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Research Method and Prediction Model of PM2.5 in Cities

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Abstract: Hefei has suffered from heavy air pollution, especially car exhaust and industry emissions. The smoke contains PM2.5 and PM10. These smoke will enter people's bodies and have a bad impact on the human body. This review is about PM2.5. This review covers the sources and hazards of PM2.5. It introduces the use of modelling methods to analyze PM2.5 pollution in various places and proposes treatment measures. These cities were heavily polluted by PM2.5, and after the local government's management and renovation, there has been a significant improvement. However, there are still many shortcomings in the process of pollution improvement. This review combines the means used in the process of pollution prevention and control in Handan City, Beijing. Hefei now suffers from some of the same pollution as these cities did in the past.

Key Words: PM2.5;air pollution; pollution prevention;

1. Introduction

With the rapid economic growth and increasing, the air quality decrease heavily. In 2013, pollution in the Pearl River Delta, Beijing and Tianjin was very serious. In severe cases, PM2.5 reached 600. At the same time, Taiwan revised its air environment standards in 2012[1]. In the next few years, Taiwan's PM2.5 showed a downward trend. Taiwan promotes the use of electric vehicles by limiting the emission of atmospheric pollutants from some industries (steel, electricity and glass), and encouraging citizens to use low-carbon modes of travel (bus ride, bicycle ride). In the process of governance, Beijing closed down. Many heavy industrial enterprises or relocated them to the surrounding provinces and cities. After several years of observation, the air quality was obviously better than that of previous years, but the relocated heavy industrial enterprises also had some influence on Beijing with the seasonal wind direction.

2. Basic Principles

2. 1 PM2.5 Definition

PM 2.5 particles with an aerodynamic diameter smaller than 2.5 μm[2].

2. 2 PM2.5 Damage

PM2.5 is very easy to enter human body because of the small diameter of PM2.5 particles, which can not be prevented by human defense. After entering the human body, it will directly contact organs, causing cardiovascular disease, cancer, respiratory diseases[3].

2. 3 PM2.5 Generation Source

Natural sources include soil dust (containing oxide minerals and other components), sea salt (the second largest source of particulate matter, whose composition is similar to that of seawater), plant pollen, spores, bacteria, etc. Disaster events in nature, such as volcanic eruptions discharging a large amount of volcanic ash into the atmosphere, forest fires or bare coal fires and dust storms, will transport a large number of fine particles into the atmosphere. Artificial sources include fixed sources and mobile sources. Fixed sources include various sources of fuel combustion, such as power generation, metallurgy, petroleum, chemistry, textile printing and dyeing, heating, cooking coal and gas or fume emissions. The main source of flow is the exhaust gas discharged into the atmosphere by various vehicles when they use fuel in operation.

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3. Research Method and Prediction Model

3.1 receptor model

Receptor model is a method for identifying and analyzing different sources and contribution rates of atmospheric pollutants. The basic principle is that there is a balance of mass between the receptor and the source of pollution. The proportion and quality of elements in the atmospheric particulate matter at the receptor can be used as a partial basis to infer pollution sources. This method is mainly divided into microscopic method and chemical method. Microscopic method is to analyze the composition and source of substances by analyzing the physical properties of a large number of particles, such as shape, size, surface area, color, density and photoelectric characteristics; chemical method is to analyze the composition of organic and inorganic substances and various elements by analyzing the chemical properties of particles, and then combine other analysis methods such as PCA, TTFA, CEE.

3.2 footprint

The ecological footprint model is defined as the amount of productive land and water needed by the designated unit population to meet the production requirements and to absorb the waste generated. This method converts all kinds of products and environmental resources into productive land area which can provide these functions. Productive land types are classified as arable land, grassland, woodland, construction land, fossil energy land and ocean, and land is converted according to local conditions.

3.3 air quality model

Air quality model is a mathematical method to simulate the physical and chemical processes that affect the diffusion and reaction of atmospheric pollutants. Based on the input meteorological data and pollution source information such as emission rate and chimney height, these models can simulate the primary pollutants directly discharged into the atmosphere and secondary pollutants formed by complex chemical reactions. Air quality models generally consider the following atmospheric processes: emissions (man-made and natural emissions), transport (horizontal advection and vertical convection), diffusion (horizontal and vertical diffusion), chemical transformation (gas, liquid, solid-phase chemical reactions), and removal mechanism (wet and dry deposition). The commonly used air quality models can be divided into regulatory small and medium scale models, comprehensive regional scale models and global scale air quality models. Regulated small and medium scale models include ISC3, AREMOD, ADMS and CALPUFF methods. Comprehensive regional scale models include NAQPMS, CAMX, WRF-CHEM and CMAQ methods. Global-scale air quality models include MOZART and GEOS-CHEM methods.

