Air Pollution in Beijing

Introduction

Figure 1
The research area includes most districts in Beijing except Fangshan and Pingu Districts, since there is no air quality monitor station in these districts.

Over the past three decades, China has experienced rapid economic growth and ranked the position as the world's second largest economy. (Zhang et al. 2016) Along with rapidly increasing GDP, air pollution has become one of key environmental issues in China. Of the twenty cities with the worst air pollution worldwide, 16 are located in China, including Beijing. (Clark et al. 2015)

The five most dangerous air pollutants of large Beijing area that are emitted include: SO2, NO2, CO, and particulate matter (PM2.5 and PM10). There has been growing concern about particle pollution(PM2.5 and PM10) which have long been implicated to have adverse health impacts such as respiratory diseases and increased mortality. (Sun et al. 2004)

The causes of Beijing's widespread air pollution can be attributed to a number of factors: a surge in the number of motorized vehicles, output from manufacturing, an enormous economic boom, population growth, and natural reasons which include the city's and surrounding topography and seasonal weather. (Clark et al. 2015)

This research will base on PM2.5 data (estimated at 2014/Feb/17, 5PM) from each monitor stations (points on maps) in Beijing research area. The current air pollution situation is shown in several maps. Analysis of the causes of air pollution is focused on three main parts: emission from local factories, pollutant emitting from daily transportation motor vehicles and high population density.

Methods

1. Current air pollution situation (Figure 2 & 3)

The first map (Figure 2) is the result of local Moran's I test for PM2.5. I first run the global Moran's I test. The Moran's I index is 0.4493 which shows that this cluster pattern significantly clusters. Then colorful points on this map show the result of local Moran's I test. At last, all districts are separated to three levels as HH, HL, LH and LL districts through attribute queries. This districts background is applied to all other maps.

The second map (Figure 3) defines a different level of AQI values among all monitor stations. AQI values from 51 to 100 is defined as moderate air quality, 101 to 150 is unhealthy for the sensitive group, and 151 to 200 is unhealthy. The AQI value is calculated as the highest score of the six primary pollutant resource. Sorting from the attribute table of the AQI stations layer, PM2.5 is the highest index. So it is chosen to express the AQI values. I use select by attribute query three times to select points which PM 2.5 values are between 50 to 100, 101 to 150 and 151 to 200. And then I set different symbology for these three groups of points.

2. Influence Factors

- Emission from local factories and motor vehicles (Figure 4 & 5)

I create 5 miles buffers around each monitor station. Then join the Main Roads layer and local factories layer to the buffer layer separately. The attribute tables of two new joined layers show the count numbers of roads and factories in each buffer separately.

After that, I use the conversion tool to export attribute tables to excel sheets. Finally, I got two excel sheets. One shows the PM2.5 values at each station and the numbers of roads in each station's buffer, and another shows PM2.5 values and the number of factories in each station's buffer.

The last step is to calculate the correlation coefficients of those two sample sets: PM2.5 values and main roads numbers in each buffer; PM2.5 values and factories numbers in each buffer. A correlation coefficient is a numerical measure of some type of correlation, meaning a statistical relationship between two variables.

- Population density (Figure 6)

The population density data only includes the main city area. Also it is of the different spatial unit to the district layer. Thus, I change the symbology of the population density layer to figure out a high population density area. Then compare this map and two current air pollution situation maps to find the relationship between population density and air quality.

