Analysis of Factors Affecting Soot Pollution in Shanghai City
Based on Grey Relational Theory

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Keywords: Soot pollution, Grey correlation, Influencing factors, Shanghai City

Abstract. With the development of economy and society, people's demand for air quality is getting higher and higher. Dust emission pollution is an important factor affecting air quality. By using the method of grey relation analysis, the factors influencing the pollution degree of smoke and dust in Shanghai City city were analyzed. The results show that, in accordance with the influence factors for air quality from big to small order, influence factors are as follows: environmental protection input, total GDP, energy consumption quantity, population and the number of civilian vehicles. Therefore, in order to reduce dust pollution in Shanghai City, it is necessary to increase investment in environmental protection, improve the economic structure, reduce energy consumption and optimize the structure of energy consumption, control the number of population and reduce the amount of automobile use.

Introduction

In the process of sustained economic development, people are demanding higher air quality. Pollution caused by smoke and dust emissions has become an important factor affecting the quality of the environment.

In recent years, many scholars have discussed the problem of soot emission pollution, and some valuable conclusions are drawn. Wang Hongmin put forward his own opinion on the design of smoke and dust emission monitoring system [1]. Tian Xin and other researchers studied soot emission control technologies in coal-fired power plants [2], taking Dalian city as an example, Chi Guotai and other researchers researched the path choice question of green city’s industrial soot emissions [3]. Liu Ruijie and Zhang Zhihui analyzed the development trend and influencing factors of China’s industrial dust emission in the past 2001-2009 years, and pointed out suggestions and Countermeasures for reducing industrial dust emissions [4]. Euro Ming and Zhou Shaofu studied the relationship between industrial soot emissions and health care spending, and made three recommendations. That is to enhance the consumption capacity of residents' health care services, to provide better medical services for the aged, and to pay more attention to environmental protection [5].

This paper uses grey relational analysis to analyze the factors that affect the dust pollution in Shanghai City City, and puts forward some countermeasures.

Modeling Steps with Grey Relational Analysis

The Establishment of the Original Series and Dependent Variables Refer to the Number of Columns and Compare the Number of Independent Variables Listed

Refer to the number of columns known as the dependent variable sequences recorded as the mother;

\[ X_0^{(k)} : X_0^{(k)} = [X_0^{(1)}, X_0^{(2)}, X_0^{(3)}, \ldots, X_0^{(k)}] \]

Comparing the number of independent variables is also called the sub-sequence of the column,

\[ X_i^{(k)} : X_i^{(k)} = [X_i^{(1)}, X_i^{(2)}, X_i^{(3)}, \ldots, X_i^{(k)}] \quad (i = 1, 2, \ldots, n) \]
The Original Sequence Is to Be Treated of Non-dimensional

The purpose is to eliminate the impact of different sizes and to facilitate calculation and comparison, initialize method and the average method can be used. calculate formulas are

\[ X_i^{(k)} = \frac{X_i^{(l)}}{X_i^{(1)}}, \quad \text{or} \quad X_i^{(k)} = \frac{X_i}{X_i} \]

C.calculate the absolute value between parent sequence and each sub-sequence at each time point to identify the biggest difference and minimum difference

\[ \Delta(k) = |X_0^{(k)} - X_i^{(k)}| \quad (i = 1, 2, 3, \ldots, n) \]

The biggest difference:

\[ \Delta_{\text{max}} = \max \max \left| X_0^{(k)} - X_i^{(k)} \right| \]

The minimum difference:

\[ \Delta_{\text{min}} = \min \min \left| X_0^{(k)} - X_i^{(k)} \right| \]

Calculate the Gray Correlation Coefficient

\[ L_{0i}^{(k)} = \frac{\Delta_{\text{min}} + \lambda \Delta_{\text{max}}}{\Delta(k) + \lambda \Delta_{\text{max}}} \]

Among these, \( L_{0i}^{(k)} \) is Gray correlation coefficient between the number of sub-sequences and the parent sequence, \( \lambda \) is distinguish factors, usually between 0 and 1.

Calculation of Gray Correlation Degree

The overall correlation need to take the different observation points in the overall level of the importance of observation into account, therefore need to determine the weight of each point. Under normal circumstances, using the arithmetic mean method to calculate the grey correlation degree.

\[ r_{0i} = \frac{1}{n} \sum_{k=1}^{n} r_{0i}^{(k)} \]

\( r_{0i} \) represent the correlation coefficient between \( X_0 \) and \( X_i \).

Sort the Correlation Degree

Correlation is sorted based on size of order. The bigger a correlation is, the bigger the relation degree between the mother sequence and sub-sequence. According to experience, when the correlation is greater than 0.6, it will be considered a significant association\(^\text{[6-8]}\).

