

Review

Advancements, Dynamics, and Future Directions in Rural Environmental Governance Research in China

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Abstract: Rural environmental governance serves as the foundational pillar of national governance, intricately linked to the modernization of agriculture and rural areas, as well as the cultivation of rural culture. Furthermore, it plays a pivotal role in fostering industrial prosperity, ensuring effective governance, and elevating living standards. This study employs a range of sophisticated software tools, including VOSviewer, Bibliometrix, and ArcGIS, among others, to analyze and construct a comprehensive knowledge map encompassing 3370 research articles focused on rural environmental governance, sourced from the CNKI (China National Knowledge Infrastructure) and WOS (Web of Science) databases. This analytical endeavor delves into research themes, key areas of interest, developmental milestones, and emerging trends within the realm of rural environmental governance, thereby shedding light on the overarching trajectory of research endeavors in this domain within China. The findings reveal distinct phases in the evolution of research trends in the Chinese rural environmental governance literature, encompassing four distinct epochs: a period of sluggish growth (2002–2009), a phase of accelerated expansion (2009–2014), a span marked by stable and rapid advancement (2014–2021), and a recent period characterized by fluctuating decline (2021–2022). Moreover, the analysis highlights a burgeoning diversity in the distribution of relevant research disciplines. However, it is noteworthy that there exists a scarcity of highly prolific authors, and the formation of cohesive research teams has encountered challenges, underscoring significant deficiencies in research collaboration and academic discourse. As a prospective direction, future research should be tailored to the unique natural resources and socio-human characteristics intrinsic to different regions. It should also emphasize interdisciplinary and multidisciplinary investigations, with a focal point on economically disadvantaged regions situated in the central and western parts of the nation. Such an approach aims to bolster the overall caliber of domestic research endeavors in the field of rural environmental governance.

Keywords: rural environmental management; CNKI; WOS; VOSviewer; Bibliometrix



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1. Introduction

Environmental governance refers to the procedure by which environmental decisions are reached and by whom they are made, per definitions by the United Nations Development Program (UNDP) and the United Nations Environment Program (UNEP). In essence, environmental governance suggests that human activities should be undertaken within the bounds of legal and regulatory obligations and should make prudent utilization of natural resources, all the while preserving a peaceful coexistence between humans and nature [1]. Rural Environmental Management (REM) encompasses the measures undertaken by pertinent organizations or public authorities to preserve a robust ecological milieu within rural regions. It entails the development of legal frameworks, regulations, and policies aimed at overseeing activities detrimental to the ecological equilibrium. REM constitutes an indispensable facet in upholding the sustainable advancement of rural ecosystems and facilitating the realization of rural modernization [2]. In 2016, the Second United Nations

Environment Assembly adopted both the “UN Environment Programme Midterm Strategy 2018–2021” and the “UN Environment Programme Work Programme 2018–2019” with the aim of advancing global environmental governance. It is beyond dispute that environmental governance holds profound significance. In the realm of international rural environmental governance, the significance of this issue is particularly acute for developing nations. Presently, rural regions in these countries grapple with challenges including inadequate infrastructure and flawed environmental health management systems [3]. Effective amelioration of these rural environmental problems could potentially serve as a pivotal moment for addressing similar issues globally [4]. Given that China is the largest developing nation, its rural environmental challenges have substantial worldwide ramifications.

China has persistently implemented scientific strategies to address rural environmental concerns over the past 13 years [5]. Despite being a pivotal component of rural rejuvenation, rural environmental issues have garnered substantial attention within the nation; however, the tangible effectiveness of governance remains less than optimal [6]. The initial national pollution source census revealed that emissions from agricultural sources constitute a significant proportion of total national emissions. In the context of ongoing industrialization and urbanization, rural areas are confronted by an array of challenges encompassing deficient environmental infrastructure, exacerbating land pollution, encroachment by household waste, contamination of rivers, ponds, and channels [7], as well as pollution stemming from livestock and poultry farming. These challenges are increasingly manifesting as a multifaceted and interrelated amalgamation of diverse pollutants. They also underscore the existing practical limitations of rural environmental governance methods, singular approaches, and antiquated paradigms [8]. The diverse pollution scenarios not only exert an impact on the physical and mental well-being of the populace, but also contribute to the widening of the urban–rural income gap, significantly impeding the realization of rural revitalization objectives and sustainable rural development.

Nevertheless, upon conducting a comprehensive examination of existing theoretical research findings, it becomes evident that the predominant focus has been centered on discussions concerning governance strategies and methodologies. Regrettably, there remains a significant gap in providing an overarching synthesis of Chinese REM. Furthermore, a distinct paucity of systematic research and critical analysis pertains to the modernization of rural environmental governance systems. Environmental governance has been the subject of study for only a handful of scholars in their academic pursuits or literature reviews, and their research predominantly belongs to a bygone era. The prevalent research methodologies employed have leaned towards qualitative analyses, culminating in subjectivity in the evaluation outcomes, which lack substantial data substantiation. Remarkably, no researchers have harnessed bibliometric approaches to dissect the historical backdrop and contemporary status of Chinese REM research. The imperative need to bridge this lacuna in research becomes unequivocally apparent. Thus, amid the current conflict between farmers’ aspirations for a better environment and the contradiction of sustainable agricultural development, researching rural environmental governance in China is not only crucial for addressing current environmental issues and enhancing the quality of life and health of rural populations, but also has profound implications for promoting an ecological civilization, achieving sustainable development goals, and responding to global climate change. What has been the progress and trends in China’s rural environmental governance over the past 20 years? What are the focal points of research? What is the status of interdisciplinary and cross-sectoral collaborative research? Answering these questions is also the purpose and significance of this study.

