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Environmental Research in China Based on Factor Analysis

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Abstract: This paper analyzes the advantages and disadvantages of the environment in various regions of China, and selects the environmental conditions and air quality index data of various regions in China from 2015 to 2017 for factor analysis. Among them, the use of industrial waste discharge, GDP, desertification, afforestation area and other variables on the air quality index AQI (air quality index) data, the total impact of environmental pollution control investment and PM2.5, as well as the comprehensive ranking of environmental problems in various regions. It was found that the degree of urban haze pollution was reduced and the situation was developing. The three major indicators of environmental pollution are industrial solid waste discharge, wastewater pollution, and air pollution. Among them, indicators include wastewater discharge, sulfur dioxide emissions, nitrogen oxide emissions, smoke (powder) dust, industrial solid waste production, desertification, PM2.5, regional GDP, afforestation area, total investment in environmental pollution control, and AQI.

Keywords: PM2.5; industrial pollutants; environmental pollution; AQI

I. Introduction

Since the reform and opening up, China's economy has developed at a high speed and has become the world's second largest economy. However, in the early days, many regions in exchange for economic returns at the expense of the environment have caused the environment to be destroyed, and the harm of environmental pollution in recent years has also effected peoples lives. The surface of the PM2.5 has been well known in the past few years, and the people are aware of the importance of the environment. With the rapid development of China's economy, environmental problems have become increasingly prominent, and smog pollution is plaguing most parts of China, jeopardizing the physical and mental health of residents. With the development of China's economy into the new normal. All along, China has placed sustainable development in a very important position. In 2013, the State Council held a standing meeting to determine ten measures for air pollution prevention and control. Referred to as "the atmosphere of ten"[1], 2017 is also the first phase of the "Atmosphere Ten" completed. Studying the environment in China has important practical significance for understanding the environmental changes in China and formulating corresponding governance measures. In recent years, China's environmental protection work has made remarkable progress. However, the current environmental problems are still very serious. The complex and diverse environmental problems facing China are the result of long-term accumulation under specific historical conditions and social backgrounds. China's environmental problems are mainly two aspects: one is the urban-centered environmental pollution problem, and the other is the natural ecological environment destruction. The two types of environmental problems cross each other, affect each other, and intertwined, making China's environmental problems quite severe.

According to statistics, more than half of the seven major river systems in the country are polluted, and 17 of the 35 key lakes are seriously polluted. One third of the country's water bodies are not suitable for fish survival, and 1/4 of the water bodies are not suitable for irrigation. The waters in cities above 100% are seriously polluted. More than 50% of the water sources in cities and towns do not meet the drinking water standards, and 40% of the water sources are no longer drinkable. Water pollution has become a major obstacle in the utilization of water resources and has become one of the important factors that threaten people's health and restrict social and economic development. Therefore, China's water environment pollution has reached the point where non-governance is impossible. [3]

At present, China's energy structure is dominated by coal, accounting for more than 75% of total primary energy consumption. China's air pollution is mainly caused by coal burning, and it is an energy-structured soot-type pollution. The main pollutants are soot and sulfur dioxide. The degree of air pollution is increasing with the increase of energy consumption. In addition, in some developed big cities, the total number of cars is often as many as one million, so traffic pollution has become one of the causes of air pollution. The main sources of urban air pollution are industrial emissions and motor vehicle exhaust emissions. The main pollutants in the atmosphere that are currently discussed are sulfur dioxide, nitrogen dioxide, ozone and total suspended particulate matter (TSP). The sulphur dioxide in the atmosphere is mainly derived from various industrial exhaust gases. In areas where the factory is concentrated, the concentration of sulphur dioxide is often high. Sulfur dioxide emitted into the atmosphere can easily form sulfuric acid mist and acid rain under appropriate climatic conditions (such as inversion, breeze, sunshine, etc.), and these substances are the main substances in the formation of PM2.5, forming PM2.5 for human health. (especially damage to the respiratory system and skin, etc.) and crops cause great harm.

