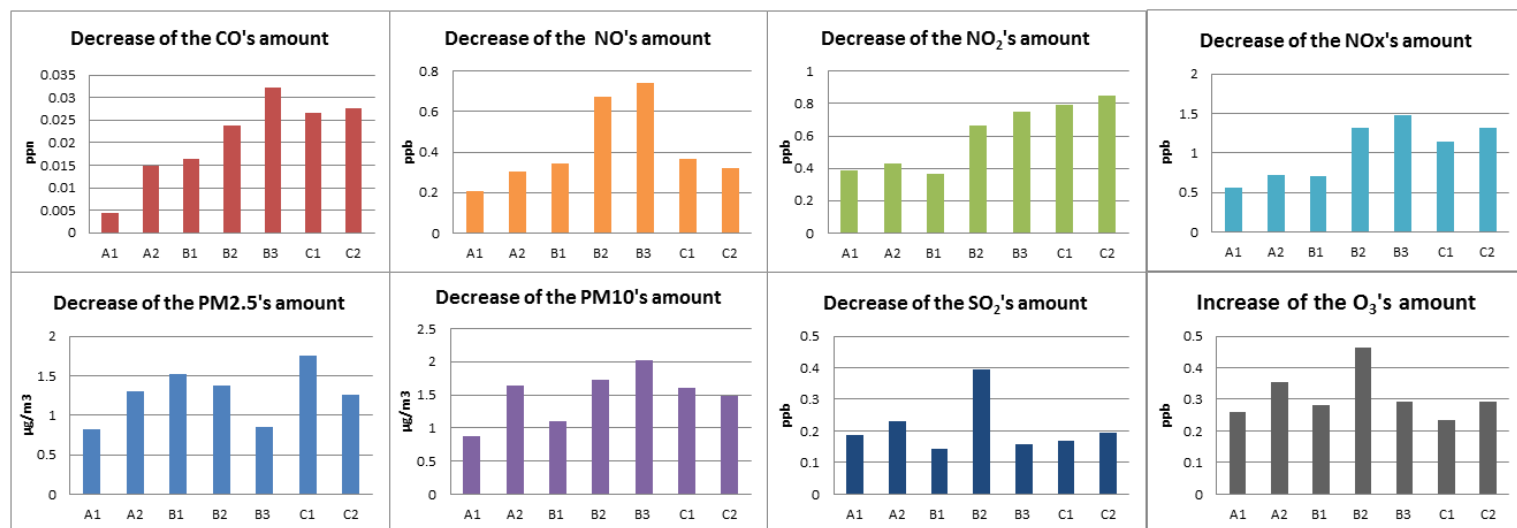


Fig.5 Bar chart of the decrease amount of the eight pollutants.

Figure 5 shows that most of the pollutants observed by A1 and A2 stations are related to the distance between station and the power plant. As the A1 station usually had the lowest decrease while the A2 station had the second low decrease, which means the amount of pollutants may keep being influenced by the Taichung Power Plant.



## Conclusion

It is common to see the news report about the pollution in Taichung, so we speculated that it should be certainly caused by the Taichung Power Plant. We downloaded eight pollutants including PM<sub>2.5</sub>, PM<sub>10</sub>, O<sub>3</sub>, CO, NO<sub>x</sub>, NO<sub>2</sub>, NO, SO<sub>2</sub> that were observed by the seven stations from 1993 to 2018 from the Environmental Protection Administration. After the statistic, we analyzed the differences among each of the general air quality monitoring stations, and the impact of the pollutant source's distance, the differences of each seasons, also the yearly changes. In this research, we have the following discoveries:

1. From the research of 2017, we discovered that except SO<sub>2</sub> and NO, other pollutants have the common seasonal change. There is a low amount of pollutants in June and July, this phenomenon may cause by the strong convective heat transfer and the heavy rain. The amount of pollutants in March and April, in contrast, reach the climax of a year. This may be related to the pollutants transmit from Mainland China.
2. The amount of PM<sub>2.5</sub>, PM<sub>10</sub>, O<sub>3</sub> decrease with the increase of distances in 2017. It shows that the amount of these three pollutants may highly related to the Taichung Power Plant. But they don't have the direct relationship. The pollutants amount may be influenced by the factors of sea breeze, basin and the local factories.
3. The nearest station A2 comparatively has the lower amount of pollutants. The landform and buildings in A2 are flat, so the influence of the sea breeze caused by specific heat capacity is obvious.
4. The amount of the seven pollutants keeps decreasing except O<sub>3</sub>. They have the negative correlation with the coal consumption of the Taichung Power Plant. It shows that the air quality is maybe actually turning better. But with the insufficient information, we conjectured that the units replacement of the power plant may lead to the decline of the pollutants amount.

5. The amount of the pollutants observed by the stations near the Taichung Power Plant has the lower yearly average rate of change except  $O_3$ . It means the amount of pollutants isn't lessened and almost remains the same. It shows the high connection between them and the power plant. As for  $O_3$ , it is related to the coal consumption. The stations near the power plant have the higher yearly average rate of change (escalating rate).
6. The landform of Taichung Basin is a factor that can't be neglected. B1 (Xitun), B3 (Zhongming), C1 (Dali) are all located in this basin, and all of them have a more serious pollution problem than other four stations. It means that the pollutants may influx along the Dadu River to the interior region of the basin and accumulate in these areas. It leads to the obvious differences among them and the other four stations.

## References

1. Article
  - a. Tsai Shu-yuan (2019). Taichung air pollution 'a crisis'. Taipei Times, 20190318, p.2
2. Source of data
  - a. Taiwan Power Company. <https://www.taipower.com.tw/tc/pageList.aspx>
  - b. Environmental Protection Administration.  
<https://taqm.epa.gov.tw/taqm/tw/default.aspx>