To stay informed about the latest research developments in the REM field within the country and to offer scholars’ novel perspectives, this study involves a bibliometric analysis using tools such as VOSviewer, Bibliometrix, and ArcGIS. This analysis explores the literature from the CNKI and WOS databases spanning the last two decades in the REM domain. Through this approach, this paper delineates research trends, categorizes key research topics and hotspots, and assesses the advancements in China’s REM. Such

insights are instrumental in driving the modern transformation of rural environmental governance and in fostering comprehensive rural revitalization, aiming to influence future scholarly inquiry and practical applications in this field. The novelty of this study lies in two primary areas: first, it adopts a China-centric research perspective, thereby broadening the investigative scope concerning rural environmental governance; second, it leverages tools like VOS viewer and Bibliometrix for a foundational literature analysis and further utilizes ArcGIS to innovatively conjecture based on institutional address analysis.

2. Literature Review

Presently, scholars hailing from diverse countries have engaged in comprehensive research concerning REM. In developed nations like the United States and Europe, these states typically boast well-established legal frameworks and governance systems, with a pronounced emphasis on sustainable agriculture [9], safeguarding water resources [10], and mitigating pollution [11]. Research endeavors pertaining to REM in these nations have reached a relatively advanced stage. The European Union's Common Agricultural Policy (CAP) underscores the importance of environmental protection and sustainable agricultural practices [12]. Initiatives within the United States, such as the Conservation Reserve Program (CRP) administered by the Department of Agriculture, are geared towards enhancing water quality, fostering the conservation of wildlife habitats, and curtailing soil erosion [13]. Conversely, in developing countries such as China and India, REM has emerged as an increasingly pivotal area of study in recent years. Primary challenges encompass industrial pollution, the excessive utilization of agricultural fertilizers and pesticides, water scarcity, and pollution concerns. For instance, China's approach to rural environmental governance accentuates the development of ecological civilization, which has led to the implementation of an array of strategies including rural wastewater treatment [14] and the recycling of agricultural waste resources [15]. In numerous countries across Africa and Latin America, REM confronts even more intricate challenges. Poverty, inadequate infrastructure, and technological limitations collectively curtail the environmental management capabilities within these regions [16].

Chinese scholars have proposed three environmental governance models as the foundational framework for Resource and Environmental Management (REM) research. Historically, China has primarily embraced the first model, known as the government-led approach [17]. In this model, the government assumes a central role in environmental governance, guided by the concept put forth by Islam regarding the public attributes of environmental resources, which solidify the government's dominant position [18]. The key to achieving sustainable rural ecological environments lies in the enhancement of rural environmental regulatory laws. Traditional rural environmental governance is characterized by a "government-direct control" strategy, heavily reliant on administrative authority, and lacking diversified participation from various stakeholders. This top-down environmental governance model encounters challenges in terms of execution and adaptability, frequently resulting in a breakdown of public involvement in rural environmental governance [19]. The second model is the rural autonomous environmental governance approach, which represents an innovative strategy for managing rural environmental issues. However, this model still exhibits several drawbacks, including a limited sense of responsibility among township governments, conflicts of interest among village officials, disorderly conduct by villagers, and communication barriers among the three involved parties [20].

The third model encompasses cooperative governance for the management of rural environments. It establishes a contemporary system for governing rural environments [21], wherein the Party committee assumes a leadership role, the government takes the initiative, enterprises play a pivotal role, and social organizations, as well as the public, participate collectively. This model explicitly integrates a multitude of entities into the framework of rural environmental governance, including the Party committee, government agencies, market forces, social organizations, research institutions, and rural residents [22]. It relies upon soft power and soft legal instruments, characterized by a diverse array of governance

entities, flexible approaches to governance, and soft legal governance rules. These features serve to address the limitations inherent in traditional, inflexible governance models. The policy orientation of the third model, which advocates for cooperation among multiple entities, aligns with the contemporary requirements of rural environmental governance. However, the ensuing governance challenges grow increasingly intricate and diverse due to cooperative dysfunction [23]. This malfunction arises from the lack of parity and equitable distribution of authority among the government, market forces, and farmers, who are pivotal stakeholders [24]. Consequently, government-driven governance and market-driven governance often overstep their boundaries, while farmer-driven governance is conspicuously absent, resulting in an overall state characterized by “disorderliness and a lack of effective governance” within cooperative governance [25,26].

