Check for updates

Bibliometric analysis of research on China's rural environmental governance in CNKI and WOS

Qin Shen[1]*, Qing Sun[2] and Aopei Zhao[3]

[1]School of Law, Chongqing University, Chongqing, China, [2]College of National Governance, Southwest University, Chongqing, China, [3]School of Information and Management Science, Henan Agricultural University, Zhengzhou, China

At present, the global consensus on the concept of sustainable development continues to deepen, and China's ecological civilization construction and rural revitalization strategy continue to advance. However, the rural environmental situation in China is becoming more and more complex. Therefore, a comprehensive review and summary of China's rural environmental governance research are particularly important, which can not only provide theoretical support for future research but also offer vital guidance for governance practices. Based on the research literature of CNKI (1993–2023) and WOS (2001–2024), bibliometrics and CiteSpace software are adopted in this review to tease out the main characteristics, research hotspots and evolution trends of rural environmental governance research in China. The results indicate that: 1) Research interest shows an overall upward trend, with an expanding scale of interdisciplinary scholars and teams emerging. The collaboration network among authors and institutions in WOS appears tighter than that in CNKI. 2) In CNKI, Research hotspots revolve around environmental issues and pollution governance, social participation and governance mechanisms, ecological civilization and sustainable development, and rural revitalization and construction. In WOS, research hotspots pivot towards policy implementation and governance mechanisms, environmental issues and resource management, socio-economic impacts and equity, information disclosure and community participation, and technology and methods. 3) The research in CNKI has undergone three stages: "initiation", "development", and "deepening". In contrast, the research in WOS started relatively late and is currently still in the "development" stage. Future research should focus on enhancing disciplinary integration and fostering collaboration among domestic and international scholars and institutions. Under the rural revitalization strategy, focus should be on achieving symbiosis between rural economic growth and ecological civilization construction. Simultaneously exploring diverse stakeholder governance models, focusing on rural living environment issues and striving to reduce rural carbon emissions to address climate change challenges.

KEYWORDS

rural environmental governance, Citespace, research characteristics, hot topics, evolution trend

1 Introduction

Since the new century, the acceleration of China's industrialization and urbanization has promoted the rapid development of the rural economy, but at the same time, it has also brought severe rural environmental problems. General issues such as pollution from township industries and livestock breeding, non-point source pollution from agriculture, pollution from rural living environments, and the destruction of natural resources are prevalent (Ren and Gao, 2010). The loss of biodiversity, air and water pollution are increasingly prominent (Zhao et al., 2017). These issues not only threaten the health of the rural ecosystem and the quality of life for residents but also constrain the prospects for sustainable rural development. Consequently, China has started to pay attention and take measures to strengthen rural environmental governance, to promote green development and rural revitalization in rural areas.

However, compared with the more perfect policies and models of urban environmental governance, there is still a large gap in rural environmental governance. These gaps are due to the continuous decline of rural areas caused by the disparity in living standards between urban and rural areas (Young, 2013), irrational urban-rural policies, imbalance of environmental rights, poor enforcement of environmental regulations (Fan and Tang, 2016), and loss of discourse power in rural environmental governance (Qu, 2021). The rural environmental governance has not been able to develop synchronously with urban environmental governance for a long time, always facing issues such as "historical debt, a large gap in funding, and lack of long-term mechanisms" (Zong et al., 2012) and "lack of normative standards, governance entities, and judicial safeguards" (Zhang and Guo, 2023). In recent years, all sectors of society have begun to pay more attention to China's rural environmental issues, aiming to explore effective methods and strategies to reduce pollution, govern, and restore the ecological environment.

Rural environmental governance refers to the comprehensive management of the rural environment by political actors based on specific concepts, rules, institutions, resources, etc (Driessen et al., 2012). Since the late 20th century, many countries have gradually shifted their understanding of the environmental field from an excessive dependence on and infatuation with engineering technology and treating symptoms rather than causes concepts to seeking a "governance" approach, meaning that a fundamental change in production and lifestyle and development concepts is needed (Cashore, 2002; Bulkeley, 2005). Environmental governance is technical, policy-based, systematic, and public in nature, hence, It is not only related to technological, economic, and social issues but also a core issue of the interaction between human society and the natural environment (Du et al., 2010). In the practice of rural environmental governance in China, government regulation and market adjustment are two main modes, but there have been long-standing issues of "government failure" and "market failure" (Du et al., 2018).

In recent years, scholars have used Western governance theories to reexamine environmental governance issues and proposed a series of new ideas and methods. These studies were primarily conducted from the following perspectives: 1) From the perspective of the government, which include discussing the dilemma of government governance models based on the Theory of Planned Behavior; studying the "institutional inaction" phenomenon in government governance using the fuzzy-conflict framework; and proposing pathways for achieving positive interaction between government leadership and farmer participation based on the embeddedness theory of action (Zhang and Guo, 2023). 2) From the perspective of rural residents, studies have also included advocating resident self-governance based on the common-pool resource theory (Li et al., 2011) and self-governance theory (Sheng and Ma, 2023); aiming to empower and cultivate residents' subjective consciousness and participation confidence based on the Theory of Planned Behavior (Wang and Li, 2021; Yu et al., 2023). 3) From the perspective of multi-subject collaboration, studies have involved constructing a governance model involving government, market, and social multi-subject participation based on the polycentric governance theory (Zhang et al., 2023); utilizing holistic governance theory to construct coordination, integration, and trust mechanisms to schedule beneficial elements, integrate policy objectives, optimize the organizational function of bureaucratic subjects, and promote public participation (Zheng and Chen, 2022); and clarifying the conflict and game state between stakeholders such as government, enterprises, cities, villagers, and environmental organizations based on stakeholder theory to achieve good rural environmental governance (Shen and Liu, 2016).

Additionally, scholars have: 1) Established new development philosophies from the perspective of governance concepts, including the idea that "lucid waters and lush mountains are invaluable assets" (Wang et al., 2017), green development (Du, 2019), and comprehensive, innovative, coordinated, open, and share (Ren and Wen, 2018). 2) Discussed the establishment of standard assurances through both formal policy and legal systems (Zhang et al., 2011; Wang et al., 2019), as well as informal systems like village regulations and conventions (Yang Y. et al., 2022; Yang Z. et al., 2022). 3) From the perspective of governance resources, discussions have centered on issues such as social capital (Ruan et al., 2022), financial support (Niu et al., 2019), technological innovation (Gu et al., 2016; Chen et al., 2023), rural elites (Chang and Huang, 2021), and public infrastructure (Du and Jiao, 2023).

In summary, the research on China's rural environmental governance presents a state of "blooming flowers". Meanwhile, with the deepening global consensus on the concept of sustainable development and the continuous advancement of China's ecological civilization construction and rural revitalization strategy, the field is facing unprecedented historical opportunities. Against this backdrop, reviewing and deeply analyzing the literature in the field of China's rural environmental governance seems particularly urgent. At present, although there are some research reviews on rural environmental governance in CNKI, most still use traditional literature review methods and lack systematicness (Du, 2019; Lin et al., 2020). In WOS, literature reviews on rural environmental governance in China are less common and focus on the field of human settlement environments (Wang C. et al., 2023; Wang H. et al., 2023; Wei et al., 2023). Hence, it is necessary to systematically comb through the research on rural environmental governance in CNKI and WOS using bibliometric method to fully understand the current research status and development trends, to promote knowledge accumulation and innovation, and to provide a scientific basis for future research directions and policy formulation.

Traditional literature review, a "narrative literature review" (Jesson et al., 2011), mainly involves reading, summarizing, and organizing

existing literature to reveal the current research status, development trends, and important views of a specific field. In the positivism era, traditional literature reviews were heavily criticized, mainly due to their lack of rigorous research standards (You and Huang, 2017). In an era of data explosion, the time and resources required for traditional literature reviews have also increased significantly. In contrast, bibliometric analysis provides a comprehensive and objective perspective through quantitative analysis and analysis of large-scale literature data. However, we believe that conducting a traditional literature review before engaging in bibliometric analysis is necessary to help define the research questions.

Bibliometrics, proposed by the famous British information scientist Alan Pritchard (Pritchard, 1969), is a quantitative analysis method based on mathematical and statistical principles. It enables a quantitative analysis of literature information and, with the help of knowledge graphs, displays complex relationships between knowledge units and groups, such as network relationships, structural features, and evolutionary trends. Knowledge graphs combine the advantages of quantitative statistics and intuitive visualization, helping researchers understand the knowledge structure more accurately (Kao et al., 2022). With the explosive growth of literature in various disciplines, bibliometric method has become an important method for studying the development of various disciplines (Rodrigues Sousa et al., 2020). CiteSpace is a widely used bibliometric tool known for its powerful functions and excellent performance in bibliometric statistics and visualization of knowledge maps (Wang C. et al., 2023; Wang H. et al., 2023). This paper will use CiteSpace to quantitatively analyze the literature on rural environmental governance in China in CNKI and WOS, aiming to explore the following questions:

(1) What are the trends in the publication of papers in the field of rural environmental governance in China?
(2) What are the characteristics of research authors and institutions?
(3) What are the hot research topics?
(4) What are the trends and frontiers of research?

The subsequent chapters of this article will unfold as follows: Chapter 2 will provide a detailed introduction to data sources, selection criteria, and analysis methods. Chapter 3 will employ descriptive statistical methods to examine annual paper publication volumes and disciplinary contributions in CNKI and WOS, and utilize CiteSpace to explore collaboration networks among researchers and institutions, research hotspots, trends, and frontiers. Chapter 4 will discuss the characteristics, similarities, and differences in research strengths, hotspot topics, and developmental trends between CNKI and WOS, and propose future research directions. Chapter 5 will summarize the main findings of this study and discuss its limitations.

2 Materials and methods

2.1 Data

All Chinese data in this text were derived from the "Chinese Social Sciences Citation Index (CSSCI)" and "Peking University Core Journal Directory" sub-databases under the China National Knowledge Infrastructure (CNKI) database. English data were sourced from the Web of Science database, including SCI-EXPANDED and SSCI sub-databases. WOS is widely regarded as the primary source of authoritative and representative citation data (Mongeon and Paul-Hus, 2016). The study adopted the PRISMA flowchart used in Caro-Gonzalez et al. (2023) research to meticulously illustrate the data retrieval, selection, inclusion criteria, and processes (Figure 1). This ensures systematic confirmation, extraction, and evaluation of existing research findings, ensuring the reliability and relevance of bibliometric analysis. As shown in Figure 1, in CNKI, TS = "rural environmental governance or "rural environmental protection" or"rural ecological governance" or "rural pollution governance"; DT = "article"; no time span. This search yielded 1,143 documents distributed from 1993 to March 2023. Initially, documents such as national or local government reports, conference abstracts, promotional articles, book reviews, news, and irrelevant articles were excluded based on titles and abstracts. Subsequently, after full-text reading, papers that did not focus on rural environmental governance, had incomplete arguments, or were in engineering fields were further excluded, resulting in a final selection of 867 valid documents.

In WOS, TS = "rural environmental governance" and "China"; DT = "article or review"; LA = "English"; no time span. Given that this paper primarily discusses rural environmental governance research from CNKI, with supplementary perspectives from WOS, only the most relevant keyword, "rural environmental governance," was chosen. This keyword accurately reflects the level of international attention to "rural environmental governance" in China. As a result, 232 documents from 2001 to March 2024 were retrieved. Initially, retracted publications, editorial materials, and papers unrelated to the topic had been excluded based on titles and abstracts. Subsequently, after full-text reading, articles with insufficient discussion on rural environmental governance in China and those of poor research quality were further excluded, resulting in a final selection of 186 valid documents.

2.2 Methodology

In this study, CiteSpace is used as a versatile citation visualization software based on modern scientometrics and informetrics techniques, which enables the scientific analysis of literature data and its underlying information (Li and Chen, 2017). Such literature data includes titles, authors, affiliations, journals, keywords, and citation information. Based on these data characteristics, it is possible to generate knowledge maps such as citation networks, co-occurrence networks, and document coupling (Najmi et al., 2017). This paper combines descriptive statistical analysis and Citespace bibliometric analysis, and at the same time, content analysis should be supplemented in the bibliometric analysis to objectively sort out the basic characteristics, hot topics, research trends and frontier development of Chinese and international research on China's rural environmental governance (Figure 2).

