Research status and trends of soil pollution from 1999 to 2018

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Abstract. In order to understand the global research status and development trend in the field of soil pollution remediation, this paper, based on the Web of Science (WOS) database, conducted a statistical analysis of the SCI papers in this field from 1999 to 2018 through bibliometric method, and quantitatively explored the development and change trend of the topic in this field. It was found that the number of papers published in the field of soil remediation in the world showed a linear growth trend with each year, while the number of papers published in China showed an exponential growth trend with each year, indicating that China pays more and more attention to this field.

Keywords: soil pollution; Research Status; WOS.

1. Introduction
Soil is an important natural resource, the material basis for human survival and development, and also an important component of the ecological environment. It is a living natural body with life. It has a certain purification capacity and a certain buffer against pollutants, but the carrying capacity of this capacity is also limited[1]. With the rapid development of economic globalization, the intensity of land use also shows a rapid and continuous increase in the development trend, and the pollution problems caused by the development process are becoming more and more prominent and serious, while the intensification of industrial and urban pollution and the increase of the types and quantities of agricultural chemicals make the soil pollution increasingly serious[2]. Soil pollution has become a global problem, causing widespread concern and attention of researchers and governments. According to the Bulletin of National Soil Pollution Survey released in 2014, the overall state of China’s soil environment is not optimistic, with the rate of soil pollution exceeding the national standard up to 16.1%. While the soil environmental problems in industrial and mining abandoned lands are prominent, the quality of cultivated land soil environment is even more worrying[3-4]. At present, the world is facing food, resources and environmental problems are inseparable with the soil. According to Web of Science (WOS) database search, 15,245 academic papers on soil remediation were published from 1999 to 2018. Due to the diversity of factors that cause soil pollution and the diversity of soil
remediation, it is difficult for researchers to grasp and sort out the information about the yield distribution of literature achievements, the distribution of scholars' contributions, and the key research hotspots in the field of soil remediation.

With the rapid development of urbanization and industrialization in China, more and more environmental problems have emerged[5-6]. As an important part of the natural ecosystem, soil environment has also been confronted with unprecedented challenges. Soil can not only receive heavy metal pollutants in atmospheric precipitation, but also with the surface water and groundwater contamination in the process of interaction, and through the absorption of plants in the enrichment of accumulated inside body, finally enter human body through food chain makes the toxic heavy metal material, poses a great threat to people's health[7-8]. Therefore, this study intends to discuss the research status of this field from the relevant papers published in the last 20 years.

2. Data Sources
Data in this study came from five subdatabases of "SCIE", "SSCI", "CPCI", "CPCI-SSH" and "ESCI" in the core database of Web of Science (WOS). The database covers the most important and influential research in the world, and is recognized as the most important search platform in the field of natural science. The time span of literature retrieval was from 1999 to 2018, the keyword was "soil remediation", the field was "topic", including title, abstract and keyword, and a total of 15,245 published papers were finally retrieved.

| Table 1 data retrieval conditions of soil remediation research literature |
|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| index type                  | SCI-EXPANDED, SSCI, CPCI-S, CPCI-SSH, ESCI |
| Literature category         | ARTICLE                     |
| time span                   | 1999-2018                   |
| retrieval results           | 15245 articles in total     |

3. Analysis of total published articles and annual changes
The number of published papers can reflect the scientific community's interest in the field, but also to a certain extent, the speed and degree of development of the field. The distribution trend of annual publication quantity is the mapping of literature quantity in time nodes, and it is also the specific performance of research heat over time[7]. Through the retrieval of WOS database from 1999 to 2018, a total of 15,245 articles were retrieved with soil remediation as the key word. The distribution of the scatter plot of global annual published articles is shown in Figure 1. As can be seen from Figure 1, the global studies on soil remediation increased at a steady speed and a linear trend from 280 papers in 1999 to 1,561 papers in 2017. Although the number of papers published in 2018 decreased to 1,352, it was still 4.8 times the global number of papers published in 1999. China started relatively late in this research field. As shown in Figure 2, only two papers on soil remediation were published in 1999, indicating that this period was the initial stage of soil remediation research in China, and it was a preliminary study involving this field. Since 2003, our country to repair the number of papers published in the field of soil in the growth of the leap, to 2018, our country on soil restoration subject number reached 564, accounts for 41% of the annual global number, in recent years, the soil reparative related problems began to attach great importance to by the researchers, research in this field and the heat is becoming more and more high.
In most literatures, researchers mainly analyzed the current situation of soil pollution in the study area, but lacked the investigation and research on the history of the study area. Researchers tend to analyze the soil pollution situation in the study area according to the existing materials, and propose treatment measures based on the evaluation of the current state. However, the degree of soil pollution has been accumulated for a long time. Therefore, it is necessary to investigate the history of the study area to find out the causes of soil pollution in the study area.

