

Knowledge Mapping Analysis of Research on Green Development

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Keywords: Green Development, Knowledge Mapping Analysis, Circular Economy, Low- Carbon Economy.

Abstract: As the ecological and environmental problems continue to worsen, China has also assumed more responsibility for energy conservation and emission reduction. Green development is an inevitable way to achieve "Carbon Neutrality". This paper used the software Citespace to obtain mapping, and analyzed the relevant literature about green development from 2010 to 2020. Finally, the trend of the content was divided into three stages. The first stage is from 2010 to 2013, focusing on the necessity and feasibility of achieving green development in China. The second stage is from 2014 to 2017, focusing on the construction of green development evaluation system. The third stage, from 2018 to 2020, studied in depth how to realize the green development in each industry.

1 INTRODUCTION

Economic growth is not opposed to environmental protection and resource conservation. The development experience of some Nordic countries, such as Denmark and Finland (Huang, 2015), shows that there is a way to achieve production and ecological win-win development. Based on green development technologies, these countries promote green development with green development systems and laws as safeguards. At the APEC CEO Summit in 2013, Jinping Xi pointed out that growth based on excessive resource consumption and environmental pollution will not pay off, and called for innovative development ideas and approaches to achieve Green development. Green development stems from the idea of green economy, and green economy came out in the Blue Book of the Green Economy in 1989, written by the British economist Pearce. Green economy pursues the harmony between social development and ecological environment, and advocates the establishment of an environmental "Affordable economy". If a country only focuses on economic development and ignores environment protection, sustainable development will not be achieved, and ecological crisis and resource depletion will threaten the survival of mankind. Since the concept of green development was put forward, the Central Committee of the party has issued policies and taken measures to

promote green development. Green development has been included in the "13th Five-Year Plan". The strategic position of green development in the overall situation of China's modernization construction was emphasized again in the "Outline of the 14th Five-Year Plan". In this period, Chinese scholars have also carried out a large number of research on green development, and has achieved fruitful results. This study used the Knowledge Graph Analysis method to analyse the literature in recent years, to understand the overall picture of green development, to clarify the evolution trend of the theme.

2 ANALYTICAL METHODS AND DATA SOURCES

2.1 Analytical Methods

With problems of environmental pollution and resource waste becoming more and more serious, people have been exploring how to solve these problems, and put forward the idea of green development. Accordingly, China has formulated a series of policies on green development, which has also led scholars' research on concept, realization path and evaluation method of green development. In order to clarify the trend of green development in recent years, and to understand the current theoretical

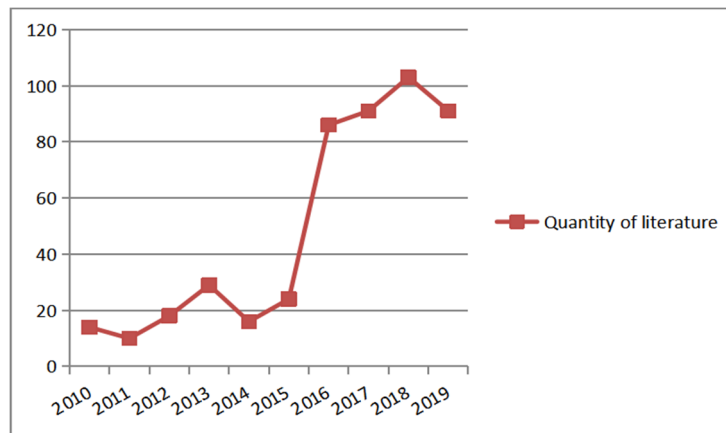


Figure 1: Statistics on the number of green development studies published in China from 2010 to 2019.

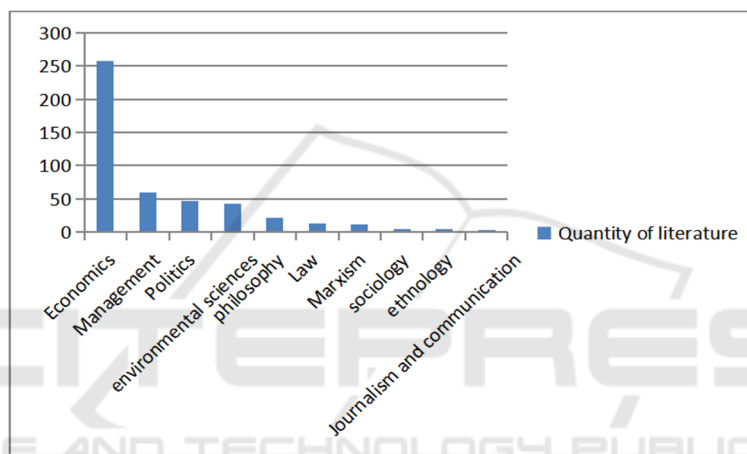


Figure 2: Statistical chart of the discipline distribution of green development research in China from 2010 to 2020.

frontiers, software Citespace was used to analyse the recent literature on green development. Citespace is a Java-based document visualization software developed by Chinese American scholar Chaomei Chen. The software integrates co-occurrence analysis, cluster analysis and time series analysis, aiming to reflect the overall situation of the literature.