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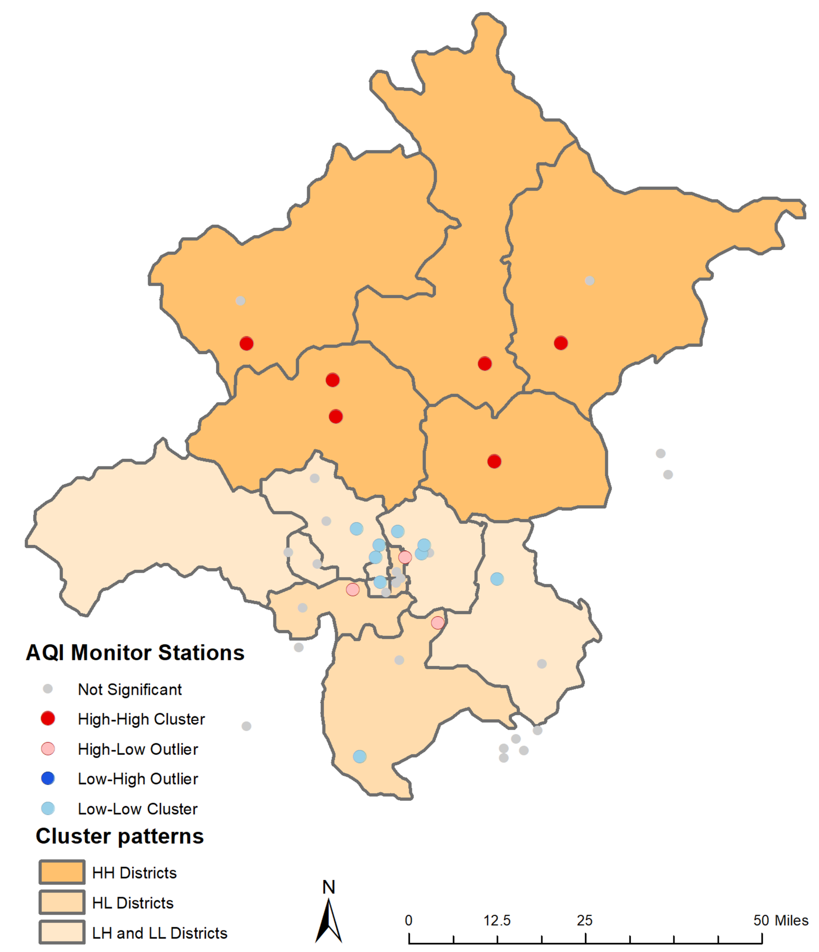


