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Trends and Frontiers of International Soil Remediation Research-based on WOS Database

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Abstract

The data set of soil remediation from 1988 to 2018 in the Web of Science database was analyzed by bibliometrics to clarify the current research trends and hotspots of soil remediation in the field of quantitative analysis and global vision. The results showed that The hot topic groups of the identified soil remediation studies are divided into heavy metal pollution, Organic pollution, Solute transport, and electro-remediation technology by keyword clustering and knowledge graph analysis. Heavy metal pollution research will still rank first, followed by organic pollution research in the next five years by hotspot prediction. Bioremediation and chemical leaching technology will continue to be hotspots. Phytoremediation, curing stabilization, and electro-remediation technology will increase attention in the future. The results have direct guidance value for grasping the dynamics and frontiers in the field of soil remediation and doing related research work.

Keywords

Soil remediation; Bibliometric method; Hot topic.

1. INTRODUCTION

Soil, as a limited natural resource, is an important component of terrestrial ecosystem, but soil pollution has become a serious environmental problem affecting the safety of agricultural products and aquatic ecosystems. Contaminated soil significantly reduces arable land[1-2], and although most organic compounds and inorganic metals are released into the atmosphere or water, they accumulate in the soil. About 90% of the world's environmental Polycyclic aromatic hydrocarbon (PAHs) are found in soil, including several human carcinogens. Human health is threatened by the consumption of vegetables and crops grown in contaminated soil [3] . In order to protect the root of everything and prevent further deterioration of soil, many countries have carried out contaminated soil remediation research [4] . Soil remediation technology has covered many aspects of chemistry, biology, agricultural ecology and electrodynamics in the development of several decades [5] . In the process of research, new research ideas, methods and means are introduced to improve the research system of soil remediation. However, the rapid development of soil remediation research is not consistent with the demand for multi-disciplinary research in the future. In order to better comb the development of soil remediation

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research, focus on the key processes and bottlenecks in soil remediation, and explore the evolution of soil remediation research, information in this area needs to be Quantitative analysis.

Bibliometrics is the study of the distribution structure, quantitative relationship, change law and quantitative management of document information by means of mathematical and statistical methods, then it discusses some important subjects of structure, characteristic and law of science and technology [6]. The problem-oriented map of scientific knowledge not only provides the visual knowledge graph, but also produces the serialized knowledge genealogy [7]. This paper analyzes the current research situation and development trend in the field of soil remediation by bibliometrics, and forecasts the research hotspots and development trend in the field of soil remediation to a certain extent, it is helpful for soil remediation researchers in China to grasp the essence of higher subject in this homologous field. The research results can provide guidance for the planning and implementation of soil remediation in the future, and promote our soil remediation to a deeper level.

2. DATE SOURCES

The data comes from the Web of Science Core Collection, which includes five subrepositories, Science Citation Index Expanded, Social Sciences Citation Index, Conference Proceedings Citation Index-Science, Conference Proceedings Citation Index-Social Science & Humanities, and Emerging Sources Citation Index. From 1988 to 2018, a total of 13,917 published journal articles were retrieved with the keyword “Soil remediation” and the field “Subject”, including titles, abstracts and keywords. The search date is January 18,2019. Wos-derived literature records include titles, authors, abstracts and keywords, and cluster analysis is carried out by using Vosviewer.

3. RESEARCH HOTSPOTS OF SOIL REMEDIATION

There are 395 keywords with more than 50 frequency in the field of soil remediation research, and 4 subject groups were identified, they are heavy metal pollution, organic pollution, solute transport in contaminated soil, electrokinetic remediation technology (Figure 1) . Among them, phytoremediation technology is closely integrated with the fields of heavy metal pollution and organic pollution. As a link between the two, phytoremediation is of great significance in the research of soil remediation.