2.2 Data Sources

The entire literature for this study was sourced from the Chinese Social Science Citation Index (CSSCI). This research searched the literature in recent years (2010-2020) under the title of "Green Development", and obtained 491 articles in total. Based on the statistics, the quantity and the changing trend of the literature related to green development research in China from 2010 to 2019 were obtained. As can be seen from Figure 1, the number of literature will be relatively small, with about 20 articles being published each year. Since 2016, the number of

articles published has increased significantly, with around 100 per year. The year 2016 marks the beginning of the "13th Five-Year Plan". As one of the five development concepts, green development has received more attention.

Research on green development in China involves a wide range of disciplines. Among them, the number of economic literature is the largest, 258, accounting for 52.4% of the total. Figure 2 is the statistical chart of the discipline distribution in China from 2010 to 2020. It can be seen, in addition to economics, other disciplines covered by the literature include management, political science, environmental science, philosophy, law, Marxism, human and economic geography, sociology.

Table 1: Statistics on prolific author of green development research in China from 2010 to 2020.

Number	Author	Cited Times	Number	Author	Cited Times
1	Chuanqing Wu	6	6	Zhibin Huang	4
2	Yaobin Liu	5	7	Huaxi Yuan	3
3	Fawen Yu	5	8	Aiping He	3
4	Lei Huang	4	9	Zhizhong Zhang	3
5	Chao Feng	4	10	Jianjun Zhao	3

Table 2: Statistics of highly-cited authors in China's green development research from 2010 to 2020(Top 10).

Number	Author	Cited Times	Number	Author	Cited Times
1	Angang Hu	64	6	Shujing Yue	17
2	Xiaoxi Li	39	7	Shiyi Chen	16
3	Bing Wang	38	8	Jianjun Zhao	14
4	Jianhuan Huang	19	9	Lin Li	13
5	Zhengge Tu	18	10	Jun Zhang	13

3 RESEARCH THREAD OF GREEN DEVELOPMENT

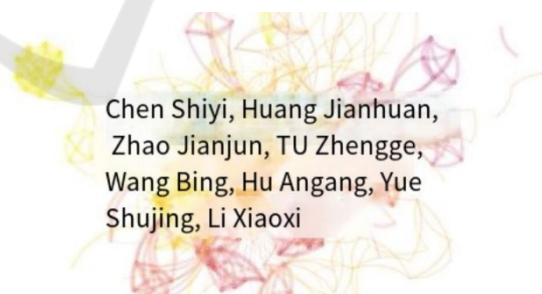
3.1 Analysis of Highly Cited Researchers

In recent years, there have been many high-yield authors who have achieved fruitful results in green development research. Table 1 lists the names of the top ten authors in terms of the number of published papers. They have studied green development from multiple perspectives. For example, Chuanqing Wu and Lei Huang from Wuhan University did a series of studies on the green development in cities and industries along the Yangtze River Economic Belt. The research focused on the green development efficiency and its synergy effect, the measurement of the green development level and the promotion path. Fawen Yu, a researcher at the Chinese Academy of Social Sciences, pondered the motivation and path of agricultural green development in the new era of China under the background of the rural revitalization strategy and the acceleration of agricultural and rural modernization. Yaobin Liu, a professor at Nanchang University, explored the impact of financial deepening on China's green development process from a financial perspective.

A large number of research results has provided reference and research ideas for later scholars. Many results have been cited many times for the field of research to make a contribution. In order to identify the core authors who currently make a significant contribution to green development, the Citespace software was used to generate a high-cited authors statistical map, and the names of the top ten high-

cited authors and the numbers of citations were reflected in Table 2.

As can be seen from Table 2, the papers of researchers such as Angang Hu from School of Public Administration of Tsinghua University, professor Xiaoxi Li from Institute of Economics and Resource Management of Beijing Normal University, professor Bing Wang from Department of Economics of Jinan University, Jianhuan Huang from Hunan University, and Zhengge Tu from Central China Normal University were cited frequently. Among them, professor Angang Hu's work was cited for 64 times, ranking the first, followed by professor Xiaoxi Li and professor Bing Wang, both of whom were cited more than 30 times.



