Changes in the PM2.5 concentration from 2015 to 2017 in Bijie City, Guizhou Province, China

Shaofei Jin
Department of Geography, Ocean College, Minjiang University, Fuzhou, 350108, China
Email: jinsf@tea.ac.cn

Abstract. Atmospheric environmental problems have received more and more attention. Research of PM2.5 has become the core issue of atmospheric environment research. This paper takes the PM2.5 data of the Bijie City from 2015 to 2017 as the research object, and investigates the trend in PM2.5 concentration. The PM2.5 concentration generally showed a decline trend, and the air quality was relatively good. The PM2.5 concentration in Bijie City was basically maintained within the secondary concentration limit of the air environmental quality. The PM2.5 concentration in Bijie City has a weekend effect, and the concentrations on the weekends were slightly higher than those on weekdays. This study can provide a scientific basis for the prevention and control of air pollutants in the Bijie City.

1. Introduction
PM2.5 particles are usually defined as the particulate matter with less than 2.5 μm in aerodynamic diameter. PM2.5 can not only cause the reduction of atmospheric visibility and the occurrence of haze, but also result in great harm to human health. They can cause harm to human body after entering the body through breathing. They may cause diseases such as heart disease, cardiovascular and cerebrovascular diseases, rhinitis, bronchitis, lung cancer and asthma [1,2].

PM2.5 was listed as the sixth leading risk factor for premature death by the WHO [1,2]. In 2016, about 4.1 million people died of heart disease, lung cancer, chronic lung disease and respiratory infections due to PM2.5 [1]. In addition, about 2.1 million people die due to the increase in the concentration of particulate matter such as PM2.5 [2]. Previous studies showed that 23.9% of lung cancer deaths in China can be induced to the PM2.5 pollution [3]. The problem of air pollution has been the greatest issue in China [3]. Fully understanding the characteristics and the trends in PM2.5 can provide a theoretical basis for the formulation of pollution prevention measures, and then better maintain the excellent atmospheric environment. Finally, it can lay a solid battle for pollution prevention and control [4-5].

Bijie City, a city in the Guizhou Province, is a pilot area for “development of poverty alleviation and ecological construction”. To better understand its air quality, this study selects the daily PM2.5 concentration data of Bijie City, and analyzes the distribution characteristics of PM2.5 in Bijie City in the past three years (2015-2017).

In the study, the overall trend in PM2.5 in Bijie City in the past three years (2015-2017) was firstly analyzed. Secondly, the seasonal pattern of PM2.5 in spring, summer, autumn and winter was analyzed. Due to the weekend effect of air pollution, this study compared the PM2.5 of Bijie City weekends and working days [5-9]. In addition, since the fireworks and firecrackers during the Spring
Festival have a greater impact on the quality of the air environment [8-12], this paper separately compares the PM2.5 concentration during the Spring Festival, and obtains a detailed trend change in PM2.5. This study can provide a scientific basis for the government to formulate environmental protection policies and air pollution control.

2. Materials and methods

2.1. Introduction to the study area
Guizhou Province is located in the southwestern of China. Bijie City is located in the northwest of Guizhou, bordering Yunnan in the west and Sichuan in the north. Figure 1 shows the geographical location of Bijie City. It is also the origin of Beipan River and Wujiang River. As a settlement of ethnic minorities, it is rich in natural resources and is the national new energy chemical base. It is also the only experiment area in China with the theme of "development poverty alleviation and ecological construction". Bijie City occupies a typical subtropical monsoon climate. The annual average temperature is around 13.2 °C. There is no severe cold in winter, no hot summer, abundant rainfall, and the altitude difference is large, and the vertical climate is more obvious. The industrial development level of Bijie City is primitive, the use of new environmentally friendly energy sources is low, and there are more traditional industries, such as coal mine, iron mining.

![Figure 1. The location of the Bijie City.](image)

According to results of air monitoring stations, the number of days with good air quality in Bijie City is about 350 days in 2018, which means that above 90% days in 2018 take excellent air quality. These days meet the secondary standard of "Environmental Air Quality Standards" in China. According to the biographical environmental status bulletin of Bijie City, the pollution in Bijie City is relatively small, and its primary pollutant is inhalable particulate matter.

