Research Status of Soil Organic Remediation -- Visual Analysis of Literature Based on Web of Science Database

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Abstract. In order to understand the latest research progress, research trend and future research hotspot of remediation of soil organic pollutants at home and abroad, this paper uses the core database of web of science and its own literature analysis tools, vosviewer visual analysis software and origin, etc., and publishes the top 10 countries (regions) in the amount of papers and publications at different times, research institutions, research directions, journal sources and other types of published literature on remediation of soil organic pollutants were analyzed. The results showed that: with the growth of time, the number of publications increased gradually; China, the United States and Spain ranked in the top 3, among which China had 9 organizations in the top 10; the journal with the most publications was Chemosphere, while the journal with the most citations was Water Research, indicating that the remediation of soil organic pollution mostly drew lessons from the remediation of water organic pollution.

Keywords: Soil, organic pollution, remediation, Bibliometrics.

1. Introduction
In recent years, due to the expansion of human industrial activities and the needs of agriculture, soil organic pollution caused by sewage irrigation, factory leakage and pesticide abuse has attracted great attention [1-3]. These exotic organic pollutants caused by the source can be transported by air or water for a long distance, and finally accumulate in the soil, thus endangering the ecosystem and human health [4, 5]. Therefore, based on human health and environmental safety, the remediation of soil contaminated by organic pollutants has important practical significance.

Remediation of soil organic pollution mainly includes physicochemical remediation, bioremediation, chemical and biological remediation, etc. [6-8] In physical remediation, the removal or fixation of organic pollutants are mainly carried out by the methods of external soil, gas phase stripping and thermal desorption [9, 10]. Chemical remediation mainly includes ozone oxidation,
photocatalytic oxidation, leaching, microwave oxidation, redox, reductive dechlorination, proton transfer and other methods, which can realize the remediation of soil organic pollution by degrading or transforming organic pollutants into low toxic or non-toxic substances [11]. Due to the quick effect of chemical remediation, it is often used as a preliminary means of remediation. However, chemical remediation has the characteristics of large amount of chemical reagents and high cost, so it is generally combined with physical and biological remediation. Bioremediation mainly includes microbial remediation, phytoremediation and animal remediation. Bioremediation is the process of removing pollutants from soil and water through microbial metabolism, which includes the degradation or harmless process of pollutants under natural and man-made control conditions. Phytoremediation is the use of plant growth, the extraction and fixation of plants to remove organic pollutants in contaminated soil, and then part of the organic pollutants can be decomposed by plant metabolism. Phytoremediation has the advantages of low cost, no damage to soil and no secondary pollution.

Bibliometrics is a method of quantitative analysis of published literature. Through the analysis of the collected statistical data, we can find out the law of change, and then predict the future development trend. At present, bibliometrics has been applied in medicine, chemistry, biology, environment, agriculture, materials, etc. The purpose of this paper is to study the new methods, new materials and new technologies to solve the remediation of organic pollution in soil from the field of bibliometrics, to find out the leading countries and institutions at present, and to predict the future research direction and trend through the analysis of research hotspots and hot keywords, so as to make a guiding work for the future research on the remediation of organic pollution in soil.

2. Method

2.1. Data sources
Using the web of science database of Thomson Reuters, the search period is from January 1, 2000 to November 11, 2019, with the key words of (organic contacts * or organic polymers * and soil removal * or soil control * or soil removal * or soil treatment * or soil repair * or organic contacts removal *). The paper type is "article".

In the web of science core collection database, 7714 research papers on remediation or solution of soil organic pollution published in 2000-2019 were searched.

2.2. Analysis tools
The bibliometric analysis of different types of literature was carried out by the analysis method in web of science, the mapping was carried out by origin9.1, and the analysis of different types of connections was carried out by vosviewer.

3. Result Analysis

3.1. Number of published papers
Figure 1 lists the annual number of papers on remediation of organic pollutants in soil from 2000 to 2019. It can be seen from Figure 1 that the number of papers on remediation of organic pollutants in soil is on the rise. Before 2009, only less than 100 papers were published every year, indicating that people did not pay enough attention to the remediation of organic pollutants in soil before 2010. In addition, because SCI evaluation requires more innovation, it also reflects that there is no big breakthrough in remediation of organic pollutants in soil before 2009. However, in 2010, the number of papers on remediation of organic pollutants in soil increased to 347, and with the passage of time, the number of papers published in 2019 reached 1393, which indicates that after 2010, researchers all over the world pay more attention to remediation of organic pollutants in soil, which may be due to the increasingly serious problem of soil organic pollution, forcing researchers to solve the problem of soil pollution Remediation of soil organic pollution.
3.2. Countries and regions
The amount of papers published by different countries and regions on remediation of organic pollutants in soil indicates that the country attaches great importance to this kind of problem. According to the number of published papers on remediation of organic pollutants in soil retrieved from web of science database, table 1 lists the top 10 countries with published papers on remediation of organic pollutants in soil. Among them, China and the United States ranked the top two in terms of the number of papers published. This may be due to the fact that both China and the United States are big countries in land resources. In China, due to the rapid industrialization process in the past, a large number of soil was polluted by organic matter. Therefore, China urgently needs to solve the problem of remediation of soil organic matter pollution.

| Country / Region       | Number of papers | % of 7714 |
|------------------------|------------------|-----------|
| PEOPLES R CHINA        | 2528             | 32.772    |
| USA                    | 1299             | 16.840    |
| SPAIN                  | 595              | 7.713     |
| AUSTRALIA              | 377              | 4.887     |
| GERMANY                | 374              | 4.848     |
| CANADA                 | 367              | 4.758     |
| ITALY                  | 312              | 4.045     |
| INDIA                  | 301              | 3.902     |
| SOUTH KOREA            | 275              | 3.565     |
| FRANCE                 | 269              | 3.487     |