Chen Shiyi, Huang Jianhuan,
Zhao Jianjun, TU Zhengge,
Wang Bing, Hu Angang, Yue
Shujing, Li Xiaoxi

Figure 3: Statistics of highly-cited authors in green development research in China.

Based on China's national conditions and the development concept in the "13th Five-Year Plan": green development, Angang Hu, director of the National Situation Center of Tsinghua University, explained the goals, ideas and methods of green development from the perspective of political economy. Xiaoxi Li is devoted to the research on the

assessment of the level of green development, based on the "human development index", and put forward the "human green development index". Many foreign economists have long proposed that if resource and environmental factors are ignored in the study of regional development efficiency and productivity, the calculation results will be biased. Therefore, Bing Wang considered resource and environmental factors, put forward the concept of "green development efficiency" to measure its efficiency level, and used "green total factor productivity" to measure the level of productivity growth. From the financial perspective, Jianhuan Huang studied the impact of financial development on green development and its spatial spillover effect. Zhengge Tu studied how to improve the efficiency of agricultural subsidies and promote agricultural growth.

3.2 Analysis of Core Research Institutions

Through the statistical analysis of green development research institutions from 2010 to 2020, the results in Figure 4 can be found that there are a number of strong scientific research institutions in China conducting green development-related research. Among the institutions with the highest number of papers are: Chinese Academy of Social Sciences, Institute of Geographic Sciences and Natural Resources Research, Wuhan University, Central South University of Forestry and Technology, Beijing Normal University, Xi 'an Jiaotong University and so on.



Figure 4: Statistics on core institutions of green development research in China.

According to the statistical results, the core research institutions were concentrated in China's research institutes and universities, and Chinese Academy of Social Sciences and universities in central China have more achievements. The number of papers published by the Chinese Academy of Social Sciences is 19, while Wuhan University and Central South University of Forestry and Technology

each published 8 posts. Most of the universities' research results come from the School of Economics and Management, and a few from the School of Marxism. The total number of nodes is 227, the number of Links is 29, and the Density is only 0.0009, showing a scattered distribution basically. This indicates a lack of connection and cooperation among various research institutions.

Table 3: China's green development research institutions and their number of published papers from 2010 to 2020 (Top 5).

Number	Research Institution	Number of Published Papers
1	Chinese Academy of Social Sciences	19
2	Chinese Academy of Sciences	8
3	Wuhan University	8
4	Central South University of Forestry and Technology	8
5	Beijing Normal University	7

3.3 Analysis of Core Journals

As can be seen from Figure 5, the most frequently cited journals include: China's Population, Resources and Environment, Economic Research, China's Industrial Economics, and Management World. These journals are the top journals in China's management and economics disciplines, with relatively high quality articles.



Figure 5: Statistics of highly-cited journals on green development research in China.

Among these journals, "China's Population, Resources and Environment" was cited the most, with 135 citations. It is headed by the Ministry of Science and Technology, PRC and it is the journal of the China Society for Sustainable Development. Its main columns include sustainable development theory research, sustainable industry. Green development

accords with the requirements for the inclusion of the journal. The second most cited journal is Economic Research, a national journal of comprehensive economic theory, run by the Chinese Academy of Social Sciences. Its columns involve circular economy and ecological economy, so it also includes some articles on green development.

Table 4: Statistics of China's green development research is highly cited journal (Top 10).

Number	Publication Name	Cited Times
1	China's Population, Resources and Environment	135
2	Economic Research	81
3	China's Industrial Economy	69
4	Management World	41
5	Economic Geography	40
6	Chinese Social Sciences	39
7	Energy Policy	36
8	Quantitative Economics and Technical Economics Research	34
9	China Soft Science	31
10	Ecological Economics	31

4 THEORETICAL FRONTIER ANALYSIS OF GREEN DEVELOPMENT RESEARCH

4.1 Keyword Frequency Analysis

The key words of China's green development research from 2010 to 2020 were counted and the high frequency keywords were obtained, as is shown in Figure 6. The keywords include ecological civilization, efficiency of green development, sustainable development etc.



Figure 6: Statistic on high frequency keywords of green development research in China.

The keywords reveal the research direction and main ideas of the literature. At present, the research on green development mainly focuses on the following aspects: necessity and feasibility of realizing green development in China, evaluation of green development level and efficiency, green development mode of each industry.

Table 5: Statistics on high frequency keywords of Green development research in China.