Co-occurrence refers to the phenomenon of simultaneous occurrence of a knowledge unit, which includes title, author,
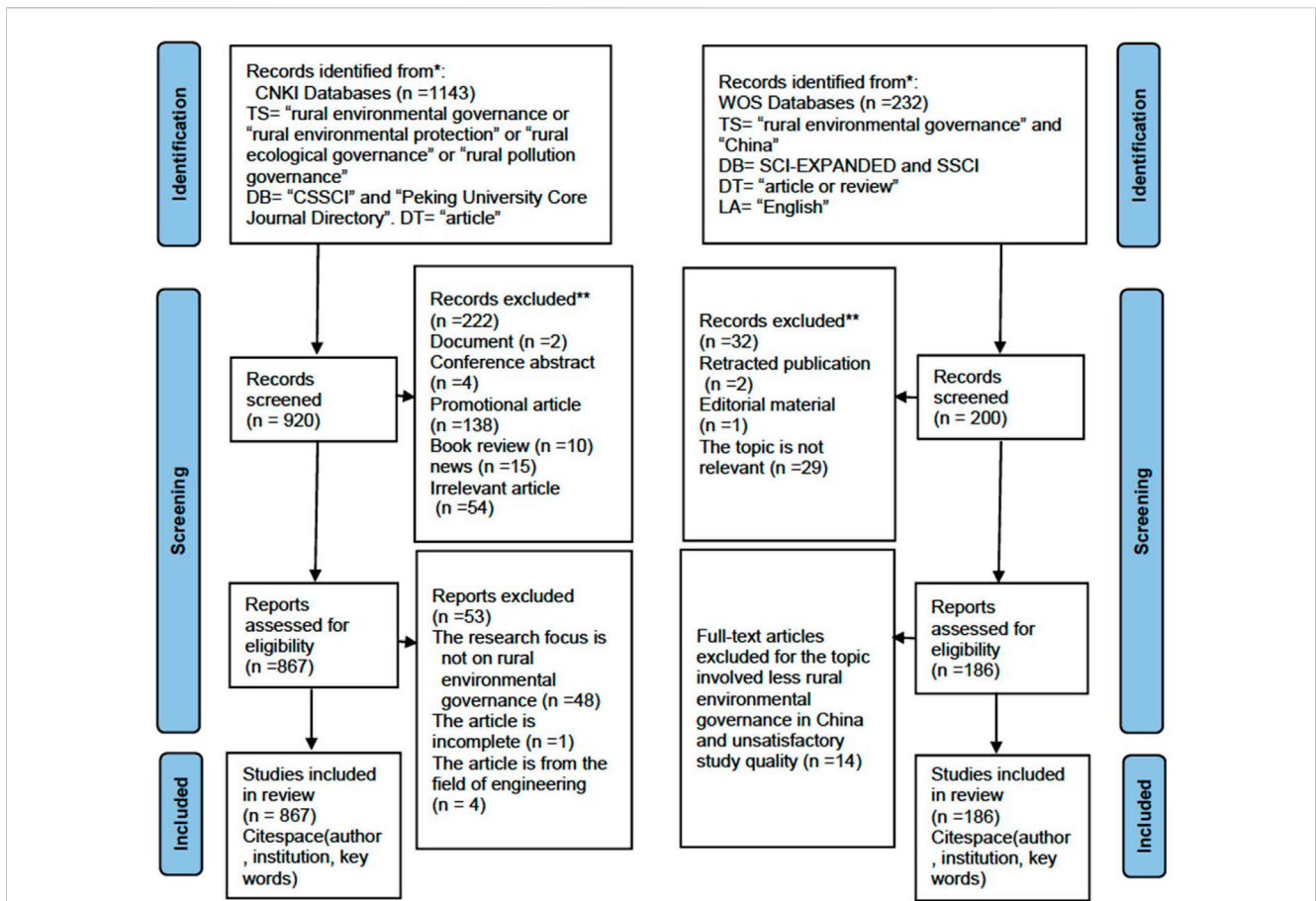
FIGURE 1
PRISMA flow diagram for literature search and selection.
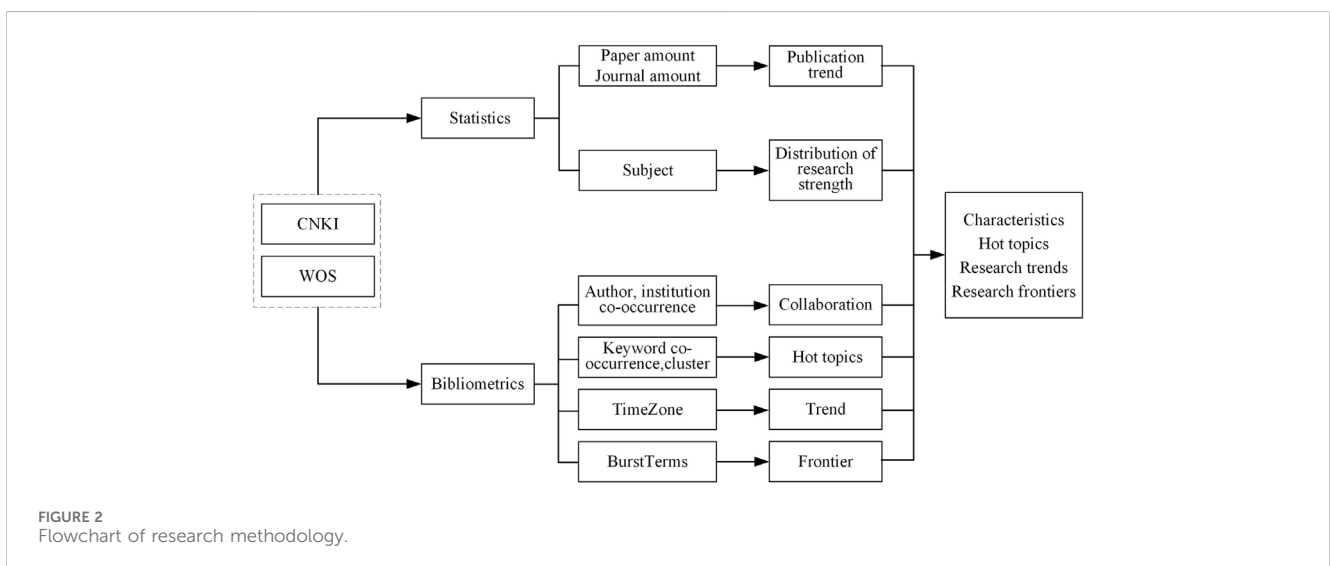
FIGURE 2
Flowchart of research methodology.

institution and keywords. Firstly, author and institution co-occurrence analysis in CiteSpace are used to identify the formation of main researchers, research institutions and their collaboration networks. To explore the author collaboration dynamics within the field of rural environmental governance

research, Price's Law (Zong, 2016) is introduced to assess the number of publications required to form a core group of authors, hence determining whether the discipline has developed a stable, mature core group or community of authors. The formula for Price's Law is in Eq. 1:

FIGURE 3
Papers and journals amount change in CNKI and WOS ((A), Papers, (B), Journals).
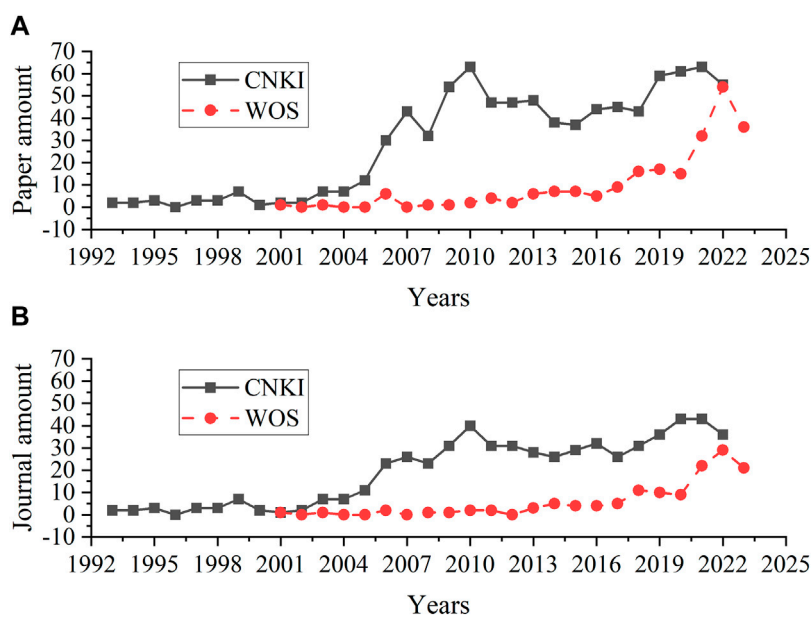
$$Mp = 0.749 \times \sqrt{Npmax} \qquad (1)$$

Npmax represents the maximum frequency of publication by authors in the discipline, while Mp represents the number of publications required to become a core author.

Keywords, as the central content of research, reflect the hot topics in the research field through high-frequency co-occurrence. They can also be further clustered into higher-level abstractions. In order to display research hotspots through high-frequency keywords, the formula of high-frequency and low-frequency words segmentation proposed by Donohue (1973) is introduced. The formula is shown in Eq. 2:

$$T = \left(-1 + \sqrt{1 + 8 \times I1}\right)\big/2 \qquad (2)$$

(T) represents the boundary frequency between high-frequency and low-frequency keywords, while (I1) denotes the frequency of keywords that occur only once.

The time-zone map of keywords primarily reflects the frequency changes of major keywords across different years and their relationships. Analyzing the time-zone map can reveal the dynamic changes in knowledge structure, aiding in understanding the developmental context and evolutionary trends of the research field. Additionally, bursts highlights sudden increases or declines in the popularity of specific keywords within certain time periods, which can help predict future research trends.

2.3 Paramerer setting

We utilized CiteSpace software for literature processing, setting the node types as author, institution, and keyword. For the CNKI database, our timeline spans from 1993 to 2023, while for the WOS database, it ranges from 2001 to 2024, with each time slice set to 1 year (years per slice). The trimming methods selected were pathfinder and pruning sliced networks to eliminate redundant, cumbersome, or visually unappealing links (Song et al., 2016), with other settings left as default.

3 Results

3.1 Annual volume of papers

3.1.1 Annual papers and annual journals

Figure 3A illustrates the distribution of academic articles in the field of rural environmental governance. In CNKI, the overall number of publications on rural environmental governance research showed a tortuous upward trend. The related research can be divided into four stages based on the publication frequency. The first stage (1993–2004) witnessed a slow start, with a cumulative publication of 39 articles, averaging only about 3 articles per year. The second stage (2005–2010) saw a rapid growth, with a cumulative number of 234 publications and an average annual publication rate of 39 articles, which is 13 times that of the first stage. Notably, the publication volume in 2010 reached 63 articles. The third stage (2011–2018) experienced a slight slowdown but maintained a high level, with a cumulative publication volume of 349 articles, accounting for 40.3% of the total publications. The annual average was 43 articles, which is 14.3 times and 1.1 times that of the first and second stages. The fourth stage (2019-) has seen a continuous rise in research popularity, reaching a cumulative total of 238 papers by March 2023, with an annual average of 60 papers. This is 20 times, 1.54 times, and 1.4 times that of the first, second, and third stages, respectively.

In WOS, research on rural environmental governance in China started later but overall shows an upward trend in publications, especially with an explosive growth in the last 3 years. The related
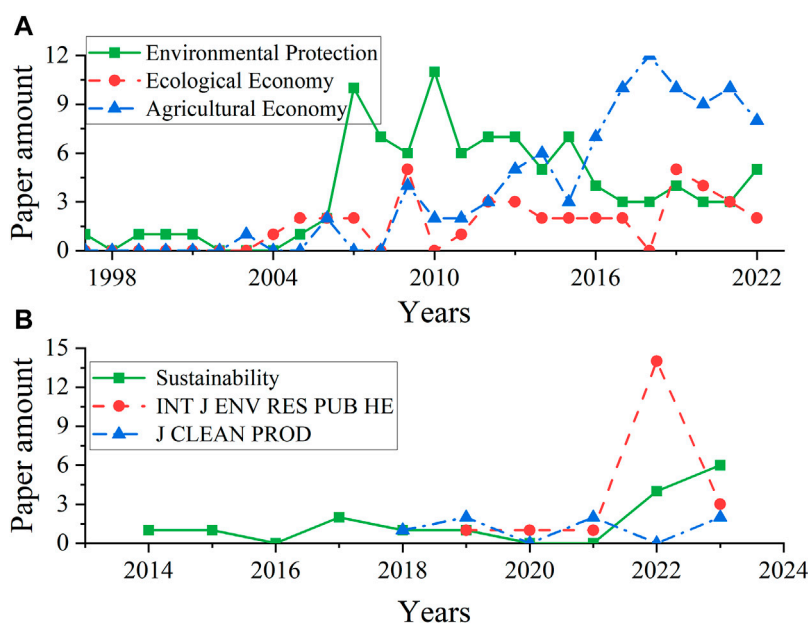
FIGURE 4
Annual number of papers of the top three journals in CNKI and WOS ((A), CNKI, (B), WOS).

research can be divided into three stages. The first stage (2001–2010) with a slow start and a cumulative publication of 9 articles. The second stage (2011–2019) experienced relatively steady growth, with a cumulative number of 66 publications, which is 7.3 times that of the first stage. The third stage is after 2020, with a cumulative publication volume of 101 articles, which is 11.2 times and 1.53 times that of the first and second stages, respectively.

Figure 3B shows the distribution of journals that published papers in the field of rural environmental governance. Compared with Figure 3A, it can be clearly seen that the trend of annual journal changes is highly consistent with the trend of the number of publications. It is only because some journals publish multiple papers in the same year, so the number of journals is often less than the number of papers.

3.1.2 Annual papers of the top three journals

Figure 4 presents the annual of papers for the top three journals by publication volume in both CNKI and WOS. In CNKI (Figure 4A), the journals with the highest publication volumes are Environmental Protection (98), Agricultural Economy (94), and Ecological Economics (41), together accounting for 27% of the total journal publications. From 2005 to 2010, these journals showed synchronized growth, with Environmental Protection showing the most significant increase. Since 2011, Environmental Protection's output declined to about 4 papers annually, while Agricultural Economy grew steadily. Ecological Economics grew slower.

In WOS (Figure 4B), the top three journals by publication count are INT J ENV RES PUB HE (20), Sustainability (16), and J CLEAN PROD (7), comprising 23% of all publications. Sustainability started early and maintains a gradual upward trend. INT J ENV RES PUB HE surged in 2022 but then decreased, influenced by journal

conditions. J CLEAN PROD has a stable output, averaging about 2 papers annually.

3.2 Subject area statistics

Table 1 and Table 2 list the main discipline/professional research literature on rural environmental governance in CNKI and WOS, respectively. In CNKI, the largest number of documents falls within the field of environmental science and resource utilization, constituting 55.48% of the total. Following this, agricultural economy accounts for 17.64%. Other fields such as political parties and mass organizations (7.79%), agricultural basic science (7.46%), and administrative law and local legal systems (5.22%) show gradual increases, although their overall proportions remain relatively low. In WOS, the largest number of documents falls within the field of Environmental Sciences, constituting 44.25% of the total. This is followed by Environmental Studies and Green Sustainable Science Technology, accounting for 27.43% and 18.14%, respectively. The remaining literature is relatively evenly distributed among the professional fields of Public Environmental Occupational Health (10.62%) and Development Studies (7.52%). Overall, Environmental Sciences constitute the highest proportion among the literature on rural environmental governance in both databases, highlighting the interdisciplinary nature of the research.

3.3 Author's cooperation

Figure 5 is the author co-occurrence map of rural environmental governance research in CNKI, N = 539, E = 223, D = 0.0015. From a single author's perspective, Du, Y., Yu, F., Wang, X., and Li, N. have more outstanding results in the field of rural environmental

TABLE 1 The top 10 disciplines/majors in CNKI.

No.	Disciplines/Professionals	Number of papers	Proportion (%)
1	Environmental science and resource utilization	840	55.48
2	Agricultural economy	267	17.64
3	Political parties and mass organizations	118	7.79
4	Agricultural basic science	113	7.46
5	Administrative law and local legal system	79	5.22
6	Macroeconomic management and sustainable utilization	37	2.44
7	Chinese politics and international politics	17	1.12
8	Public administration and national administration	15	0.99
9	Agricultural engineering	14	0.92
10	Finance and taxation	14	0.92

TABLE 2 The top 10 disciplines/majors in WOS.