Index Choose and Calculation

Index Choose

In this paper, the soot emission quantity is used as a general index to measure the degree of soot pollution, which was denoted as A (unit: \%). Factors that affect the soot pollution degree in Shanghai City are as follows: GDP quantity (unit: hundred million yuan, denoted as B1); the population (unit: ten thousand, denoted as B2); energy consumption quantity (unit: ten thousand tons of standard coal, denoted as B3); vehicle ownership quantity (unit: ten thousand, denoted as B4); Environmental protection inputs (unit: hundred million yuan, denoted as B5). Specific data are as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>A</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>B4</th>
<th>B5</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>8.98</td>
<td>19196</td>
<td>2347.5</td>
<td>11131.4</td>
<td>329.2</td>
<td>557.9</td>
</tr>
<tr>
<td>2012</td>
<td>8.71</td>
<td>20182</td>
<td>2380.4</td>
<td>11184.0</td>
<td>260.9</td>
<td>570.5</td>
</tr>
<tr>
<td>2013</td>
<td>8.09</td>
<td>21818</td>
<td>2415.2</td>
<td>11456.1</td>
<td>282.5</td>
<td>607.9</td>
</tr>
<tr>
<td>2014</td>
<td>14.17</td>
<td>23568</td>
<td>2425.7</td>
<td>11281.7</td>
<td>304.5</td>
<td>699.9</td>
</tr>
<tr>
<td>2015</td>
<td>12.07</td>
<td>25123</td>
<td>2415.3</td>
<td>11549.6</td>
<td>332.4</td>
<td>708.8</td>
</tr>
</tbody>
</table>
Calculation
According the above steps, the results are as follows:

Table 2. Grey relation coefficient between the soot pollution and its affecting factors.

<table>
<thead>
<tr>
<th></th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>B4</th>
<th>B5</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.753</td>
<td>0.697</td>
<td>0.701</td>
<td>0.672</td>
<td>0.763</td>
</tr>
</tbody>
</table>

According the importance, the grey relation coefficient are as follows

B5  B1  B3  B42  B4

Conclusion and Advice
Environmental protection input is the most important factor affecting the soot emission in Shanghai City. The increase of investment in environmental protection can affect the soot emission to a great extent. Firstly, we can increase publicity funds to make units and the public understand the importance of reducing soot emissions. In this way, it can enhance the initiative and enthusiasm to reduce soot emissions. Secondly, we should increase investment in technology research and development of reducing soot pollution. by means of more advanced technology, we can reduce soot emission effectively.

The total amount of GDP also has a significant impact on the soot emission in Shanghai City. In the process of sustained economic growth, the consumption quantity of raw materials is increased gradually, so the number of smoke and dust emissions increases greatly. What we should do is to strive to improve the quality of economic growth, and to maintain the continuous increase in GDP. We should carry out the concept of green development and realize a development mode of resource-saving and environment-friendly. We must accelerate the pace of structural transformation and upgrading. On the one hand, we should eliminate high energy consumption and high pollution enterprises. On the other hand, we should develop industries with low resource consumption and low smoke emissions.

The third factor affecting soot emissions in Shanghai City is energy consumption quantity. In the process of exploitation, transportation and use of energy, a lot of smoke and dust will be produced. Coal is the main source of energy in China, and the consumption of coal produce more smoke and dust, which cause more pollution. For Shanghai City, practical measures should be taken to improve the energy consumption structure and reduce the total energy consumption. On the one hand, we should pay attention to the introduction of small amounts of soot emissions of energy, such as power, natural gas resources. On the other hand, we should encourage enterprises and residents to use clean energy.

Population quantity is the fourth factor that influences the emission of soot in Shanghai City. With the increasing income of our people, the consumption level of residents is increasing gradually, and the consumption patterns are gradually diversified. But new ways of spending have brought more air pollution, which leads to more smoke and dust emissions. For example, more and more people like to eat barbecue, which results in a lot of smoke. Because the main fuel used for barbecue is charcoal or coke. Therefore, we advocate people to form green consumption mode to reduce soot emissions effectively.

The fifth factor affecting the soot emission in Shanghai City is the amount of civilian car ownership. China's automobile industry is developing quickly. Statistics show that, the quantity of soot emission caused by a car is 3 times larger than its own weight during one year. Therefore, we should take practical measures to reduce the number of civilian cars. The important thing is to establish a convenient public transportation system and promote green travel in Shanghai City. At the same time, the use of new energy vehicles is necessary to reduce soot emissions.
Reference


