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# The stagnant air and haze in China : where come and go?

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## ABSTRACT

In the last several years, the air pollution in north China had been taken as great threaten to economy development. The air pollution and haze had been one of hot topics among experts and normal people. The clear evidence and obvious observation that Haze Pollution or PM2.5 had been stay is threaten to public health under attack. The air pollution had been studied from the observation that north wind and pollution. The result had shown that the pollution is relative with the strong wind. The blue sky depending on the strong wind from North China.

## KEYWORDS

Haze; Air pollutants emission; Wind stilling; Wind farm.



## INTRODUCTION

Haze pollution hits eastern and middle china with frequency in recent years. This paper investigates the influential factors of haze from the perspective of data analysis, including pollutants emission, climate and energy exploitation. Results show that air pollutants discharge, especially from industry, is the main intrinsic factor of haze pollution in China. An increase of pollutants discharge in these years is observed. Data analysis also demonstrates wind force slowdown as the most important external factor that aggravates haze. Factors that might related to air stilling problem is discussed.

## EMISSION OF AIR POLLUTANTS IS THE MAIN CAUSE FOR HAZE

### Haze pollution areas are those with high pollutants discharge

Generally, the level of air pollution is closely associated with pollutants mission intensity. We calculate the pollutants emission intensity through dividing the pollutants emission volume (including sulfur dioxide, smoke and dust) by the land area of in different regions[1] (see Figure 1). We find that Shanghai, Tianjin, Shandong, Shanxi, Hebei, Jiangsu, Liaoning, Ningxia, Henan, Beijing rank the top ten regions with highest air pollutants emissions intensity.

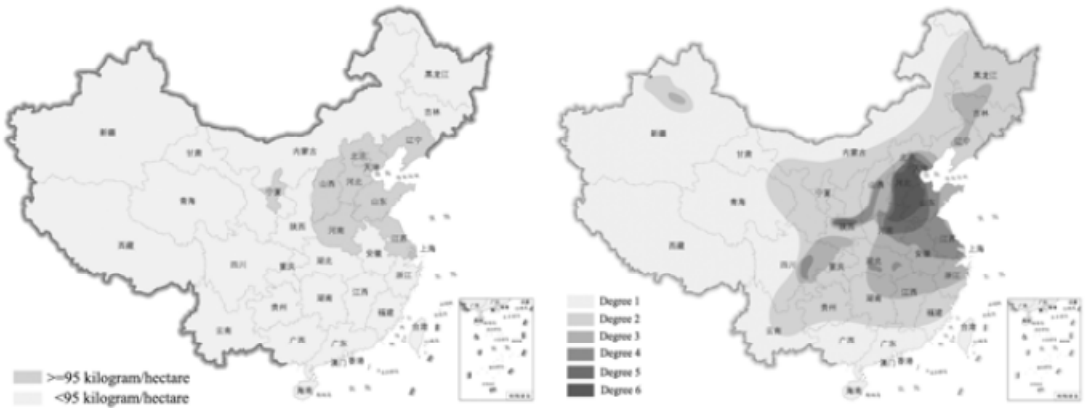


**Figure 1 : Distributions of pollutants emission (left) and air quality (right)**

Obviously, these ten regions are also those regions with most serious haze pollution. The right part of Figure 2 represents the air pollution distribution during the period of 2014.2.21 to 2014.2.24. There is positive correlation between haze and air pollution from spatial distribution view. We could reasonably infer that the emission of air pollutants is the main cause for haze.

### Industrial air pollutants emission decrease and then rise again

Yearly records on emissions of air pollutants shows that industrial emission accounted for more than 80% of air pollutants (see Figure 2). In recent years, China's economy grew fast and the energy consumption further accelerated in the twenty-first century. Fortunately, the air pollutants emission level was still under control, even with downward trend, after 2006. This is mainly due to the governments' great effort in strengthening the control of atmospheric emissions. China successfully cut down the industrial pollutants emission and the total air pollution discharge as well. However, a clear upward trend since 2010 was observed, which remind us to pay closer attention to the air pollution caused by industrial emission.