No.	Disciplines/Professionals	Number of papers	Proportion (%)
1	Environmental Sciences	100	44.25
2	Environmental Studies	62	27.43
3	Green Sustainable Science Technology	41	18.14
4	Public Environmental Occupational Health	24	10.62
5	Geography	23	10.18
6	Development Studies	17	7.52
7	Regional Urban Planning	16	7.08
8	Urban Studies	13	5.75
9	Ecology	12	5.31
10	Engineering Environmental	10	4.43

governance research, with a maximum of 9 papers. According to formula (1), the core authors published 250 articles, accounting for 30% of the total number of articles, not meeting Price's Law requirement of 50%. This indicates that the core group of authors has not yet formed. The number and thickness of the lines reflect the collaboration relationships and intensity among authors. It is observed that there are seven research teams in the field of rural environmental governance research, with the team centered around Du, Y. being the largest, comprising more than ten researchers. The research teams with Xue, L., Wang, X., Li, N., and Feng, J. as their core are gradually growing. However, overall, the teams primarily consist of two to three individuals.

Figure 6 is the author co-occurrence map in WOS, N = 534, E = 884, D = 0.0062. According to formula (1), the core authors published 86 articles, accounting for 46% of the total number of articles, indicating that the core group of authors within WOS is nearing formation. From the number of nodes and connections, it is apparent that there is substantial collaboration among authors, forming research teams centered around Liu, P., Ravenscroft, N., Matzdorf, B., and Du, Y.

3.4 Institutional's cooperation

Figure 7 is the institutional co-occurrence map of rural environmental governance research in CNKI, N = 474, E = 174, D = 0.0016. Research institutions are concentrated in universities, provincial social science academies, and national environmental policy research institutes. Currently, the College of Public Administration at Nanjing Agricultural University (14), the Rural Development Institute of the Chinese Academy of Social Sciences 8), the College of Humanities and Development Studies at Agricultural University of China (7), the School of Environment at Renmin University of China (6), and the School of Agricultural and Rural Development at Renmin University of China (6) serve as the core of rural environmental governance research, driving theoretical and practical innovation in the field. Based on the thickness, tightness and network density values of the links in the figure, it can be observed that despite the formation of a collaboration network centered around Nanjing Agricultural University, Renmin University of China, and the Chinese Academy of Social Sciences, there is a lack of research institutions radiating from
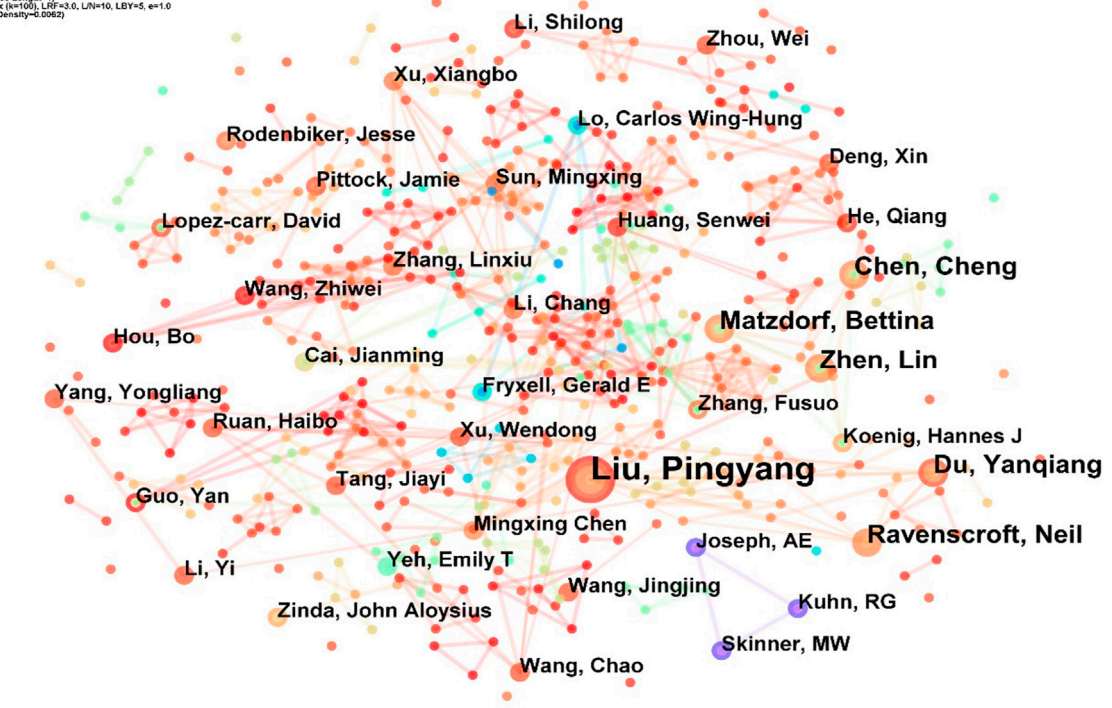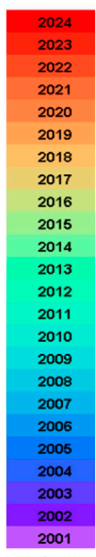
FIGURE 5
Author co-occurrence map in CNKI.

FIGURE 6
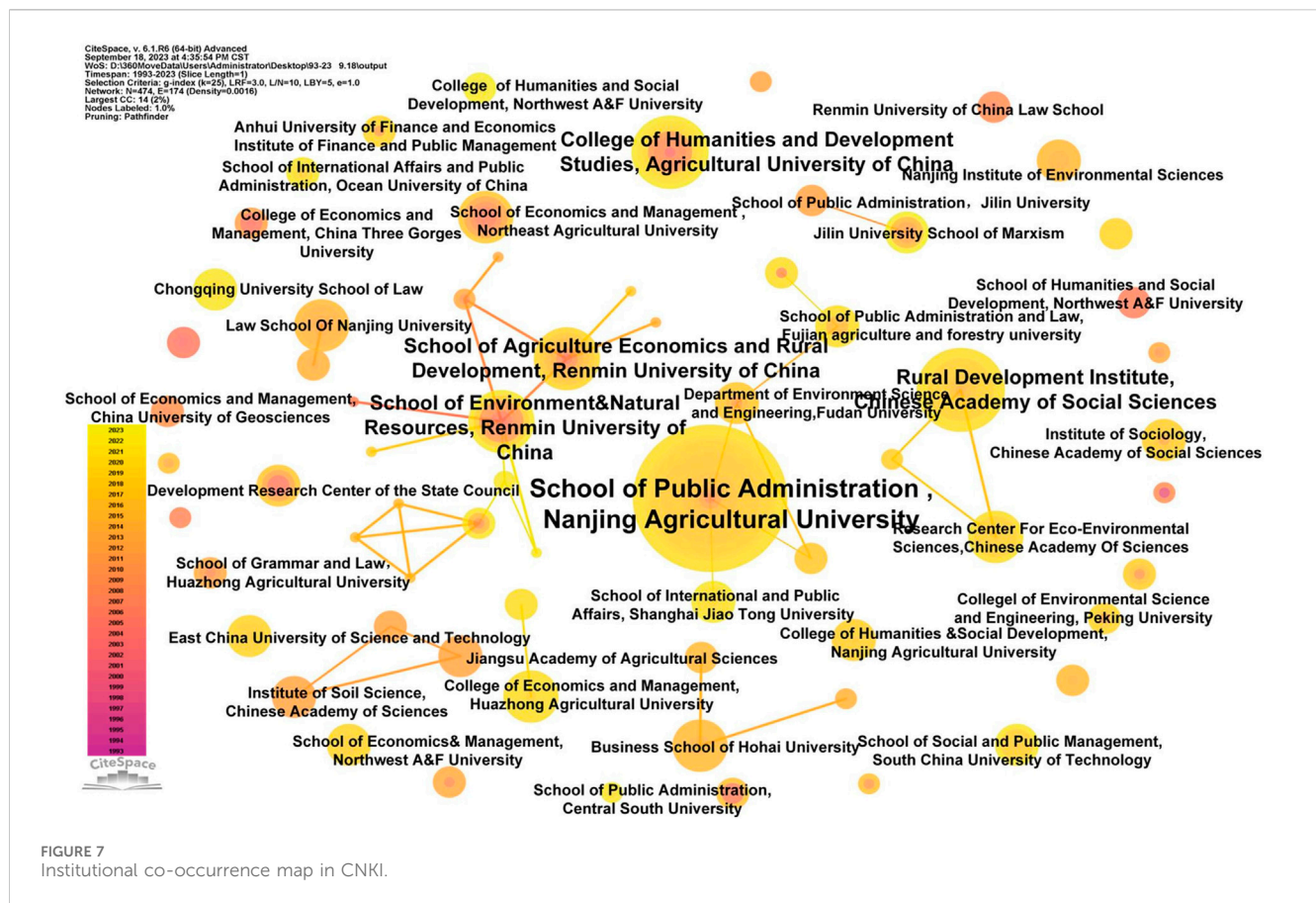Author co-occurrence map in WOS.

FIGURE 7
Institutional co-occurrence map in CNKI.

the central point to the periphery. Notably, most of these research institutions are located in China's capital, Beijing, reflecting Beijing's role as a national economic and cultural center with heightened focus on socioeconomic development and environmental balance (Fujii et al., 2016).

Figure 8 is the institutional co-occurrence map in WOS, N = 241, E = 363, D = 0.0126. The top five publishing institutions are the Chinese Academy of Sciences (44), Zhejiang University (9), Fudan University (9), Huazhong Agricultural University (8), and Fujian Agriculture & Forestry University (7). Compared to CNKI, institutional collaboration on rural environmental governance in WOS is more frequent. Although most research institutions in WOS also originate from China, the institutions with higher publication volumes differ from those in CNKI, indicating potential differences in research on the theme of rural environmental governance between the two databases.

3.5 Hot topics

3.5.1 Keywords co-occurrence

Keywords can be used to summarize the main content of the paper, extract useful information such as objectives, methods, and viewpoints (Tian X. et al., 2018; Tian Y. et al., 2018). Frequency analysis of keywords is crucial for identifying hot topics and developments in a given field (Wang et al., 2018). Figure 9 presents a co-occurrence map of keywords from CNKI research on rural environmental governance, N = 344, E = 496, D = 0.0084.

The fact that the number of connections exceeds the number of nodes indicates a close relationship between the keywords. Figure 9 shows that "rural environmental governance" is the most significant keyword node, followed by "rural environmental protection", "rural ecological environment" and "rural environmental pollution", which are frequently mentioned and longstanding in research. Later emerging keywords, such as "ecological civilization", "rural revitalization", "rural human settlement environment" and "governance measures" reflect the current research hotspots in the field of rural environmental governance.

Based on formula (2), there are 14 high-frequency keywords (Table 3). In Citespace, centrality measures the impact of a node on the shortest paths between other nodes; a higher centrality value indicates greater influence (Zeb et al., 2022). When centrality exceeds 0.1, the node is considered key. Table 3 shows that keywords such as "rural environmental protection", "rural ecological environment, rural areas, rural environment, governance measures, non-point source pollution in rural areas", "rural environmental issues", "sustainable development", "township enterprises" and "the current situation" all have a centrality above 0.1, indicating the formation of multiple core keywords. Keywords like "rural environmental protection", "rural environmental governance" and rural environmental pollution often find themselves at the communication pathways with other keywords.

Figure 10 presents a co-occurrence map of keywords from WOS, N = 171, E = 234, D = 0.0161. Among these, "management" is the largest node, closely followed by "governance" and "policy".
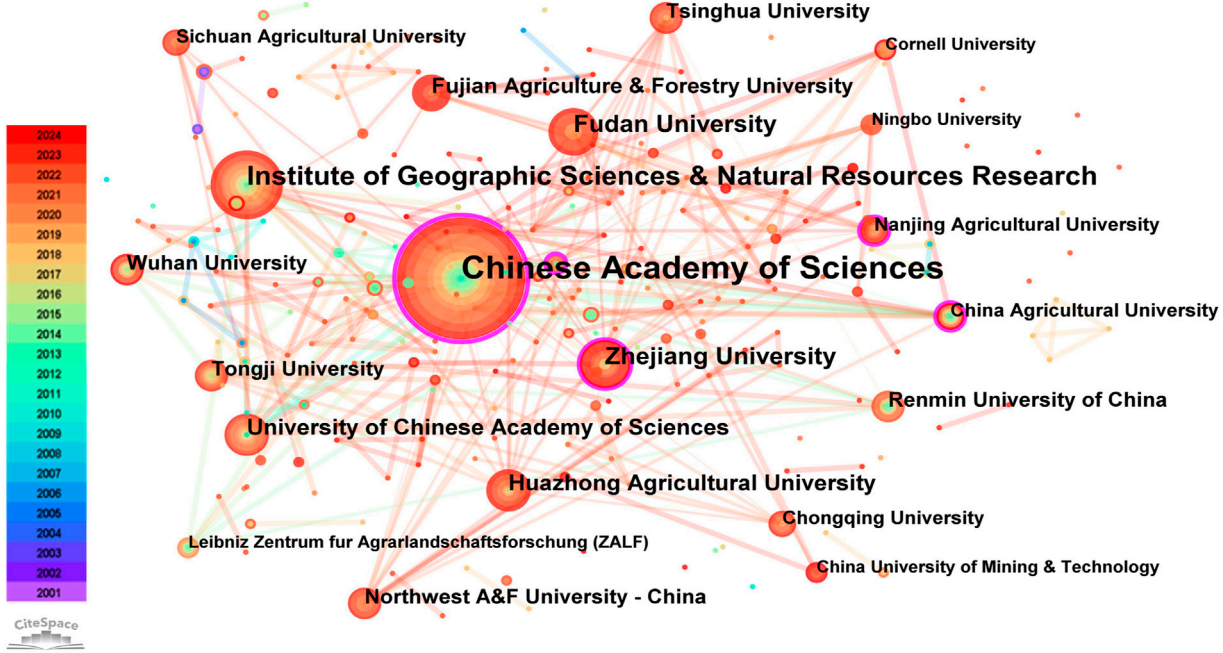
FIGURE 8
Institutional co-occurrence map in WOS.

FIGURE 9
Keywords co-occurrence map in CNKI.

TABLE 3 High frequency keywords in CNKI.

No.	Keywords	Count	Centrality
1	Rural environmental governance	190	0.37
2	Rural environmental protection	176	0.69
3	Rural ecological environment	98	0.22
4	Rural area	86	0.3
5	Rural environment	74	0.35
6	Rural environmental pollution	69	0.37
7	Rural revitalization	63	0.07
8	Governance countermeasure	58	0.23
9	New rural construction	51	0.10
10	Ecological civilization	40	0.06
11	Rural non–point resource pollution	38	0.11
12	Rural living environment	28	0.09
13	Rural environment problem	23	0.11
14	Sustainable development	17	0.23

TABLE 4 High frequency keywords in WOS.