Number	Keywords	Frequency
1	Green Development	307
2	Ecological Civilization	37
3	Concept Green of Development	33
4	Efficiency of green Development	22
5	Yangtze River Economic Belt	17
6	Sustainable Development	12
7	Environmental Protection	11
8	Ecological Civilization Construction	11
9	Green Economy	10
10	Environmental Regulation	10

4.2 Time Zone Distribution and Burst Term Analysis of High Frequency Keywords

Burst term is the term that appear or use more frequently in a short period. The time zone map of keyword can help us identify hotspots of research in different periods.

Through the time zone distribution map of high-frequency keywords, the trend of green development research from 2010 to 2020 is divided into three stages. The first stage is from 2010 to 2013, with the most frequent keywords being: industrial structure, climate change, sustainable development, environmental protection, green economy. The second stage is from 2014 to 2017, keywords are circular economy, green development view, Marxism, green development efficiency. The third stage is from 2018 to 2020, keywords are environmental regulation, high quality development, green industrial development, green agricultural development.

4.2.1 Main Research Contents in The First Stage

In the first stage (2010-2013), the research on green development mainly explored how to achieve sustainable development.



Figure 7: Statistics on burst term of high frequency keywords in green development research in China.

Greenhouse gases emitted by human activities are causing the temperature to rise. Global warming has become a common problem for human survival. With the rapid development of China's economy in recent years, along with the energy consumption and greenhouse gas emission, China has assumed important responsibility of energy conservation and emission reduction (Hu, 2010). We should achieve economic development and growth, at the same time we should also improve energy efficiency. Since the concept of sustainable development was put forward in 1987, the awareness of ecological and environmental protection has been gradually enhanced. To achieve green development, we need a safer and cleaner development mode. Therefore, extensive economic growth mode must be changed. Forming green industrial system and developing low-carbon economy and circular economy (Qiang, 2010) are the keys.

"Decoupling" theory and Kuznets curve hypothesis hold that economic development, resource consumption and environmental pollution show an inverted U trend. That is to say, with the development of economy, resource consumption and environmental pollution will increase and worsen firstly, and then improve. These theories confirm the possibility of low-carbon economic development. To develop low-carbon economy, Zhijun Feng (2010) believes that the following measures should be taken: to adjust the industrial structure, develop low-carbon technologies, use low-carbon energy, and expand the potential of carbon sink (Feng, 2010). Based on the development experience of developed countries, compulsory transformation by administrative means

is not a long-term solution. Only by making use of economic means and policies such as price and tax, giving full play to the role of market mechanism can arouse the initiative of enterprises in green transformation (Huang, 2014).

Circular economy is based on the ecological laws. The ecological damage and environmental pollution caused by human economic activities should be reduced through saving and recycling resource as far as possible. Although the concepts of circular economy and low carbon economy are different, their intrinsic properties are the same as the connotation of green economy (Liu, 2012).

4.2.2 Main Research Contents of The Second Stage

The second stage (2014-2017) was based on Marxism to construct China's green development view and explore the harmonious development between man and nature. In this stage, a lot of research has been done on the evaluation of green development effects, and the evaluation index system has been used to measure the regional differences of green development.

To make green development scientific and sustainable, it is necessary to measure and evaluate its effects. Foreign economists have recognized that environmental factors should be taken into account when measuring productivity. Currently, some countries have already used green GDP as a method to measure productivity. Many domestic scholars have studied the assessment system which is suitable for China's green development. For example, Bing Wang (2014) combined the parameter Common boundary model with Luenberger index to measure the green development efficiency of 30 provinces and cities in China from 2000 to 2010 (Wang, 2014) by putting CO₂ and SO₂ emissions into the framework of total factor productivity analysis, and the regional difference of green development level was compared. Xiaoxi Li (2014) believes that green development is to find a new way of economic growth, that "green" and "development" should go hand in hand. On the basis of human development index, resource and environmental factors should be added to build a human green development index system and measure the green development index of different countries (Li, 2014).

To achieve green development, the construction of green cities and villages is the premise, and to achieve the Green development of cities and villages, the core is to realize the greening of industries (Wu, 2017). The green development level of urban

agglomeration plays an important role in promoting the overall green development of China. Yue Huang (2017) used projection pursuit model, Pearson correlation, coefficient of variation and Theil index to analyze the spatial characteristics (Huang, 2017) comprehensively. The development of cities depends on the concentration of industry into cities. Shujing Yue (2015) calculated the green development efficiency of 96 prefecture-level cities in China by using SBM directional distance function in view of the impact of industrial agglomeration on green development of cities (Yue, 2015). The results showed that an inverted U-shaped relationship was presented between industrial agglomeration and green development efficiency of cities. Since the 21st century, the problem of ecological environmental pollution in rural areas of China has become more and more serious. Li Xie (2016) constructed an evaluation index system of rural green development by combining various DEA models with Gini criteria, and its development performance is measured and analyzed dynamically (Xie, 2016).

