Analysis of Air Pollution in China

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ABSTRACT

Air pollution has become a severe issue in China looking at a global perspective. What we've done in this project is fourfold: Explored the relationship between air pollution and weather, vehicles and traffic, coal combustion; Conducted spatial-temporal analysis of air pollution with time series; Designed and implemented a model for relating weather factors(temperature, humidity, wind.etc) with air pollution; Proposed feasible measures for the government to improve the air quality.

INTRODUCTION

Air pollution has become a major issue in China, and poses a threat to Chinese public health. Coal combustion generates particulate matter also known as "PM". Currently, Beijing is suffering from PM2.5, which is a particulate matter with diameter of 2.5 micrometers or less. According to the U.S. Environmental Protection Agency, such fine particles can cause asthma, bronchitis, and acute and chronic respiratory symptoms such as shortness of breath and painful breathing, and may also lead to premature death.[1]

Measurements in January 2013 showed that levels of air pollution, as measured by the density of particulate matter smaller than 2.5 micrometres in size, were beyond index – higher than the maximum 755 μg the US Embassy's equipment can measure.[2] Smog from mainland China has been observed to reach as far as California.[3]

In an attempt to reduce air pollution, the Chinese government has made the decision to enforce stricter regulations. After record-high air pollution in northern China in 2012 and 2013, the State Council issued an Action Plan for the Prevention and Control of Air Pollution in September 2013. This plan aims to reduce air pollution by over 10% from 2012 to 2017.[4] The most prominent government response has been in Beijing.[5] As the capital of China, it is suffering from high levels of air pollution. According to Reuters, in September 2013, the Chinese government published the plan to tackle air pollution problem on its official website.[6] The main goal of the plan is to reduce coal consumption by closing polluting mills, factories and smelters and switching to other eco-friendly energy sources.[4]

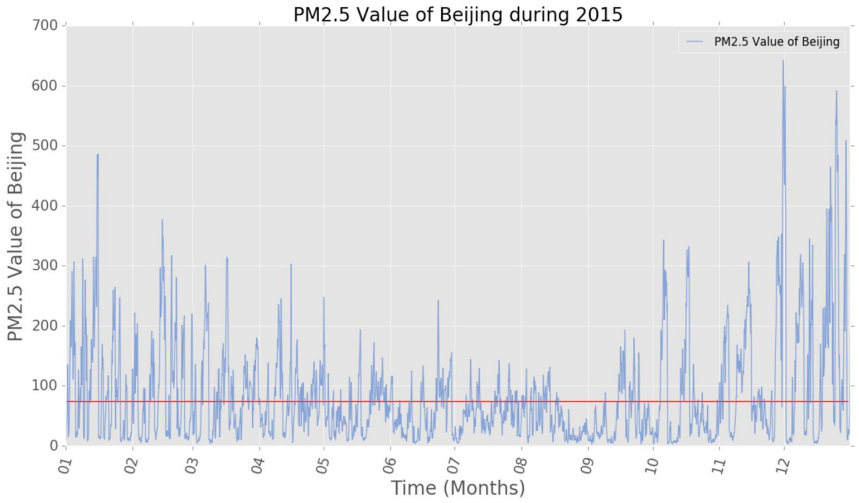
On 20 August 2015, ahead of the 70th anniversary celebrations of the end of World War II, the Beijing government shut down industrial facilities and reduced car emissions in order to achieve a "Parade Blue" sky for the occasion. This action resulted in PM2.5 concentration better than the 35 mg/m³ national air quality standard, according to data from Beijing Municipal Environmental Protection Monitoring Centre (BMEMC). The restrictions resulted in an average Beijing PM2.5 concentration of 19.5 mg/m³, the lowest that had ever been on record in the capital.[7]

China's strategy has been largely focusing on the development of other energy sources such as nuclear, hydro and compressed natural gas. The latest plan entails closing the outdated capacity of the industrial sectors like iron, steel, aluminum and cement and increasing nuclear capacity

and other non-fossil fuel energy. It also includes an intention to stop approving new thermal power plants and to cut coal consumption in industrial areas.

