Research Status and Evolution Process of LEAP Model Based on CitespaceIII

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Abstract: *LEAP model as a tool for accounting analysis of long-term energy planning has been widely used in energy demand analysis at home and abroad, which is of great significance to energy conservation and emission reduction, environmental protection and long-term energy environment planning in the country and the city. Based on the Web of Science^{TM} core database, 817 document records published about LEAP model from 2010 to 2015 are retrieved as data source. Through using CitespaceIII, the research status and evolution process of LEAP model are analyzed, and the development trend of the research subjects on LEAP model are identified. The result provides a basis for grasping the current focus and predicting future research direction.*

Keywords: *LEAP model; Knowledge map; CitespaceIII; Research hotspot*

1. INTRODUCTION

LEAP (Long-range Energy Alternative Planning System) model is an energy-environmental analysis model from bottom to up based on scenario analysis, which can be used to set up different scenarios for prediction analysis of energy and environment based on the end user's changes [1]. It belongs to the long-term energy replacement planning system model, mainly through the analysis of some important factors to strengthen energy conservation and environmental protection. Energy saving and strengthening of environmental protection is the only way for the future development when faced with China's high energy consumption and serious pollution[2]. Therefore, comprehensive and objective analysis of the research status of LEAP model is not only beneficial to the further research and application development of LEAP model itself, but also to the long-term energy planning of the country andcity. At present, the domestic and foreign scholars study on the LEAP model mainly from the perspective of specific applications, its analysis of evolution process and frontier very few. Accordingly, this paper determines to use the citation analysis software CitespaceIII to analyze the relevant research literature of LEAP model by the means of visual analysis. By understanding the relevant research status of LEAP model, the research focus in the field of long-term energy planning will be revealed.

2. DATA SOURCE AND METHODOLOGY

2.1. Data Source

In this paper, the dataset of bibliographic records on LEAP model are retrieved from the Web of Science^{TM} core database by using a topic search, mainly from SCI(Science Citation Index) and SSCI(Social Science Citation Index), because it is more accurate for the centrality of data collected. The retrieval language is set as "English", the retrieval mode is set as "Subject", and the "all document types" is chosen as our dataset. In order to improve the accuracy, we tend to choose 4 noun-phrases with the most relevant to LEAP model for searching. Actually, there is a close relationship between them, sometimes they are regarded as the same meaning though existing difference between them. Therefore, the search queries consist of 4 phrases about LEAP model: "LEAP Model"OR "Long-range Energy Alternative Planning System" OR "Energy-environment Scenario Analysis Model" OR "Final Energy Demand". The queries resulted in 817 original records during the period of 2010-2015 on December 4, 2015. Each bibliographic record contains the title, the authors, the abstract, the keywords and a set of references cited by the article. Finally, set data download mode as full record, and save the file in plain text format.

2.2. Methodology

In this study, the exploitative software of CiteSpaceIII created by Dr. Chaomei Chen is used as a scientific visualization tool to generate cluster view and co-citation network. CitespaceIII is the latest

version and hereinafter refers to it as Citespace. Citespace can quickly understand a development in the field of literature, and locate the information of this field such as the important research literatures and scholars, drawing out the chronological chart citation in the field of literature and showing the development trend and new tendency in a certain period of time[3]. CiteSpace is designed to synthesize and visualize a time series of individual networks extracted from each year's publications. The resultant network can be divided into clusters based on their interconnectivity. Each cluster represents a distinct specialty or a thematic concentration.