Nonetheless, there is currently a dearth of systematic studies that provide a comprehensive synthesis of the research encompassing Chinese Resource and REM. This deficiency extends to the critical aspects of its evolutionary trajectory, knowledge repository, applicable domains, and prospective prospects, resulting in a deficiency in effectively addressing pragmatic challenges and requisites. Consequently, this paper endeavors to build upon a thorough examination of extant research to compile the foundational knowledge and collaborative state of Chinese REM. It seeks to elucidate the prevailing areas of research interest and developmental trends, scrutinize salient concerns, and proffer recommendations for the prospective advancement of Chinese REM. This contribution serves as a valuable point of reference for decision-makers and pertinent researchers.

3. Data Sources and Research Methodology

3.1. Data Collection

Data collection serves as the bedrock of literature analysis. Academic journal publications are a mirror reflecting the forefront of developments in academic research. Consequently, access to an extensive reservoir of literature becomes imperative as a fundamental prerequisite for conducting comprehensive literature reviews [26]. For this paper, the English-language literature data have been drawn from the Web of Science (WOS) platform, developed by Clarivate Analytics. Concurrently, the Chinese-language literature data have been curated from CNKI (China National Knowledge Infrastructure), presently recognized as China’s largest academic journal database [27]. This selection ensures the representativeness and authoritative nature of our literature sources.

The retrieval formula for Chinese literature data was formulated as follows: Topic = “Rural Environmental Management”. English literature data were retrieved from the Science Citation Index Expanded (SCI-EXPANDED) database within the Web of Science core collection, utilizing “Rural environmental management” and “China” as the subject search terms. The search spanned from 1 January 2002 to 31 December 2022. After a rigorous process of repeated screening and examination, irrelevant data, including conference summaries, newspapers, books, duplicate publications, and publications lacking authorship attribution, were systematically excluded. Subsequently, after rigorous querying and filtering procedures, a total of 2689 Chinese articles and 681 English articles were successfully identified. The cumulative body of literature, eligible for quantitative analysis, amounted to 3370 articles. VOSviewer1.6.18 and BibliometrixR4.3.1 analyses were subsequently conducted to facilitate the attainment of a comprehensive understanding of the breadth and depth of the literature.

3.2. Research Methodologies

VOSviewer is a visual analysis program for creating and examining bibliometric maps. It was created in partnership with a team from the Leiden University of the Netherlands [28]. Bibliometrix is an R-based scientific bibliometric software developed by Massimo Aria and Corrado Cuccurullo et al. in Italy. A holistic scientific bibliometric and visual presentation process can be performed using the program [29]. Current bibliometric research in academia relies mostly on tools such as Citespace and VOSviewer, whereas Bibliometrix

is seldom used. The Environment System Research Institute's ArcGIS represents a new generation of GIS software (ESRI). It has robust geographic data management, and geographical analysis, among additional capabilities [30]. Therefore, this study employs visual bibliometric analysis to investigate the progress and trends in research on rural environmental governance in China. Additionally, leveraging the geographical data of the institutions affiliated with the authors of the 3370 articles, this study employs ArcGIS10.2 software to generate density heat maps encompassing the entire nation. These maps serve as a visual representation of the geographical distribution of research endeavors pertaining to rural environmental management in China.

3.3. Research Processes

The primary focus of this article's research encompasses an analysis of publication trends, disciplinary distribution, citation trends, core authors, collaborative institutional networks, keyword co-occurrence network analysis, and timeline-based clustering. This investigation comprises six distinct steps: (1) Formulating research inquiries and delineating pivotal search terms; (2) Establishing criteria for article inclusion and exclusion, conducting screening, and curating data; (3) Employing two bibliometric tools for a comprehensive and essential data evaluation; (4) Summarizing and amalgamating the outcomes acquired. Figure 1 provides an illustrative depiction of the fundamental steps outlined in this article.