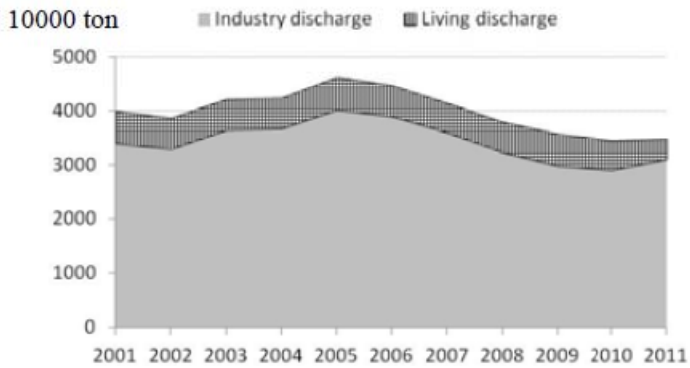


**Figure 2 : Air pollutants discharge composition (2001-2011)**

However, it's hard to be explained why the haze pollution become aggravated even with the non-increased air pollutant emission after 2006. To answer this question, we propose another factor of the determinants of haze: the impact of meteorological conditions.

## DECREASED AIR FLOW WORSEN HAZE POLLUTION

### Repelling haze needs adequate air flow

Wind, in haze pollution weather, could help to break the suspension status of pollutant particles. The role of wind in haze is not just to move the pollutants from one place to another, to be equally important, it could dilute the haze particles through chemical reaction, sedimentation and other approaches.

We could find evidences to support the role of wind for haze cleaning. Taking Beijing for example, we collected 89 days of weather monitoring data which covered the most polluted winter season of Beijing. We find that there is significant negative correlation between wind speed and severity of the haze pollution. For the days with pm2.5 value more than 250 (i.e., heavily polluting weather), none of their wind speed exceed 2m/sec, as shown in the lower right area in Figure 3. While for the days with wind speed over 2.5m/s, their Pm2.5 records are all smaller than 200, as shown in the upper left area of Figure 3.

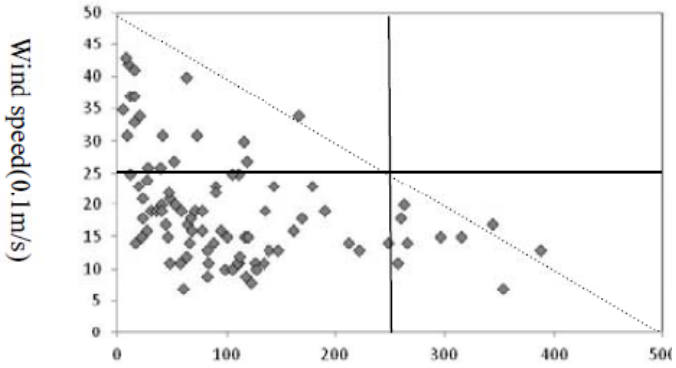


**Figure 3 : Average wind force and pm 2.5 values (2013/12/1-2014/2/28)**

### Decrease in wind speed aggravated haze pollution

Based on the meteorological data provided by 195 meteorological monitoring stations distributed nationwide[2], we try to further figure out the relationship between wind speed and haze pollution. We find that the average wind speed in some areas decreased significantly in recent years. If we mark those spots with average wind speed of 2006-2013 dropped more than 10% compared with that of 1998-2005, we find that these stations are mainly in the heavy air pollution regions (see Figure 4). A similar distribution was also shown in another study[3].

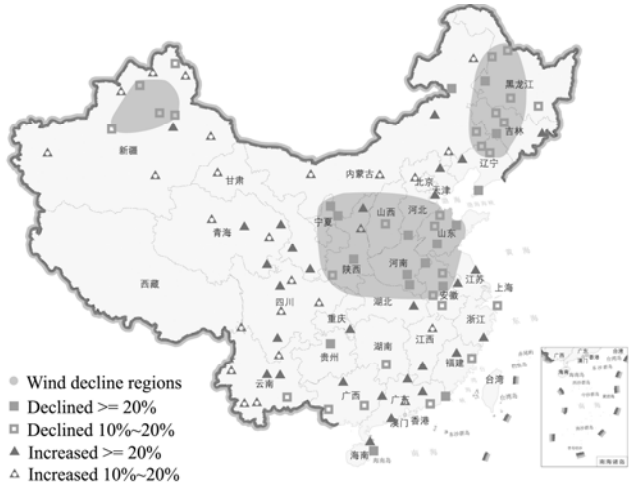


**Figure 4 : Distribution of wind force change**

What is important is that the wind speed decreasing regions and heavy haze pollution regions are highly geographically consistent (see right part of Figure 1), indicating that a significant decrease in the wind speed plays the role of 'adding fuel to the fire' for haze pollution.

