Analysis of Factors Affecting Soil Environmental Quality in Beijing City based on Grey Relational Theory

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Abstract: With the continuous improvement of people's living standards, people's requirements for environmental quality are also getting higher and higher. Soil environmental quality is an important component of environmental quality. Soil environmental quality is related to people's living, diet and life safety. In this paper, the factors affecting soil environmental quality in Beijing were studied by using grey relational theory. In the order of importance from big to small, these factors are as follows: total energy consumption, gross domestic product, input level of science and technology, fertilizer use and environmental protection input level. Based on the above analysis, the corresponding countermeasures are put forward.

1. Introduction
In recent years, with the continuous advancement of ecological civilization construction, our government has made more and more efforts to prevent and control soil pollution, and has made a series of important progress in the prevention and control of soil environment. Soil environmental control is an important part of ecological civilization construction. Soil environmental quality is related to the quality of ecological civilization construction in China.

Scholars have also conducted research on soil environmental control deeply, and achieved a series of important results. Wang Yangyang and other scholars have studied the impact of agricultural use of municipal sludge on soil environmental quality [1]. Tian Yuan and others discussed the influence of sewage discharge around the city on the soil environmental quality of green space [2]. Studies by Zhu Jianhua and other scholars show that the application of compound fertilizer has a significant impact on the soil environmental quality of vegetable protected areas [3]. Yang Zhiping discussed the effect of long-term fertilization of vegetable on soil environmental quality in protected areas of Shanxi Province. The results showed that long-term fertilization had a significant impact on soil environment quality [4]. Liu Yanjun and other studies have shown that protected cultivation has a direct impact on soil environment [5]. Huang Xiaoyang and others considered that the application of pig manure organic fertilizer had a significant effect on soil environmental quality [6]. Ningchuan and Sichuan summarized the research results on the effects of organic fertilizer on soil fertility and soil environmental quality [7].

Based on the research of scholars, this paper comprehensively analyzed the influencing factors of soil environmental quality in Beijing city, and put forward corresponding countermeasures.
2. Modeling Steps with Grey Relational Analysis

2.1 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; $X^{(k)}_0 = X^{(1)}_0, X^{(2)}_0, ... , X^{(k)}_0$.

Comparing the number of independent variables is also called the sub-sequence of the column, $X^{(k)}_i = X^{(1)}_i, X^{(2)}_i, ... , X^{(k)}_i$ $(i = 1, 2, 3, ..., n)$

2.2 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. initial method and the average method Can be used. calculate formulas are

$$X^{(k)}_i = \frac{X^{(k)}_i}{X^{(i)}}; \text{ or } X^{(k)}_i = X^{(k)}_i / X^{(i)}$$

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

$$\Delta_i(k) = |X^{(k)}_0 - X^{(k)}_i| (i = 1, 2, 3, ..., n)$$

difference sequence:

$$\Delta_{max} - \max_{i} \max_{k} |X^{(k)}_0 - X^{(k)}_i|$$

The biggest difference:

$$\Delta_{min} = \min_{i} \min_{k} |X^{(k)}_0 - X^{(k)}_i|$$

the minimum difference:

2.4 calculate the Gray correlation coefficient

$$L^{(k)}_{0i} = \frac{\Delta_{max} + \lambda \Delta_{max}}{\Delta(k) + \lambda \Delta_{max}}$$

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

2.5 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 $X^{(k)}_0$ and $X^{(k)}_i$.

2.6 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[8-10].

3. Index Choose and Calculation

3.1 Index Choose
In this paper, soil value is used as a general index to measure the degree of soil environment quality in Beijing city, which was denoted as \( A \) (unit: hundred million yuan). Factors that affect the soil environment quality in Beijing city are as follows: GDP quantity (unit: hundred million yuan, denoted as \( B_1 \)); energy consumption quantity (unit: ten thousand tons of standard coal, denoted as \( B_2 \)); Environmental protection inputs (unit: hundred million yuan, denoted as \( B_3 \)); Science and technology input (unit: hundred million yuan, denoted as \( B_4 \)); Fertilizer usage quantity (unit: ton, denoted as \( B_5 \)). Specific data are as follows:

|       | 2013  | 2014  | 2015  | 2016  | 2017  |
|-------|-------|-------|-------|-------|-------|
| \( A \) | 14.3  | 8.2   | 14.9  | 17.4  | 17.1  |
| \( B_1 \) | 20330 | 21944 | 23686 | 25669 | 28015 |
| \( B_2 \) | 6724  | 6831  | 6853  | 6962  | 7133  |
| \( B_3 \) | 138.2 | 213.4 | 303.3 | 363.4 | 458.4 |
| \( B_4 \) | 234.7 | 282.7 | 287.8 | 285.8 | 361.8 |
| \( B_5 \) | 127809| 116398| 105284| 96530 | 85494 |

### 3.2 Calculation

According to the above steps, the results are as follows:

|       | \( B_1 \) | \( B_2 \) | \( B_3 \) | \( B_4 \) | \( B_5 \) |
|-------|-----------|-----------|-----------|-----------|-----------|
| \( A \) | 0.875     | 0.885     | 0.553     | 0.846     | 0.790     |

According the importance, the grey relation coefficient are as follows: \( B_2 \gg B_1 \gg B_4 \gg B_5 \gg B_3 \)

### 4. Conclusion and Advice

According to the above results, in the order of importance from big to small, the factors affecting soil environment quality in Beijing city are as follows: total energy consumption, gross domestic product, input level of science and technology, fertilizer use and environmental protection input level. From this factos, we can draw the following conclusions and suggestions.