3. RESULT ANALYSIS

3.1. The Temporal and Spatial Analysis in LEAP Model

First of all, we study the LEAP model from the perspective of time. In this paper, we have made the following statistics on the number of literatures and the number of cited times in LEAP model. As shown in Figure 1 and Figure 2, we can understand the development context and research situation from the perspective of time.
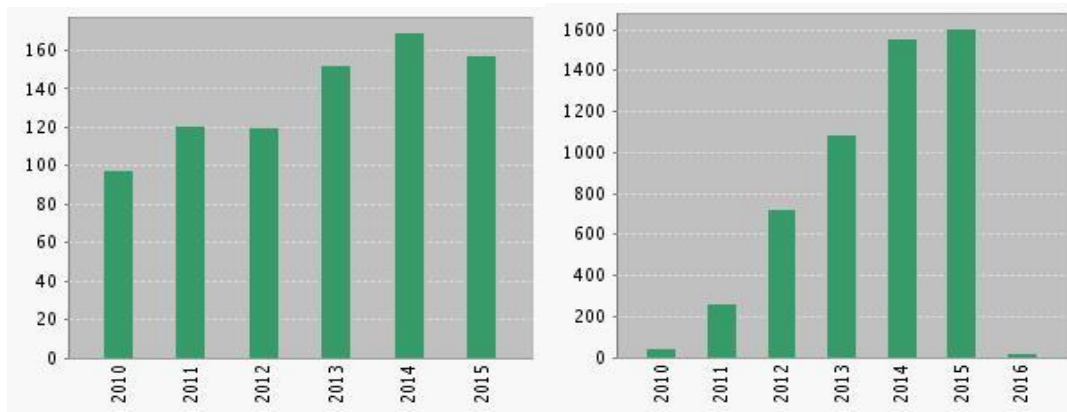

**Figure1.**_The publications in every year_   **Figure 2.**_The cited times in every year_

According to the above figure, nearly 5 years of research on the LEAP model is rising steadily, both from the number of published literature and citation quantity. Although the number of published literature has a slight decline, but the overall still has upward trend. In recent years, the deterioration of the environment, such as the natural disaster, global warming, air pollution and other environmental issues has formed a high degree of threat to people's life. This has aroused great concern of governments, research institutions and the media, so many countries have developed a corresponding environmental development strategy and planning[4]. It has played a huge role in promoting the research and development of LEAP model, in the meanwhile the number of relevant literature is rising rapidly, which not only shows the research is in a period of rapid development, but also demonstrates the necessity of this study.

Next, we study the LEAP model from the perspective of space. In this paper, the "Country" is used as the network node to run the software. Using Citespace software, the number of literatures related to the LEAP model is expressed in the way of time evolution, as shown in Figure 3. The size of the circle represents the number of documents issued in the country, and the circle of different colors is behalf of the amount of documents in different years. The links between the rings represent the first time of cooperation between two countries[5]. From the figure, we can see that the cooperation between different countries in this research field is relatively weak. It contains 34 nodes and 22 links, which shows that countries in the world are more concentrated on the research of LEAP model. In order to reflect the content more directly, the Table 1 is given. From the number of documents, the United States (USA) has the largest contribution to the literature, which shows that the United States in the LEAP model is more active in the study. China, Spain, Italy, Germany and England, etc. take the next place. From the point of centrality, Portugal has the largest centrality, which shows that Portugal has played a strong intermediary role in the related research of LEAP model and it has a strong influence in the field of research. Although the contribution rate of literature in China is only inferior to the United States, but the centrality is very low. It shows that China is still in a weak position in the field and the research results do not have a certain influence and control. From this, we know that China needs to strengthen cooperation with countries that is of significant influence for advancing academic authority in the field.