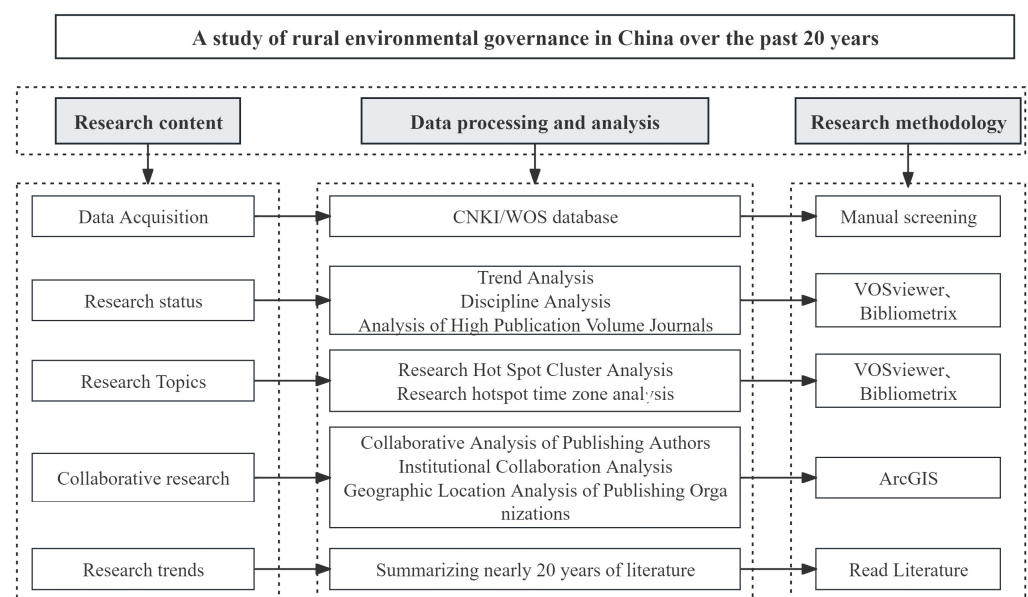


Figure 1. Flow chart of the research process.

The specific research inquiries addressed within this article encompass the following:

- What are the distinctive attributes characterizing publication trends, disciplinary distribution, citation patterns, and prominence in high-impact journals within the realm of Chinese Resource and Environmental Management research?
- In what manner does Chinese REM research manifest specific traits in terms of keyword co-occurrence, clustering, and emerging focal points?
- What distinctive features arise concerning authorship and institutional collaborations in the realm of Chinese REM research?

4. Analysis of Overall Research Trends

4.1. Number of Publications and Trend Analysis

The number of published pieces of literature can, to some extent, reflect the development status and trends of Chinese research related to REM. Examining the annual publication count serves as the foundation for bibliometric analysis [31]. Figure 2 depicts

the yearly publication of academic papers related to Chinese REM. Analyzing the overall article count trend reveals a continuous growth pattern in REM articles over the past two decades. This growth can be categorized into four phases. Firstly, from 2002 to 2009, there was a period of gradual growth, with an average of 23 articles published annually, which was relatively low. Secondly, the period from 2009 to 2014 marked accelerated growth. Increased funding for rural environmental protection efforts in China in 2009 led to a significant rise in the number of articles during this period, indicating progress in rural environmental management [32]. Thirdly, from 2014 to 2021, a stable and rapid growth phase ensued. As China elevated “ecological civilization construction” to a national strategy and introduced various legal policies, particularly the 2014 revision of the “Environmental Protection Law of the People’s Republic of China [33]”, which substantially increased penalties for environmental violations, and the introduction of top-level design documents guiding comprehensive ecological civilization development in China in 2015, the number of articles in this field surged [34]. This demonstrates that research on rural environmental management in China is undergoing rapid development and in-depth exploration and, to some extent, reflects the alignment between research enthusiasm in rural environmental management and national policy direction. Lastly, from 2021 to 2022, a fluctuating downward trend has emerged. During this period, the COVID-19 pandemic may have directly or indirectly impacted research on rural environmental management, hindering researchers from conducting field investigations.

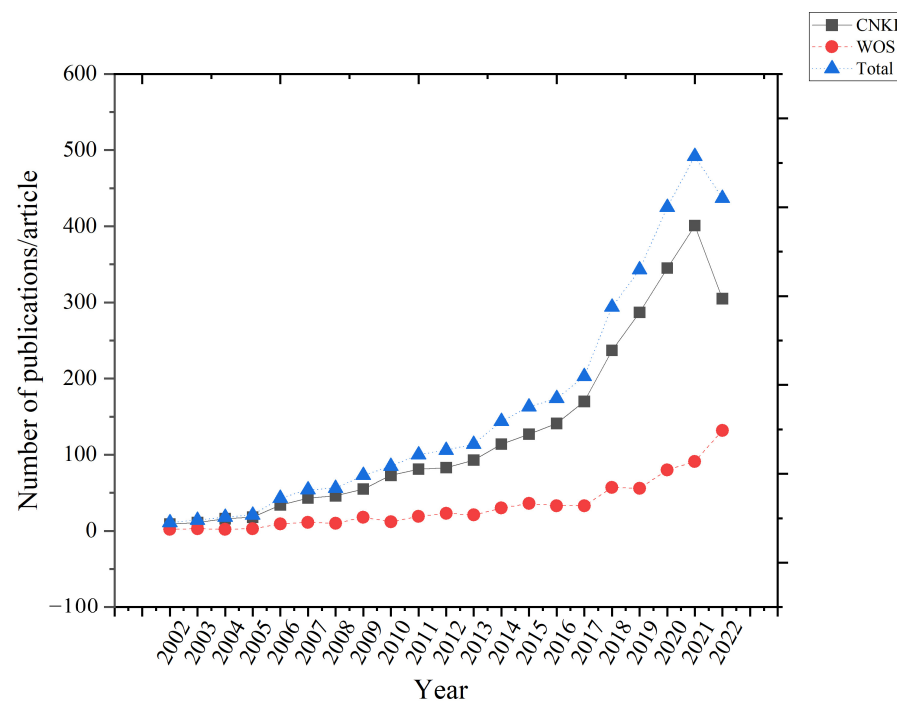


Figure 2. Trend of publications in the field of REM in China, 2002–2022.