In recent years, the amount of industrial solid waste generated, emissions, and accumulated stockpiles have been on the rise. According to statistics, the national industrial solid waste production in the last year of the "Ninth Five-Year Plan" period was 8.1608 billion tons. The increase in the output of industrial solid waste in the country during the 10th Five-Year Plan period mainly came from the rapid development of industry. At present, the annual output of the country is 150 million tons, 60% of which is concentrated in 52 key cities with more than 500,000 in the country. Moreover, due to the low utilization rate of comprehensive utilization and harmless treatment of domestic garbage, nearly two-thirds of the more than 600 cities in the country are surrounded by garbage. The simple dumping of garbage in the open air not only affects the urban landscape, but also pollutes the atmosphere, water and soil, posing a great threat to the health of urban residents. Garbage has become one of the most difficult environmental problems in urban development. [4]

At present, China's environmental research is manifested in the following two aspects. First, research on changes in PM2.5 across the country or in different regions. Zhao X et al (2009) analyzed the seasonal changes and daytime changes of PM2.5 in Beijing and rural areas from 2005 to 2007. It was found that the concentration of PM2.5 was highest in winter and summer, the highest in spring in rural areas, followed by summer and winter[5].Wang Zhenbo et al. (2015) used the spatial data statistical model to reveal the spatial and temporal patterns of PM2.5 in China based on PM2.5 observation data of 945 monitoring stations in 190 cities in China in 2014 [6].Wang S et al (2017) used PM2.5 data from 945 observation points in 190 cities in 2014 to compare PM2.5 concentrations between cities and found that PM2.5 concentrations in the eastern part of the Hu Huanyong line and in the northern part of the Yangtze River The highest, the highest PM2.5 in winter and the lowest in summer [7]. Second, the research on the social and economic factors of PM2.5 in China. There have been many studies from the perspective of economic growth, such as Ma Limei et al. (2014) found that with the continuous growth of per capita GDP, the level of pollution continues to rise [8].Guan D et al (2014) analyzed the socio-economic drivers of China's primary PM2.5 emissions changes from 1997 to 2010. The results show that China's significant efficiency gains completely offset emissions growth caused by economic growth and other drivers [9]. Xiang et al. (2015) found that the total GDP growth in the sample area will continue to worsen PM2.5 pollution, while raising the per capita GDP level can effectively reduce the pollution level [10]. Some studies from the perspective of industrial structure, such as Dong Tongtong (2015) use spatial measurement methods to verify the theoretical model of the relationship between smog pollution and industrial agglomeration. The results show that there is a Kuznets curve relationship between industrial labor agglomeration and haze pollution [11]. Wu Jiannan et al. (2016) used the data of PM2.5 monitoring stations in China in 2014 to explore the influencing factors of PM2.5. It was found that economic structural imbalance is a deep-seated incentive for haze weather, energy consumption structure, motor vehicle exhaust and building dust. It is the direct cause of smog weather [12].

According to the network data, in 2017, the average concentration of PM2.5 in 365 cities nationwide was 44.1 μg/m3, which was 4.5% lower than that of 46.2 μg/m3 in 2016. In 2017, the average concentration of PM2.5 in 74 key cities nationwide. It is 48 μg/m3, which is 33.3% lower than that of 72 μg/m3 in 2013;In 2017, the average concentration of PM2.5 in the Beijing-Tianjin-Hebei, Yangtze River Delta and Pearl River Delta regions was 64.6 μg/m3, 44.7 μg/m3, and 34.8 μg/m3, respectively, down 39.2% and 33.3% from 2013. 26.0%, exceeding the specific targets of the ten regulations of the atmosphere. In 2017, the average concentration of PM2.5 in Beijing was 57 μg/m3, which was 36.0% lower than the average annual concentration in 2013, and the index of 60 μg/m3 specified by the atmosphere was completed [13].

Compared with previous studies, the contributions of this paper are mainly reflected in: First, using the panel data of PM2.5, air quality index AQI and total investment amount in major regions to study the Chinese environment; Second, from the perspective of industrialization, explore the effects of variables such as PM2.5 in various regions; Third, it has increased the impact of GDP and afforestation on PM2.5 in the region and broadened the scope of research. This paper analyzes the advantages and disadvantages of the environment in various regions of China and the comprehensive environmental rankings, which has practical significance for ordinary people to choose healthy working and living areas.