**Discussions on factors of air stilling**

Scientific studies have shown that greenhouse gas discharge has been influencing global climate. Temperature increase in the North Pole led to the decrease in the grads of atmospheric press over north hemisphere, which further induced change in atmospheric circulation. This is one of the most important reasons that explain the air stilling phenomenon in north hemisphere in recent half century.

However, change in global atmospheric circulation can't fully explain the phenomenon of wind force decline in local regions. There are researchers[4] argued that, besides the factor of atmospheric circulation change, an increase in land-surface roughness has significant influence to the recent slow-down of near-surface wind speeds in the Northern Hemisphere. The study shows that changes in atmospheric circulation can explain 10–50% of the surface wind stilling. And the increase in surface roughness, which is estimated from increases in biomass and land-use change, could explain between 25 and 60% of the slow-down of the wind. In China, there are also evidences that support this viewpoint. A nationwide planting project started from 1978, aimed to control the sand storm rage in north China, especially in Inner Mongolia and north Xinjiang province. Planting activity helps to solidify sand and prevent soil erosion, and contributes much to the improvement of overall ecological environment of China.

However, the planted forests are mainly located in the pathway of north wind from Siberia region, an affection to wind force slow-down in leeward area may be induced. The historical changes of the average wind speed and the accumulated scale of "Sanbei" shelter forest are shown in Figure 5. Augment Dickey-Fuller test result shows that it's stationary for wind speed time series before 1979, and there is significant decline after that year (see TABLE 1).

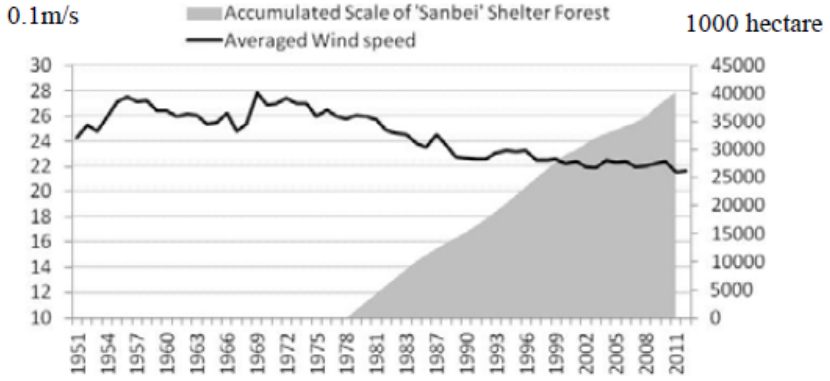


**Figure 5 : Historical change of wind speed and accumulated scale of 'Sanbei' shelter forest (1951-2012)**

**TABLE 1 : Augment Dickey-Fuller test result**

| period | Test Statistic | 1% Critical Value | 5% Critical Value | 10% Critical Value | MacKinnon approximate p-value |
|---|---|---|---|---|---|
| 1951-1978 | -2.880 | -3.750 | -3.000 | -2.630 | 0.0477 |
| 1979-2013 | -2.923 | -4.316 | -3.572 | -3.223 | 0.1550 |

Correlation analysis was then conducted between the historical change of wind speed during 1979-2013 and the accumulated area of "Sanbei" shelter forest. Result shows significant negative correlation with correlation coefficient of -0.883.