4.2. Distribution of Disciplines

From the perspective of disciplinary distribution (Table 1), research concerning rural environmental governance in China primarily encompasses a variety of disciplines, including environmental science, agricultural economics, party and government organizations, macroeconomic management, and sustainable development. Research in other fields is comparatively limited. The overall distribution of disciplines exhibits diversity, with 3370 papers spanning 30 academic domains. This suggests that issues associated with rural environmental governance have piqued the interest of scholars across diverse disciplines, resulting in extensive interdisciplinary engagement. This underscores that the research theme of REM (Rural Environmental Management) in China not only pertains to environmental protection but also exhibits close ties to public health, politics, and economic

management, thus attracting widespread academic attention. The amalgamation of various disciplinary perspectives lays a robust foundation for the study of Chinese REM.

Table 1. Top 10 categories.

CNKI Categories	Percentage	CNKI Categories	Percentage
Environmental science and resource utilization	58.3%	Environmental studies	3.9%
Agricultural economy	17.7%	Green sustainable science technology	3.4%
Environmental sciences	10.9%	Macroeconomic management and sustainable development	2%
Political parties and mass organizations	10.5%	Environmental engineering	1.9%
Basic agricultural sciences	6.7%	Administrative law and the local legal system	1.7%

4.3. High-Yield Journal Information

Figure 3 illustrates the top ten journals in China's Renewable Energy Management (REM) research field, as determined by the number of publications. The journal "Sustainability" stands out with a significant lead, boasting 50 articles, and holds a prominent position in terms of both activity and influence within this research domain. Closely following are the "Journal of Cleaner Production" and the "Science of the Total Environment", with 33 and 32 articles, respectively. Other journals, such as the "International Journal of Environmental Research", "Anhui Agricultural Science", and "Environmental Science and Pollution Research", among others, have published between 24 and 28 articles, underscoring their substantial contributions and academic impact in this field. It is noteworthy that these journals encompass various disciplines, spanning environmental science and agricultural economics. This diversity underscores the multidisciplinary nature of research in Chinese REM. Consequently, this graph can serve as a valuable resource for prospective researchers in related fields seeking to identify suitable journals for their submissions. These journals exhibit a strong alignment with REM-related topics and may boast a larger pool of peer reviewers who can offer profound insights and evaluations of REM research.

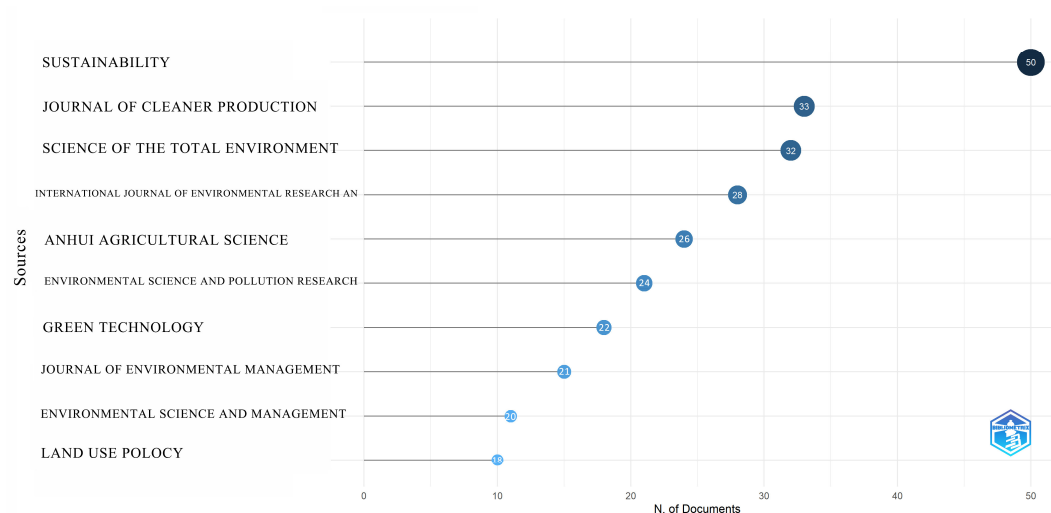


Figure 3. Most relevant sources.

5. Research Hot Frontier Analysis

5.1. Hot Topic Analysis

Conducting co-occurrence analysis on keywords in the literature provides a more intuitive and clear depiction of the field's research hotspots. In this study, VOSviewer was used to analyze 3370 documents with keyword data. The analysis, facilitated by the