Table1. *The 10 important countries ranked by frequency and centrality*

Frequency	Country	Centrality	Country
168	USA	0.29	PORTUGAL
74	PEOPLES R CHINA	0.27	SWEDEN
56	SPAIN	0.27	DENMARK
55	ITALY	0.25	INDIA
45	GERMANY	0.22	PHLIPPINES
45	ENGLAND	0.12	JAPAN
40	AUSTRALIA	0.11	GERMANY
36	CANADA	0.06	CANADA
34	BRAZIL	0.05	BRAZIL
28	GREECE	0.03	GREECE
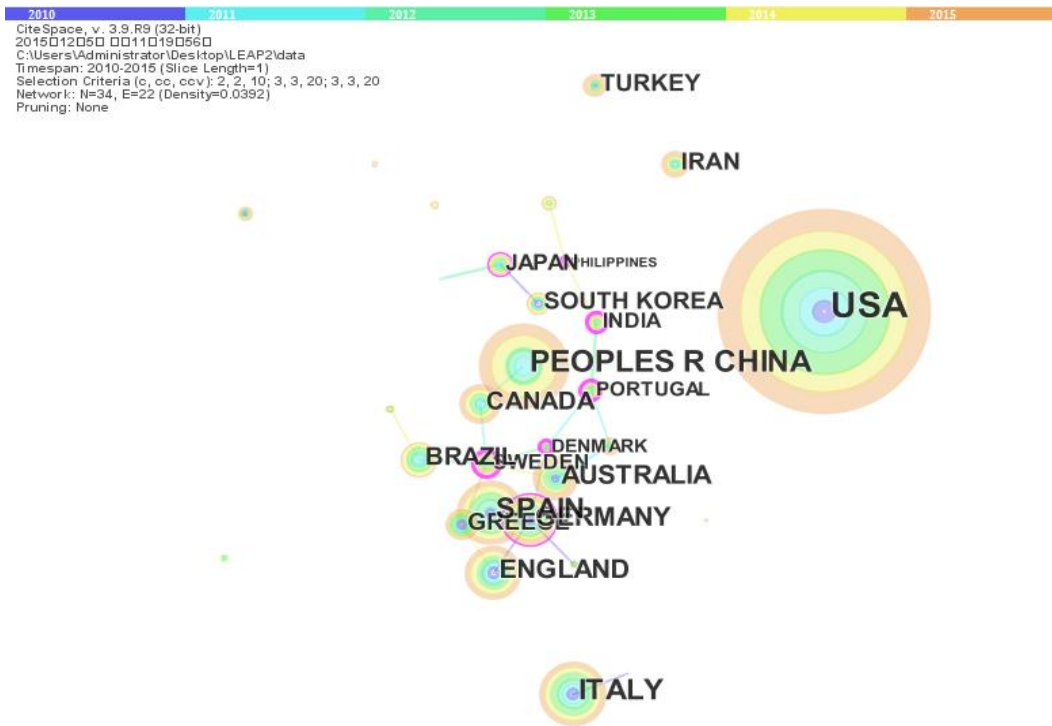
Figure3. *The visualization map of country/region in LEAP model*

3.2. The Hot Topics and Evolution Process in LEAP Model

3.2.1. The co-occurrence analysis of keywords

By understanding the hot topics and its evolution of LEAP model, we can grasp the whole research trend in this field, which can make a clear understanding of the development trend for researchers to straight hit research subject. The co-occurrence knowledge map of keywords can clearly show the focus in a certain period of time, which can be used to determine the hotspots and frontiers in this field [6]. In this paper, 817 document records are loaded into Citespace, and the node type "Key Word" is determined to select. The threshold Top N=20 means that there are top 20 keywords will be selected, and then a knowledge map of keywords can be obtained, as shown in Figure 4, a total of 56 nodes and 155 lines. According to the keywords represented by the network nodes in the figure, the hotspots and development process of this research area can be calculated from each time period. In 2010, energy, model, renewable energy, optimization, system and so on are the hot words, which have been extensively investigated in the LEAP model. In 2011-2012, uncertainty, China, generation, consumption, power, demand and so on are the hot words, which indicates that China has a certain influence in this field for these two years, and the study of the LEAP model has turned to the field of people's life. In 2013, system, emissions CO2, sustainability and so on are the hot words, which indicates that the phenomenon of environmental degradation has been very serious due to the development of industrialization. And in 2014, decision making, performance and others are the hot words, which undertakes the study year before and puts forward countermeasures for further solving a series of problems on the environment. In 2015, energy efficiency, impacts, policies and so on are the