Figure 2 Local Moran's I Test

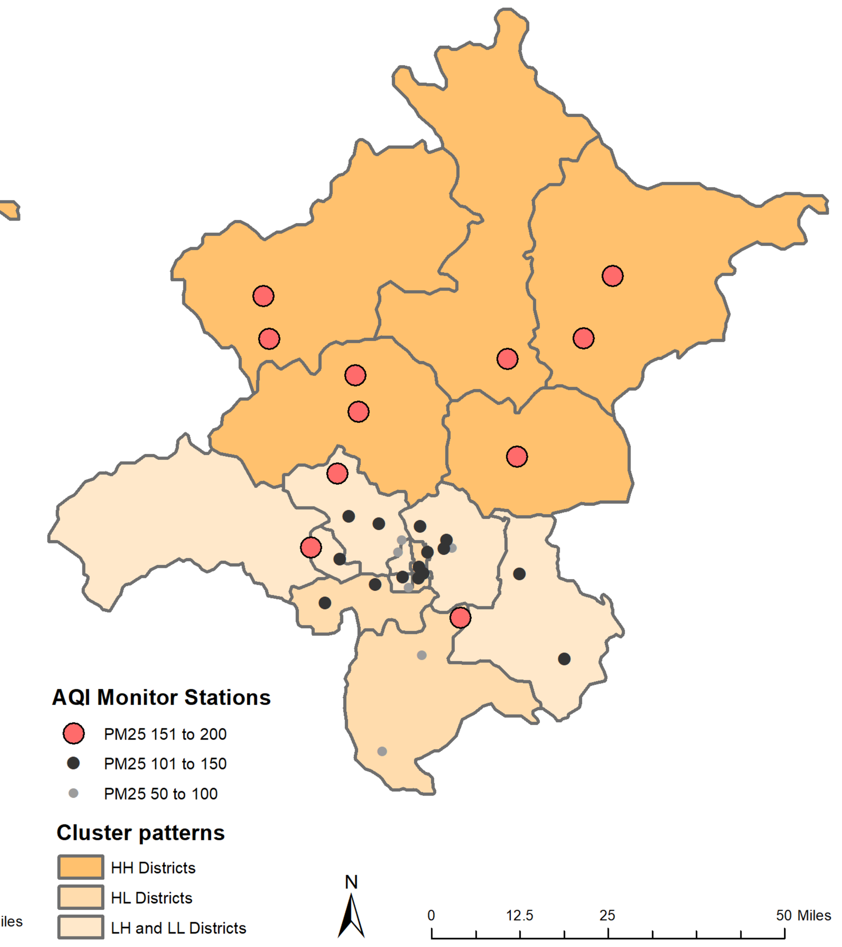


Figure 3 PM2.5 Distribution

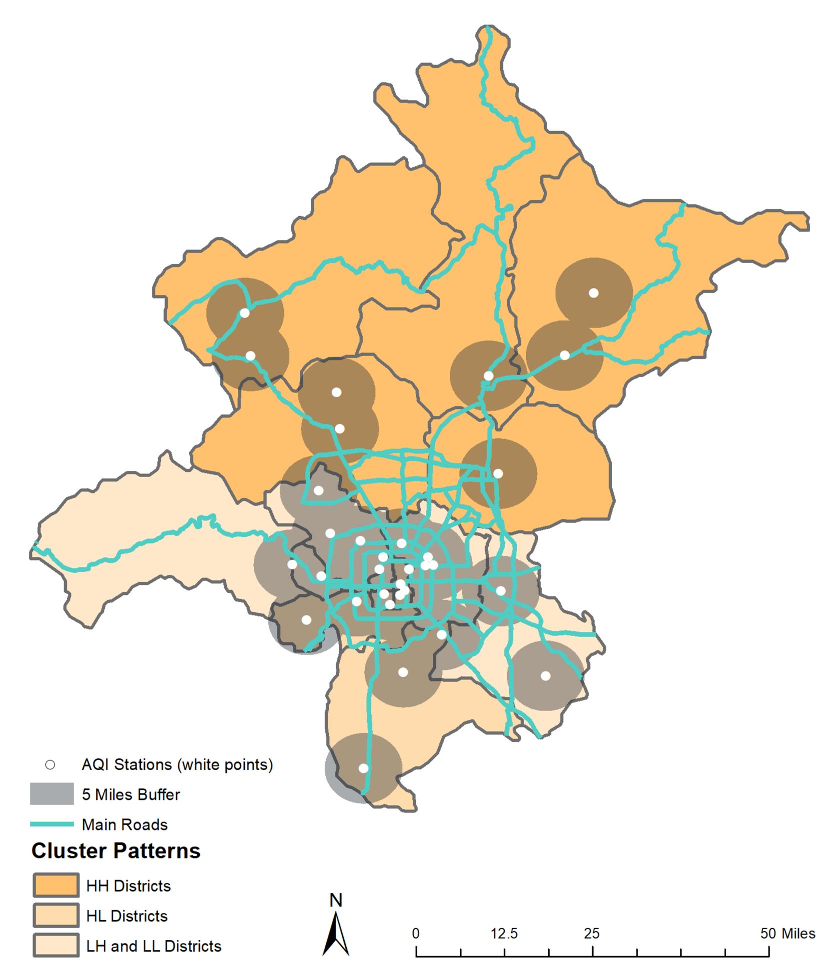


Figure 4 Buffers with Main Roads

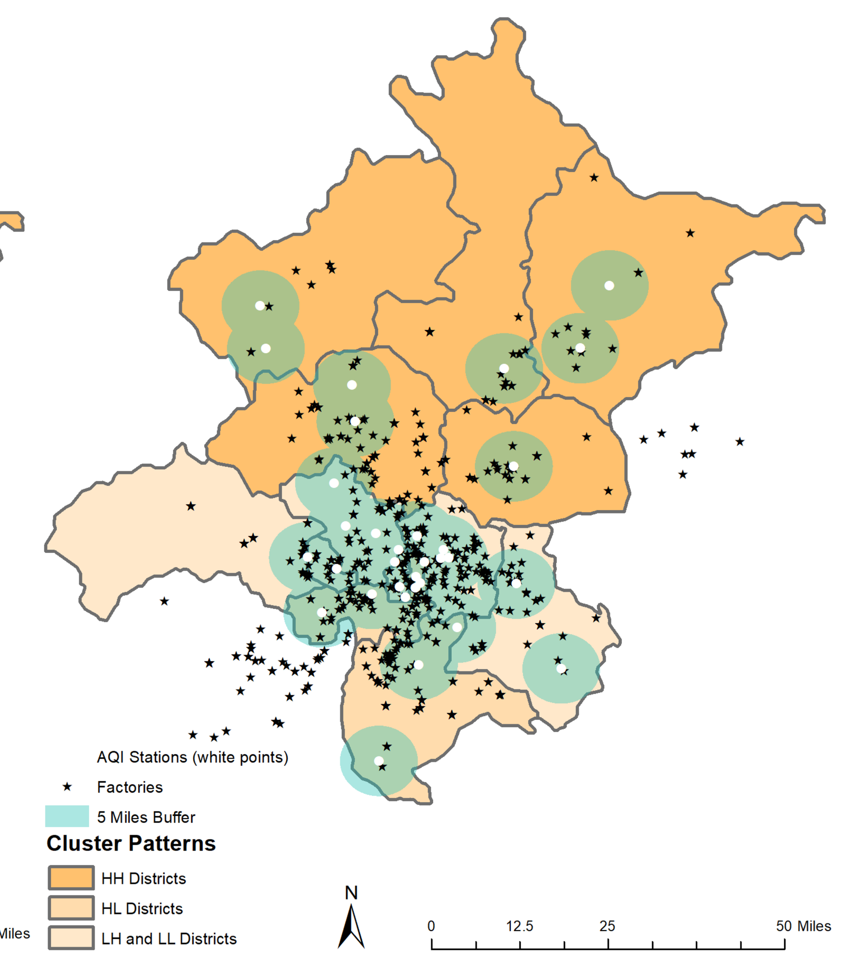


Figure 5 Buffers with Factories