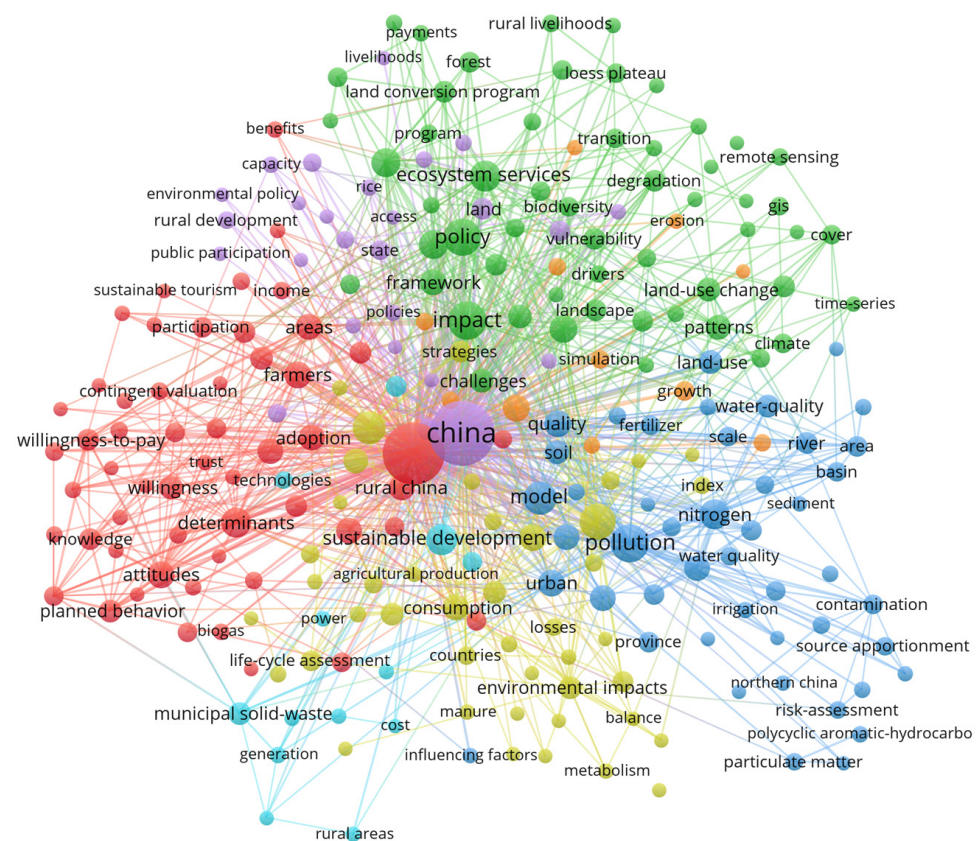


Figure 5. Keyword co-occurrence map of Chinese REM studies in WOS.

5.2. Hot Trend Analysis

Co-occurrence time zone maps effectively illustrate the annual research hotspots and their developmental trends over time. Figures 6 and 7, generated with VOSviewer software, presents a time zone map showcasing the patterns of keyword co-occurrence within China's REM research field. This map delineates the frequently used keywords and their changes over time in Chinese REM studies. In the figure, each node symbolizes a keyword; the size of a node corresponds to its frequency in the literature. The color of each node indicates the temporal aspect, with a gradient color bar in the lower right corner marking time progression from blue to yellow, signifying the variation in keyword frequency over time. Furthermore, the interconnecting lines between nodes depict the relationships of keyword co-occurrence. The thickness of these lines represents the co-occurrence strength, with thicker lines suggesting a higher frequency of concurrent appearance of two keywords in the same document.

Since 2014, research has concentrated on rural environmental pollution [43] and governance measures [44]. Fawen Yu explored ecological issues in rural areas, proposing policy measures for building an ecological civilization by integrating socio-economic and environmental strategies [45]. The incorporation of big data and information technology has increasingly become a viable solution for enhancing the efficiency of environmental governance and addressing rural challenges [46]. By 2016, studies were focusing on environmental governance [47] and the water crisis in rural settings [48], noting that a considerable portion of the rural population lacked access to safe drinking water, thus facing health risks from inferior water quality [49]. Additionally, the diverse geographical and infrastructural settings across rural China have impeded effective water supply and quality management. In 2018, the research emphasis shifted towards sustainable development [50] and ecological governance [51]. Yijia Wang's analysis showed how social relationships and the principles of the circular economy—reduction, reuse, and recycling—impacted waste management practices among farmers, revealing significant interactive effects that influenced rural

governance strategies [52]. Xinming Li utilized advanced technologies, such as deep convolutional neural networks, to foster innovative approaches for sustainable rural ecological governance, aiming to improve the monitoring and management of ecological resources and underscoring the transformative potential of technology [53]. Since 2020, academic research has been directed at rural residential [36] and ecological environments [54], waste disposal [55], and sewage treatment [14], driven by policy guidelines. Binglu Wu discovered that rural environmental governance is increasingly adopting integrated approaches that meld policy management, environmental science, and community participation to address these challenges effectively [56]. Changxu Wang's bibliometric analysis from 1992 to 2022 indicated that policies governing rural residential environments have progressed through initial, exploratory, enhancement, and deepening phases, showing a mature policy framework. This research encompasses the nuances of rural residential environments, governance models, effective evaluations, and governance technologies, with a gradual shift towards more systematic and comprehensive research methods [57].

