Research Status and Hotspot Analysis of Mine Wasteland Reclamation Based on Bibliometric Method

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Abstract. In order to reveal the research status and hot spots in the field of mine wasteland reclamation, this study uses the bibliometric method, uses CNKI database to retrieve the related literatures in the field of mine wasteland reclamation from 2000 to 2020, and makes a systematic analysis from the aspects of literature type, number of papers, keywords, main research institutions, fund projects and subject distribution. The results show that 856 papers were published from 2000 to 2020, and the number of papers increased from 2000 to 2014, reaching the highest in 2014. Colleges and universities play an important role in the research in this field. This paper analyzes the fund projects in this field. Most of them are funded by the state, and the state has given great support and attention to the research in this field.

1. Introduction
Mining wasteland refers to the land that is destroyed by mining activities and cannot be used without treatment. According to its nature and form, the mining wasteland mainly includes: ① the dump wasteland formed by the accumulation of stripped topsoil; ② the waste rock dump wasteland formed by the accumulation of mined rock fragments and low-grade ores; ② the waste rock dump wasteland formed by the accumulation of mined rock fragments and low-grade ores; ③ Mining pit wasteland formed by mined out area and collapse area after ore body mining; 4. Tailings wasteland formed by tailings accumulation after ore concentrate is selected; 5. Land occupied first and then abandoned by mining working face, mechanical facilities, mine auxiliary buildings and road traffic; 6. Land that cannot be used and developed due to mining influence [1].

In the 1980s, China's mine environmental protection work has made great progress, but on the whole, the trend of mine environmental deterioration has not been effectively curbed. There are more than 8000 state-owned mining enterprises and 230000 individual mines in China. The damage to land and environment caused by such a large number of mining is quite amazing. According to statistics, the total damaged land area of mining areas in China is 2.88 million Hm², and the annual growth rate is about 4.67 million hm² [2]. According to statistics, 16.2 million hectares of land have been completely damaged in medium-sized coal mines. In terms of iron ore, the output of iron ore has reached 100 million...
tons, of which 90% are open-pit mines, and the annual amount of stripped soil and rock is more than 200 million tons. Nonferrous metal industry discharges more than 60 million tons of solid waste every year, and the accumulated stock has reached 1 billion tons, occupying more than 70000 hm² of land [3]. The distribution of various types of land occupation in mining industry is 59% of mining activities, 20% of dump, 13% of tailings, 5% of waste rock heap and 3% of collapse area [4]. The ecological restoration of mining wasteland has become one of the urgent tasks in China, and also one of the priority issues in the implementation of sustainable development strategy.

With the development and prosperity of mining industry, a series of problems such as ecological damage, environmental pollution and so on caused people's great attention, especially the development of nonferrous metal industry makes the continuous discharge of toxic mining waste, which seriously pollutes the environment, and forms a large number of mining wasteland, causing serious and lasting pollution sources [5]. With the rapid development of China's national economy, the government and all sectors of the society pay more attention to the ecological environment protection, and the rapid growth of the demand for land resources. The pressure of environmental damage and shortage of land resources is increasing, which has become an important factor restricting China's social and economic development. The research on land reclamation and ecological reconstruction in mining areas has become an important research topic for the sustainable development of social economy in mining cities [6].

Bibliometrics is a method that takes the literature system and characteristics as the research object, adopts quantitative research methods such as statistics and Philology, studies the distribution structure, quantitative relationship and change law of the literature in the subject field, and then discusses the internal structure, characteristics and law of science and technology research. Through this method, we can not only understand the development status, laws and trends of the discipline to a certain extent, but also see through the structure of various fields in the huge knowledge system, predict the latest trends of the discipline, and evaluate the research situation and influence of scholars in the field [7]. In view of the growing concern in the field of mine wasteland reclamation, but the research results from the bibliometric point of view are less, this study makes a bibliometric analysis on the mine wasteland reclamation in wenen County, in order to help scientific researchers accurately grasp the research status and frontier dynamics in this field.

2. Data sources and research methods

The literature data used in this study comes from CNKI "China journal full text database". In the "Journal", the keywords are "mine wasteland" + "reclamation". The retrieval time span is from January 1, 2000 to January 1, 2020. The analysis function and bibliometric method of CNKI database are used for analysis, and the visualization analysis software CiteSpace is used to draw the map of scientific knowledge in order to show the research status and hot issues in the field of mine wasteland reclamation from 2000 to 2020 with more scientific and intuitive images.

3. Results and analysis

3.1. Basic characteristics of literature

3.1.1. Types of literature. After searching, CNKI database collected 856 papers on the subject of "mine wasteland reclamation" from 2000 to 2020, which were classified according to the types of literature (some papers belong to two or more types, and repeated calculation method was adopted), including 376 journal articles, 416 academic papers (76 doctoral theses, 340 master theses), 24 conferences, newspapers, achievements, etc 40 other characteristic journals.