Firstly, practical measures should be taken to further reduce energy consumption in Beijing. From the above analysis, we can see that the total energy consumption has a very significant impact on soil environment quality in Beijing. In the process of energy consumption, a large number of pollutants will be produced, and a large part of these pollutants will enter the soil, seriously affecting the soil environmental quality of Beijing. Although the quality of energy consumption in Beijing has improved in recent years, manifested in the obvious decline in energy consumption of 10,000 yuan GDP, the total energy consumption has been showing an upward trend. In 2017, Beijing’s total energy consumption reached 71.33 million tons of standard coal, up 6.08% from 67.24 million tons in 2013.

Beijing city government should formulate more scientific and strict policies to strictly control the further increase of total energy consumption. We should vigorously eliminate enterprises with high energy consumption and pollution, further improve the level of science and technology, so as to reduce the total energy consumption. More measures should be taken to encourage people to form good habits of thrift, walk more and drive less, which can further reduce the total energy consumption in Beijing.

Secondly, the GDP also has a significant impact on soil environment quality in Beijing. The gross domestic product (GDP) of a region can be obtained by summing up three major industries. Obviously, the development of any industry will inevitably use a large number of human, material and financial resources, which will also lead to the production of waste, which will have a significant impact on soil environment quality. For example, dust pollution in the production process of construction industry will affect the quality of soil if the waste is piled randomly after the demolition of buildings. The waste gas, dust and dripping fuel produced in the process of logistics and transportation will have an
impact on the soil. All kinds of waste produced by waiters can also have a significant impact on soil environment quality.

Therefore, Beijing city government should pay more attention to the quality of its GDP while increasing the number of its GDP year by year. More advanced science and technology should be adopted to develop low-pollution high-tech industries, which can effectively improve the soil environment quality of Beijing while increasing the GDP of the region.

Thirdly, the input level of science and technology has a great impact on soil environment quality in Beijing. After the level of scientific and technological investment is raised, the enthusiasm of scientific and technological personnel can be fully mobilized, and scientific research equipment can be substantially updated. All these contribute to the birth of a large number of new scientific and technological achievements. After the improvement of the whole social science and technology level, all walks of life can adopt the latest science and technology, which will effectively reduce the generation of waste in the process of production and life, thus contributing to the steady improvement of soil environment quality in Beijing.

Therefore, Beijing city government should further institutionalize a long-term mechanism for scientific and technological input to ensure that the annual level of scientific and technological input is steadily improved, and that it can reach the level of developed countries in the foreseeable future and become a strong city for scientific and technological input, which will be of great help to the improvement of Beijing's scientific and technological level and the improvement of Beijing's soil environment quality.

Fourthly, the amount of chemical fertilizer used has a direct impact on soil environmental quality in Beijing. According to the data released by the Ministry of Agriculture, compared with developed countries, the utilization rate of chemical fertilizer in China is not ideal at present. The average amount of chemical fertilizer per Mu is 21.9 kg, which is much higher than the world average of 8 kg per Mu, 2.6 times that of the United States and 2.5 times that of the European Union. At present, the utilization rate of nitrogen fertilizer for food crops in the United States is about 50%, and that of food crops in major European countries is about 65%, which is 15-30 percentage points higher than that in China. The main harm of improper use of chemical fertilizer to soil is that it can cause changes in soil acidity, lead to soil consolidation and decrease in fertility, and cause pollution of soil by harmful substances. Mineral and chemical raw materials for fertilizer production contain a variety of heavy metal radioactive substances and other harmful components, which pollute farmland soil with fertilization.

Therefore, Beijing city government should take further measures to improve the utilization rate of chemical fertilizer and reduce the use of chemical fertilizer. We should formulate a unified plan and adopt a large-scale and intensive approach to agricultural production. We can draw lessons from the agricultural production mode and production technology of developed countries, such as drip irrigation technology and sprinkler irrigation technology to replace the current irrigation technology, which can greatly reduce the use of chemical fertilizer. Increase the guidance to farmers, so that farmers can master more advanced agricultural production technology.

Fifth, the level of investment in environmental protection also has a certain impact on soil environment quality in Beijing. Because the increase of investment in environmental protection can change the overall environment of Beijing. Beijing is a part of the overall environmental quality of soil. With the increase of investment in environmental protection, the soil environmental quality of Beijing will be further improved. Beijing can formulate a long-term mechanism for environmental protection, formulate an investment system for environmental protection suitable for Beijing's characteristics, and steadily increase investment in environmental protection every year in line with relevant national policies. This can effectively improve the soil environment quality in Beijing.
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