No.	Keywords	Count	Centrality
1	management	30	0.29
2	governance	26	0.56
3	policy	24	0.27
4	environmental governance	24	0.3
5	china	19	0.15
6	impact	19	0.13
7	pollution	12	0.03
8	air pollution	10	0.1
9	areas	9	0.04
10	implementation	8	0.24
11	quality	8	0.09
12	public participation	8	0.1
13	ecosystem services	7	0.17
14	climate change	7	0.06

FIGURE 10
Keywords co-occurrence map in WOS.

Through the analysis of keywords over a temporal span, we can observe the evolutionary trends of certain keywords. For instance, earlier appearing keywords include "policy", "impact", "reform", "rural china", and "local government", while more recent ones comprise "carbon neutral", "agrarian change", "climate governance", and "governance". These newly emerged keywords may indicate new directions for future research.

Based on formula (2), there are 12 high-frequency keywords (Table 4). Observing the intermediary centrality metric, which represents the node's facilitating role, it is found that keywords
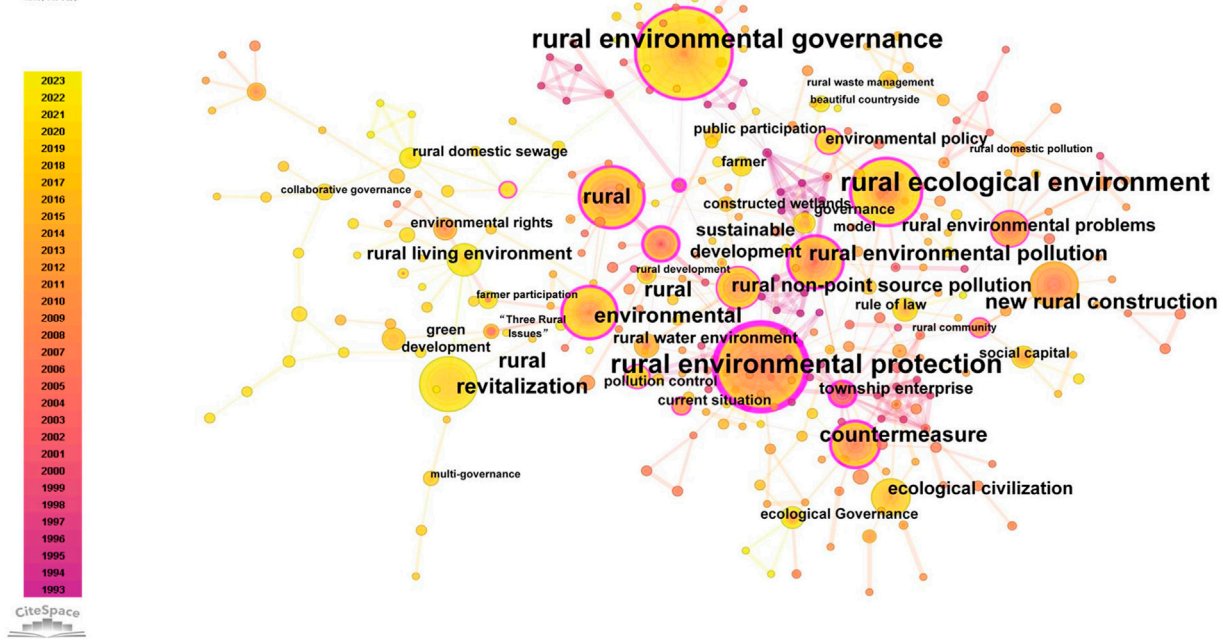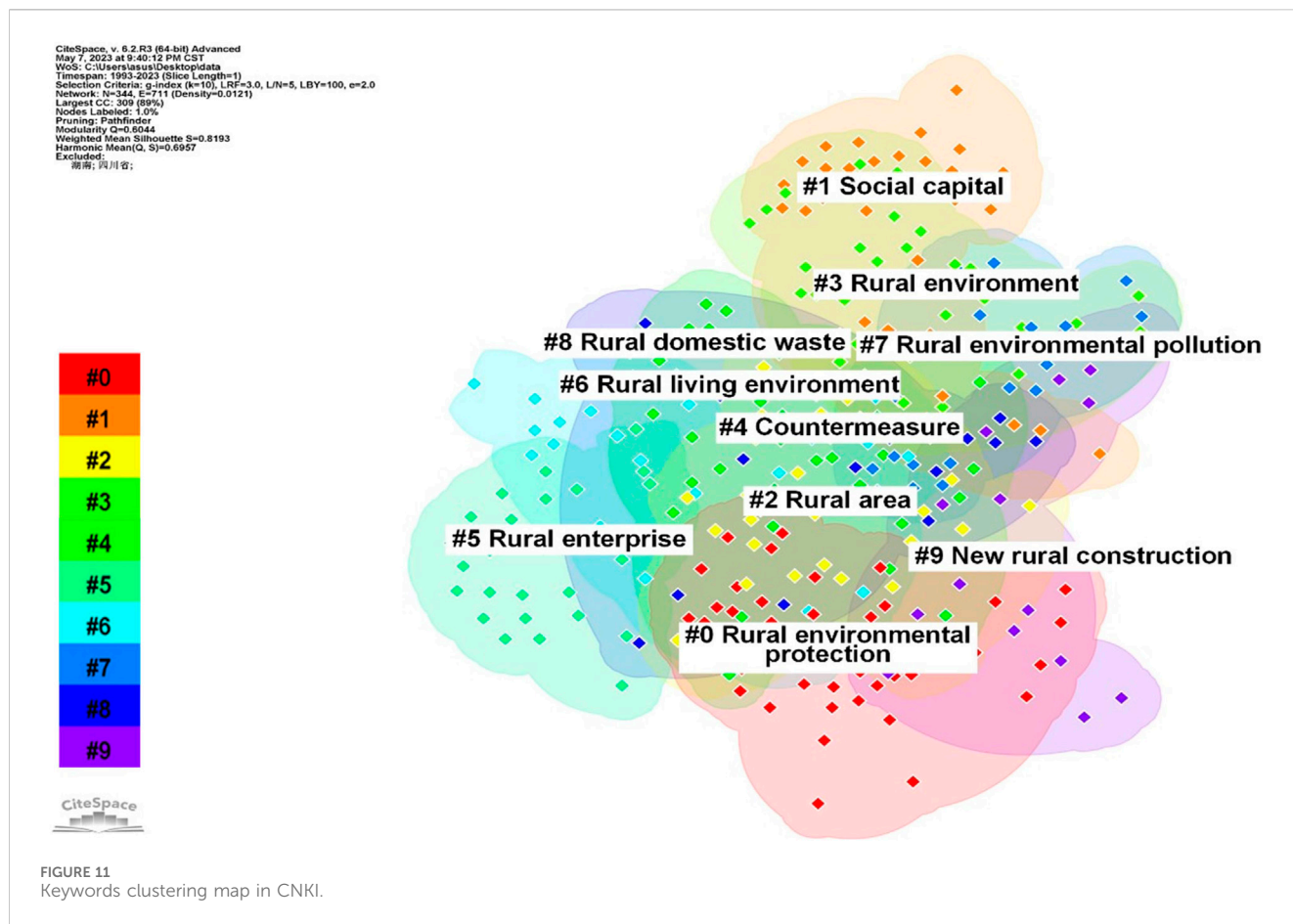
FIGURE 11
Keywords clustering map in CNKI.

such as "governance", "environmental governance", and "management" frequently communicate with other hot topic keywords. This suggests that they play an active role in the inter-citation relationships among the literature, often finding themselves on the communication pathways with other keywords.

3.5.2 Keywords clustering

In this paper, the LLR (log-likelihood rate) algorithm in CiteSpace is used to cluster the co-occurrence of keywords, aiming to intuitively display the hot topics of research. Figure 11 is a keywords clustering map of rural environmental governance from CNKI, where color blocks represent clustered areas containing related clustered keywords. The clusters, in descending order of size, are #0 rural environmental protection, #1 social capital, #2 rural, #3 rural environment, #4 measures, #5 township enterprises, #6 rural human settlement environment, #7 rural environmental pollution, #8 rural domestic sewage, #9 new rural construction. To assess the effectiveness of the map's construction, the Modularity (Q) and the mean Silhouette (S value) are examined. Within the (0, 1) range, larger Q and S indicate a better clustering effect. A Q greater than 0.3 signifies a significant structure; meanwhile, an S over 0.5 indicates the clustering results are reasonably coherent. as the figure shows, Q = 0.6044, S = 0.8193, both surpassing their respective thresholds. This signifies that the clustering structure within the map is significant and coherent. Additionally, it implies

that research outputs from 1993 to 2023 have primarily concentrated on the ten major keyword groups mentioned above.

Keyword clustering are sorted out, the 5 maximum keywords of Log-likelihood label are enumerated, and the clustering label table of rural environmental governance keywords are drawn (Table 5). #represents a cluster, and size refers to the number of cited references in each cluster, The mean year of a cluster serves as a straightforward yet valuable indicator, which is points out recent or old articles (Dhital et al., 2022).

Figure 12 is the keywords clustering map of rural environmental governance in WOS, with N = 333, E = 1,378, and Density = 0.0249 network. Q = 0.5869, indicating that the clustering effect of the network structure is good. S = 0.8614, which indicates that the homogeneity is high and the division of different clusters is more accurate. Here are the top ten clusters: #0climate change, #1management, #2policy implementation, #4 rural environmental governance, #5 coupled infrastructure systems, #6 high-density regions, #7 environmental management, #8 polycentric governance, #9 spatial econometrics.

Table 6 shows the keywords clustering labels in WOS. The average year of the top 9 clusters is roughly concentrated between 2011 and 2019, indicating that related research reached a certain level of maturity during this period. The largest cluster is "climate change," dated 2017, comprising 59 keywords, including primary terms like climate change, digital divide, spatial differentiation, watershed, accuracy, etc.

TABLE 5 Keywords cluster labels in CNKI.

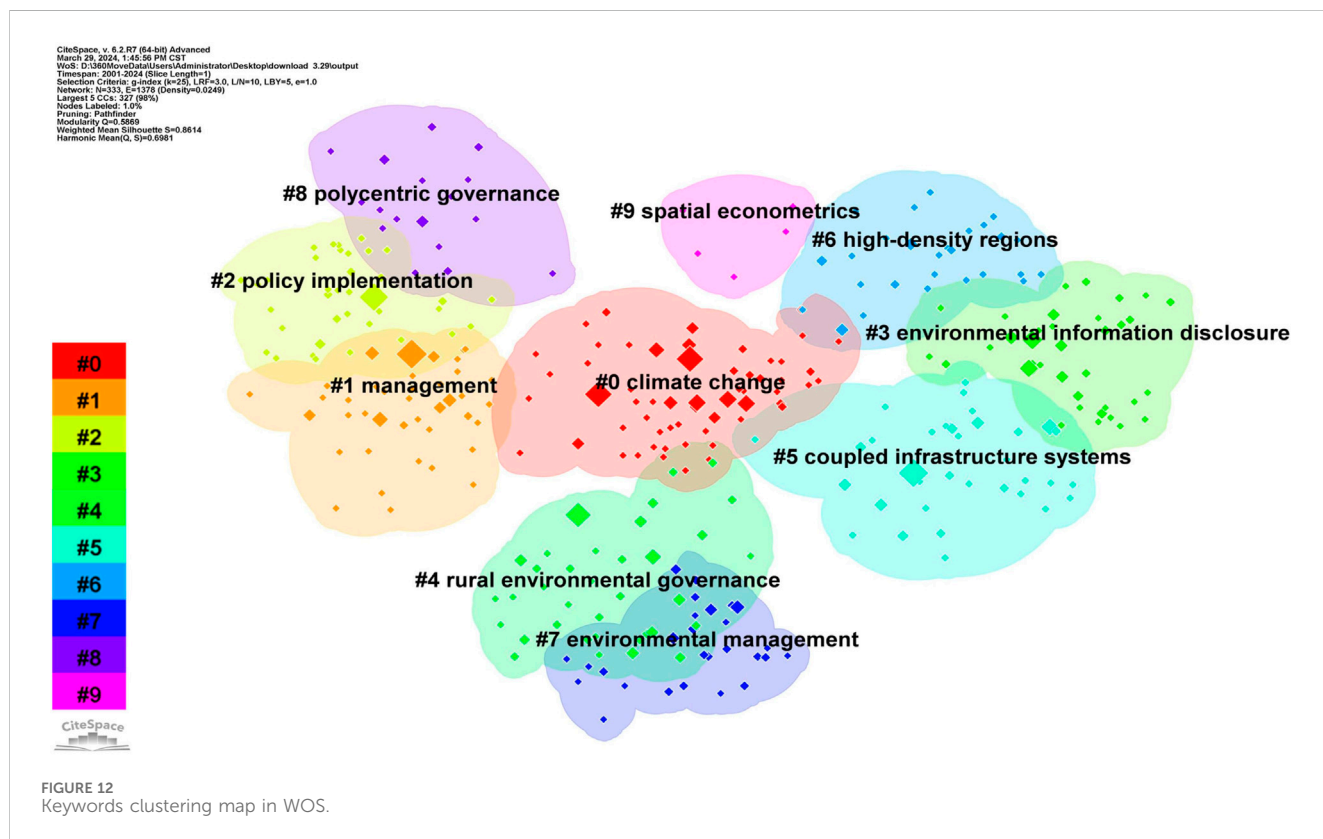| Id	Size	Silhouette	Mean (year)	Top terms (log-likelihood radio, p-level)
#0	45	0.668	2007	Rural environmental protection (37.29, 1.0E-4); Environmental protection (21.93, 1.0E-4); Environmental governance (9.26, 0.005); Rural ecological environment (8.05, 0.005)
#1	38	0.868	2016	Social capital (36.28, 1.0E-4); Rural environmental governance (27.71, 1.0E-4); Environmental governance (17.25, 1.0E-4); Governance (16.87, 1.0E-4); Farmers (13, 0.001)
#2	36	0.922	2012	Rural (34.8, 1.0E-4); Ecological environment (25.07, 1.0E-4); Rural ecological environment (25.07, 1.0E-4); Ecological civilization (19.35, 1.0E-4); Rule of law (14.26, 0.001)
#3	34	0.691	2010	Rural environment (63.47, 1.0E-4); Farmer participation (14.28, 0.001); Rural waste management (14.25, 0.001); Farmers' environmental rights (9.5, 0.005); Policy enforcement (9.5, 0.005)
#4	34	0.811	2007	Countermeasures (27.97, 1.0E-4); Non-point source pollution (20.49, 1.0E-4); Rural non-point source pollution (16.37, 1.0E-4); Rural water environment (12.26, 0.001); Rural water pollution (12.26, 0.001)
#5	27	0.932	1999	Township enterprises (33.81, 1.0E-4); Industrial pollution in rural areas (20.32, 1.0E-4); Environmental protection investment (9.76, 0.005); Agricultural environmental issues (9.76, 0.005); Environment and Economy (6.73, 0.01)
#6	27	0.753	2018	Rural human settlements (51.94, 1.0E-4); Rural revitalization (31.31, 1.0E-4); Cooperative governance (19.24, 1.0E-4); Beautiful Country (14.43, 0.001); Ecologically livable (9.59, 0.005)
#7	20	0.92	1996	Rural environmental pollution (28.08, 1.0E-4); Environmental pollution (15.55, 1.0E-4); Environmental protection bureau (10.77, 0.005); local government (10.77, 0.005); fish breeding and poultry raising (10.77, 0.005)
#8	20	0.921	2017	Village domestic sewage (40.04, 1.0E-4); Constructed wetlands (13.27, 0.001); Evolutionary game (13.2, 0.001); Governance system (9.45, 0.005); Collaborative Governance (7.8, 0.01)
#9	16	0.886	2007	New rural construction (34.64, 1.0E-4); Rural communities (19.64, 1.0E-4); Environmental protection (12.22, 0.001); Community governance (12.22, 0.001); Rural Road Construction (12.22, 0.001)

FIGURE 12
Keywords clustering map in WOS.