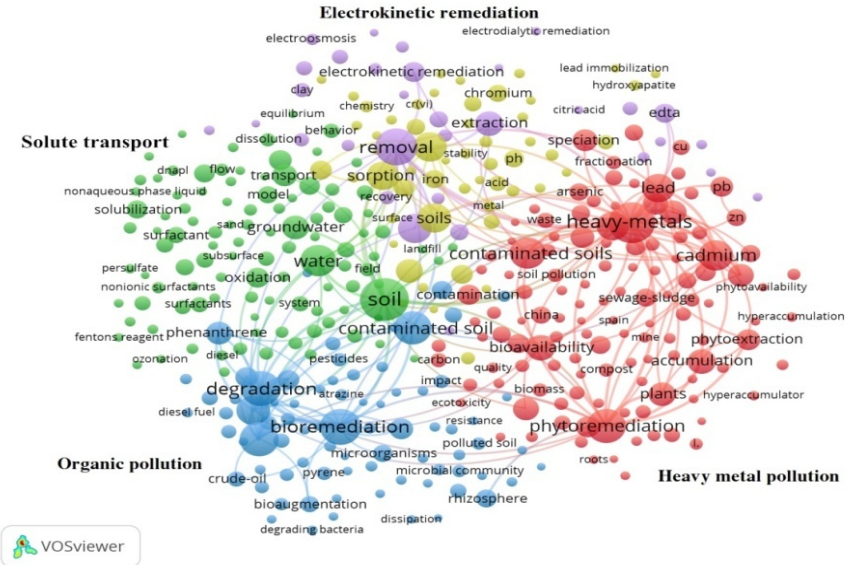

Figure 1. Cluster map of soil remediation research area

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In the field of heavy metal pollution, the main research fields are heavy metal pollution types and phytoremediation technology, the restoration technologies with high attention include phytoremediation, bioavailability, and plant extraction. In the direction of solute transport in contaminated soil, leaching techniques and oxidation and dissolution techniques are mainly studied. The popular direction is to increase the leaching effect of soil infiltration zones by means of zero-valent iron, trichloroethene, Surfactant, at the same time, the volatilization, transport and solubilization of contaminated soil solute are concerned. In the field of organic pollution, we mainly study the types of organic pollution and bioremediation technology. Studies have focused on bioremediation, biodegradation, and bioaugmentation of remediation Polycyclic aromatic hydrocarbon, arsenic-containing organic compounds, and crude oil. Electrokinetic remediation technology is closely related to the field of heavy metal pollution. As a new research direction, electrokinetic remediation technology is under the action of external electric field, direct current drives the migration of soil pore water and charged ions, and makes ions accumulate near the electrode. The research in this direction focuses on the removal of pollutants by electroosmosis with EDTA, chelating agent. Electrodynamic remediation technology is not only a soil remediation technology, but also can be applied in land engineering such as construction land preparation and soil contamination monitoring.

3.1. Research hotspots of pollution types

In the next 5 years, heavy metal pollution types will continue to be the first research focus, especially for chromium, lead, copper and other heavy metals. Organic pollution is the second most popular research area, particularly in Polycyclic aromatic hydrocarbon and arsenic-containing organic compounds. Heavy metal pollution is a hot topic in the field of soil remediation, and it will still be concerned by domestic and foreign scholars in the future. On the one hand, due to the continuous reduction of organic contaminated sites, the natural degradation of organic pollutants makes the need for centralized treatment of low-concentration contaminated sites less, and on the other hand, heavy metal pollution continues to increase, the new area of pollution expanded, so that the treatment of heavy metal pollution has been widely concerned. Under the condition of economic and social development, heavy metal pollution is caused by improper industrial and agricultural production while pursuing economic benefits, various ways of improper disposal, such as rainwater leaching of open-pit tailings and waste mines, irrigation of sewage containing heavy metals and application of chemical fertilizers, and waste batteries and thermometers entering the soil directly or indirectly, it makes the content of heavy metals in soil exceed the standard, and affects the quality of agricultural products, which is a threat to human health. Therefore, the study on remediation of heavy metal pollution in soil can effectively reduce the risk of human health and environmental damage.

For our country, the following remediation of heavy metal contaminated soil should be carried out from the ecological point of view, and at the same time, the original physical and chemical properties and ecological characteristics of soil should be maintained or enhanced, to achieve ecological conservation and restoration. Based on the fact that each remediation method has its own scope of application and advantages, it is necessary to avoid using it alone and combine the physical, chemical and biological methods to take advantage of its advantages, to obtain ecological environmental protection, low-cost restoration program. It is suggested that the mechanism of soil remediation should be studied deeply, the selection of complex remediation plants should be strengthened, the breeding and domestication of existing soil remediation plants should be strengthened, the biomass and growth rate should be increased, and the remediation efficiency should be accelerated To carry out multi-plant combined remediation, to study microbial combined phytoremediation, to explore the role of plant

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rhizosphere and rhizosphere microorganisms on phytoremediation, and to develop and apply plant-based soil remediation agents.