I.

II. Empirical analysis

Due to the complexity and variety of pollution, this paper takes the following several representative regional data for analysis. (See the attached table for data) [14][15], the PM2.5 value of the provincial capital or representative of the administrative area. Use SPSS for a comprehensive analysis of environmental issues. The whole environment is complex and diverse, with many pollutions such as industrial solid pollution, wastewater pollution and air pollution. In this paper, several industrial solid pollution, wastewater pollution, air pollution, afforestation, GDP, land desertification and other issues are analyzed. In recent years, China has witnessed the most serious atmospheric pollution. PM2.5 and PM10 have appeared frequently. Some local merchants have forced sewage into deep wells, resulting in large-scale land pollution and water pollution. This pollution will affect ten or even hundreds of years. The phenomenon that factory waste is pushed into the mountains in many parts of China is also a major pollution and cross-contamination.

Multivariate large sample studies provide a wealth of information, but in most cases, because many variables may be related before, the complexity of problem analysis is increased and the analysis is inconvenient. According to the pearson correlation analysis, AQI is correlated with sulfur dioxide emissions, nitrogen oxide emissions, soot emissions, industrial solids emissions, and PM2.5.The total investment in environmental pollution control is highly correlated with wastewater discharge, sulfur dioxide emissions, nitrogen oxides emissions, soot emissions, industrial solids emissions and GDP, and is highly correlated with regional GDP in governance investments, as well as the local environment. There are also related. PM2.5 is also correlated with sulfur dioxide emissions, nitrogen oxide emissions, soot emissions, and industrial solids emissions.

If each indicator is analyzed separately, the analysis may be isolated and cannot be comprehensively analyzed. Blindly reducing indicators can lose a lot of information and is prone to erroneous conclusions. Therefore, it is necessary to find a reasonable method to reduce the analysis indicators, minimize the loss of information contained in the original indicators, and conduct a comprehensive analysis of the collected data. Since there is a certain correlation between the variables, it is possible to use a small number of comprehensive indicators to synthesize the various types of information in each variable to make the research easier.

Table 1. Test KMO et Bartlett

KMO sampling suitability measure.		.549
Bartlett sphericity test	Approximate chi square	345.517
	Degree of freedom	55
	Significant	.000

a. Based on relevance

As can be seen from Table 1, the KMO statistic = 0.549>0.5, the spherical test chi-square statistic = 345.517, and the one-sided p = 0.00 < 0.01, suitable for factor analysis.

Table 2. Common factor variance

	initial	extract
Waste water discharge (10,000 tons)	1.000	.875
Sulfurdioxide emissions (10,000 tons)	1.000	.862
Nitrogen oxide emissions (10,000 tons)	1.000	.940
Smoke (powder) dust (10,000 tons)	1.000	.883
Industrial solid waste production (10,000 tons)	1.000	.887
Desertification (hectare)	1.000	.323
PM2.5	1.000	.946
GDP (100 million yuan)	1.000	.949
Afforestation area (hectare)	1.000	.662
Total investment in environmental pollution control (100 million yuan);	1.000	.658
AQI1	1.000	.951

Extraction method: principal component analysis.

Table 2 shows that each variable has a proportional amount in the extraction amount. The article also shows that the extraction amount is relatively large. Basically above 0.6.

Table 3. Explanation of total variance

ingredient	Initial eigenvalue total	Initial eigenvalue Percentage of variance	Initial eigenvalue Cumulative %	Extract the sum of squared loads total	Extract the sum of squared loads Percentage of variance	Extract the sum of squared loads Cumulative %
1	5.357	48.704	48.704	5.357	48.704	48.704
2	2.058	18.705	67.408	2.058	18.705	67.408
3	1.519	13.810	81.219	1.519	13.810	81.219
4	.836	7.597	88.815			
5	.529	4.812	93.627			
6	.376	3.414	97.041			
7	.194	1.762	98.804			
8	.066	.600	99.403			
9	.034	.310	99.713			
10	.024	.221	99.934			
11	.007	.066	100.000			

Extraction method: principal component analysis.

