

Analysis of changes in the subject of soil remediation in recent 20 years

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Abstract: In order to understand the global research status and development trend of the field of soil pollution remediation, based on the Web of Science (WOS) database, this paper uses the bibliometric method to count the SCI papers in this field from 1999 to 2018, and quantitatively detect the development trends of the subject in this field. The study found that the number of papers published in the global soil remediation field increased linearly with the year, and the number of papers published in China showed an exponential growth trend with the year, indicating that China's attention to this field is getting higher and higher. The analysis of the word frequency contribution of mutants shows that from 1999 to 2018, the research on soil heavy metal pollution, bioremediation and chemical remediation technology in the field of soil remediation has been the focus and core topic of current research, while the research on physical remediation technology has been decreasing.

1. Introduction

Soil is an important natural resource, the material basis on which human beings depend for survival and development, and an important part of the ecological environment. It is a living natural body with life, and it has certain purification ability and has pollutants. A certain amount of cushioning works, but the carrying capacity of this capacity is also limited [1-2]. With the rapid development of economic globalization, the intensity of land use has also been rapidly and continuously increasing. The pollution problems caused by the development process have become more prominent and serious, while the pollution of industries and cities and the types of agricultural chemicals have increased. The increase in the number makes the soil pollution increasingly serious [3-5]. At present, the issues of food, resources and environment facing the world are inseparable from the soil.

Bibliometrics can objectively and quantitatively reflect the macro development trend of a certain discipline, and it has been adopted by many disciplines [6]. It is an effective way and method to

explore the layout and development trend of scientific research from the perspective of bibliometrics [7-8]. By database search on the Web of Science (abbreviated WOS), in 1999--2018 years to publish academic papers related to soil remediation have 15245. Due to the various factors that cause soil pollution and the variety of soil remediation, it is difficult for scientific researchers to grasp and sort out the information on the distribution of literature achievements in the field of soil remediation, the distribution of scholars' contributions, and key research hotspots. Therefore, this study intends to discuss the research status, research priorities and development trends in this field from the perspective of bibliometrics, for the development of soil environmental disciplines, the planning of research layout, and for the innovation of soil pollution remediation technology in China, agricultural environmental protection and government Provide reference and reference for decision-making of management department.

2. Data source

The research data comes from the five sub-libraries of "SCIE", "SSCI", "CPCI", "CPCI-SSH" and "ESCI" in the core database of Web of Science (WOS). The documents included in this database cover the most important and influential research achievements in the world, and are the most important search platform in the field of natural science recognized by the world. The literature search time span is from 1999 to 2018, the search keyword is "soil remediation", and the field is "subject", which contains the title, abstract and keywords, and the total number of published articles finally retrieved is 15,245.

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. Research methods

3.1 Subject type division

According to the different roles of themes in the field, this article divides the subject terms into three categories: core themes, general themes and emerging themes. The core topic in the field represents the main research content of the field in the core position of the word group; the feature of the topic is that the high-frequency words are the center and the distribution is relatively concentrated, with a certain word group size. Generally, the core theme will not show a sudden change in the near time window. The general topic is less important than the core topic in the field. The medium frequency words or medium frequency word clusters are the main ones. The word groups are scattered in the field and the distribution scale is small. There are a large number of general themes, and you can focus on monitoring keywords with sudden changes in order to discover the trend of general themes. Emerging themes are some sporadic new words or phrases that have not formed the scale of word groups, but they may grow into core themes.

