Study on the changing trend of soil remediation theme

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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 bibliometric survey on the SCI papers in this field from 1999 to 2018, and quantitatively explored the development and change trend of the topic in this field. According to the analysis of the word frequency contribution of mutation words, the research on soil heavy metal pollution, bioremediation technology and chemical remediation technology in the field of soil remediation research has been the current hotspot and core topic, while the research on physical remediation technology has paid less and less attention.

Keywords

WOS database; Soil remediation; Thematic trend; Mutations in the word.

1. Introduction

Soil is an important natural resource, the material basis for human survival and development, and also an important part of the ecological environment. It is a living natural body with life, and it has a certain purification ability and a certain buffer against pollutants, but the carrying capacity of this ability 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 caused by the development process is 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 chemical substances make the soil pollution increasingly serious [2].

Bibliometrics is the interdisciplinary science of quantitative analysis of all knowledge carriers using mathematical and statistical methods. Bibliometrics can objectively and quantitatively reflect the macro development trend of a certain discipline, and has been adopted by many disciplines [3]. In agriculture, forestry, environmental science, new energy utilization and other aspects, scholars have done a lot of bibliometric analysis, and the research methods are relatively mature [4-7]. Some scholars have also done relevant analysis in the fields of soil pollution remediation, soil heavy metal pollution, soil and water conservation research, soil aggregate research, etc. [8-11].

According to Web of Science (WOS) database search, 15,245 academic papers related to 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. Therefore, this study intends to discuss the research status, focus and development trend of this field from the perspective of bibliometrics, so as to provide reference and reference for the development of soil environment discipline and the planning of research layout.

2. Data source

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 for short). The literature retrieval span from 1999 to 2018, with the keyword "soil remediation" and the field "topic", including titles, abstracts and keywords, finally retrieved a total of 15,245 published papers.

3. Research methods

3.1. Classification of topic types

According to the different functions of the subject in the field, this paper divides the subject words into three categories: core theme, general theme and emerging theme.

Table 1 types and characteristics of subject words

category	characteristic	Feature representation word
core themes	Concentrated distribution, with high-frequency words as the center of clustering, forming a certain word group size	core word
General themes	Scattered distribution, give priority to with intermediate frequency words or intermediate term clusters, word group is small	Burst Terms
Emerging themes	Sporadic distribution, mainly new words or phrases, did not form a word group	Coinage

3.2. Extraction of Burst Terms

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

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

C(I,n) represents the contribution of word frequency change 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 the total word frequency of keyword I; 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 the contribution of keywords in different time Windows, the ratio of DOC (n) and DOC (all) is used to standardize the formula.

4. Results and analysis

4.1. Analysis of the change trend of the theme

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

word frequency of mutant words in literature keywords in each time period was counted, and the mutant words were extracted according to the change in the contribution degree of word frequency. A total of 18 mutant words were extracted in this paper. They are heavy-metals, phytoremediation, contaminated soil, cadmium, bioavailability, and polycyclic Aromatic - carbocarbons (polycyclic aromatic hydrocarbons), immobilization (solid), plants (plants), toxicity (bacteria), iron (iron), EDTA (buffer), and sorptive (inhalation) (ii), soils, 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 study 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 can be represented.

4.2. Ascending Burst Terms

The characteristics of ascending topic mutation are that the frequency of change gradually increases with time, and the research trend gradually intensifies. From 1999 to 2018, 12 ascending mutation words were extracted from papers on soil remediation, and the years 1999-2018 were divided into four time Windows: window 1 was 1999-2003, window 2 was 2004-2008, and window 3 was 2009-2013. Window 4 is from 2014 to 2018. The word frequency contribution degree and the change rate of the word frequency contribution degree of the four time Windows were calculated, as shown in Table 2.

Table 2 Ascending subject words and word frequency contribution

Burst Terms	Contribution of word frequency				Change rate of word frequency contribution		
	1999-2003	2004-2008	2009-2013	2014-2018	window 1-2	window 2-3	window 3-4
heavy-metals	0.437	0.823	1.065	1.168	0.386	0.242	0.103
phytoremediation	0.464	0.883	1.026	1.161	0.419	0.143	0.136
contaminated soil	0.444	0.707	1.122	1.176	0.263	0.415	0.053
cadmium	0.611	0.927	1.039	1.100	0.317	0.112	0.061
bioavailability	0.541	1.076	1.014	1.075	0.535	-0.062	0.061
polycyclic aromatic-hydrocarbons	0.546	0.906	1.212	1.021	0.361	0.305	-0.191
immobilization	0.412	0.749	0.811	1.354	0.337	0.062	0.544
plants	0.489	0.944	1.007	1.143	0.455	0.062	0.137
toxicity	0.520	0.892	1.076	1.114	0.372	0.185	0.038
bacteria	0.456	0.894	0.975	1.190	0.438	0.081	0.215
iron	0.444	1.065	1.107	1.048	0.621	0.042	-0.058
edta	0.482	1.288	1.178	0.911	0.806	-0.110	-0.267

As can be seen from Table 2, the development trend of word frequency contribution of the 12 mutation words indicates that, except for contaminated soil and immobilization, the maximum mutation rate of the remaining 10 words occurred in the 2004-2008 time window, indicating that this period is a period of transformation in the direction of soil remediation research. From 2009 to 2018, the contribution of the word frequency of these 10 words remained in a relatively

stable state, indicating that the research heat and attention of these keywords were still in a relatively high state.

4.3. Declining Burst Terms

Decline topic mutation refers to the topic change type whose frequency decreases year by year. It is characterized by that the topic has evolved into a mature topic and its research popularity gradually weakens to a stable level.

Table 4 Declining keywords and word frequency contribution

Burst Terms	Contribution of word frequency				Change rate of word frequency contribution		
	1999-2003	2004-2008	2009-2013	2014-2018	window 1-2	window 2-3	window 3-4
sorption	1.285	1.078	0.940	0.936	-0.206	-0.138	-0.005
soils	1.213	1.274	1.058	0.808	0.060	-0.216	-0.250
zinc	1.029	1.271	1.182	0.780	0.242	-0.089	-0.402
kinetics	1.117	1.509	1.029	0.759	0.392	-0.480	-0.270
transport	1.179	1.282	1.146	0.760	0.103	-0.136	-0.386
hydrocarbons	1.377	1.123	1.153	0.769	-0.254	0.030	-0.384

The change trend of word frequency contribution of mutant words in each time window was compared. It is found that the contributions of hydrocarbons, Zinc, Kinetics, sorbent, Transport, and Soils have all declined since 2008. Therefore, in the field of soil remediation, The research on these words as keywords has gradually declined and received less attention, but the research on the combination of soil and other words has become more and more popular.

5. Conclusion

(1) The ascending mutation words are mainly reflected in the three aspects of heavy metal pollution, bioremediation technology and chemical remediation technology, and there are more ascending mutation words in these three aspects. Heavy metal, cadmium pollution, polycyclic aromatic hydrocarbon compounds, toxicity and other topics have gradually become the focus of scientific research workers. In particular, phytoremediation, bioavailability, plant fixation, bacteria, EDTA and other topics in bioremediation represent the focus and core of future research.

(2) Decline mutant 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, and there are certain limitations in the future research on these topics.

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