TABLE 6 Keywords cluster labels in WOS.

Id	Size	Silhouette	Mean (year)	Top terms (log-likelihood radio, p-level)
#0	59	0.83	2017	climate change (6.13, 0.05); digital divide (6.13, 0.05); spatial differentiation (3.06, 0.1); watershed (3.06, 0.1); accuracy (3.06, 0.1)
#1	40	0.842	2012	management (7.59, 0.01); collective action (4.09, 0.05); agricultural water (3.78, 0.1); pollution (3.78, 0.1); perceived benefit (3.78, 0.1)
#2	37	0.906	2011	policy implementation (9.63, 0.005); local government (9.63, 0.005); rural industrialisation (9.63, 0.005); rural restructuring (4.79, 0.05); circular economy (4.79, 0.05)
#3	37	0.782	2018	environmental information disclosure (8.76, 0.005); development-induced displacement and (4.36, 0.05); rural environmental issues (4.36, 0.05); resettlement (4.36, 0.05); preference (4.36, 0.05)
#4	36	0.82	2019	rural environmental governance (8.9, 0.005); social capital (8.9, 0.005); rural residents (8.9, 0.005); rural china (5.31, 0.05); urban integration (4.43, 0.05)
#5	35	0.882	2017	coupled infrastructure systems (3.95, 0.05); equity (3.95, 0.05); impact (3.95, 0.05); locality (3.95, 0.05); community (3.95, 0.05)
#6	27	0.927	2013	high-density regions (5.95, 0.05); bivariate tobit (5.95, 0.05); forests (5.95, 0.05); natural forest protection programme (5.95, 0.05)
#7	27	0.858	2018	environmental management (11.39, 0.001); rural ecological environment (5.66, 0.05); integrated network (5.66, 0.05); improvement of rural residential environment (5.66, 0.05)
#8	17	0.936	2016	polycentric governance (7.93, 0.005); opportunity cost (7.93, 0.005); water eutrophication (7.93, 0.005); rural pollution (7.93, 0.005)
#9	5	1	2024	spatial econometrics (9.02, 0.005); carbon neutral (9.02, 0.005); theil index (9.02, 0.005); climate governance (9.02, 0.005)

FIGURE 13
Keywords time-zone map in CNKI.
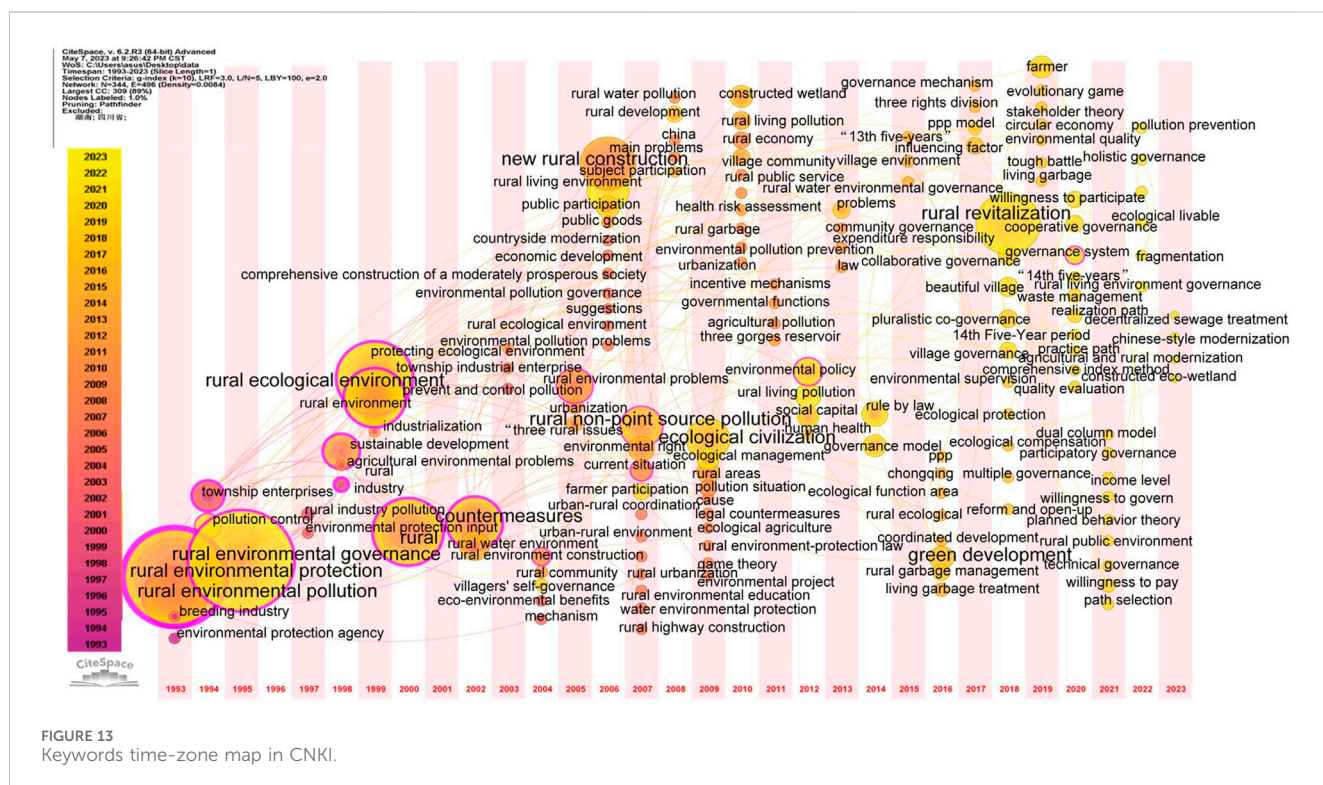
3.6 Research trends

Figure 13 is the keywords time-zone map of rural environmental governance research in CNKI. In the time-zone map, the node size

represents the frequency of occurrence of that keyword; a higher frequency suggests a hotter research topic. The year a node is located in indicates the first appearance of the keyword, with a longer span on the timeline suggesting stronger sustainability in research

FIGURE 14
Keywords time-zone map in WOS.
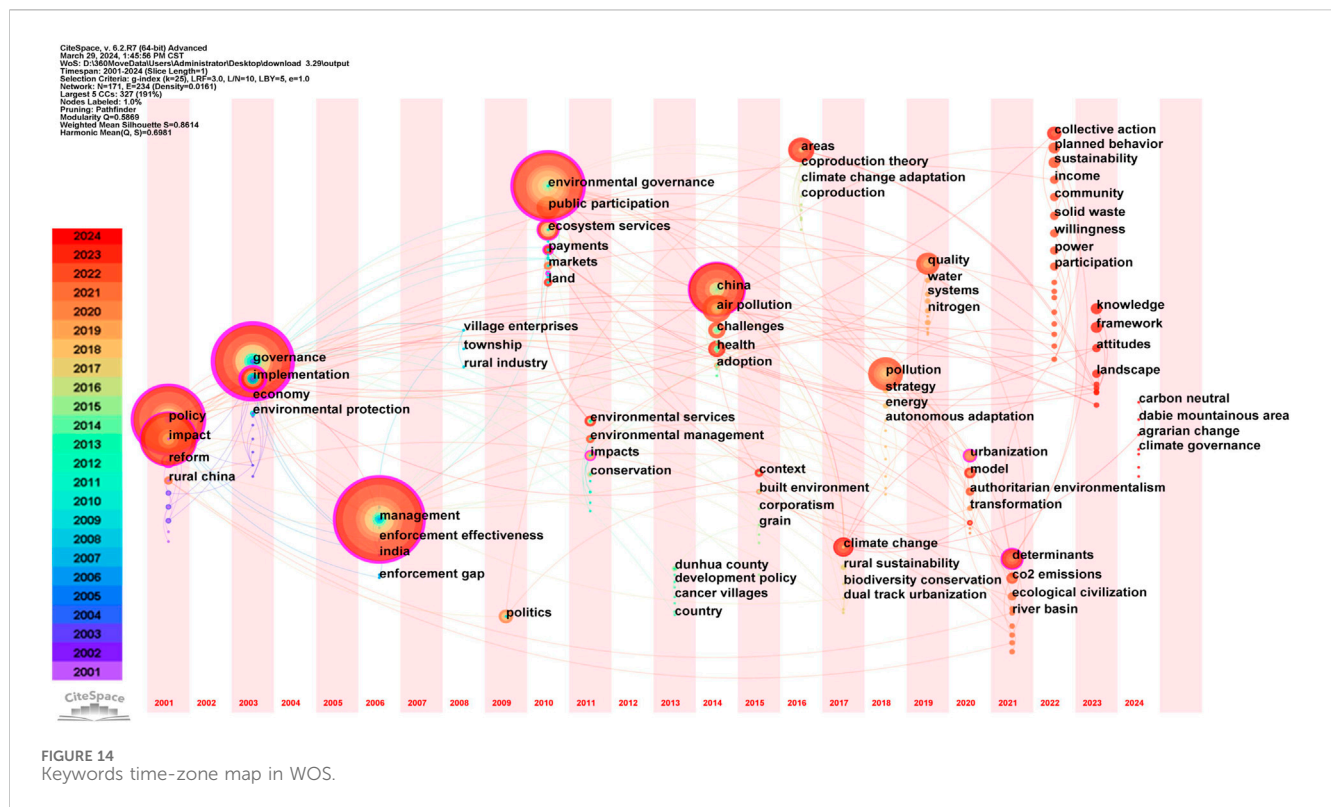
interest. As illustrated in Figure 13, the largest keyword, introduced in 1993, is "rural environmental protection", followed by gradually emerging high-frequency keywords such as "rural environmental governance", "rural", "governance measures" and "ecological civilization". The current research focus is concentrated on rural revitalization. This evolutionary process intuitively showcases the gradual developmental trajectory of research in rural environmental governance.

Figure 14 depicts the keywords time-zone map in WOS. Among them, "management" proposed in 2006 became the largest node in the related literature. Other high-frequency keywords in early research include "policy", "impact", "governance", "environmental governance", etc. These high-frequency keywords construct the basic conceptual framework of this field and have a profound impact on subsequent research. With the passage of time, related research has been developed and new research concepts have been introduced, such as "pollution", "carbon neutral" and "climate governance". These keywords reflect the trend of rural environmental governance research in China gradually adapting to and responding to global environmental changes.

3.7 Frontier development

The burst detection function of CiteSpace is used to calculate the frequency and time of the occurrence of keywords in the literature, and then determine the development trend and future research direction of the field (Zhou and Zhao, 2015). Figure 15A is the keywords with the strongest citation bursts in CNKI. The duration and intensity of the emergence of 19 keywords indicate a clear phase-based nature of rural environmental governance

research, which aligns with the research trends reflected in Figure 13. Firstly, regarding the emergence timing of keywords, "township enterprises" and "sustainable development" appeared earliest and have sustained the longest duration. Simultaneously, the emergence spans of "ecological environmental protection", "rural environmental protection", "measures", "rural environmental pollution", "new rural", "rural non-point source pollution", and "ecological civilization" are all more than 5 years. Secondly, in terms of the intensity of keyword emergence, "rural revitalization", "rural environmental governance", and "rural environmental protection" are the top three keywords, with their emergence intensities all above 10. "Rural revitalization" emerged later but has continued to burst since 2018, with the highest intensity of 20.14. Thirdly, "rural environmental governance", "rural revitalization", "rural human settlement environment", and "rural domestic sewage" started to emerge in different years and have continued to present, indicating that rural environmental governance under the backdrop of rural revitalization will become a sustained hotspot.

Figure 15B is the keywords with the strongest citation bursts in WOS, with a total of 10 emergent words, all appearing after 2016. From the perspective of emergence time, most of the emergence time span of these keywords is concentrated in 1 year, and the longest is only 3 years. From the perspective of emergence intensity, "environment governance" is the highest, with an intensity of 2.77. This is followed by environmental governance and pollution, both with an intensity of 2.28. "Planned behavior" and "climate change" emerged from 2022 and continued until now, which may point to foreign concerns about China's rural environmental governance.