Moreover, the evolution trends of the major hotspot keywords ‘rural area’, ‘environmental governance’, ‘rural environment’, ‘governance’, and ‘rural revitalization’ from 2002 to 2022 are shown in Figure 8. Within these trends, research in the ‘rural’ category has maintained a leading position, exhibiting a consistent upward trajectory. The prominence of ‘rural revitalization’ as a keyword escalated notably post-2015, following the state’s release of the ‘Comprehensive Implementation Plan for Deepening Rural Reform’ [58]. Commencing in 2018, the introduction of the philosophy that ‘clear waters and green mountains are as valuable as mountains of gold and silver’ marked a shift in state focus to pressing environmental issues [59]. This shift became a priority in 2018, catalyzing significant advancements in the realm of ‘governance’ research.

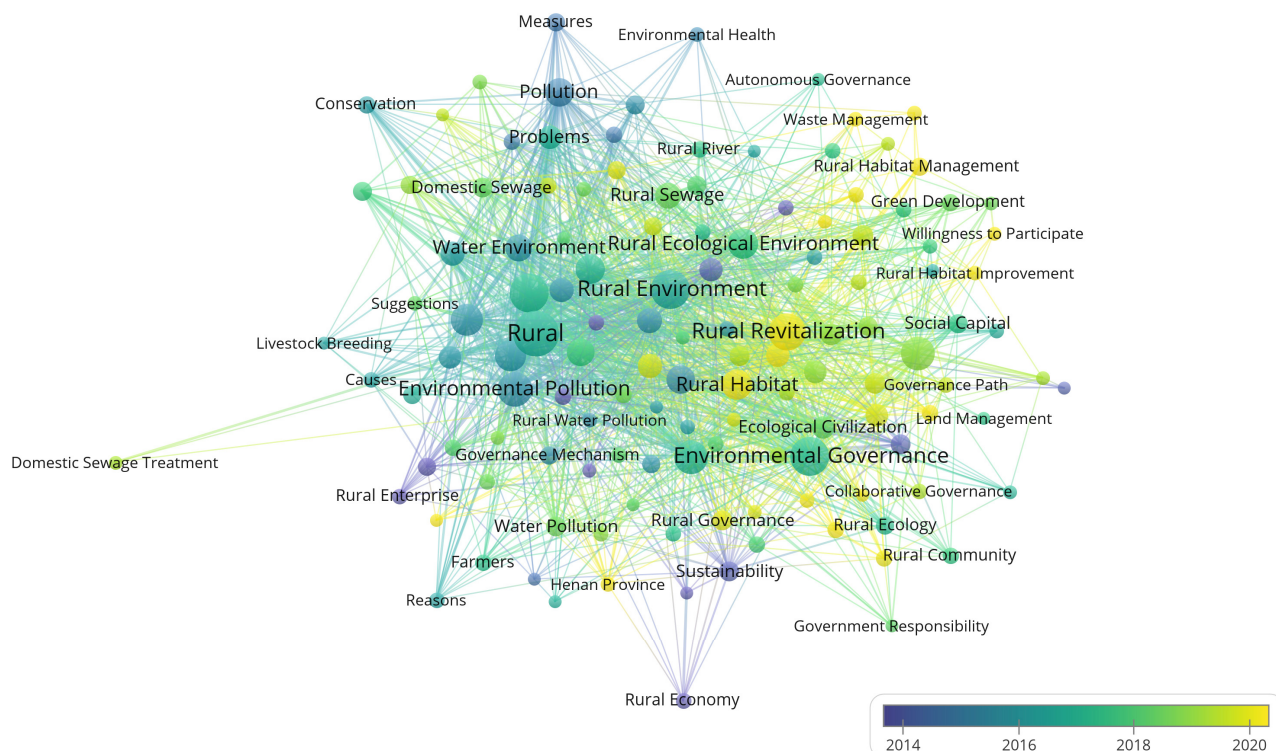


Figure 6. Keyword time zones of CNKI for REM studies in China.