Major Finding 1

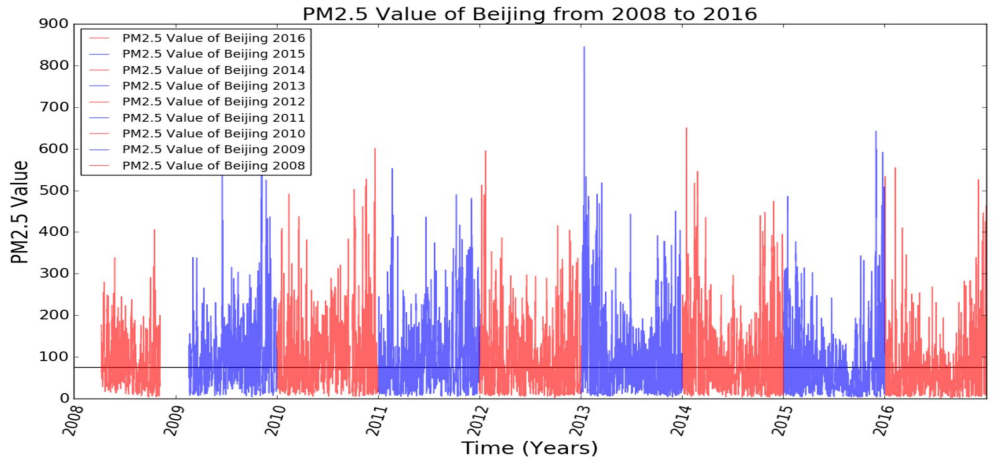
The first finding is that emission of factories and emission of vehicles are potential factors of air pollution in Beijing. We drew a time series plot with the hourly PM2.5 data from U.S. Embassy.



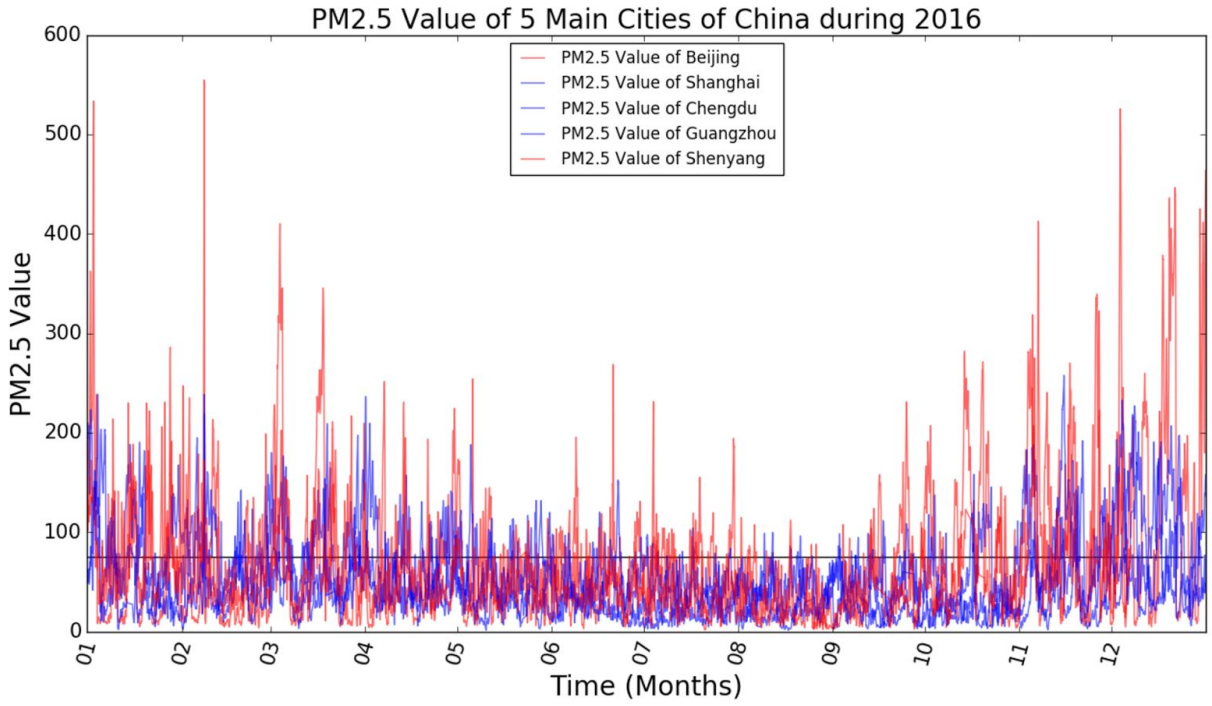
The horizontal red line is the standard level of daily PM2.5 average(24-hour) value of China, which is 75 $\mu g/m^3$. From the figure we can tell that the air pollution of Beijing is a severe problem but in September 2015 almost all of the Beijing PM2.5 values meet the standard. We searched the Internet and made one event detection. In September, Beijing planned a huge military parade to celebrate China's 70th anniversary of the victory during World War II. The city temporarily closed hundreds of factories and banned half of the cars in the city from driving. That is a reduction of about 2.5 million cars. This event is considered to be the reason for a period of time with low PM2.5 values and good air quality. Above all, we conclude that emission of factories and emission of vehicles are potential factors of air pollution in Beijing.