3.1.2. Annual number of papers. According to the theory of bibliometrics, we can analyze the development of the research in this field and reflect the degree of attention of the scientific community in this field by making chronological statistics on the literature of a certain discipline and a certain topic from the time scale. Figure 1 shows the annual distribution of literatures published in the field of mine
wasteland reclamation. As can be seen from Figure 1, from 2000 to 2014, the number of published papers showed an overall growth trend, reached the highest in 2014, and then decreased year by year.

![Figure 1. Annual statistics of literatures published in the field of mine wasteland reclamation](image)

3.2. Analysis of subject words

3.2.1. Overall analysis. Subject words can reflect the main content of literature research. Using bibliometric method to analyze the frequency of keywords in the field of mine wasteland reclamation can quantitatively analyze the research hotspots and help to grasp the overall research trend. A total of 40 keywords were retrieved from 2000 to 2020.

3.2.2. Word frequency analysis. CiteSpace is used to count the top 20 keywords of word frequency, as shown in Table 1. In addition to the three core words of mine wasteland, land reclamation and wasteland, the frequency of ecological restoration, ecological restoration and vegetation restoration is high, which indicates that the ecological restoration of mine wasteland has been widely concerned by scholars.
Table 1. Statistics of top 20 keywords in the field of mine wasteland reclamation

| Rank Order | Number of Articles | Frequency | Key Word                          | Rank Order | Number of Articles | Frequency | Key Word                          |
|------------|--------------------|-----------|-----------------------------------|------------|--------------------|-----------|-----------------------------------|
| 1          | 100                | 15.53%    | Industrial and mining wasteland    | 11         | 22                 | 3.42%     | Mining wasteland                  |
| 2          | 90                 | 13.98%    | Land reclamation                  | 12         | 19                 | 2.95%     | Land reclamation in mining area   |
| 3          | 51                 | 7.92%     | Wasteland                         | 13         | 16                 | 2.48%     | Open cut coal mine                |
| 4          | 46                 | 7.14%     | Ecological restoration            | 14         | 15                 | 2.33%     | Ecological reconstruction         |
| 5          | 45                 | 6.99%     | Mine wasteland                    | 15         | 13                 | 2.02%     | Abandoned mine                    |
| 6          | 40                 | 6.21%     | Ecological restoration            | 16         | 13                 | 2.02%     | Mining wasteland                  |
| 7          | 36                 | 5.59%     | Vegetation restoration            | 17         | 13                 | 2.02%     | Reclamation potential             |
| 8          | 35                 | 5.43%     | Mining wasteland                  | 18         | 13                 | 2.02%     | Suitability evaluation            |
| 9          | 30                 | 4.66%     | Coal mine wasteland               | 19         | 13                 | 2.02%     | Land consolidation                |
| 10         | 23                 | 3.57%     | heavy metal                       | 20         | 11                 | 1.71%     | Reclamation of industrial and mining wasteland |

3.3. Research status and trends
The analysis of emergent subject terms is mainly to detect the subject words with high frequency change rate by investigating the time distribution of keyword frequency. Compared with the traditional analysis of high-frequency subject terms, it is more suitable to detect the emerging trends and sudden changes of subject development by highlighting subject terms. The analysis shows that most of the key words appear in 2011-2014, and these two years are also the important nodes of the amount of related literature on mine wasteland reclamation. Since then, the number of related research literature has shown a decreasing trend year by year. Among the key words that have emerged since 2014, the word "vegetation restoration" has the strongest emergence intensity; vegetation restoration is to make full use of the function of soil plant complex system to improve local environment, improve soil physical and chemical properties, and promote the formation of biological species diversity. Vegetation restoration is the core of ecological reconstruction of mine wasteland.

3.4. Main research institutions and journals
According to the statistics of the publishing organizations of mine wasteland reclamation papers, the data shows that there are 30 publishing organizations in total. Table 2 lists the names of the top 10 organizations and the number of published papers in this field There are four institutions with more than 20 articles. China University of Geosciences (17.69) is the most cited institution, and China University of mining and Technology (Beijing) is the most downloaded institution, with 1274.31. The most cited institution is China University of Geosciences, with 637 citations. These institutions are the main publishing institutions in this field, which shows that the research of mine wasteland reclamation in
China is in a slow development period, and most of the research is concentrated in Colleges and universities, and the research institute has less research in this area.