- Cartographer: Peiyao Wang
- Class: UEP-0232-01 Introduction to GIS
- Date: May/07/2019

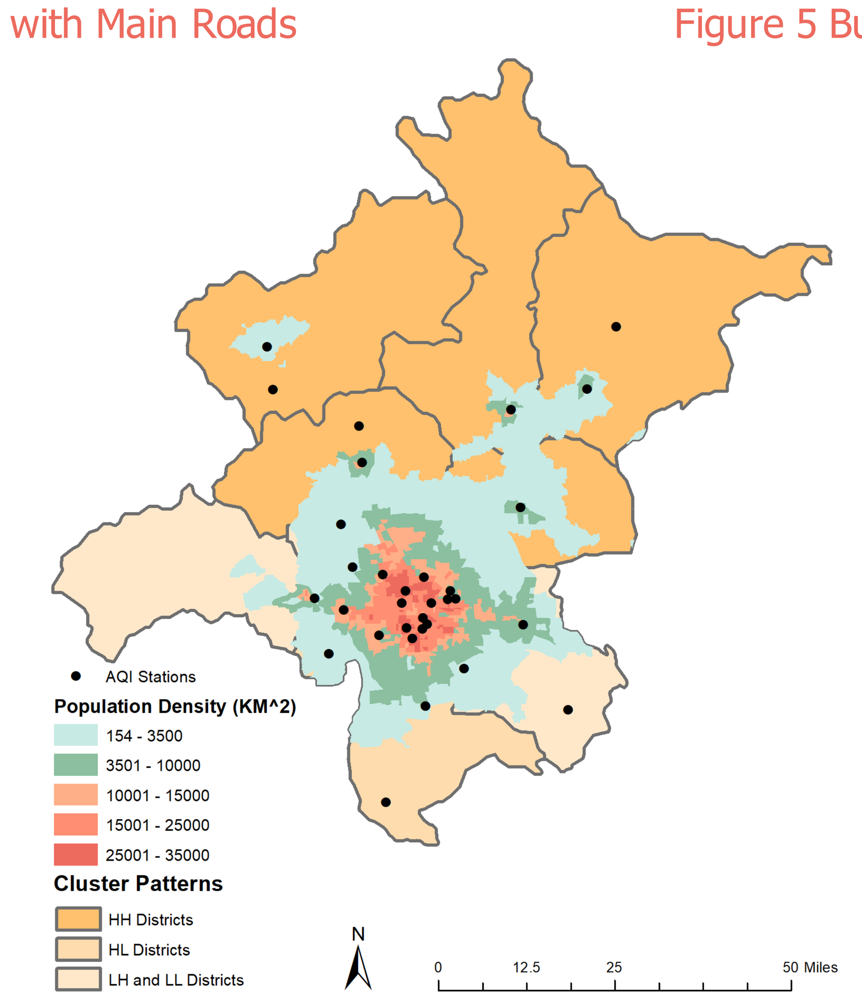


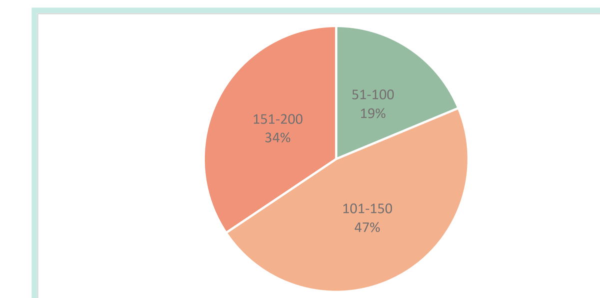
Figure 6 Population Density

- Geographic Coordinate System:

  GCS_WGS 1984
- Data sources
  - Tufts Data Lab M drive,
  - Tufts Data Lab S drive
  - China AQI PM25s Archive Dataverse

Result and Conclusion

AQI Index	Number of Monitor stations
51-100	6
101-150	15
151-200	11
Sum	32



AQI Values	Air Quality Descriptor	Health Concerns* PM2.5	Health Concerns* PM10
0 - 50	Good	None	None
51 - 100**	Moderate	None	None
101 - 150	Unhealthy for Sensitive Groups	People with respiratory or heart disease, the elderly, and children should limit prolonged exertion.	People with respiratory disease, such as asthma, should limit outdoor exertion.
151 - 200	Unhealthy	People with respiratory or heart disease, the elderly, and children should avoid prolonged exertion; everyone else should limit prolonged exertion.	People with respiratory disease, such as asthma, should avoid outdoor exertion; everyone else, especially the elderly and children, should limit prolonged outdoor exertion.
201 - 300	Very Unhealthy	People with respiratory or heart disease, the elderly, and children should avoid any outdoor activity; everyone else should avoid prolonged exertion.	People with respiratory disease, such as asthma, should avoid any outdoor activity; everyone else, especially the elderly and children, should limit outdoor exertion.
301 - 500	Hazardous	Everyone should avoid any outdoor exertion; people with respiratory or heart disease, the elderly, and children should remain indoors.	Everyone should avoid any outdoor exertion; people with respiratory disease, such as asthma, should remain indoors.

1. Current air pollution situation

This table shows the air quality index and health concerns:

The pie chart shows that most stations' air quality is unhealthy for sensitive people and over one-third station's air quality is unhealthy for all people.

Figure 2 and 3 both show that the air quality of the northern parts is worse. This is because of the city's surrounding topography. The southern part of Beijing is flatland, but the north part is highland. Lots of dunes are located on the plateau and only about 70KM from the city center. Winds blow sands to the urban area and contribute to the smog.

2. Influence Factors

- Emission from local factories and motor vehicles

Calculated through Stata, the correlation coefficient of PM2.5 and numbers of main roads in each buffer is 0.608, the correlation coefficient of PM2.5 and numbers of factories in each buffer is 0.401. Both of these two correlation coefficients have positive values, which means the more factories and roads, the higher of PM25. However, compared with the number of routes, the number of factories has more effects on the PM25. It can be concluded that to reduce the PM25, the most efficient way is to shut down more factories, which is being implemented by the Chinese government.

- Population density

The population density map shows that the highest population density area is the CBD. Population density decreases outer gradually. However, the PM 2.5 cluster pattern is different from this. That means the population density is not the main factor of PM2.5, which is also mentioned in several published research papers.

Reference and Data Sources

- Clark, Edited by Kylienne A., Travis R. Shaul, Brian H. Lower and Edited by Kylienne A. Clark, Travis R. Shaul, and Brian H. Lower. "4.2 Causes and Consequences of Air Pollution in Beijing, China." In *Environmental ScienceBites*. The Ohio State University, 2015.
- Wang, Hailin, Yahui Zhuang, Ying Wang, Yele Sun, Hui Yuan, Guoshun Zhuang, and Zhengping Hao. "Long-Term Monitoring and Source Apportionment of PM2.5/PM10 in Beijing, China." *Journal of Environmental Sciences* 20, no. 11 (January 2008): 1323–27.
- Sun, Yele, Guoshun Zhuang, Ying Wang, Lihui Han, Jinghua Guo, Mo Dan, Wenjie Zhang, Zifa Wang, and Zhengping Hao. "The Air-Borne Particulate Pollution in Beijing—Concentration, Composition, Distribution and Sources." *Atmospheric Environment* 38, no. 35 (November 2004): 5991–6004.
- Tufts Data Lab M drive, Tufts Data Lab S drive
- https://dataverse.harvard.edu/dataverse/china_pm25s