Major Finding 2

The second finding is that coal burning is also one potential factor of air pollution in Beijing. From the figure of major finding 1, we notice that the PM2.5 values are really high in December, January and February. The winter starts from December to February in China and tons of coals are burnt in Beijing for heating during this time. Then we made a time series plot including nine years of PM2.5 values data of Beijing to see whether the PM2.5 values were relatively higher in the winter time for each of these years.



As we can tell from the above figure, it is obviously that the PM2.5 values are much higher in the winter time than that of the summer time for each of these years. In China coals are burnt for heating only in the North, so we compared the time series plots of Northern cities such as Beijing and Southern cities like Shanghai.



We can also tell that in the winter time, the Northern cities(red) have a relatively higher PM2.4 values than that of the Southern cities(blue). Above all,we conclude coal burning as another potential factor of air pollution in Beijing.

Major Finding 3

We want to find the correlation between weather and PM 2.5. Firstly, We extracted Beijing's weather data and PM 2.5 data in Dec. 2016. Secondly, before training the prediction model, we normalized the whole features' value.Thirdly, we used linear regression model to build model.

Based on model parameters, we found that humidity and temperature have positive impact on the density of PM 2.5. In other words, the higher humidity and temperature, the more PM 2.5. Additionally, wind speed has negative impact on the density of PM 2.5. The results make sense, the wind can blow away haze and reduce PM 2.5.

OLS Regression Results

Dep. Variable:	PM	**R-squared:**	0.838
Model:	OLS	**Adj. R-squared:**	0.819
Method:	Least Squares	**F-statistic:**	44.71
Date:	Thu, 30 Mar 2017	**Prob (F-statistic):**	2.10e-10
Time:	19:16:56	**Log-Likelihood:**	-154.12
No. Observations:	30	**AIC:**	316.2
Df Residuals:	26	**BIC:**	321.8
Df Model:	3		
Covariance Type:	nonrobust		

	coef	**std err**	**t**	**P>|t|**	**[95.0% Conf. Int.]**
Intercept	-264.6228	55.551	-4.764	0.000	-378.810 -150.436
humidity	6.7201	0.702	9.570	0.000	5.277 8.163
Temperature	2.4516	4.711	0.520	0.607	-7.232 12.135
wind	5.5907	2.506	2.231	0.035	0.439 10.742

Omnibus:	3.892	**Durbin-Watson:**	2.045
Prob(Omnibus):	0.143	**Jarque-Bera (JB):**	2.544
Skew:	0.682	**Prob(JB):**	0.280
Kurtosis:	3.417	**Cond. No.**	383.

Figure 1. The result of linear regression

References

[1] Link to Project's GitHub Repository: https://github.com/cx495/Analysis-of-Air-Pollution-in-China

[2] "PM2.5". *United States Environmental Protection Agency*. Retrieved 7 October 2014.

[3] Wong, Edward (3 April 2013). "2 Major Air Pollutants Increase in Beijing". *The New York Times*. Retrieved 4 April 2013.

[4] Kaiman, Jonathan (16 February 2013). "Chinese struggle through 'airpocalypse' smog". *The Guardian*. London. Retrieved 4 March 2013.

[5] Andrews-Speed, Philip (November 2014). "China's Energy Policymaking Processes and Their Consequences". *The National Bureau of Asian Research Energy Security Report*. Retrieved 24 December 2014.

[6] Usman W. Chohan (May 2014). "An Eco-friendly Exodus: Heavy Industry in Beijing 环保政策". *McGill University Economic Publications*.
[7] Stanway, D (6 November 2013). "China cuts gas supply to industry as shortages hit". Reuters.
[8] Boren, Zachary Davies (27 August 2015). "China air pollution: Beijing records its cleanest air ever". Retrieved 29 August 2015.