Table 2. Top 10 institutions in terms of published papers

| Issuing organization                  | Number of publications | Total citations | Number of citations per article | Download times per article | Download citation ratio |
|---------------------------------------|------------------------|-----------------|---------------------------------|---------------------------|------------------------|
| China University of Geosciences       | 41                     | 637             | 17.69                           | 784.36                    | 44.33                  |
| China University of mining and technology | 32                     | 365             | 11.41                           | 928.59                    | 81.41                  |
| Beijing Forestry University           | 24                     | 280             | 11.67                           | 1127.92                   | 99.68                  |
| Shanxi University                     | 20                     | 97              | 4.85                            | 305.85                    | 63.06                  |
| Shanxi Agricultural University       | 16                     | 57              | 3.56                            | 249.31                    | 69.98                  |
| Land in China                         | 15                     | 103             | 6.87                            | 221.33                    | 32.23                  |
| Northwest A & F University            | 14                     | 106             | 7.57                            | 461.64                    | 60.97                  |
| Land and resources                    | 13                     | 16              | 1.23                            | 96.77                     | 78.63                  |
| China University of mining and Technology (Beijing) | 13                     | 178             | 13.69                           | 1274.31                   | 93.08                  |
| Land and resources in North China     | 9                      | 8               | 0.89                            | 70.22                     | 79                     |

3.5. Fund project analysis

According to the statistics of CNKI, there are 856 research articles on mine wasteland reclamation, involving 39 fund projects. The top 10 fund types are listed in Table 3, which are National Natural Science Foundation, international science and technology support plan, national key research and development plan, national high technology research and development plan (863 plan), Heilongjiang Science and technology research plan, Liaoning science and Technology Fund and Inner Mongolia Science and technology research and development plan. Science and technology plan of ancient autonomous region, special scientific research fund for doctoral program of colleges and universities, science and technology research plan project of Anhui Province, land and resources investigation project. Among them, the National Natural Science Foundation of China accounts for 41.79% of the total number of funds. The international science and technology support program, the national key R &D program, and the national high technology research and development program (863 Program) account for 14.18%, 3.73%, and 2.99% of the total number of funds, respectively. The rest of the funds account for a small proportion. This further shows that there are many projects funded by the state, and the state has given great support and attention to this aspect of research.
### Table 3. Fund projects

| Serial Number | Name of fund project                                      | Number |
|---------------|-----------------------------------------------------------|--------|
| 1             | National Natural Science Foundation of China              | 56     |
| 2             | International Science and technology support program      | 19     |
| 3             | National key R & D plan                                  | 5      |
| 4             | National High Tech Research and development program (863 Program) | 4      |
| 5             | Scientific and technological research plan of Heilongjiang Province | 3      |
| 6             | Science and technology foundation of Liaoning Province    | 3      |
| 7             | Science and technology plan of Inner Mongolia Autonomous Region | 2      |
| 8             | Special research fund for doctoral programs in Colleges and Universities | 2      |
| 9             | Anhui Science and technology project                      | 2      |
| 10            | Land and resources survey project                         | 2      |

3.6. Analysis of subject distribution

A total of 856 articles on mine wasteland reclamation were retrieved, involving 30 disciplines. As can be seen from Figure 2, the top 10 disciplines are mining engineering, environmental science and resource utilization, agricultural economy, basic agricultural science, architectural science and engineering, agronomy, biology, industrial economy, physical geography and surveying and mapping, and agricultural engineering.

![Figure 2. Distribution of subjects of mine wasteland reclamation from 2010 to 2020](image)

4. Conclusion and discussion

This study uses bibliometric method to make statistical analysis on the research papers related to mine wasteland reclamation in the past 10 years from 2000 to 2020. The contents involved in the study include literature type, annual number of papers, research status, fund project distribution and discipline distribution. In the research process, there are the following problems worthy of attention.

(1) The reason analysis of the change trend of the number of papers. In the past decade, the number of published literatures on mine wasteland reclamation reached the highest in 2014, and then gradually decreased. The number of articles downloaded has shown a decreasing trend in recent three years. On the one hand, it may be due to more and more reviews, less citations and downloads; on the other hand, it may be due to the continuous refinement of disciplines, which leads to the decline of the attention of the subject literature.
(2) Analysis of the results of issuing institutions and fund projects. According to the statistics of the research and analysis institutions of mine wasteland reclamation, most of the papers are published by colleges and universities, and the number of papers in this field by the research institutes is relatively short; the analysis results of fund projects show that the projects funded by the state level occupy the main position.

In this study, CNKI database is selected, which has high authority and limited the time range. We hope to accurately study the research status and hot spots in the field of wasteland reclamation at this stage. But this study also has some limitations, such as the lack of comprehensive analysis in the research process, can not accurately summarize the relationship between keywords, authors, institutions and so on. The literature database is constantly updated, but the bibliometric research in a certain field needs to lock in a specific time range, because although this research method can not cover all the literature, it can also objectively reflect the development situation and trend of this field.

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