Table 3 analyzes the factor of one variable and selects the factors that can carry most of the variables. When the cumulative contribution rate of the factors reaches 80%, the default factors can explain most of the factors. When the factor in this paper is 3 The cumulative variance contribution rate reached 81.219%, so three factors were selected.

Table 4. Composition matrix

	ingredient 1	ingredient 2	ingredient 3
Waste water discharge (10,000 tons)	.590	.717	.118
Sulfur dioxide emissions (10,000 tons)	.865	-.184	.284
Nitrogen oxide emissions (10,000 tons)	.960	.075	.110
Smoke (powder) dust (10,000 tons)	.887	-.304	.061
Industrial solid waste production (10,000 tons)	.833	-.387	.208
Desertification (hectare)	-.084	-.518	.217
PM2.5	.608	-.300	-.697
GDP (100 million yuan)	.661	.715	.019
Afforestation area (hectare)	.387	-.434	.569
Total investment in environmental pollution control (100 million yuan)	.729	.356	-.011
AQI1	-.604	.279	.713

Extraction method: principal component analysis.

a. Extracted 3 components.

Table 4 shows the first main components: sulfur dioxide emissions, nitrogen oxide emissions, smoke (powder) dust, industrial solid waste production, total investment in environmental pollution control; the second major component: desertification, GDP, wastewater discharge; The third main component: AQI1, PM2.5, afforestation area (hectare).

Table 5. Common factor variance

	initial	extract
REGR factor score 1 for analysis 1	1.000	.593
REGR factor score 2 for analysis 1	1.000	.407
REGR factor score 3 for analysis 1	1.000	.000

Extraction method: principal component analysis.

Through the factor analysis of the three principal components in Table 5, a principal component is obtained, and then sorted to obtain a comprehensive ranking of the environmental advantages and disadvantages of each region: Hebei, Inner Mongolia, Shandong, Xinjiang, Liaoning, Henan, Shaanxi, Sichuan, Ningxia, Yunnan, Guizhou , Anhui, Heilongjiang, Hunan, Jiangxi, Hubei, Jiangsu, Jilin, Chongqing, Tianjin, Beijing, Guangxi, Zhejiang, Fujian, Guangdong, Shanghai, Tibet, Hainan, Shanxi, Gansu, Qinghai.

III. Conclusion

Through factor analysis, the significance of the ANOVA model is 0, less than 0.05, rejecting the null hypothesis. Get the advantages and disadvantages of each region, the main pollutants in various regions, this can control the pollution, can effectively improve the environmental pollution, avoid blind management or overall governance. The areas where the overall environment is well done are in Hebei and Inner Mongolia; the worst in Gansu and Qinghai, but only the air, the best in Fujian, Hainan and other regions. The government has paid great attention to environmental issues and invested heavily in manpower and economy. Environmental laws have become more sophisticated, law enforcement has increased, and investment in environmental pollution control has increased significantly year by year. China's environmental problems have been developing in a good direction. Qu Geping is the first national environmental protection director and the chief representative of the Chinese government to the United Nations Environment Program. He is known as the "father of China's environmental protection."He put forward: "The idea of not punishing corruption and ruining the party and ruining the country, not eliminating environmental pollution, not protecting the ecological environment, but also dying the party and ruining the country" will become the norm in China's ecological governance and environmental protection undertakings in the next few years.

Overall, China's ecological environment is still grim. First, more and more heavy air pollution, in the current China, the hottest issue of public concern is the smog PM2.5. Second, fresh water shortages and water pollution. China is a country with severe water shortage. The per capita fresh water resources are not enough in the world average. The existing precious water resources are also seriously polluted. The seven major water systems in China are polluted to varying degrees. Third, soil pollution is serious. Sewage irrigation, air pollution, particulate sedimentation, especially the widespread misuse of fertilizers and pesticides, are the causes of soil pollution. Soil pollution has already produced a picture of China's food safety and public health.

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