Grey relational theory analysis of factors affecting air quality in Shanghai City

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Abstract: Improving air quality is important to improve the quality of the environment. Taking Shanghai city as an example, this paper analyzes the main factors affecting the air quality by using the grey correlation theory. The results show that, in accordance with the influence factors for air quality from big to small order, influence factors are as follows::energy consumption quantity;the population; environmental inputs;GDP quantity;vehicle owenership quantity;RD inputs. Therefore, we should focus on reducing the amount of energy consumption and the number of population firstly. On the other hand, some effective measures should be taken to further increase investment in environmental protection and to improve the quality of economic development. At the same time , we should make scientific policies to control the number of motor vehicles, and to further enhance the level of scientific research.

Introduction

In the process of building a well-off society, environmental problems are getting more and more attention. Air quality is an important part of environmental quality. Air quality is directly related to the quality of the people's life.

In recent years, many scholars have discussed the factors that affect the air quality, and some valuable conclusions are drawn. Li Yumin and Li Mingli research results show that the urban green coverage rate and population size have a significant impact on the air quality in Beijing [1]. Jiang Jianhua analyzed factors that affect the air quality in Hohhot by stepwise regression analysis. these factors include PM2.5, NO2, PM10 and SO2, as well as air drying and wind speed [2]. Chen Yonglin analyzed the spatial distribution characteristics of urban air quality in the 156 cities as the research sample,. The results show that, the air pollution is serious in following areas:Beijing, Tianjin, North China, Huaihe basin ;while in other areas, the overall air quality is better.these areas include:the southeast coast and southwest, Northeast China.At the same time, the air quality is influenced by the following aspects:precipitation, the population density of the city area, the amount of SO2 emissions and the total amount of liquefied petroleum gas [3].Yan Zhiyong has analyzed the factors affecting Shenzhen city's air quality in recent years. The results showed that the main sources of air pollution in Shenzhen City includes following aspects: motor vehicles, power plants, ports and terminals[4]. Zhang Yanbo and Yan Huijie's research showed that the main factors affecting the air quality in Urumqi include urban greening, energy consumption and industrial

pollution [5].

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;

$x_0^{(k)} : x_0^{(k)} = [x_0^{(1)}, x_0^{(2)}, x_0^{(3)}, ..., x_0^{(k)}]$;

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

$x_i^{(k)} : x_i^{(k)} = [x_i^{(1)}, x_i^{(2)}, x_i^{(3)}, ..., x_i^{(k)}] \ (i = 1, 2, 3, ..., n)$

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

$x_i^{(k')} = x_i^{(k)} \Big/ x_i^{(1)}$; or $x_i^{(k')} = x_i^{k} \Big/ \overline{x_i}$

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

difference sequence: $$\Delta_i(k) = \left| x_0^{(k')} - x_i^{(k')} \right| (i = 1, 2, 3, ..., n)$$

The biggest difference: $\Delta_{max} = \max_i \max_i \left| x_0^{(k')} - x_i^{(k')} \right|$

the minimum difference: $\Delta_{\min} = \min_i \min_i \left| x_0^{(k')} - x_i^{(k')} \right|$

calculate the Gray correlation coefficient

$L_{0i}^{(k)} = \dfrac{\Delta_{\min} + \lambda \Delta_{\max}}{\Delta_i(k) + \lambda \Delta_{\max}}$ Among these , $L_{0i}^{(k)}$ is Gray correlation coefficient between the number of sub-sequences and the parent sequence, λ 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[6-8].

Index Choose and Calculation

Index Choose

In this paper, the good air rate is used as a general index to measure the air quality, which was denoted as A (unit: %). Factors that affect the air quality in Shanghai city are as follows: Environmental inputs (unit: hundred million yuan,denoted as B1);energy consumption quantity(unit:ten thousand tons of standard coal,denoted as B2); the population (unit: hundred million,denoted as B3);GDP quantity(unit : hundred million yuan,denoted as B4) ; RD inputs (unit: hundred million yuan,denoted as B5);vehicle ownership quantity (unit:ten thousand,denoted as B6).Specific data are as follows:

Table 1 the original data of the air quality and its affecting factors

	2012	2011	2010	2009	2008	2007
A	93.7	92.3	92.1	91.5	89.6	89.9
B1	570.49	557.92	507.54	460.42	422.37	366.12
B2	11020.30	10943.46	10842.33	9951.81	9750.47	9314.77
B3	2380.43	2347.46	2302.66	2210.28	1888.46	1858.08
B4	20181.72	19195.69	17165.98	15046.45	14069.87	13698.15
B5	679.46	597.62	481.70	423.38	362.30	307.50
B6	260.90	329.17	309.70	285.00	261.50	253.60

Calculation

According the above steps, the results are as follows:

Table 2 grey relation coefficient between the agricultural carbon emission quantity and its affecting factors

	B1	B2	B3	B4	B5	B6
A	0.696	0.869	0.829	0.672	0.552	0.753

According the importance, the grey relation coefficient are as follows

B2 **>** B3 **>** B1 **>** B4 **>** B6 **>** B5

Conclusion and Advice

From the above analysis, we can find that , the greatest affecting factor to air quality in Shanghai city is energy consumption quantity.

At present, China's extensive economic development mode has not been fundamentally changed. In the process of economic development, the phenomenon of energy consumption and energy consumption is so popular that it can greatly increase the quantity of pollutants discharged into air, which leads to the decline of the air quality. Therefore, we should take effective measures to improve energy efficiency and reduce energy consumption so as to improve the air quality.

the second factor of air quality in Shanghai city is population quantity. Clearly, more population need consume more resources, which discharge more waste into the air. So, we should take some measures to control the total population of Shanghai City, which will help improve the air quality of Shanghai city.

The third factor that affects the air quality in Shanghai is the investment of environmental protection. With the increase in environmental protection,we can use more advanced equipment and

attract more outstanding people to control air pollution.It is conducive to the improvement of air quality. Therefore, we should further increase the intensity of environmental protection in order to improve air quality in Shanghai continuously.

GDP number also has a significant impact on the air quality in Shanghai city. in the process of GDP growth, consumption of energy resources will inevitably lead to the production of life waste. In view of this, the city of Shanghai should take effective measures to enhance the quality of GDP growth. low energy consumption and high added value of the industry should be given priority.

Vehicle ownership quantity has an important impact on the air quality in Shanghai city. There are a lot of harmful components in the vehicle exhaust, which can directly affect the air quality. Therefore, Shanghai can take more scientific and effective measures. on the one hand,the number of motor vehicles should be limited; on the other hand, more strict emission standards should be taken to reduce the negative impact of vehicle emissions on air quality.

RD input is also an important factor affecting the air quality in Shanghai city. The continuous increase of RD investment is conducive to the production of various new technologies. These new technologies will effectively reduce the emissions of pollutants in the production and life, and thus effectively improve the air quality in Shanghai city.

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