Table 2 Types and characteristics of subject terms

category	characteristic	Feature expression
Core theme	The distribution is concentrated, with high-frequency words as the center, forming a certain word group scale	Core words
General topic	The distribution is scattered, with intermediate frequency words or intermediate frequency word clusters as the main, and the word cluster is small	Mutation words
Emerging topics	Sporadic distribution, dominated by newly appeared words or phrases, without forming word groups	New words

3.2 Extraction of mutant words

The extraction of mutation words essentially calculates the contribution of keywords in different time windows, and locks the mutation words through the mutation of the contribution of the word frequency. Among them, the calculation formula of word frequency contribution in a certain time window is:

$$C(i, n) = \frac{freq(i, n) \times doc(all)}{freq(i, all) \times doc(n)} \quad (1)$$

In the formula, $C(i,n)$ represents the word frequency change contribution of keyword i in time window n ; $freq(i,n)$ represents the word frequency of keyword i in time window n ; $freq(i,all)$ represents keyword i The total word frequency of; $doc(n)$ represents the number of documents produced in the time window n ; $doc(all)$ represents the output of all documents. In order to eliminate the impact of the different scales of document output in different time windows on the contribution of keywords, the formula uses the ratio of $doc(n)$ and $doc(all)$ to standardize.

4. Results and analysis

According to the word frequency contribution, the mutation words in the soil remediation literature are extracted. Taking five years as a time interval, count the word frequency contribution of mutation words in the literature keywords in each time period, and extract mutation words according to the change of word frequency contribution. There are 18 mutation words extracted in this article ,respectively are heavy-metals, phytoremediation, contaminated soil, cadmium, bioavailability, polycyclic aromatic-hydrocarbons, immobilization, plants, toxicity, bacteria , iron , edt, sorptio, soil, zin, kinetics, transport, hydrocarbons. The themes represented by the keywords with frequent sudden changes are more likely to be the direction of future theme evolution in the subject field. In the research on the subject field literature, the mutation weight of the mutation word and the mutation occurrence time period can help analyze the rise, development and decay process of the research hotspot in the subject research field. Mutation words also include ascending mutation words and descending mutation words. By summarizing the temporal change trend of the frequency contribution of mutation words, we can characterize the type of theme mutation.

4.1 Ascending mutation

The characteristic of rising theme mutations is that the frequency of changes gradually shows an upward trend over time, and the research trend is gradually strengthened. From 1999 to 2018, a total of 12 rising mutation words were extracted from papers in the field of soil remediation, and the period from 1999 to 2018 was divided into 4 time windows. Window 1 was 1999 to 2003, window 2 was 2004 to 2008, window 3 was from 2009 to 2013, window 4 was from 2014 to 2018.

According to calculations, a total of 12 ascending mutation words are found: heavy-metals, phytoremediation, contaminated soil, cadmium, bioavailability, polycyclic aromatic-hydrocarbons, immobilization, plants, toxicity, bacteria, iron, etc. From the perspective of the development trend of the word frequency contribution of 12 mutant words, except for contaminated soil and immobilization, the largest mutation rates of the other 10 words all occurred in the 2004-2008 time window, indicating that this time period is the direction of soil remediation research. During a period of transition, higher attention and breakthroughs in research results began in areas that were less involved in the early stage. From 2009 to 2018, the frequency contribution of these 10 words remained relatively stable, indicating the research enthusiasm and attention of these keywords are still at a high level.

4.2 Descending mutation

Declining theme mutation refers to the type of theme change whose frequency is decreasing year by year. Its characteristic is that it has evolved and developed into a mature theme, and the research enthusiasm has gradually weakened and stabilized. According to calculations, it is found that there are 6 descending mutation words in all mutation words: sorption, soil, zinc, kinetics, transport, hydrocarbons. The word frequency contribution of the 6 descending mutation words are all negative in the 2-3 and 3-4 windows, indicating that the research interest of descending mutation words is showing a gradual decline.

5. Conclusion

(1) The rising mutation word represents the hotspot and core of future research in this field. The future research directions in the field of land restoration are mainly reflected in three aspects: heavy metal pollution, bioremediation technology and chemical restoration technology.

(2) Declining mutant words mean that these words have been research hotspots in the past, but with the development of time, the subject research of this type has become more and more mature, and there are certain limitations in the research, so the research interest will decrease in the future. In the field of soil pollution remediation, the descending mutation word is mainly reflected in the research of physical remediation technology.

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