FIGURE 15
Keywords with the strongest citation bursts in CNKI and WOS ((**A**), CNKI, (**B**), WOS).
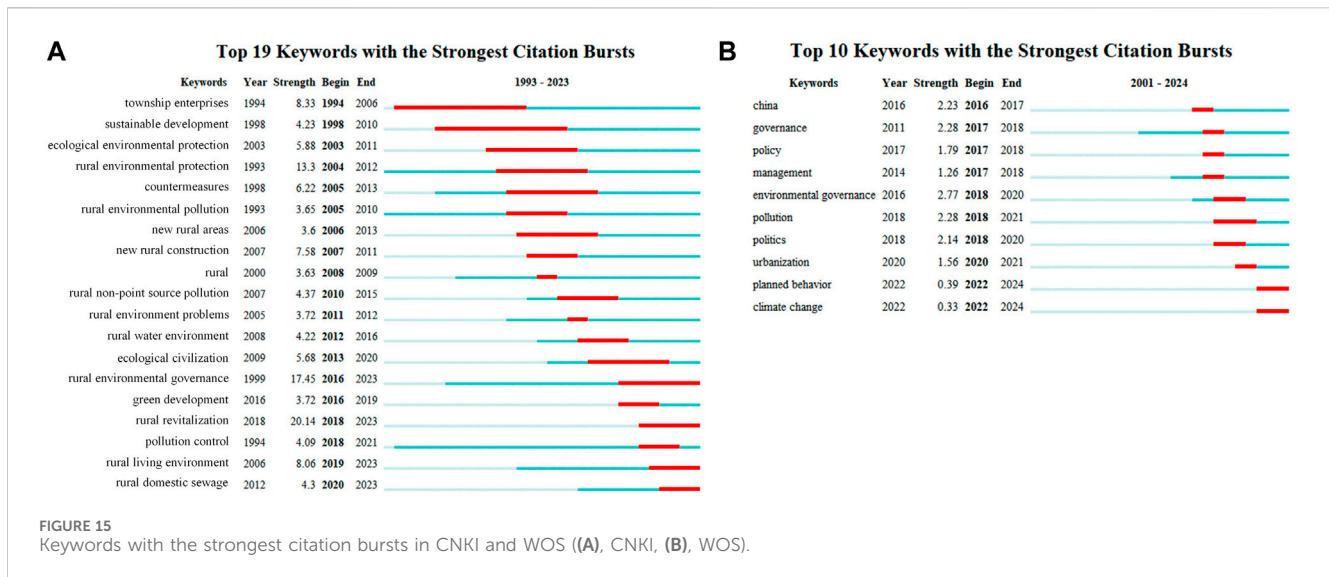
4 Discussion

4.1 Number of publications and research strength analysis

The emergence and progression of research on rural environmental governance in China display a pattern of escalating scholarly interest and dispersed research endeavours. In CNKI, rural environmental governance research started early, but until the past 15 years, the number of relevant literature and journals has increased significantly, showing obvious policy guidance characteristics (Wu and Chang, 2020). That is, with the national attention to rural environmental governance practices, the academic community has been paying increasing attention to this field. Forecasts from CNKI, the popularity of rural environmental governance research will continue to grow, which is likely due to the promotion of the "rural revitalization" strategy (Shi and Yang, 2022). However, in WOS, Research on rural environmental governance in China started late and grew slowly, which may be affected by factors such as information access, language barriers, cultural differences, and international research progress. In general, the number of documents in CNKI database far exceeds WOS, which reflects the research activity of Chinese scholars in this field, while WOS reflects the lack of attention paid by international scholars to the problem of rural environmental governance in China.

Although the enthusiasm for research on rural environmental governance continues to increase, there is insufficient collaboration between authors and research institutions, particularly evident in the CNKI. Currently, authors and institutions involved in research on rural environmental governance exhibit a pattern of "partial concentration and overall dispersion." Collaboration among authors mainly occurs within university or research institute research teams, with less exchange among authors across regions and institutions, resulting in low concentration of core author groups. The intensity of institutional collaboration is positively correlated with the intensity of author collaboration. As shown in Figures 5, 7, apart from some central nodes, other institutional nodes are not prominent, and connections appear scattered. Therefore, it is

necessary to further strengthen collaboration and communication with dispersed institutions. In comparison, the collaboration network of authors and institutions in WOS is more closely knit, with higher levels of international collaboration on research into rural environmental governance in China than domestic collaboration. However, the increasing research enthusiasm and dispersed research efforts are not contradictory, as environmental governance is a comprehensive research field involving multidisciplinary knowledge. Therefore, future research should be based on the systematic, complex, and cross-regional characteristics of rural environmental governance, constructing a theoretical system under the background of disciplinary integration to provide effective support for addressing complex environmental governance issues and promoting interdisciplinary innovation.

4.2 Hot topic analysis

Based on the data from Figure 11 and Table 5, this study excluded keywords directly related to the research topic and divided the significant issues of rural environmental governance research in CNKI into four aspects.

(1) Environmental issues and pollution governance: Rural environmental issues are rooted in specific historical and social contexts. In developing countries, the process of urbanization often comes at the expense of rural environments (Westlund, 2014). As the world's largest developing country, China has prioritized urbanization, resulting in the significant depletion of rural resources to support urban construction and heavy industrial development (Li, 2011). Therefore, early research on rural environmental governance primarily focused on industrial and agricultural pollution issues caused by township enterprises and livestock farming, such as #5 and #7. With the rapid development of agricultural economy, pollution problems caused by agriculture itself gradually emerge, including non-point source pollution and water pollution,

such as #4. Yu et al. (2022) believes that there are endogenous and exogenous environmental problems in rural areas, mainly manifested as non-point source pollution, household waste pollution, livestock and poultry manure pollution and rural water pollution, etc. These problems pose severe challenges to rural ecology, production and human settlement environment.

(2) Social participation and governance mechanisms: Keywords include "social capital" in #1, "farmer participation" in #3, "cooperative governance" in #6, "collaborative governance "and "community governance" in #8. Zhu (2017) proposed that the complexity and systemization of the rural environment and the diversity of human behaviour make it difficult to rely solely on government or market forces for environmental governance. Therefore, it is necessary to construct a comprehensive system of multi-subject collaborative governance. Tian (2013) further requires each subject to follow the principle of subject diversity, cooperative modes and mutually beneficial outcomes to solve the problem of rural environmental governance. In this process, social capital (Duan et al., 2022) should be constructed to promote farmers (Sun et al., 2020) to participate in environmental governance.

(3) Ecological civilization and sustainable development: Keywords include #2 ecological civilization and ecological environment, #6 ecologically livable and #5 environment and economy. Since 2007, national strategies such as ecological civilization construction and "Two Mountains" have promoted the importance of environmental governance in economic and social development. At present, the "Two Mountains" have gone through three stages: "trading clear water and green mountains for gold and silver mountains, balancing clear water and green mountains with gold and silver mountains, and green water and green mountains are gold and silver mountains" (Wang et al., 2017), completely jumping out of the zero-sum game paradox of economic development and environmental protection, and laying a theoretical foundation for the practice of rural environmental governance. Therefore, to explore the relationship between economic development and regional environment (Zhang et al., 2024). has become the focus of research.

(4) Rural revitalization and construction: Keywords include rural revitalization and beautiful countryside in #6. Under the background of the rural revitalization strategy, the research focus has gradually turned to the reconstruction of rural living space (Wang, 2018) and the categorized governance of rural communities (Qi, 2019). These studies combine environmental governance with rural revitalization and beautiful rural construction, emphasizing the integration of environmental protection and rural development.

According to the data in Figure 12 and Table 6, this paper refines the hot topics of China's rural environmental governance research in the WOS database into five main aspects.

(1) Policy implementation and governance mechanism: it mainly includes #2policy implementation and local government,

#4social capital, #8polycentric governance. In 2018, China released the Strategic Plan of Rural Development (2018–2022), which marked a shift in policy focus from urbanization to rural development. Special attention will be paid to environmental governance and ecological progress (Xu et al., 2021). However, Mol and Carter (2006), Kostka and Mol (2013) believe that China's decentralized administrative structure is no longer suitable to deal with China's increasing environmental challenges. In this regard, Kochskämper et al. (2016) proposes that the polycentric Governance system, which is jointly participated by multiple subjects, may be more effective than the single-center government governance system. Previous studies have shown that strengthening public attention to environmental issues is crucial for environmental governance. For example, Ma (2023) analyse the impact of environmental regulation of "The Blue Sky Defense War" on public environmental concerns. It is concluded that increasing public environmental concern can reduce air pollution. These studies focus on how the government effectively implements environmental governance policies and the construction and operation of governance mechanisms.

(2) Environmental issues and resource management: mainly related to #0climate change and watershed, #1agricultural water and pollution, #6forests. Liao et al. (2024) explore the interrelationship between agricultural transformation and climate change, and regarded sustainability as the core issue of agricultural transformation. Tian X. et al. (2018), Tian Y. et al. (2018) argue the impact of urban wastewater discharge on agricultural water use during urbanization. Ma et al. (2020) advocate dealing with domestic waste pollution through garbage classification, treating it as a resource and minimizing harm, as a fundamental measure to address environmental pollution.

(3) Socio-economic impacts and equity: mainly related to #3development-induced displacement, #8 opportunity cost, #4social capital, #5equity. Zhang and Guo (2023) pointed out that in China, the policy decision of prioritizing the development of cities and heavy industry will inevitably lead to the formation of a dual pattern in urban and rural areas, resulting in serious issues of unbalanced development stages and resource allocation. Urbanization has indeed brought about economic development, but it has come at the cost of environmental degradation and social injustice for ecosystems, rural areas around cities, and rural residents (Ricketts and Imhoff, 2003). Rural people are attracted to cities as laborers due to the availability of high-quality public services, high income, and numerous opportunities (Cattaneo et al., 2021), resulting in a decrease in the rural population and a "hollowing out" (Amcoff and Westholm, 2006), this is especially true in China (Xu et al., 2021).

(4) Information disclosure and community participation: mainly related to #3environmental information disclosure, #1collective action and #5community. Yang Y. et al. (2022), Yang Z. et al. (2022) found a significant difference between environmental information disclosure and residents' satisfaction with the effect of government

policies in rural areas. Therefore, it is suggested that the government should increase the openness and transparency of environmental information to improve residents' enthusiasm to participate in environmental governance. Additionally, Liu and Han (2023) further pointed out that rural communities can achieve this by leading and demonstrating, mobilizing and organizing, and building reputation and credibility. Research shows that local governments and community leaders can promote environmental collective action in different ways.

(5) Technology and methods: Including keywords such as #9spatial econometrics (Wei et al., 2024) and #6bivariate to bit (Mullan et al., 2011), Wang (2023) demonstrates that digital technology can provide more effective, rapid and reliable risk monitoring and forecasting for climate change, and provide a basis for government decision-making. Indicates a focus on the application of various technologies and methods to solve the problem of rural environmental governance.

In general, the research hotspots of rural environmental governance in China, as observed in the CNKI and WOS databases, mainly focus on governance basis, governance object, and governance process. Although most of the studies in the WOS database are written by Chinese scholars, they inevitably combine China's environmental challenges with international environmental issues in their research, which leads to differences in research focus.

4.3 Research trend analysis

Large-scale urbanization around the world has brought many problems to the countryside, including the degradation of farmland (Barbier and Hochard, 2018), overdevelopment and severe pollution (Li et al., 2021), and vulnerability to disasters (Gupta et al., 2021). Therefore, in developed countries, scholars have paid attention to rural environmental problems earlier (Vermeer and Frate, 1979). China, once home to one of the largest rural populations, has been relatively late to urbanization, but it has developed rapidly, bringing with it a host of environmental challenges (Bai et al., 2014). Consequently, rural environmental governance has become a global issue.

As shown in Figure 13, research on rural environmental governance in CNKI has undergone three stages: the initial stage (1993–2004), development stage (2005–2012), and deepening stage (2013- up to present). In the initial stage, discussions primarily centred around key topics such as "township enterprises", "breeding industry", "rural environmental pollution". During the development period, environmental concepts such as "new rural construction", "ecological civilization" and "rural modernization" were established. Governance content expanded to include "rural human settlement environment", "agricultural ecological environment", "rural water environment" and "rural waste management". Additionally, the scope of governance subjects broadened to encompass "government functions", "public participation" and "farmer participation." The deepening period corresponds with the "rural revitalization" strategy, prioritizing "green development" and advocating for an "ecological and livable" "beautiful countryside."

It seeks to establish a governance model of "multi-governance," emphasizing the PPP model, "collaborative governance," "cooperative governance," "participatory governance," and "holistic governance." Theoretical frameworks such as "evolutionary game", "two-column model," "willingness to pay", "stakeholder theory" and "theory of planned behaviour" are employed to broaden the research horizon.

According to Figure 14, research on rural environmental governance in the Web of Science (WOS) has progressed through two distinct stages: the initial stage (2001–2010) and the development stage (2011–2024). The initial stage primarily focused on the management and protection of the rural environment, encompassing topics such as "township industries", "policy impact", and "law enforcement efficiency". In contrast, the development phase has shifted its focus towards addressing issues such as "air pollution", "climate change", "water pollution", "carbon emissions", "urbanization", "ecological civilization".

Chinese and international studies on China's rural environmental governance exhibit a disparity, despite the majority of authors in WOS who study China's rural environmental governance being from China. This phenomenon primarily arises from the relatively late attention given by Chinese academia to local rural environmental issues, while international research has already been established on a large scale. In the 1980s, the traditional rural functions of western developed countries, which had undergone earlier urbanization, were transformed into modern functions such as leisure vacations, consumption, and environmental pursuits (Holmes, 2008). Scholars began systematically studying changes in agricultural structure (Knickel, 1990), rural community transformation (Halfacree, 1994), rural residential space transformation (Michon and Mary, 2004), and rural environmental pollution (Lewis and Mrara, 1986). With the gradual rise and development of research on rural environmental governance in China, international attention has shifted towards issues such as the impact of rural air pollution on the residential environment (Braun-Fahrländer et al., 1999), and the remediation and management of rural residential resources (Rist et al., 2007). Consequently, when Chinese scholars discuss China's rural environmental governance on the international stage, they tend to focus on the governance of natural resources such as the atmosphere, water resources, or forests, which are the primary concerns of the international community. Given the relative lag in China's rural environmental governance research, future studies could benefit from drawing on international theoretical frameworks and research methods to provide a more comprehensive and diversified perspective, thereby enhancing its relevance and internationalization.

4.4 Future development and policy recommendations

CNKI has generated rich research outcomes on the logic of rural environmental governance, theoretical interpretations, institutional innovations, and path construction, providing profound insights and suggestions for sustainable agricultural development and rural livelihood improvement. Research on rural environmental governance in the WOS database, with its unique research

methods, disciplinary perspectives, and theoretical orientations, aligns with international research paradigms, thus offering valuable supplements and references for Chinese scholars. Based on the current characteristics and hotspots of rural environmental governance research, future studies should focus on the following aspects:

(1) Breaking the boundaries between core leading disciplines such as environmental science and ecology and other disciplines, and strengthen interdisciplinary integration. According to Nita (2019), current environmental governance research needs developing countries to overcome political, economic, social and technical barriers and make considerable efforts to foster scientific cooperation. Hence, it is essential to foster cooperation and in-depth communication among domestic and international scholars and institutions, to jointly explore solutions for rural environmental governance issues.