hot words. Meanwhile, they are also the forefronts in the research. From the evolution of hot words in different years, it can be seen that the research on LEAP model is widely concerned, because the energy environment problem is the common problem for the whole world.
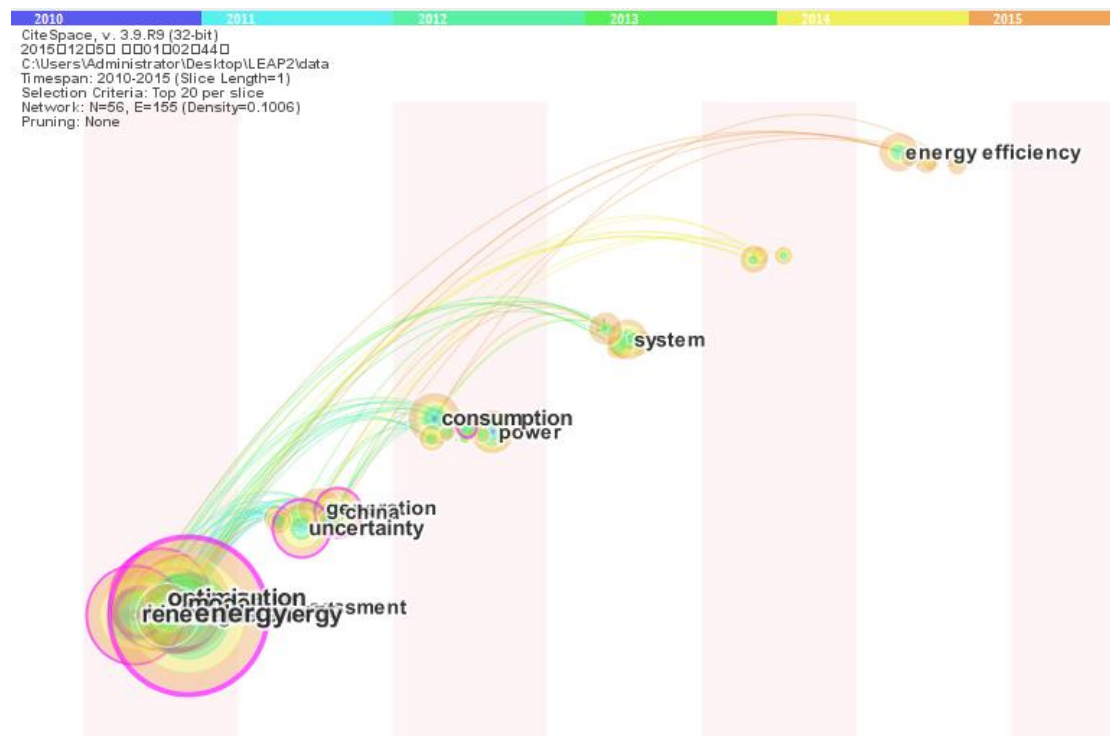

Figure4. *Co-occurrence keywords timezone visualization in LEAP model*

3.2.2. The co-citation analysis of references

The co-citation frequency of the literature can reflect the academic level and authority of a certain field, and it can explore the hot topics in the field of literature [7]. Again, 817 document records are loaded into Citespace, but the node type "Cited Reference" is determined to select. The threshold Top N=20 will still be selected, which means that there are top 20 references are identified, and then a knowledge map of references can be obtained, as shown in Figure 5, a total of 107 nodes and 241 lines. Each network node in the figure represents a reference, the color of the node is corresponding to the publication year of the literature, and the thickness of the ring is proportional to the number of citations. Here, a total of 5 important documents are dug out, and the details are shown in Table 2. Clustering listed in the right in the knowledge map is a collection of a certain type of literature subject, which reflects the hot topics in the research area [8]. Based on the knowledge map, the clustering topic on LEAP model is focusing on several aspects such as the establishment of multicriteria [9], the substitution of renewable energy sources [10], the development of LEAP model [11], the reduction of energy consumption [12], the construction of decision support system [13] and so on. In addition, researchers can grasp the research trend in this field and pave the way for further research by focusing on the important documents related to the LEAP model.

