A Review and Expectation on Land Engineering Reclamation Research——Using Bibliometric Method Based on Web of Science

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Abstract. To verify the international development of land engineering reclamation research, so as to provide data analysis result for the researchers, keywords included in the meaning of land engineering were selected, and related articles on web of science between 1980 and 2016 were reviewed. The results concluded that: 955 articles on land reclamation engineering from 99 countries were published from 1980 to 2016, annual trend of articles was in line with the law of linear. Articles from countries included China, America, England, Spanish made the strongest influence, and University of Chinese Academy of Sciences published the most articles. There is a growing concern on engineering reclamation research all over the world. Further researches on ecology and environmental sciences, agriculture, biodiversity protection, engineering science, business economics will be taken in the future.

1. Introduction
"Land remediation project" is a relatively old industry, which has a certain foundation of practice and scientific research [1-2]. In the development course of land consolidation engineering industry, different terms have appeared successively, such as land development and consolidation, land consolidation and reclamation, land consolidation and reclamation, land consolidation and comprehensive reclamation, rural land consolidation, land development, consolidation and reclamation, etc., causing confusion in concept and understanding. China through the national land renovation plan (2011 ~ 2015) "is conceptually unified in the first place, which chose the term" land management ", will be more nouns covers, land management is defined as "the inefficient use, unreasonable use, unused, and production and construction activities and natural disaster damage of land for regulation, improve the efficiency of land use activities", clear the connotation of land reclamation.

At present, existing articles, based on various databases, search land reclamation, contaminated land repair and rehabilitation, land use and other subjects [3-6], analyze the progress of domestic and
international scientific research on land remediation. However, these articles only analyze part of the meaning of land remediation, without a comprehensive analysis from the macro perspective of land remediation engineering. Therefore, based on the current common land reclamation engineering in the field of vocabulary is a key words related to web of science core collection database to retrieve the source, using the articles metrology to web of science database from 1980 to 2016, included the land management articles measurement analysis, quantitative data to reveal the development of global land renovation engineering research, characteristics and future developing trend of thought that land reclamation engineering industry data reference for the researchers.

2. Data sources and research methods
This paper takes the web of science database as the data source. TS= "land restoration" or "land reclamation" or "land consolidation" or "land rearrangement" or "soil reclamation" or "soil reclamation"Consolidation "as the search, retrieval in SCI, SCI-e between 1980 ~ 2016 worldwide land engineering related research published in the articles, were retrieved with 955 references, types of the language of English, German, French, Russian, Portuguese, Italian, Chinese and other 19 kinds of languages, including English articles 899, accounting for 94.14% of the total number of article, major languages for articles.

In this study, the Web of Science database with its own analysis function and Sigmaplot 10.0 mapping function were used to analyze and process the annual change trend of articles on land reclamation and ecological reconstruction, the distribution of major publishing countries/institutions, journals, and major researchers.

3. Result analysis and discussion

3.1. Analysis of the annual change trend of the publication volume
The number of articles published in a certain research field indicates the importance attached to this research [7]. From 1980 to 2016, a total of 955 articles were published in the study of global land remediation engineering, showing an obvious linear trend between the number of articles published and the year ($R^2=0.6239^{**}$). Among them, the number of published articles increased slowly from 1980 to 2006, with the number of published articles ranging from 5 to 26 per year, and the average annual number of published articles was 14. During the 10 years from 2007 to 2016, the number of articles published per year surged by an average of 56.9, and the number of articles published in a single year in 2016 was as high as 106. This fully shows that with the development of land remediation industry, land remediation engineering research has attracted more and more attention worldwide. This research result is similar to the retrieval results using land reclamation and other keywords [8-9].

![Figure 1. Annual articles on land reclamation engineering around the world.](image-url)
3.2. Analysis of issuing countries and institutions
The number of published articles of a country or institution on a certain research can reflect its research level to some extent [10]. From 1980 to 2016, a total of 99 countries published academic articles on land improvement projects. Among them, China ranked first among the countries that published 301 articles, accounting for 33.48% of the total amount of published articles in international land improvement projects. The United States, the United Kingdom, Spain, Australia, Germany, Canada, Poland, the Netherlands and India rank 2nd to 10th in terms of the number of published articles. The total number of published articles of these 9 countries is 429, accounting for 44.90% of the total number of published articles in the world (Figure 2). This means that in addition to the above 10 countries, the total output of the other 89 countries only accounts for 23.6% of the global total. That is to say, the dominant countries in the study of land remediation engineering are distributed in a concentrated way.

From the perspective of research institutions (Figure 3), among the top 20 institutions in terms of global land remediation engineering research publications, there are 8 institutions in China (including the university of Hong Kong), among which 5 institutions are in the top 10. The university of Chinese academy of sciences is the top one with 63 articles. In addition, the total number of publications of these 8 institutions is 201, accounting for 66.78% of the total number of publications in China, which means that research on land remediation projects in China is concentrated in some advantageous institutions. There are 4 organizations in the United States, and the output of each unit is 7~8. The output is not high, and the total output is 31, accounting for 22.30% of the total output in the United States, and the overall proportion is also small. That is to say, the research on land remediation projects in the United States is relatively scattered, and no institutions have formed obvious research advantages. This situation is similar to that of Britain and Australia, which are also among the top five countries in terms of output. Spain's top scientific research council has published 35 articles, ranking third in the ranking of institutions, while the total number of articles published in Spain is only 43. Even considering that a single paper may have multiple signatories, it shows that Spain has a high concentration of research institutions in this industry.