(2) Rural areas often face conflicts between economic development and ecological environmental protection. How to foster a positive interaction between economic growth and ecological civilization has become a critical issue of concern among scholars globally (Scharlemann et al., 2020). Future research could explore the development path of rural areas from the aspects of rural revitalization, ecological livability and sustainable development, to promote coordinated development of the environment and economy.

(3) Further exploration is needed into environmental governance models that involve joint participation by the government, businesses, and the public, with particular emphasis on achieving public participation. The public, as a significant stakeholder in environmental governance, plays an essential role in addressing governmental and market failures and promoting environmental equity (He et al., 2021). Future research should discuss how to enhance public environmental awareness, strengthen information openness and transparency, strengthen public participation mechanism and enhance public governance capacity, so as to provide guidance for realizing the effectiveness of public participation in environmental governance.

(4) Rural environment encompasses a system involving production, ecology, and human living conditions. Figures 9, 15A indicate that rural residential environment governance is not only a research hotspot but also a growing trend. It is closely related to rural sustainable development and individual residents' health. In 2021, the "Five-Year Action Plan for Rural Living Environment Upgrade (2021–2025)" in China explicitly stated that future core tasks for improving rural residential environments include wastewater treatment, household waste, toilet renovation, and village appearance enhancement (Wang et al., 2022), providing significant guidance for future research.

(5) Figure 12 and 16 show that the climate change issues triggered by the rural environment have become the focus of international scholars. In view of the fact that China ranks first in the total global carbon emissions and that rural carbon emissions account for a large proportion (Zhao et al., 2024),

we should further explore the characteristics and influencing factors of carbon emissions in rural areas, especially the impact of agricultural activities and domestic energy consumption on carbon emissions. At the same time, we should strengthen the research on the innovation and application of low-carbon agricultural technology and new energy to provide scientific basis for reducing rural carbon emissions.

Based on the above research analysis, to advance rural environmental governance, this paper proposes the following policy recommendations:

(1) Incorporate rural environmental governance into the national overall development strategy, strengthen the top-level design and planning of rural environmental governance, and establish short, medium, and long-term goals for comprehensive environmental governance to ensure well-founded governance efforts.

(2) Establish a multi-center governance system, as the single-center government governance structure is no longer suitable for addressing complex rural environmental issues. Promote governance mechanisms involving multiple stakeholders, including governments, community organizations, and social capital, to form a more effective environmental governance network.

(3) Enhance the transparency and accessibility of environmental information to ensure that residents understand environmental policies and governance effectiveness, thereby enhancing public awareness and participation in environmental protection.

(4) Under the backdrop of rural ecological revitalization, solidly advance rural waste and wastewater treatment, and harmless treatment of livestock and poultry manure. Implement the "toilet revolution" to increase the rate of rural domestic wastewater treatment and toilet renovation, improving the quality of rural residential environments.

(5) Based on implementing the "dual carbon" concept, strengthen technological innovation, focusing on transforming agricultural production methods towards low-carbon practices. Optimize the energy consumption structure of rural residents and actively promote the development of clean energy to reduce rural non-point source pollution.

5 Conclusion

This study conducted a comprehensive analysis of 867 literature in CNKI and 186 literature in WOS on rural environmental governance research, utilizing CiteSpace visualization software, and explored the research characteristics, hot topics, and research trends in this field.

Compared to existing research, this paper makes breakthroughs in the selection of research methods and objects. When searching and evaluating literature, the paper adopts the PRISMA flowchart. The authors have extensively reviewed the papers on CNKI that use PRIAMA method, most of which are in the medical field. This

method is currently underutilized in China and requires further promotion. Reviews of rural environmental governance in China found in CNKI and WOS mostly analyze literature from CNKI alone, neglecting literature from WOS that studies rural environmental governance in China. However, from an international perspective, the main flaw of such comparative studies may lie in potential language and regional biases, as well as differences in research areas and methods covered by the two databases. These factors could affect the comprehensiveness and universality of the research.

The annual volume of papers and journal, the annual publication volume of major journals and keyword time zone maps in CNKI and WOS both indicate that the research on rural environmental governance in China has undergone a rich and vibrant development process, with the current research still in a state of warming up. It is expected that this field will remain in a stage of academic prosperity for a long time to come. However, research in CNKI started earlier than in WOS, and its growth trend is faster, indicating that the international academic community's attention to rural environmental governance in China still needs to be enhanced. Therefore, Chinese scholars need to further promote the internationalization of relevant research outcomes. The co-occurrence analysis of authors and institutions reveals a multitude of scholars involved in the research in CNKI, with key figures such as Du, Y., Yu, F., and Wang, X. leading to the formation of several teams. However, the overall cooperative relationships are rather scattered, and a clear core cooperation network has not yet formed. The main research institutions are concentrated in higher education institutions, and the degree of cooperation is also relatively low. In contrast, although much of the research in WOS comes from China, such as by authors like Liu, P. and Du, Y., the cooperation network between authors and institutions is more closely knit. This cooperation model is more conducive to promoting the exchange and sharing of research technologies and outcomes, enhancing the impact of the research, and the potential for sustainable development. The co-occurrence and clustering analysis of keywords reveals four major focus themes in CNKI regarding rural environmental governance in China: environmental issues and pollution management, social participation and governance mechanisms, ecological civilization and sustainable development, and rural revitalization and construction. The research hotspots in WOS, on the other hand, mainly revolve around policy implementation and governance mechanisms, environmental issues and resource management, socio-economic impacts and equity, information disclosure and community participation, technology and methods. The identification of research priorities provides a certain guiding significance for policy formulation and resource allocation.

The limitations of this study mainly include: First, the analysis results of Citespace are subject to the selected database and the keywords used, which may lead to incomplete research results if the relevant literature is not included in CNKI and WOS. Additionally, the keywords selected for this study are relatively broad, potentially overlooking specific aspects of rural environmental governance

research, such as water environment or solid waste management. Second, the scientific visualization charts generated by Citespace largely depend on the interpretation and parameters set by researchers, and there is a certain subjectivity, which may affect the understanding and interpretation of the research field. In future research, by expanding the literature search scope to cover more specialized areas and employing more specific and diverse keywords, a more comprehensive research perspective can be achieved, thereby deepening our understanding of the developmental trends in this field.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Author contributions

Funding

Acknowledgments

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

Amcoff, J., and Westholm, E. (2006). Understanding rural change-demography as a key to the future. *Futures* 39 (4), 363–379. doi:10.1016/j.futures.2006.08.009

Bai, X., Shi, P., and Liu, Y. (2014). Society: realizing China's urban dream. *Nature* 509, 158–160. doi:10.1038/509158a

Barbier, E. B., and Hochard, J. P. (2018). Land degradation and poverty. *Nat. Sustain.* 1, 623–631. doi:10.1038/s41893-018-0155-4

Braun-Fahrländer, C., Gassner, M., Grize, L., Neu, U., Sennhauser, F. H., Varonier, H. S., et al. (1999). Prevalence of hay fever and allergic sensitization in farmer's children and their peers living in the same rural community. *Clin. Exp. Allergy.* 29 (1), 28–34. doi:10.1046/j.1365-2222.1999.00479.x

Bulkeley, H. (2005). Reconfiguring environmental governance: towards a politics of scales and networks. *Polit. Geogr.* 24, 875–902. doi:10.1016/j.polgeo.2005.07.002

Caro-Gonzalez, A., Nita, A., Toro, J., and Zamorano, M. (2023). From procedural to transformative: a review of the evolution of effectiveness in EIA. *Environ. Impact Assess. Rev.* 103, 107256. doi:10.1016/j.eiar.2023.107256

Cashore, B. (2002). Legitimacy and the privatization of environmental governance: how non–state market–driven (nsmd) governance systems gain rule–making authority. *Governance* 15, 503–529. doi:10.1111/1468-0491.00199

Cattaneo, A., Nelson, A., and McMenomy, T. (2021). Global mapping of urban–rural catchment areas reveals unequal access to services. *Proc. Natl. Acad. Sci. U. S. A.* 118 (2), e2011990118. doi:10.1073/pnas.2011990118

Chang, Y., and Huang, J. (2021). Project entering the village and community response: a study on the mechanism of rural ecological environmental governance. *J. Hohai Univ. (Philosophy Soc. Sci.)* 23 (5), 94–100. doi:10.3876/j.issn.16714970.2021.05.012

Chen, X., Xing, L., Wang, K., and Lu, J. (2023). How does digital governance affect the level of domestic waste separation for rural residents? Empirical evidence from rural areas in Jiangsu Province, China. *Front. Public Health* 11, 1122705. doi:10.3389/fpubh.2023.1122705

Dhital, S., Rupakheti, D., Rupakheti, M., Yin, X., Liu, Y., Mafiana, J. J., et al. (2022). A scientometric analysis of indoor air pollution research during 1990-2019. *J. Environ. Manag.* 320, 115736. doi:10.1016/j.jenvman.2022.115736

Donohue, J. C. (1973). *Understanding scientific literature——a bibliometric approach.* Cambridge, MA: The MIT Press, 49–50.

Driessen, P. P. J., Dieperink, C., Van Laerhoven, F., Runhaar, H. A. C., and Vermeulen, W. J. V. (2012). Towards a conceptual framework for the study of shifts in modes of environmental governance—experiences from The Netherlands. *Environ. Policy Gov.* 22, 143–160. doi:10.1002/eet.1580

Du, X., and Jiao, F. (2023). How the rural infrastructure construction drives rural economic development through rural living environment governance—case study of 285 cities in China. *Front. Environ. Sci.* 11, 1280744. doi:10.3389/fenvs.2023.1280744

Du, X., Zhou, F., Yang, Y., and Guo, H. (2010). An uncertainty-based modeling framework for counter measure optimization in strategic environmental assessment of regional plans. *Acta Sci. Circumstantiae* 30 (6), 1331–1338. doi:10.13671/j.hjkxxb.2010.06.002

Du, Y. (2019). The change of China's rural environmental governance from 1949 to 2019: basic history. Transformation logic and future trend. *J. China Agric. Univ. Soc. Sci.* 36 (5), 82–89. doi:10.13240/j.cnki.caujsse.2019.05.021

Du, Y., Liu, P., and Wu, N. (2018). Can public private partnership (ppp) in rural environmental governance become a new governance model in China? An analysis based on a reality testing on six cases. *Chin. Rural. Econ.* 12, 67–82.

Duan, C., Ding, M., Wang, H., and Wu, Z. (2022). Effects of social capital and satisfaction with government on residents' willingness to pay for air quality improvement. *J. Arid Land Resour. Environ.* 36 (4), 15–23. doi:10.13448/j.cnki.jalre.2022.087

Fan, H., and Tang, H. (2016). The changes of rural environmental governance structure and the construction of urban--rural ecological community. *Inn. Mong. Soc. Sci.* 37 (04), 149–155. doi:10.14137/j.cnki.issn1003-5281.2016.04.025

Fujii, M., Fujita, T., Dong, L., Dong, L., Lu, C., Geng, Y., et al. (2016). Possibility of developing low-carbon industries through urban symbiosis in Asian cities. *J. Clean. Prod.* 114, 376–386. doi:10.1016/j.jclepro.2015.04.027

Gu, B., Fan, L., Ying, Z., Xu, Q., Luo, W., Ge, Y., et al. (2016). Socioeconomic constraints on the technological choices in rural sewage treatment. *Environ. Sci. Pollut. Res.* 23, 20360–20367. doi:10.1007/s11356-016-7267-z

Gupta, D., Fischer, H. W., Shrestha, S., Shoaib Ali, S., Chhatre, A., Devkota, K. R., et al. (2021). Dark and bright spots in the shadow of the pandemic: rural livelihoods, social vulnerability, and local governance in India and Nepal. *World Dev.* 141, 105370. doi:10.1016/j.worlddev.2020.105370

Halfacree, K. (1994). The importance of "the rural" in the constitution of counterurbanization: evidence from England in the 1980s. *Sociol. Rural.* 34 (2-3), 164–189. doi:10.1111/j.1467-9523.1994.tb00807.x

He, Q., Deng, X., Li, C., Yan, Z., and Qi, Y. (2021). Do internet skills increase farmers' willingness to participate in environmental governance? Evidence from rural China. *Agriculture* 11 (12), 1202. doi:10.3390/agriculture11121202

Holmes, J. H. (2008). Impulses towards a multifunctional transition in rural Australia: interpreting regional dynamics in landscapes, lifestyles and livelihoods. *Landsc. Res.* 33, 211–223. doi:10.1080/01426390801912089

Jesson, J. K., Matheson, L., and Lacey, F. M. (2011). *Doing your literature review: traditional and systematic techniques.* Los Angeles, CA: Sage, 5–125.

Kao, X., Wang, W., Kao, Q., and Zhang, J. (2022). Visualization of energy-environment-economy system research characteristics and hotspots evolution trends based on CiteSpace. *Environ. Res. Commun.* 4, 055004. doi:10.1088/2515-7620/ac637f

Knickel, K. (1990). Agricultural structural change: impact on the rural environment. *J. Rural Stud.* 6 (4), 383–393. doi:10.1016/0743-0167(90)90051-9

Kochskämper, E., Challies, E., Newig, J., and Jager, N. W. (2016). Participation for effective environmental governance? Evidence from water framework directive implementation in Germany, Spain and the United Kingdom. *J. Environ. Manag.* 181, 737–748. doi:10.1016/j.jenvman.2016.08.007

Kostka, G., and Mol, A. P. (2013). Implementation and participation in China's local environmental politics: challenges and innovations. *J. Environ. Policy & Plan.* 15, 3–16. doi:10.1080/1523908X.2013.763629

Lewis, C. A., and Mrara, A. Z. (1986). Rural settlements, mission settlements and rehabilitation in Transkei. *GeoJournal* 12, 375–386. doi:10.1007/BF00262360

Li, J., and Chen, C. (2017). *Citespace: scientific text mining and visualization, Vol. 7.* Beijing: Capital University of economics business press.