2.2. Data processing
The data used is based on daily PM2.5 data from January 2, 2015 to December 30, 2017 in Bijie City. The main source of data is from the Bijie City Ecological Environment Bureau (http://www.bijie.gov.cn) and the Guizhou Provincial Department of Ecology and Environment
There are two environmental monitoring stations in Bijie City, which are located in the eighth middle school of Bijie City and the Bijie Teachers College. The layout of the site is in line with the requirements of the detection environment, and then the data obtained are simply processed and selected in the text. Firstly, I compared the monthly concentration of the PM2.5 from 2015 to 2017, by using the daily dataset in this study. Then, to test the weekend effect of air pollution, I analyzed the averaged concentration of the PM2.5 in the working day and weekend, respectively. Finally, to invest the festival effect, I analyze the PM2.5 concentration values during the Spring Festival, and compares the PM2.5 concentration values for the 7 days before the Spring Festival, during the Spring Festival, and the 7 days after the Spring Festival (Table 1).

### Table 1. Spring Festival date list from 2015 to 2017.

| Year | Before the Spring festival | Spring festival | After the Spring festival |
|------|-----------------------------|-----------------|---------------------------|
| 2015 | 02-11—02-17                | 02-18—02-24     | 02-25—03-03               |
| 2016 | 01-31—02-06                | 02-07—02-13     | 02-14—02-20               |
| 2017 | 01-20—01-26                | 01-27—02-02     | 02-03—02-09               |

### 3. Results

#### 3.1. The overall trend of PM2.5
The average PM2.5 concentrations in Bijie City are 15.39 μg/m³, 14.33 μg/m³, and 12.19 μg/m³ in 2015, 2016, and 2017, respectively. There is a decrease trend in the PM2.5 concentration in the Bijie City from 2015 to 2017.

#### 3.2. Monthly characters of PM2.5 in Bijie City
In the monthly trend chart of 2015-2017, it can be seen that the monthly PM2.5 concentration value curve is roughly "U" type distribution (Figure 2). Specifically, for an overall trend, the PM2.5 concentration in spring (March, and April) and winter (January, February, and December) is greater than that in summer and autumn.

![Figure 2. Monthly PM2.5 concentration in the Bijie City from the 2015 to 2017.](http://hb.guizhou.gov.cn)
3.3. PM2.5 changes in holidays

3.3.1. Characteristics of PM2.5 concentration in weekends and working days. In order to study the existence of PM2.5 in Bijie City, the working day data in the PM2.5 concentration data of Bijie City in the past three years was selected, and the statistical characteristics of the changes in the week were statistically analyzed by the AVERAGE function of Excell. Over the study period from 2015 to 2017, the average concentration values in the working days were 12.36 μg/m$^3$, 15.34 μg/m$^3$, 15.23 μg/m$^3$, 15.33 μg/m$^3$, 19.40 μg/m$^3$ from Monday to Friday, respectively, which were lower than the annual average secondary concentration limit (35 μg/m$^3$) of the national air environmental quality. The overall concentration in Saturday, and Sunday (19.45 μg/m$^3$, 19.46 μg/m$^3$, respectively) is higher than Monday to Friday. The average concentration on Friday and Saturday is the highest, and the concentration on Monday is the lowest. It can be seen that the PM2.5 in Bijie City has a weekend effect in the change in the week, and the PM2.5 concentration on Saturday and weekend is higher than that on the working days (Figure 3).

![Figure 3](image1.png)

**Figure 3.** Changes in the PM2.3 in different days in a week.

3.3.2. PM2.5 concentration during the Spring Festival. During the Spring Festival, a large number of fireworks and firecrackers burned, and the fireworks and firecrackers will cause certain damage to the air quality. Thus, the spring festival effect in the Bijie City was conducted. There was no obvious spring festival effect on the air quality in the Bijie City (Figure 4). The PM2.5 concentration in the Bijing City during the spring festival from the 2015 to 2017 was 95.5 μg/m$^3$, 129.54 μg/m$^3$, and 85.66 μg/m$^3$, respectively. The concentration of PM2.5 during the spring festival in 2015 and 2017 was lower than that before and after the spring festival. The results showed that there was no spring festival effect on the PM2.5 concentration in the Bijie City.

![Figure 4](image2.png)

**Figure 4.** Changes in PM2.5 in the seven days before, during, and after the Spring Festival.
4. Discussion and conclusion
The main sources of PM2.5 concentration in Bijie City are traffic, industrial pollution, coal burning, building cement, road dust and so on [3, 11, 12]. PM2.5 is considered as a serious hazard to the air environment and people's health. Bijie City is the only experimental area in China with the theme of “developing poverty alleviation and ecological construction”. However, in recent years, the concentration of PM2.5 in Bijie City has been increasing continuously following the previous studies [5]. The environmental quality monitoring and prevention of environmental protection departments in Bijie City is insufficient, and the prevention and control of pollutant concentration has not achieved obvious results. PM2.5 is the main factor in Bijie City. In the overall trend analysis of PM2.5 concentration in Bijie City from 2015 to 2017, the overall concentration of PM2.5 in Bijie City showed a decline trend.