Figure 2. Top 10 countries published most articles. Figure 3. Top 20 institutions published most articles.

3.3. Analysis of published journals
By analyzing the journals and periodicals, it is possible to clarify the concentrated journals of this research direction, and provide reference for researchers to submit and read the articles. The global publication of land remediation engineering research directions was published in 500 journals, and the number of single publications was 1.91. From the highest number of journals (Table 1), the total number of journals in the top 10 journals was 121, accounting for 12.67% of the total. The average impact factor of these 10 journals is 3.028, and the overall impact is high. It is concentrated in the
United States (4 journals) and the United Kingdom (3 journals), but the top one in the publication is China's Land Use Policy, which is included in SSCI, with an impact factor of 2.631 and 25 publications, followed by The British "Land Degradation Development” has an impact factor of 8.145 and 23 publications. The journal is also the highest impact factor among the top 10 journals.

### Table 1. Top 10 journals published most articles around the world.

| Order | Journals                                      | Countries         | IF of 2015 | Published articles | Proportion (%) |
|-------|----------------------------------------------|-------------------|------------|--------------------|----------------|
| 1     | Land Use Policy                              | China             | 2.631      | 25                 | 2.62           |
| 2     | Land Degradation Development                 | British           | 8.145      | 23                 | 2.41           |
| 3     | Journal Of Environmental Quality             | The United States | 2.238      | 12                 | 1.26           |
| 4     | Eurasian Soil Science                        | The United States | 0.74       | 11                 | 1.15           |
| 5     | Ecological Engineering                       | Netherlands       | 2.74       | 10                 | 1.05           |
| 6     | Agriculture Ecosystems Environment           | Netherlands       | 3.564      | 9                  | 0.94           |
| 7     | Journal Of Applied Ecology                   | British           | 5.196      | 8                  | 0.84           |
| 8     | International Journal For Numerical And Analytical Methods In Geomechanics | British | 1.758 | 8 | 0.84 |
| 9     | Applied Soil Ecology                         | The United States | 1.377      | 8                  | 0.84           |
| 10    | Restoration Ecology                          | Spain             | 1.891      | 7                  | 0.73           |

### 3.4. Authors, high frequency citations and research directions

The top 10 authors of the global land remediation project published an average of 8.5 academic articles per person (Table 2), and four authors were from China. Among them, Daoliang Li of China Agricultural University ranked first with 15 articles. Arulrajah A of the University of Science and Technology of Australia ranked second with 12 articles, but combined with a single paper cited in the top 10 articles, the only 10 authors with the highest number of publications were Seville. The article "Application of two organic amendments on soil restoration: Effects on the soil biological properties" published by Manuel Tejada of the University of Lleida in the Journal of Environmental Quality, with a frequency of 77 times, and the first 10 articles cited. Bit (Table 3). Other high-yielding authors have no articles to enter the high-leading ranks.

Of the top 10 articles in the global land remediation project, three of them were published by Chinese researchers, which is basically proportional to the number of Chinese articles published. In addition, among the journals published in these 10 articles, the three journals “Land Use Policy”, “Journal of Environmental Quality” and “Ecological Engineering” are among the top 10 in the global land remediation engineering research publications. Journals not only pay attention to land remediation projects, but also publish articles with high quality. Lal R. of the Ohio State University in the United States, "Residue management, conservation tillage and soil restoration for mitigating greenhouse effect by CO2-enrichment" published in "Soil & Tillage Research" in 1997 [11], reviewed the management and protection of wreckage Severe farming and soil restoration have great potential in global soil carbon sequestration. At present, the cumulative frequency of citations has reached 242 times, which is the highest frequency of land remediation engineering research articles. Throughout these 10 articles, 2 of them are aimed at remediation of desertification land [12, 13], and 4 topics are the application of biology (microorganisms, tree beans, cactus) in land remediation [14-17], 2 for biology The application of soil improvement materials such as charcoal, poultry manure, and biological residue composting [18, 19], and another is the economic and social impact assessment of land remediation projects. These high-frequency articles belong to the research field and issue the research direction of the top 30 is also basically consistent (Figure 2).

It is not difficult to find out from the research direction of the top 30 global land remediation projects (Figure 4). Eco-environmental science, agriculture, biodiversity conservation, engineering, and business economy are the areas where global land consolidation projects are concentrated. Among them, 556 articles were published in the direction of ecological environment science research, that is,
58.2% of articles in land remediation engineering research involve ecological environmental science research.