Table2. *The top 5 references with high frequency in LEAP model*

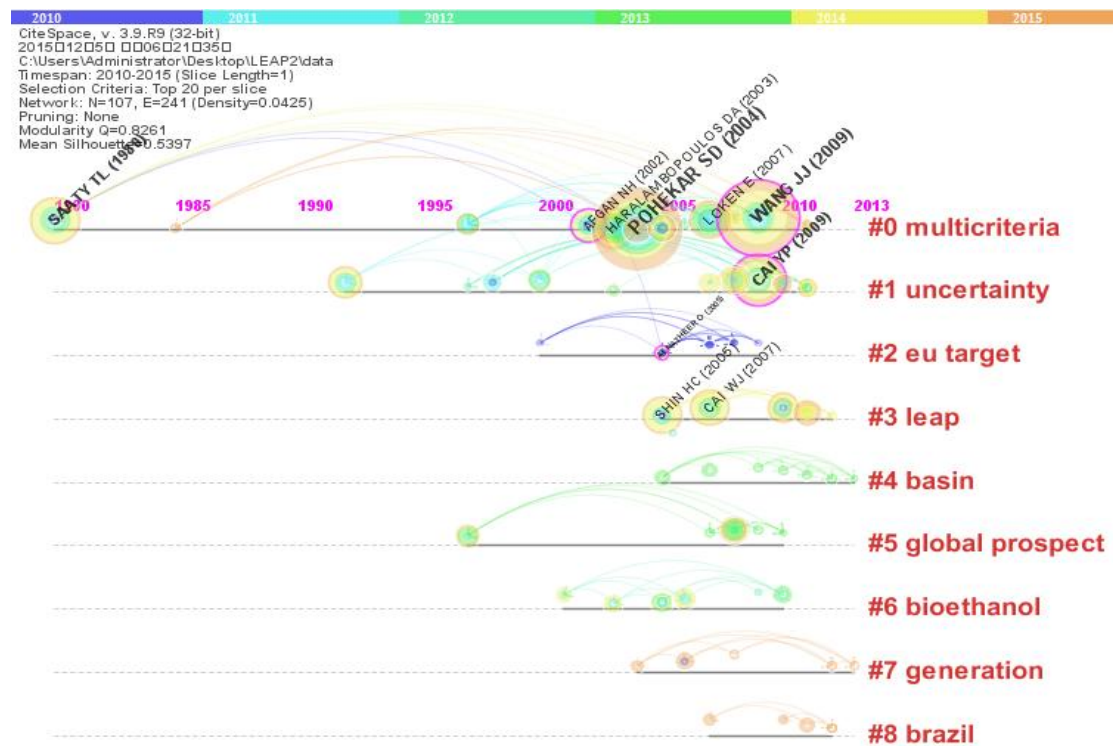| Frequency	Centrality	Cited Reference	Year
23	0.09	POHEKAR SD,2004,RENEW SUST ENERG REV,V8,P365[14]	2004
20	0.12	WANG JJ,2009,RENEW SUST ENERG REV,V13,P2263[15]	2009
14	0.01	SAATY TL,1980,ANAL HIERARCHY PROCE,V,P[16]	1980
13	0.14	CAI YP,2009,APPL ENERG,V86,P480[17]	2009
12	0.02	HARALAMBOPOULOS DA,2003,RENEW ENERG,V28,P961[18]	2003

Figure6. *Co-citation references timeline visualization in LEAP model*

4. CONCLUSION AND PROSPECT

Through the visual analysis of LEAP model in recent 5 years, the following conclusions can be obtained. First, both of the number of published literature and citation quantity on the study of LEAP model are rising steadily, which indicates that the energy-environment planning problem is getting high attention. Second, USA is more active in the LEAP model research, and the literature contribution rate is also the largest, followed by China, Spain, Italy and other countries. Portugal has played a strong mediating role in the study of LEAP model, causing a strong influence on this field. Third, research hotspots in this field mainly include energy, renewable energy, uncertainty, China, consumption, power, etc. And energy efficiency, impacts, policies, etc. are the frontiers. Fourth, POHEKAR SD, WANG JJ and CAI YP's research on LEAP model have been widely recognized in the scientific community with strong authority. Then, the related research on LEAP model is focused on several key aspects, such as the establishment of multicriteria, the substitution of renewable energy sources, the development of LEAP model, the reduction of energy consumption and the construction of decision support system, etc. In addition, in order to overcome the limitation of lack of important literature, the extension scope of the database will be considered to follow up for more accurately grasping the related research topics of changes and application prospects of LEAP model.

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