There are also studies indicate that wind farm construction can slow down the wind speed in leeward area[5]. The results sound reasonable because the principle of wind power generator is to transform kinetic energy of wind into power energy. Researchers in Denmark confirmed the affection of wind farm to wind speed in the 10 kilometer scope of leeward area[6]. Due to the extreme complexity of atmospheric velocity, it is hard to strictly testify the precise affection of wind farm to large scope climate. However, numerical simulation has been employed in a study to demonstrate the attenuation effect of wind farm to wind force and to global climate as well[7].

China has seen an explosion in wind farm construction from 2005. According to the statistic data of National Energy Bureau[8], Chinese gross power generation from wind energy reached 134.9 billion kilowatt-hour in 2013. For example, 75 wind farms have been constructed by about 30 investors in Zhangjiakou area, which is the main tuyere zone of Beijing. The overall wind power capacity of Zhangjiakou has reached 6 billion walt to the end of 2013. The historical change of accumulated capacity of wind power in Hebei and Inner Mongolia province and the change of wind force in different directions in Beijing are shown in Figure 6, with a correlation coefficient of -0.83.

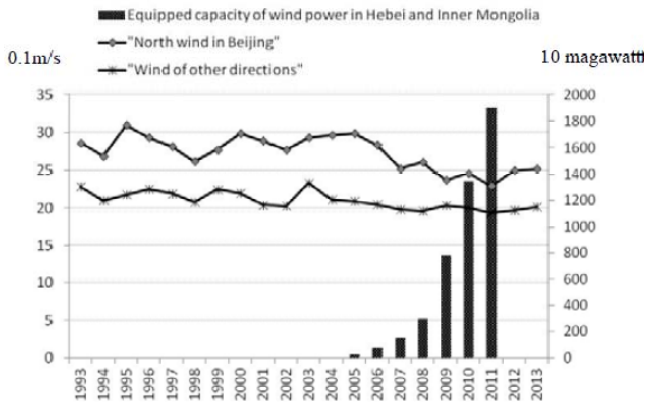


**Figure 6 : Wind speed change in Beijing and accumulated capacity of wind power in Hebei and Inner Mongolia (1993-2013)**

## CONCLUSION

We discussed several possible factors that may have influence on haze pollution in China. Considering the sophisticated mechanism of atmospheric activity, there should be a co-function by multiple factors accounting for the wind force variation. *Disputation may exist about which factor affects more, and how they affect. It still needs further investigations.* Anyway, the fact of wind force stilling in some areas of China is out of controversy. It has aggravated haze pollution in the middle and east regions of China. So, is the wind still inexhaustible? We could not get enough wind when we need it, just as we have encountered in serious haze pollution weather in these years. In such circumstances, large scale exploitation of wind energy should be more cautious today than any time before. The scale of wind energy exploitation in China should be compatible with the geographical limitation and air pollutants discharge level of current development stage. The study has also demonstrated the importance of before-hand social impact evaluation during large projects planning.

## PREFERENCES

**[1]** National bureau of statistics of China, *China Statistical Yearbook 2013*, **(2013)**.
**[2]** China meteorological data sharing service system. http://cdc.cma.gov.cn/home.do.
**[3]** Hua Guo, Ming Xu, Qi Hu; Changes in near-surface wind speed in China: 1969–2005. *International Journal of Climatology*, **31**, 349–358 **(2011)**.
**[4]** Robert Vautard, Julien Cattiaux, Pascal Yiou, Jean-Noël Thépaut, Philippe Ciais; Northern hemisphere atmospheric stilling partly attributed to an increase in surface roughness, *Nature Geoscience*, **3**, 756-761 **(2010)**.
**[5]** Z.C.Zhao, Y.Luo, Y.Jiang; Advances in assessment on impacts of wind farms upon climate change, *Advances in Climate Change Research*, **6**,400-406 **(2011)**.
**[6]** S.T.Frandsen, H.E.Jorgensen, R.Barthelmie et al.; The making of a second-generation wind farm efficiency model complex. *Wind Energy*, **12**, 445-458 **(2009)**.
**[7]** C.Wang, R.G.Prinn; Potential climatic impacts and reliability of very large-scale wind farms, Atmos Chem Phys., **10**, 2053-2061 **(2010)**.
**[8]** National Energy Bureau, http://news.xinhuanet.com/2014-02/25/c_119497640.htm.