Climatic conditions are important factors affecting the concentration of pollutants in the atmospheric environment [3]. In the seasonal variation characteristics of PM2.5 concentration, the overall appearance is an "U" type distribution. For the 2015, the PM2.5 concentration is highest in winter, followed by spring, and decreased in autumn and summer. In the seasonal distribution characteristics of PM2.5 concentration in 2017 in 2016, the PM2.5 concentration in spring is the highest, followed by winter. However, in the analysis of the overall seasonal variation characteristics of the past three years, the concentration of PM2.5 pollutants was the highest in winter. In the analysis of PM2.5 concentration characteristics on weekends and working days, there is a weekend effect. This result implied that a more stricter management should be carried out in the weekend to control the PM2.5 emission.

In this paper, a detailed analysis of the distribution characteristics of PM2.5 in Bijie City, Guizhou Province was carried out. It was found that the concentration of PM2.5 in Bijie City is declining year by year. At the same time, the concentration of PM2.5 is changing in season, with winter and spring concentrations higher than other seasons. There is a certain difference between the weekends and the working days. The concentration of the weekends is slightly higher than that of the working day. Further, this study did not find a spring festival effect on the PM2.5 concentration. Research results show that Bijie City should strengthen the protection of air and air environmental quality and strictly control the emission of polluting gases and related chemical pollutants.

Acknowledgments
This research was supported by Natural Science Foundation of Fujian Province (No. 2019J01768), Open Fund Project of Fujian Provincial Key Laboratory of Information Processing and Intelligent Control (Grant No. MJUKF-IPIC201812), Outstanding youth training program of Fujian Province.

References
[1] Brunekreef B and Holgate S T 2002 Air pollution and health The Lancet 360(9341) 1233-1242
[2] Pope C A, Burnett R T, Thun M J, Calle E E, Krewski D, Ito K and Thurston G D 2002 Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution JAMA 287(9) 1132-1141
[3] Li M and Zhang L 2014 Haze in China: Current and future challenges Environ Pollut 189(189) 85-86
[4] Lin C C, Yang L S and Cheng Y H 2016 Ambient PM2.5, Black Carbon, and Particle Size-Resolved Number Concentrations and the Angstrom Exponent Value of Aerosols during the Firework Display at the Lantern Festival in Southern Taiwan Aerosol Air Qual Res 16(2) 373-387
[5] Ye C, Chen R S and Chen M X 2016 The impacts of Chinese Nian culture on air pollution J Clean Prod 112 1740-1745
[6] Zhang M, Wang X M, Chen J M, Cheng T T, Wang T, Yang X, Gong Y G, Geng F H and Chen C H 2010 Physical characterization of aerosol particles during the Chinese New Year's firework events Atmos Environ 44(39) 5191-5198
[7] Chen X, Liu Z and Wu P 2014 Analysis on chinese urban air quality's"spring festival effect": evidence from 31 key cities in China Statistics and Information Forum 29(12) 57-62

[8] Wu C, Wang G H, Wang J Y, Li J J, Ren Y Q, Zhang L, Cao C, Li J, Ge S S, Xie Y N, Wang X P and Xue G Y 2018 Chemical characteristics of haze particles in Xi'an during Chinese Spring Festival: Impact of fireworks burning J Environ Sci 71 179-187

[9] Zheng Y, Che H Z, Zhao T L, Zhao H J, Gui K, Sun T Z, An L C, Yu J, Liu C, Jiang Y C, Zhang L, Wang H, Wang Y Q and Zhang X Y 2017 Aerosol optical properties observation and its relationship to meteorological conditions and emission during the Chinese National Day and Spring Festival holiday in Beijing Atmos Res 197 188-200

[10] Lai Y H and Brimblecombe P 2017 Regulatory effects on particulate pollution in the early hours of Chinese New Year, 2015 Environ Monit Assess 189 467 https://doi.org/10.1007/s10661-017-6167-0

[11] Tan P H, Chou C, Liang J Y, Chou C C K and Shiu C J 2009 Air pollution "holiday effect" resulting from the Chinese New Year Atmos Environ 43(13) 2114-2124

[12] Ngo N S, Zhong N and Bao X 2018 The effects of transboundary air pollution following major events in China on air quality in the US: Evidence from Chinese New Year and sandstorms J Environ Manage 212 169-175