The research of organic pollution is second only to heavy metal pollution. Organic pollutants are mainly Polycyclic aromatic hydrocarbon and arsenic-containing organic compounds. PAHs (Polycyclic aromatic hydrocarbon acid) are highly polluting and Polycyclic aromatic hydrocarbon in part because of rapid urban development, increased consumption of fossil fuels, and incomplete combustion of fossil fuels, on the other hand, the application of organic pesticides and insecticides from agriculture has become the biggest pollution source in China. Arsenic is a ubiquitous element that can be found in some 240 minerals in soil and groundwater. Arsenic-containing organic compounds can co-exist with other heavy metals, and arsenic is carcinogenic and can be released and transported into the soil environment through various routes. For organic pollutants, the agricultural chemicals atrazine, chlorpyrifos and dichlorodiphenyl trichloroethane are the main focus of research in China. It is suggested to study the optimal conditions and enhanced degradation methods for different biodegradation of PAHs, and to continue to explore the removal methods and degradation mechanism of high-cyclic PAHs. The focus of this study was shifted to the actual remediation of PAHs-contaminated soil in farmland.

3.2. Research hotspots of restoration technology

In the next five years, bioremediation, chemical leaching and institutional control, as traditional remediation technologies, will continue to be hot spots, plant Remediation, solidification/stabilization, and electrokinetic remediation technologies will continue to receive increasing attention in the future. In the process of sustainable development of soil remediation technology, the development process of different kinds of technologies is different. Phytoremediation has become a research hotspot in the world since the end of 1990s, with an increase of more than 10% in recent 10 years. After a technical peak period of gas extraction and incineration, the R & D investment is reduced. Bioremediation, chemical leaching and other technologies have been maintaining a relatively stable number of research. Phytoremediation, solidification/stabilization, and electrokinetic remediation are the new hot spots in the last decade, and bioremediation, chemical leaching and institutional control have been paid much attention to as traditional remediation technologies. Domestic restoration technology is mainly based on chemical leaching, immobilization, redox regulation and pharmaceutical R & D, while more attention is paid to incineration, gas extraction and other equipment or process imported technology, influenced by the international phytoremediation technology, and the domestic policy and guidance of soil remediation, phytoremediation technology has also become a domestic research hotspot.

In addition, biochar will become a hot material for soil remediation because of its low price and easy application. With the acceleration of industrialization in our country, the problem of soil pollution is becoming more and more serious. In the next few years, China will become a hot research area of soil remediation. In the future research of soil remediation, we should not only regard the soil as a single factor, but also regard the soil as an organic life complex, the research direction will pay more attention to the human settlement environment.

4. CONCLUSION

The hot topics of soil remediation include heavy metal pollution, organic pollution, solute transport and electrokinetic remediation. In the next few years, the research on heavy metal pollution will remain the first, followed by the research on organic pollution, the future of phytoremediation, solidification/stabilization, and electrokinetic remediation will be of increasing interest. The research results have direct guiding value for grasping the trends and frontiers in the field of soil remediation and doing related research work well.

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REFERENCES

[1] Fent K. Ecotoxicological effects at contaminated sites [J].Toxicology, 2004, 205(3):223-240.

[2] Ji, Z., Pei, Y.. Bibliographic and visualized analysis of geopolymer research and its application in heavy metal immobilization: A review[J]. Journal of Environmental Management, 2019, 231, 256-267.

[3] Panagos P, Van Liedekerke M, Yigini Y, et al. Contaminated Sites in Europe: Review of the Current Situation Based on Data Collected through a European Network[J]. Journal of Environmental and Public Health, 2013, 2013:1-11.

[4] Mao G, Shi T, Zhang S, et al. Bibliometric analysis of insights into soil remediation[J]. Journal of Soils and Sediment,2018(18):2520-2534.

[5] Rene, E. R., Shu, L., Lens, P N L , Jegatheesan, J. V. Tools, techniques, and technologies for pollution prevention, control, and resource recovery[J]. Environmental Science and Pollution Research, 2018,25, 5047-5050.

[6] Toth, G., Hermann, T., Da Silva, M. R, Montanarella, L. Heavy metals in agricultural soils of the European Union with implications for food safety[J]. Environment International, 2016,88, 299-309.

Hussain, I.,Aleti, G., Naidu, R., Puschenreiter, M. Microbe and plant assisted-remediation of organic xenobiotics and its enhancement by genetically modified organisms and recombinant technology: A review[J]. Science of The Total Environment, 2018,628, 1582-1599.