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Visualization analysis of ecological assets/values research by knowledge mapping

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ABSTRACT

Using knowledge mapping tools (CiteSpace), we conducted the visualization analysis on both of international and domestic literatures in relation to ecological assets/values from the Web of Science (WoS) databases and China National Knowledge Infrastructure (CNKI) databases. By combination of the statistical data and visualization mapping, we studied on the research relationship networks and status for the co-authors' institutions, co-authors, co-citation literatures and co-occurring keywords of ecological assets/values based on the sample data from literatures. In the aspects of research on ecological values, our results showed that: (i) main countries of researches on ecological values were the United States, Australia, Canada and China in order, especially the US had the most plenty of literatures in relation to ecological values, and at the same time, literatures from China in this field are in the upper level; (ii) the hotspots of researches on ecological values from the global literatures covered various fields including biodiversity, species richness, ecosystem services, landscape, climate change and dynamic simulation; (iii) as a result of the multidisciplinary integration, the hotspots of researches on ecological values emerge endlessly, so that many high yielding authors and relevant international institutions constantly expanded the research scopes and fields, which promoted the combination of theories and made the significant contribution to themselves; (iv) the mass domestic researches on ecological values began in 1992. The number of posting paper increased obviously and the scopes in relation to ecological value expanded gradually, particularly involved with ecology, economy, even legal and ideology, which illustrated that concepts of "ecological values" had not been only confined to the researches on the traditional science, but also been widely used in many fields of humanity and social science. In the aspect of research on ecological assets, our results showed that: (i) domestic researches on ecological assets had many points in common with ecological values research. In fact, driven from ecological values, researches on ecological assets became gradually characteristic, such as assessment of forest ecological asset, ecological industry and fair value measurement of ecological assets, all of which contained lots of considerable consequences; (ii) the Chinese Academy of Sciences was in the dominant position of domestic research on ecological assets. Other colleges and universities like Beijing Normal University and Nanjing Forestry University were also effective and productive in this field. Their achievements were already improving Chinese academic level; (iii) domestic research teams also changed from different discipline backgrounds to enrich the research scopes of ecological assets. Based on analysis of typical literatures from our results, in the similarity and difference of the concept of "ecological asset" between foreign and domestic literatures, we summarized key points that we should pay attention to: (i) ecological assets included natural resources and ecosystem services; (ii) ecological assets consisted of tangible and intangible parts; (iii) ecological assets were of profitability and public welfare at the same time. Finally, we elucidated that future trend of research on ecological assets would pay more attention to the internal mechanism of changes of ecological assets, determination of the bearing capacity of the ecological environment by such changes, and discovery of accumulation of ecological assets for a stable and sustainable development of the ecosystem, and for harmony between humans and environment.

1. Introduction

In recent years, with the development of economy and technology, ecological assets research has been improved gradually and becomes a new field of ecology and ecological economics. As a multidisciplinary field and focuses on the combination of theory and practice, this broad base of applications of emerging research object thus often leads to confusion regarding the exact semantics of various definitions in the literatures. Numerous scholars often defined the concept of "ecological assets" based on theoretical knowledge and technical methods of their professional disciplines, which may emphasis on different perspectives. From the generalized definitions, the concept referring to ecological

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assets is obtained from the category of ecological values. This domain is a new branch from ecological values research, so it plays an important role in discovering the status quo and research trends as well as defining explicitly concept of "ecological assets" for subsequent research.

The goal of this article is to use visualization analysis to give a scientometrics overview of international and domestic relevant literatures based on mapping knowledge. To identify key literatures which refer to ecological assets/values domains, we used such visual and scientometrics analytical indicators as the identification, in particular, including institutes and countries of manuscript origin, the top and most highly cited authors, the core literatures and journals, key research hotspots and breakthrough points etc. Then, we presented the comparison between international and domestic definition of "ecological assets". Through analyzing the similarities and differences between different concepts, we summarized the key points that should be paid attention to define "ecological assets". Finally, we concluded the future trends of ecological assets research.