4. Analysis of the change trend of the topic

The change of publication trend can be analyzed according to the research keywords, and the mutation of keywords can represent whether a particular keyword is a research hotspot, thus forming the mutation words. Mutant words refer to the keywords or phrases whose contribution of word frequency changes significantly in different time Windows, and the change trend shows a sudden rise or a sudden decline. By tracking the change of word frequency contribution of keywords in different time Windows, that is, whether the topic is suddenly enhanced or weakened in different time Windows, the change trend of the general topic in the research field can be found.

The extraction of mutant words is to calculate the contribution degree of keyword frequency in a certain time window and to lock the mutant words through the mutation degree of word frequency contribution. Wherein, the calculation formula of the contribution degree of word frequency in a certain time window is:

$$C(i, n) = \frac{freq(I,n) \times \text{doc}(all)}{freq(I,all) \times \text{doc}(n)}$$

(1)

$C(i,n)$ represents the contribution of word frequency change of keyword I in time window n; $\text{Freq(I,n)}$ represents the word frequency of keyword I in time window n; $\text{Freq(I,all)}$ represents the total word frequency of keyword I; $\text{Doc(n)}$ represents the number of literatures produced within the time window n; DOC (ALL) represents total literature output. In order to eliminate the influence of different
scale of literature output on keyword contribution in different time Windows, the ratio of DOC (n) and DOC (all) is used to standardize the formula.

The mutation words in the literature of soil remediation were extracted according to the contribution of word frequency. Taking five years as a time interval, the contribution degree of the mutation words appearing in the literature keywords in each time period was counted, and the mutation words were extracted according to the change in the contribution degree of the mutation words. A total of 18 mutation words were extracted in this paper. They are heavy-metals, phytoremediation, contaminated soil, cadmium, bioavailability, polycyclic aromatic hydrocarbons, immobilization, plants, toxicity, bacteria, iron, buffer, sorptive, soils, zinc, kinetics, transport and hydrocarbons. The topic represented by the keywords with frequency mutation is more likely to be the direction of the topic evolution of the subject field in the future. In the research of literature in the discipline field, the weight of mutation and the time period of mutation can help to analyze the rise, development and fading process of research hot spots in the discipline research field. The mutants also include ascending mutants and descending mutants. By summarizing the time variation trend of the contribution of word frequency of mutant words, the topic mutation types of mutant words can be represented.

5. Conclusion
(1) In the past 20 years, the total number of papers published in the field of soil remediation has shown a steady growth trend, and the scientific community has paid more and more attention to the field of soil remediation.

(2) Rising type mutation term mainly embodied in the bioremediation of heavy metal pollution, and chemical remediation technology from three aspects, the rise in the three type of mutation word more, heavy metals, cadmium pollution and polycyclic aromatic hydrocarbons, toxicity, has gradually become the attention hot spot of scientific research workers, especially the bioremediation of phytoremediation, bioavailability, fixed plants, bacteria, EDTA, such as theme, these research topics and the future research hot spot and the core

(3) Mutation words are mainly reflected in the research of physical repair technology, and the research heat shows a gradual decline to a steady state. Physical remediation technology has been developed relatively mature, and the research on such topics as adsorption, kinetics, migration, migration, etc., has become less popular. There are certain limitations in the future research on these topics.

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