Figure 1. The number of papers published in 2000-2019.
3.3. Research institutions

The amount of papers published by different research institutions represents the academic research and technical strength of the institution, and different research institutions have their own research directions. Therefore, in order to understand the current strength of research institutions related to soil organic pollution remediation, this paper obtains the top 10 institutions by statistics, and lists them in Table 2. Among them, among the top 10 institutions in the field of remediation of organic pollutants in soil, there are 9 in China, indicating that China has the most extensive research on remediation of organic pollutants in soil. In addition, the Chinese Academy of Sciences published the most papers, and the number of papers published by the Chinese Academy of Sciences was three times that of the second, indicating that the Chinese Academy of Sciences occupied a dominant position in the field of soil organic pollutants remediation. Wollongong university is also in the forefront of remediation of soil organic pollutants. This may be because Australia is a big agricultural country, and its economy is more dependent on agriculture and animal husbandry, so it pays more attention to remediation of soil organic pollutants.

Table 2. Number of papers published by different research institutions.

| institutions                   | Number of papers | % of 7714 |
|-------------------------------|-----------------|-----------|
| CHINESE ACAD SCI              | 392             | 5.082     |
| ZHEJIANG UNIV                 | 129             | 1.672     |
| TONGJI UNIV                   | 115             | 1.491     |
| TSINGHUA UNIV                 | 113             | 1.465     |
| UNIV CHINESE ACAD SCI         | 105             | 1.361     |
| HARBIN INST TECHNOL           | 102             | 1.322     |
| UNIV WOLLONGONG               | 80              | 1.037     |
| CHINA UNIV GEOSCI             | 75              | 0.972     |
| NANJING UNIV                  | 74              | 0.959     |
| PEKING UNIV                   | 72              | 0.933     |
analyzing the key words of all published papers and their connections, we can understand the current

3.5. Key words
The key words of the paper represent the research direction and key points of the paper. Therefore, by

Figure 3. The volume of documents issued by different organizations and their relationship.

3.4. Journals
The number of papers on remediation of soil organic pollution in the journal indicates the importance

Table 3. Top 10 journals.

| Journal                                             | Number of papers | % of 7714 |
|-----------------------------------------------------|------------------|-----------|
| CHEMOSPHERE                                         | 433              | 5.613     |
| SCIENCE OF THE TOTAL ENVIRONMENT                     | 404              | 5.237     |
| CHEMICAL ENGINEERING JOURNAL                        | 377              | 4.887     |
| JOURNAL OF HAZARDOUS MATERIALS                       | 307              | 3.980     |
| WATER RESEARCH                                      | 292              | 3.785     |
| ENVIRONMENTAL SCIENCE AND POLLUTION RESEARCH        | 286              | 3.708     |
| ENVIRONMENTAL SCIENCE TECHNOLOGY                     | 212              | 2.748     |
| DESALINATION AND WATER TREATMENT                     | 158              | 2.048     |
| ENVIRONMENTAL POLLUTION                              | 149              | 1.932     |
| SEPARATION AND PURIFICATION TECHNOLOGY               | 126              | 1.633     |

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research focus and direction of soil organic pollutants remediation. Figure 3 shows the most involved key words in the study of soil organic pollutants remediation and the relationship between the key words. It can be seen from the figure that removal has the highest frequency among all keywords and has the most connection with other keywords, indicating that in the remediation of soil organic pollutants, physical, chemical or biological removal from soil is the most important means of soil remediation. In the treatment of soil organic pollutants, physical adsorption and biological phytoremediation are both used to remove soil organic pollution through adsorption. As can be seen from Figure 4, adsorption occupies the second place in all keywords, indicating that all current composite remediation methods are designed for adsorption, which may be due to the fact that macromolecules occupy the main position in the current organic pollutants. Adsorption is an effective method to treat soil organic pollutants.

Among the types of organic pollution, polycyclic aromatic hydrocarbons (PAHs) appear more frequently and are related to each other, which indicates that the types of organic pollution in soil are mostly polycyclic aromatic hydrocarbons (PAHs), which indicates that the organic pollution is mostly polycyclic organic compounds which are difficult to degrade. Therefore, the Fenton Method of chemistry is more difficult to treat and uneconomic. The key words of biodegradation and their relations also occupy an important position, indicating that biodegradation is an important means to treat soil organic pollution. Based on the above analysis, it is more economical and effective to use physical and biological methods to treat soil organic pollutants. Physical methods such as gas phase extraction, thermal desorption and soil method are used for early rapid treatment, and then biological methods such as plant adsorption and biodegradation are used for long-term slow treatment to ensure long-term treatment of organic pollutants.

Figure 4. Keyword analysis of different papers and their interrelations.

4. Conclusion
Through bibliometric and visual analysis, it is found that China is in the leading position in the remediation of soil organic pollutants. Among many methods to solve this problem, removal and degradation are the most important remediation means. Therefore, how to quickly and economically remove and degrade soil organic pollutants is an important research direction in the future. Based on the analysis of the source of journals, it is shown that the remediation of organic pollutants in soil is mostly based on the remediation of organic pollutants in water. Therefore, how to better use the
existing remediation methods of organic pollutants in water is also an important research direction of the remediation of organic pollutants in soil in the future.

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