Li, W., Zhang, Z., and Zhou, Y. (2021). Policy strategies to revive rural land in peri-metropolitan towns: resource identification, capitalization, and financialization. *Land* 10 (2), 132. doi:10.3390/land10020132

Li, Y. (2011). Urban-rural interaction in China: historic scenario and assessment. *China Agric. Econ. Rev.* 3, 335–349. doi:10.1108/17561371111165770

Li, Y., Song, J., Huang, B., and Wang, H. (2011). Research path of self-governance model of rural environment. *China Popul. Resour. Environ.* 21 (01), 165–170. doi:10.3969/j.issn.1002-2104.2011.01.028

Liao, C., Liu, J., and Agrawal, A. (2024). Sustainability governance for agrarian transformation under climate change. *Sustain. Sci.* 19, 361–372. doi:10.1007/s11625-023-01422-0

Lin, L., Li, R., and Chen, C. (2020). From pollution "refuge" to green "main battlefield": 70 years of rural environmental governance in China. *J. Arid Land Resour. Environ.* 34 (7), 30–36. doi:10.13448/j.cnki.jalre.2020.180

Liu, P., and Han, A. (2023). How does community leadership contribute to rural environmental governance? Evidence from shanghai villages*. *Rural. Sociol.* 88 (3), 856–894. doi:10.1111/ruso.12504

Ma, X. (2023). Environmental regulation and public environmental concerns in China: a new insight from the difference in difference approach. *Green Low-Carbon Econ.* 1 (2), 60–67. doi:10.47852/bonviewGLCE3202868

Ma, Y., Koondhar, M. A., Liu, S., Wang, H., and Kong, R. (2020). Perceived value influencing the household waste sorting behaviors in rural China. *Int. J. Environ. Res. Public Health* 17, 6093. doi:10.3390/ijerph17176093

Michon, G., and Mary, F. (2004). Conversion of traditional village gardens and new economic strategies of rural households in the area of Bogor, Indonesia. *Agrofor. Syst.* 25, 31–58. doi:10.1007/BF00705705

Mol, A. P., and Carter, N. (2006). China's environmental governance in transition. *Environ. Polit.* 15, 149–170. doi:10.1080/09644010600562765

Mongeon, P., and Paul-Hus, A. (2016). The journal coverage of Web of Science and Scopus: a comparative analysis. *Scientometrics* 106, 213–228. doi:10.1007/s11192-015-1765-5

Mullan, K., Kontoleon, A., Swanson, T. M., and Zhang, S. (2011). When should households be compensated for land-use restrictions? A decision-making framework for Chinese forest policy. *Land Use Policy* 28, 402–412. doi:10.1016/j.landusepol.2010.08.003

Najmi, A., Rashidi, T. H., Abbasi, A., and Waller, S. T. (2017). Reviewing the transport domain: an evolutionary bibliometrics and network analysis. *Scientometrics* 110, 843–865. doi:10.1007/s11192-016-2171-3

Nita, A. (2019). Empowering impact assessments knowledge and international research collaboration - a bibliometric analysis of Environmental Impact Assessment Review journal. *Environ. Impact Assess. Rev.* 78, 106283. doi:10.1016/j.eiar.2019.106283

Niu, K., Jin, S., Chen, Y., and Shen, Y. (2019). Exploration of priority issues and funding sources for rural living environment governance. *Rural Finance Res.* 1, 15–20. doi:10.16127/j.cnki.issn1003-1812.2019.01.003

Pritchard, A. (1969). Statistical bibliography or bibliometrics? *J. Documentation* 25 (4), 348–349.

Qi, X. (2019). Types of community governance and rural community environmental governance under rural revitalization. *J. Nanjing Tech Univ. Soc. Sci. Ed.* 18 (05), 49–56+111–112. doi:10.3969/j.issn.1671-7287.2019.05.005

Qu, Y. (2021). Government's responsibility in rural environmental governance: from the perspective of met governance. *China Popul. Resour. Environ.* 31 (2), 71–79. doi:10.12062/cpre.20200927

Ren, B., and Wen, F. (2018). The criteria, determinants and ways to achieve high quality development in China in the new era. *Reform* 4, 5–16.

Ren, X., and Gao, X. (2010). China's rural environmental problems and policy analysis. *Reform Econ. Syst.* 3, 107–112.

Ricketts, T., and Imhoff, M. (2003). Biodiversity, urban areas, and agriculture: locating priority ecoregions for conservation. *Conserv. Ecol.* 8 (2), 1. doi:10.5751/ES-00593-080201

Rist, S., Chidambaranathan, M., Escobar, C., Wiesmann, U., and Zimmermann, A. B. (2007). Moving from sustainable management to sustainable governance of natural resources: the role of social learning processes in rural India, Bolivia and Mali. *J. Rural Stud.* 23 (1), 23–37. doi:10.1016/j.jrurstud.2006.02.006

Rodrigues Sousa, E., Zoni, E., Karkampouna, S., La Manna, F., Gray, P. C., De Menna, M., et al. (2020). A multidisciplinary review of the roles of cripto in the scientific literature through a bibliometric analysis of its biological roles. *Cancers* 12 (6), 1480. doi:10.3390/cancers12061480

Ruan, H., Chen, J., Wang, C., Xu, W., and Tang, J. (2022). Social network, sense of responsibility, and resident participation in China's rural environmental governance. *Int. J. Environ. Res. Public Health* 19 (11), 6371. doi:10.3390/ijerph19116371

Scharlemann, J., Brock, R., Balfour, N., Brown, C., Burgess, N., Guth, M., et al. (2020). Towards understanding interactions between Sustainable Development Goals: the role of environment–human linkages. *Sustain. Sci.* 15, 1573–1584. doi:10.1007/s11625-020-00799-6

Shen, F., and Liu, Z. (2016). Logic reconstruction of good governance for village environment: the analysis based on the stakeholders theory. *China Popul. Resour. Environ.* 26 (05), 32–38. doi:10.3969/j.issn.1002-2104.2016.05.004

Sheng, L., and Ma, J. (2023). Village clans and rural households' willingness to participate in domestic waste governance: evidence from China. *J. Clean. Prod.* 425 (5), 138951. doi:10.1016/j.jclepro.2023.138951

Shi, J., and Yang, X. (2022). Sustainable development levels and influence factors in rural China based on rural revitalization strategy. *Sustainability* 14 (14), 8908. doi:10.3390/su14148908

Song, J., Zhang, H., and Dong, W. (2016). A review of emerging trends in global PPP research: analysis and visualization. *Scientometrics* 107, 1111–1147. doi:10.1007/s11192-016-1918-1

Sun, Q., Fang, K., and Liu, P. (2020). Impact of social norms and public supervision on the willingness and behavior of farming households to participate in rural living environment improvement: empirical analysis based on generalized continuous ratio model. *Resour. Sci.* 42 (12), 2354–2369. doi:10.18402/resci.2020.12.08

Tian, Q. (2013). Multiple governance model of ecological environment: concept and construction. *Adm. Trib.* 20 (3), 94–99. doi:10.16637/j.cnki.23-1360/d.2013.03.001

Tian, X., Geng, Y., Sarkis, J., and Zhong, S. (2018a). Trends and features of embodied flows associated with international trade based on bibliometric analysis. *Resour. Conservation Recycl.* 131, 148–157. doi:10.1016/j.resconrec.2018.01.002

Tian, Y., Ding, J., Zhu, D., and Morris, N. (2018b). The effect of the urban wastewater treatment ratio on agricultural water productivity: based on provincial data of China in 2004–2010. *Appl. Water Sci.* 8 (144), 144–210. doi:10.1007/s13201-018-0788-5

Vermeer, D. E., and Frate, D. A. (1979). Geophagia in rural Mississippi: environmental and cultural contexts and nutritional implications. *Am. J. Clin. Nutr.* 32 (10), 2129–2135. doi:10.1093/ajcn/32.10.2129

Wang, C., Dai, R., Chen, J., Shen, Y., and Ji, M. (2022). Research on the evolution law and promotion pathway of rural human settlements system resilience: a case study of Western Chongqing, a national pilot area for urban-rural integration. *J. Nat. Resour.* 37 (3), 645–661. doi:10.31497/zrzyxb.20220307

Wang, C., Guo, J., Liu, C., Peng, Y., and Tang, Y. (2023a). Research status, hotspots, and trend analysis of the rural living environment upgrade in China from 1992 to 2022: a bibliometric and narrative review analysis. *Sustainability* 15, 10508. doi:10.3390/su151310508

Wang, D. (2023). Digitalization and climate change adaptation in China. *Green Low-Carbon Econ.* 87, 104201. doi:10.47852/bonviewGLCE32021306

Wang, F., and Li, N. (2021). Empowerment, identity, collaboration: strategies for achieving participatory governance of rural ecological environment. *Soc. Sci. Guangxi* (2), 49–55. doi:10.3969/j.issn.1004-6917.2021.02.008

Wang, H., Feng, Y., and Ai, L. (2023b). Progress of carbon sequestration in urban green space based on bibliometric analysis. *Front. Environ. Sci.* 11, 1196803. doi:10.3389/fenvs.2023.1196803

Wang, H., Jiang, X., Chen, J., Song, W., Hu, J., Yan, H., et al. (2017). Berberine inhibits enterovirus 71 replication by downregulating the MEK/ERK signaling pathway and autophagy. *Chin. Rural. Econ.* 4, 2–12. doi:10.1186/s12985-016-0674-4

Wang, Q., Li, M., and Yang, Y. (2019). Study on environmental pollution and governance in rural development. *Fresenius Environ. Bull.* 28 (12A), 10083–10088.

Wang, X. (2018). Rebuilding the space for living: rural revitalization vs environmental governance. *J. Beijing Normal Univ. Soc. Sci.* 6, 124–130. doi:10.3969/j.issn.1002-0209.2018.06.013

Wang, Z., Zhao, Y., and Wang, B. (2018). A bibliometric analysis of climate change adaptation based on massive research literature data. *J. Clean. Prod.* 199, 1072–1082. doi:10.1016/j.jclepro.2018.06.183

Wei, J., Hu, R., Li, Y., and Shen, Y. (2024). Regional disparities, dynamic evolution, and spatial spillover effects of urban-rural carbon emission inequality in China. *Front. Ecol. Evol.* 12. doi:10.3389/fevo.2024.1309500

Wei, Y., Zhang, A., and Ma, Y. (2023). A bibliometric review of rural living environment improvement research in China based on CNKI database: 1992–2022. *Sustainability* 15, 6561. doi:10.3390/su15086561su15086561

Westlund, H. (2014). Urban futures in planning, policy and regional science: are we entering a post-urban world? *Built Environ.* 40, 447–457. doi:10.2148/benv.40.4.447

Wu, J., and Chang, I. S. (2020). *Environmental management in China*. Singapore: Springer, 7–15. doi:10.1007/978-981-15-4894-9_2

Xu, H., Pittock, J., and Daniell, K. A. (2021). China: a new trajectory prioritizing rural rather than urban development? *Land* 10, 514. doi:10.3390/land10050514

Yang, Y., Shen, L., Li, Y., and Li, Y. (2022a). The impact of environmental information disclosure on environmental governance satisfaction. *Sustainability* 14 (13), 7888. doi:10.3390/su14137888

Yang, Z., Zhang, Y., Long, Z., Yin, C., Zhang, Y. Q., and Meng, Z. (2022b). Influence of village regulation on villager's willingness to pay for domestic waste management and its mechanism. *Chin. J. Agric. Resour. Regional Plan.* 43 (7), 154–163. doi:10.7621/cjarrp.1005-9121.2022071

You, J., and Huang, P. (2017). Systematic review methodology: nature, basis and principles. *Acad. Res.* 3, 145–151+178. doi:10.3969/j.issn.1000-7326.2017.03.018

Young, A. (2013). Inequality, the urban-rural gap, and migration. *Q. J. Econ.* 128 (4), 1727–1785. doi:10.1093/qje/qjt025

Yu, F., Hu, M., and Wang, G. (2022). Research on the improvement path and countermeasures of rural living environment for the long-term goal of 2035. *China Soft Sci.* 7, 17–27. doi:10.3969/j.issn.1002-9753.2022.07.002

Yu, X., Wang, P., and Li, Y. (2023). Governance activities, villagers' awareness, characteristics, and willingness in rural environmental participation: evidence from Fujian, China. *Environ. Dev. Sustain.*, 1–23. doi:10.1007/s10668-023-03855-0

Zeb, A., Liu, W., Shi, R., Lian, Y. Y., Wang, Q., Tang, J., et al. (2022). Evaluating the knowledge structure of micro- and nanoplastics in terrestrial environment through scientometric assessment. *Appl. Soil Ecol.* 177, 104507. doi:10.1016/j.apsoil.2022.104507

Zhang, F., Shao, J., and Zhou, L. (2024). Impact of the rural collective economy on improving the rural living environment. *China Popul. Resour. Environ.* 34 (1), 118–126. doi:10.12062/cpre.20230730

Zhang, J., Fan, Z., and Wang, Q. (2011). Research on countermeasures for rural environmental governance in China: a perspective based on environmental legal analysis. *Theory Mon.* 9, 182–184. doi:10.14180/j.cnki.1004-0544.2011.09.003

Zhang, Y., Feng, M., and Yi, F. (2023). The logic, dilemma and approach of rural environment digital governance from the perspective of multi-actor governance. *Issues Agric. Econ.* 3, 36–53. doi:10.13246/j.cnki.iae.20230905.001

Zhang, Y., and Guo, X. (2023). The dilemma and path of rural environmental governance in China: from the perspective of a community with a shared future. *Int. J. Environ. Res. Public Health* 20 (2), 1446. doi:10.3390/ijerph20021446

Zhao, H., Chen, S., and Xie, L. (2024). Influence factors and prediction analysis of carbon emissions from planting industry in Liaoning Province. *Chin. J. Eco-Agriculture* 32, 1–12. doi:10.12357/cjea.20240157

Zhao, L., Zhu, H., and Hu, S. (2017). Human-environment sustainable development of rural areas in China. *IOP Conf. Ser. Earth Environ. Sci.* 64, 012054. doi:10.1088/1755-1315/64/1/012054

Zheng, Z., and Chen, D. (2022). Development path of the rural environmental governance model in the perspective of holistic governance. *J. Yunnan Minzu Univ. Soc. Sci.* 39 (2), 128–136. doi:10.13727/j.cnki.53-1191/c.20220304.005

Zhou, X., and Zhao, G. (2015). Global liposome research in the period of 1995–2014: a bibliometric analysis. *Scientometrics* 105, 231–248. doi:10.1007/s11192-015-1659-6

Zhu, X. (2017). Multiple coordination of ecological governance: a case study of Taihu River basin. *Reform* 2, 96–107.

Zong, D., Zhou, T., and Wang, D. (2012). Analysis and countermeasures on rural environment pollution in Chongqing. *Res. J. Chem. Environ.* 16 (1), 103–107.

Zong, S. (2016). Evaluation of core authors based on Price law and the comprehensive index method: a case study of Chinese Journal of Scientific and Technical Periodicals. *Chin. J. Sci. Tech. Periodicals* 27 (12), 1310–1314. doi:10.11946/cjstp.201610080819