4.2.3 Main Research Contents in The Third Stage

In the third stage, how to achieve green development in various industries has been further studied, such as agricultural green development, industrial green development, etc.

Extensive manufacturing development mode has caused industrial pollution and become one of the main reasons of ecological pollution. In December 2018, the Central Economic Work Conference proposed to "promote high-quality development in the manufacturing sector". Green development efficiency is an important indicator to measure whether to achieve high-quality development level. Under China's economic system, environmental regulation is an important factor affecting the efficiency of green development. Renfa Yang (2019) analyzed the impact of environmental regulation on China's green industrial development. The results showed that environmental regulation in eastern China had a significant positive impact on green industrial development, while the relationship between environmental regulations and green industrial development in central and western China showed an inverted "U" shape (Yang, 2019). Aiping He (2019) used SBM-DEA directional distance function to calculate the green development efficiency of China's provincial regions, and also proved that environmental regulation has a positive on green development. However, the competition

between local governments will lead to the lack of environmental regulation, so it is necessary to improve the local assessment system (He, 2019). Yongjun Tang (2019) measured the green development level of enterprises and found that gender, age and other characteristics of board members play a moderating role between environmental administrative supervision and green development (Tang, 2019).

Since the 13th Five-Year Plan, China has issued many guiding documents on green agricultural development. In 2016, the "No.1 Document" of the Central Government, proposed to "promote green agricultural development". In September 2017, China issued the Opinions on Promoting Green Agricultural Development by Innovating Systems and Mechanisms. To realize the green development in agriculture, we must have a scientific understanding of its connotation. Qianwen Gong (2020) pointed out the connotation of green agricultural development should be defined from three aspects: low carbon, economy and security. The level of green agricultural development should be evaluated from three dimensions: low-carbon production, economic growth and safety supply (Gong, 2020). Guided by the conviction that "lucid waters and lush mountains are invaluable assets", Weilin Sun (2019) constructed an index system to measure the level of green agricultural development (Sun, 2019). Agricultural industrial agglomeration is an important way to improve production efficiency. Therefore, some scholars studied the relationship between agricultural industrial agglomeration and green agricultural development. For example, Lei Xue (2020) tested the spatial spillover effect of agricultural industrial agglomeration on the efficiency of green agricultural development (Xue, 2020).

5 CONCLUSION

According to the statistical analysis of 492 papers titled "green development" in CSSCI database, Chinese scholars' research on this topic has been increasing in recent years, especially after 2015. "Green development" has been studied in many disciplines, including economics, management, political science and environmental science. Core authors with a large number of posts are Chuanqing Wu, Yaobin Liu, Fawen Yu, Lei Huang. Authors with high citation frequency are Angang Hu, Xiaoxi Li, Bing Wang, Jianhuan Huang. Core research institutions include Chinese Academy of Social Sciences, Chinese Academy of Sciences, Wuhan

University, Central South University of Forestry and Technology. The core journals mainly include China's population, Resources and Environment, Economic Research, China's Industrial Economy, Management World. High-frequency keywords include: green development efficiency, sustainable development, industrial structure, circular economy, environmental regulation, industrial green development, agricultural green development.

In this paper, the trend of research contents from 2010 to 2020 is divided into three stages. The first stage, from 2010 to 2013, discussed the necessity and feasibility of realizing green development in China under the premise of global ecological environment deterioration. In the second stage, from 2014 to 2017, focused on building a green development level evaluation system. The third stage, from 2018 to 2020, focused on how to achieve green development in each industry. From the research results on green development in recent years, we can see that theoretical development is constantly meeting the needs of social development. In 2021, the government work report proposed "carbon peak" and "carbon neutral". China has assumed the responsibility of energy conservation and emission reduction, and has pledged to achieve "carbon neutral" by 2060. China shoulders the responsibility of energy conservation and emission reduction. How to achieve this goal through green development is an important issue in the future.

ACKNOWLEDGMENTS

Fund project: Anhui Province Humanities and Social Sciences Major Project (SK2019A0433), Anhui Provincial Major Teaching Research Project in 2020 (2020jyxm2160). Outstanding Young Talents Support Program for Universities in 2022 (gxyq2022061).

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