2. Methodology

2.1. Research methodology tools

Knowledge mapping was a relatively new research front of scientometrics. The idea was to use information visualization to represent large amounts of data in research front, such as core structure, overall architecture, development process research status etc. This allowed the viewers to look at a large corpus and to develop deeper insights based on a high level view of the map integrated multidisciplinary theories and methodologies including statistics, applied mathematics, graphics, information science, bibliometrics etc. [1]. Visualization using various network modeling tools had been performed considerately for social network analysis of citation and other complex networks from the huge amounts of information to mine the implicitly effective information with some intelligent analysis methods, such as sequence analysis, clustering analysis, correlation analysis etc. [2]. Scientometrics was a quantitative study of scientific communication. It required a multitude of sophisticated techniques including citation analysis, statistical analysis and other quantitative techniques for mapping and measurement of relationships and flows among academic backgrounds, research results, research hotspots or other knowledge-based entities. In this article, we presented a visualization mapping based systematic analysis of ecological assets/values domain which involved the discovery of various types of co-citation networks as well as the complex network analysis of the overall network using CiteSpace [3,4], a recent tool which had been designed exclusively for citation networks analysis by Chaomei Chen of Drexel University. By color coding the evolution of research, it allowed the examination of some detail relational matrixes between different objects which cannot otherwise be easily captured using other tools (Table 1).

2.2. Data collection

Input data of international literatures were retrieved from the Thomason Reuters Web of Science (WoS), because the supported formats of CiteSpace were a set of bibliographic data files in the field tagged from Institute for Scientific Information (ISI) Export Format. While domestic data from China National Knowledge Infrastructure (CNKI) should be converted into supported text formats using file-format conversion tool by Shengbo Liu of Dalian University of Technology, but CNKI data don't support the citation information, namely references.

2.3. Data processing

After preprocessing all data, we analyzed all relational matrixes supported by CiteSpace using some evaluation methods such as centrality calculation, frequency statistics, clustering coefficient and burst detection. Then, we selected some representative matrix mappings to show in this paper, including five relational matrixes of WoS (co-authors' countries or institutions, co-occurring keywords, co-citation authors, co-citation references and co-citation journals) and three relational matrixes of CNKI (co-occurring keywords, co-authors' institutions and co-authors).

3. Results and analyses

3.1. Literatures of WoS

An exact topic search for "ecological value(s)" resulted 486 records published from Science Citation Index Expanded (SCI-EXPANDED) database from 2002 to 2013 and Social Sciences Citation Index (SSCI) database from 2000 to 2013. We began with some basic parameter settings: (i) Time Slicing. The entire time interval of research was chosen from 2000 to 2013; (ii) Pruning. CiteSpace supported two common network-pruning algorithms. In this article, we concentrated on minimum panning tree pruning; (iii) Links. Strength between nodes and clusters links was processed by a cosine function, and scope type was selected "within slices". Subsequently by using the various options selected by the user, the network could be viewed in different ways and parameters could be analyzed based on centrality as well as frequency.

3.1.1. Analysis of co-authors' countries or institutions

Parameter settings: Years Per Slice: 2; Node Types: Country & Institution: Top N per slice: 20.

The goal of our first analysis was to identify the most important co-authors' country or institution. Based on a time slice of two years, we chose top-20 cited literatures per sliced segment to get a knowledge mapping of co-authors' country or institution network (Fig. 1). Here in Fig. 1, we saw many different sizes of circle nodes which represented different volumes of literatures published by each country/institution. The bigger the nodes were, the more frequency of documents posted [5]. In CiteSpace, the particular centrality was well known to note the ability of a vertex to monitor communication with other vertices [6]. Generally, higher centrality meant more importance of the node which reflected the structure and dynamic essentiality in a particular field. Meanwhile, we collected statistics of co-authors' countries/institutions of international ecological values research (Table 2). Table 2 showed that, in term of frequency, the key publications in the domain originated from USA, which was followed by Australia, Spain, People's Republic of China, England, Canada, Italy and Germany. However, Australia, Spain and Italy had low centralities. These results illustrated that the most collaborations in these three countries came from themselves rather than other different nations. In contrast, high centralities of other countries/institutions such as Germany, USA, US Forestry Service, Brazil and England indicated that they had critical roles in the field of ecological values research. Noteworthy, China had both high frequency and centrality implying that many Chinese researchers had obtained some significant achievements in ecological values domain, especially who came from Chinese Academic of Science.

Table 1
The relational matrixes of CiteSpace support [1].

Relationship	Coupling			Co-author			Co-citation			Co-occurring
Object CiteSpace	Author	Reference √	Journal	Author √	Country √	Institution √	Author √	Reference √	Journal √	Keyword √