4. Case Discussions

4. 1 Beijing

Beijing is the capital of China. Beijing and its surrounding areas are developing very fast, but at the same time, the pollution problem is quite serious. Since 2013, PM2.5 exposure has caused 900,000 deaths a year[4], with the highest attributable mortality being in Beijing[5]. In 1998, the earliest environmental protection project was the Blue Sky Project. The focus of this project is on source emissions and pollution control. Because of its limitations, the problem of air pollution has not been solved well in the end. Since 2004, Beijing has been preparing for the Olympic Games. The project has covered Tianjin, Hebei Province, Shanxi Province, Shandong Province and Inner Mongolia[6]. This strategy minimizes air pollution in Beijing from one month before the Olympic Games to one month after the Games. However, just a few years later, PM2.5 concentration in Beijing exceeded American ambient air standards.

Tiantian Wang studied aerosol optical properties related to pollutant level control in Beijing[7]. From 2014 to 2017, there was no significant difference in meteorological conditions in Beijing, and PM2.5 showed a downward trend. It also points out that PM2.5 will increase when strong winds occur in

Northwest China. Therefore, controlling the source emissions of the surrounding provinces of Beijing, especially in Hebei, Henan and Shanxi provinces, is a necessary measure to reduce the impact of regional traffic in the future. Wang Li use both quantitative and qualitative methods, and he discussed the control and challenge of air pollution in Beijing, and proposed that the current air pollution control mainly embodies in the emergency measures of haze, rather than long-term air pollution control[8]. Yue Liu use the receptor model (positive matrix factorization, PMF), footprint and an air quality model to study the source and transmission mode of PM2.5 in Beijing[9].

4. 2 Handan

Handan City is located in the southern edge of Hebei Province, at the junction of Shanxi, Henan, Shandong and Hebei provinces. These four provinces are densely populated and

[10]Le Zhao,(2019), "Changes of chemical composition and source apportionment of PM2.5 during 2013 -2017 in urban Handan, China", AtmosphericEnvironment, Vol. 206, P. 119-13

industrialized, usually urbanized, accounting for 30% of the total air pollutant emissions in China. Since 2013, the government of Hebei Province has made great contributions to improving air quality. For example, comprehensive control of industrial air pollution, promotion of desulfurization and VOCS control in iron and steel, cement, coking, denitrification and dust removal, petrochemical and other industries, demolition of about 1000 old boilers, and new desulfurization and dust removal steam volume of 3180 tons. In addition, the prevention and control of motor vehicles and dust pollution will be carried out, 410,000 low and old cards will be eliminated, and high pollution areas in non-fuel combustion zones will be delineated. By 2017, the production capacity of iron and steel will be reduced by 60 million tons. Compared with 2016, the coal production capacity has also decreased by 1.29 million tons, theoretically the coal washing volume has reached more than 70%, and the energy-saving renovation of buildings has completed more than 23 million square meters in two years.

Le Zhao studied the composition comparison of PM2.5 in Handan City. As shown in the figure[10].

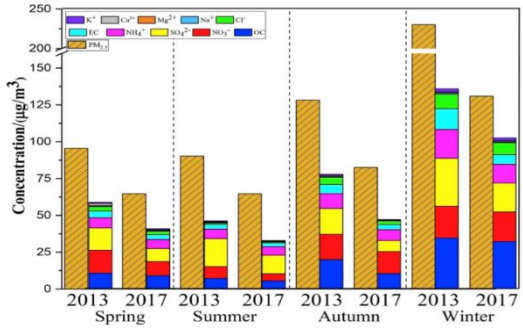

Figure 1. Seasonal concentrations of PM2.5 and its major chemical components in 2013 and 2017.

This study reveals the increase of organic species in PM2.5 and atmospheric O3, emphasizes the important role of VOC and organic aerosols in future emission control, and further studies the treatment and significant changes of chemical components of PM2.5 in severe pollution events compared with clean days, and puts forward the regional basic combination points.

5. Conclusion

Over the past 5 years, air pollution control in China has been very effective, but there are still some shortcomings. PM2.5 is an atmospheric pollutant put forward in recent years. In this respect, much has been accomplished, but in the long run, there are still large deficiencies in the treatment of atmospheric pollutants. At present, the atmospheric control of Hefei has also encountered the problems that these cities have encountered, and the haze has increased year by year. We can use the methods of these cities for reference to study the source, composition and transmission path of PM2.5 in Hefei, and establish a reasonable mathematical model to study and forecast the changes in the next period.

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