Table 2. Top 10 authors published most articles around the world.

| Order | Author          | Published articles | Institution                                    |
|-------|-----------------|--------------------|------------------------------------------------|
| 1     | Daoliang Li     | 15                 | China Agricultural University                  |
| 2     | ArulrajahA      | 12                 | Swinburne university of technology, Australia   |
| 3     | Myint Win Bo    | 9                  | Bullen consulting, UK                           |
| 4     | Manuel Tejada   | 8                  | University of seville, Spain                   |
| 5     | Yingyi Chen     | 7                  | China agricultural university                  |
| 6     | ZlaticaMuchová  | 7                  | Slovak agricultural university                 |
| 7     | Jiu Jimmy Jiao  | 7                  | University of Hong Kong, China                 |
| 8     | Zhenqi Hu       | 7                  | China university of mining and technology      |
| 9     | Carlos García   | 7                  | Spanish center for soil biology                |
| 10    | Demetris Demetriou | 6               | Ministry of land management of Cyprus          |

Table 3. Top 10 articles with most reference frequency around the world.

| Order | Author                                      | Institution                                                                 | Cited frequency | Paper topics                                                                 | Journals                                         | Published year |
|-------|---------------------------------------------|-----------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------|-------------------------------------------------|---------------|
| 1     | Lal, R.                                     | Ohio state university                                                      | 242             | Residue management, conservation tillage and soil restoration for mitigating greenhouse effect by CO2-enrichment | Soil & Tillage Research                         | 1997          |
| 2     | Zhao Ha-Lin, ZhouRui-Lian, Su Yong-Zhong, et al | Institute of environment and engineering, university of Chinese academy of sciences | 107             | Shrub facilitation of desert land restoration in the Horqin Sand Land of Inner Mongolia | Ecological Engineering                           | 2007          |
| 3     | Lehouerou, H. N.                            | France national research center, functional ecology and evolutionary ecology center | 106             | The role of saltbushes (atriplex-spp) in arid land rehabilitation in the mediterranean basin | Agroforestry Systems                            | 1992          |
| 4     | Yin, B.,Crowley, D.,Sparovek, G., et al    | University of aeronautics and astronautics, Beijing, China; university of Sao Paulo, Brazil | 100             | Bacterial functional redundancy along a soil reclamation gradient             | Applied & Environmental Microbiology             | 2000          |
| 5     | Fellet, G.Marchiol, L.DelleVedove, Get al   | University of Udinese, Italy                                                | 97              | Application of biochar on mine tailings: Effects and perspectives for land reclamation | Chemosphere                                     | 2011          |
| 6     | Franco, A., DeFaria, S. M.                  | Brazilian agricultural research corporation                                 | 88              | The contribution of N-2-fixing tree legumes to land reclamation and sustainability in the tropics | Soil Biology & Biochemistry                      | 1997          |
| 7     | LeHouerou, H. N.                            | Intergovernmental Panel on Climate Change, France                          | 78              | The role of cacti (Opuntia spp) in erosion control, land reclamation, rehabilitation and agricultural development in the Mediterranean basin | Journal of Arid Environments                     | 1996          |
| 8     | Tejada, M.,Hernandez, M. T., Garcia, C.    | University of Seville, Spain                                                | 77              | Application of two organic amendments on soil restoration: Effects on the soil biological properties | Journal of Environmental Quality                 | 2006          |
| 9     | Crecente, R.Alvarez, C. Fra, U.             | University of Santiago DE compostela, Spain                                | 71              | Economic, social and environmental impact of land consolidation in Galicia   | Land Use Policy                                 | 2002          |
| 10    | Su, Yong Zhong,Zhao, Wen Zhi,Su, Pei Xi, et al | Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences | 70              | Ecological effects of desertification control and desertified land reclamation in an oasis-desert ecotone in an and region: A case study in Hexi Corridor, northwest China | Ecological Engineering                           | 2007          |
4. Conclusion and Outlook

In the 37 years from 1980 to 2016, land remediation engineering research has received increasing attention worldwide, and the number of published articles in a single year has increased significantly with the passage of the year. China, the United States, the United Kingdom, Spain and other countries, regardless of the number of documents issued or the quality (higher citation frequency) are among the dominant countries, but the issuing agencies of each country are more concentrated, which is the research advantage of these institutions. Research on land remediation projects needs to be carried out in a wider international context.

Among the top 10 authors of the Global Land Remediation Engineering Research, there are 4 Chinese researchers, and the top 10 organizations in the publications have 6 Chinese institutions. China has a higher number of countries in the land remediation engineering industry, but only two of the top 10 articles cited by the single paper were published by Chinese researchers. This shows that the matching between the quality of Chinese researchers and the number of published documents is insufficient, and the quality of the articles needs to be further improved. At the same time, only one of the top 10 journals in the publication is a Chinese journal, and its publication focuses on management and economy, and is almost unrelated to technical and mechanistic research. This is less relevant to China's overall SCI source journals. In the future, China should start from improving the quality of journals and improve China's influence in the international land remediation academic community.

At present, the most important research on land remediation engineering in the world is the ecological environment science, agriculture, biodiversity conservation, engineering, business economy and other directions. In a period of time in the future, the land remediation project will continue to start from these angles and strengthen the land.

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