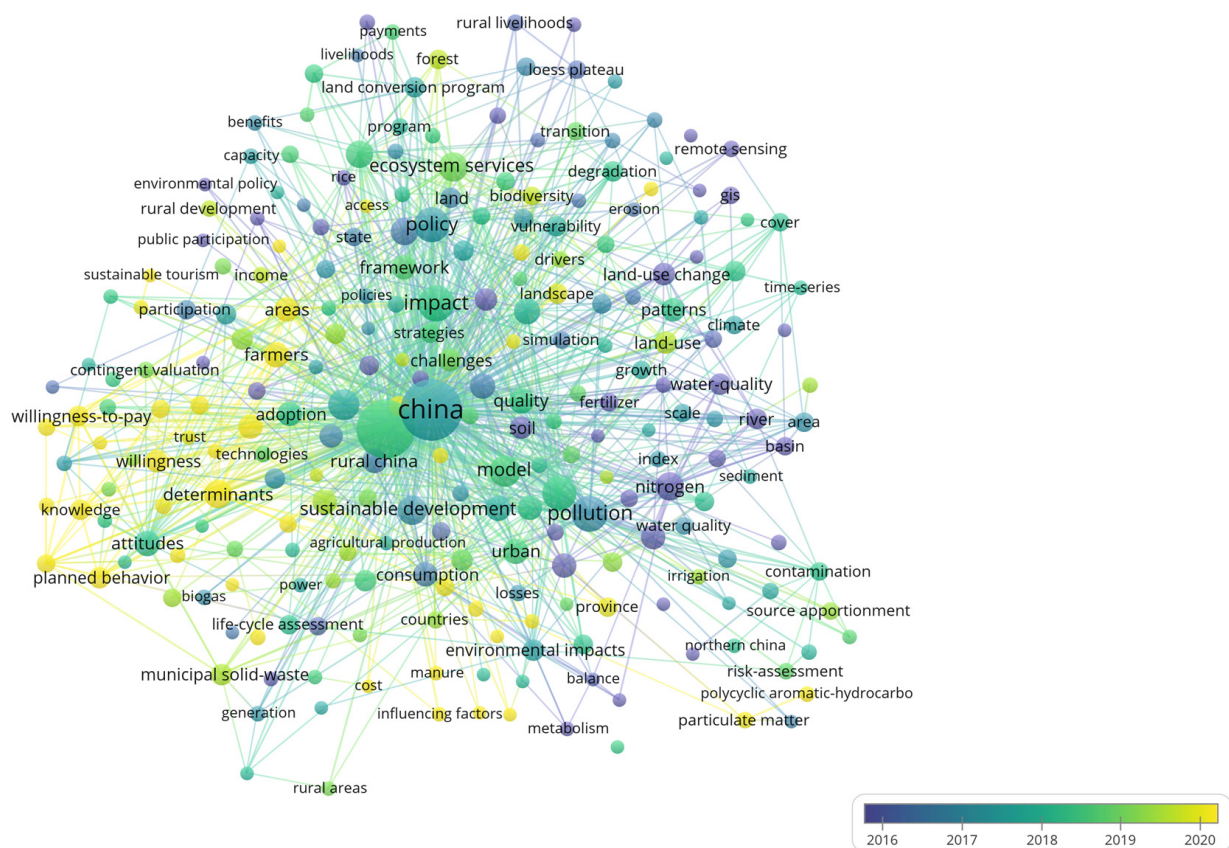


Figure 7. Keyword time zones of WOS for REM studies in China.

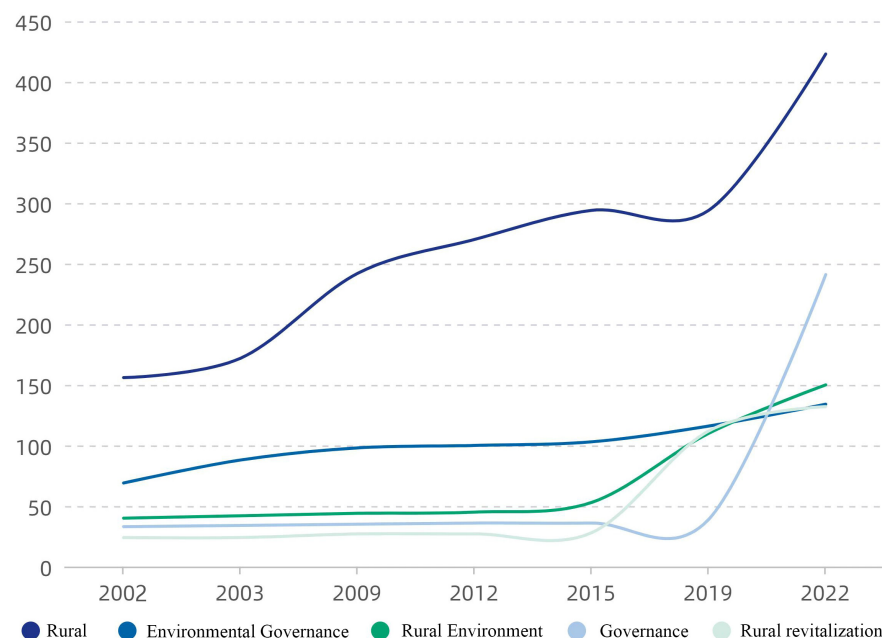


Figure 8. Line graph of popular keywords for publications on rural environmental governance in China, 2001–2022.

5.3. Analysis of Author Collaboration

The author collaboration network graph provides a visual representation to discern cooperative relationships within a research domain. This tool is particularly useful for

emerging scholars and researchers in identifying influential figures and their areas of study, as well as in locating potential collaborators and research teams. Such a tool is crucial for fostering deep research development, integrating resources, sharing data, and addressing real-world challenges. Figure 9 represents the co-occurrence collaboration graph of Chinese REM research authors from the CNKI database. Prominently, the larger nodes representing Wang Yining and Li Ning suggest their pivotal roles in this collaboration network, highlighting their substantial research contributions and wide-ranging collaborations with numerous scholars. The close links between Yu Qi, Wang Bo, and Liu Yong indicate either shared research endeavors or similar interests in REM. Furthermore, the graph exposes potential inter-regional collaborations, as illustrated by the extensive link between Jin Shuqin and Fu Sujing, hinting at the possibility of inter-provincial or international collaborations.

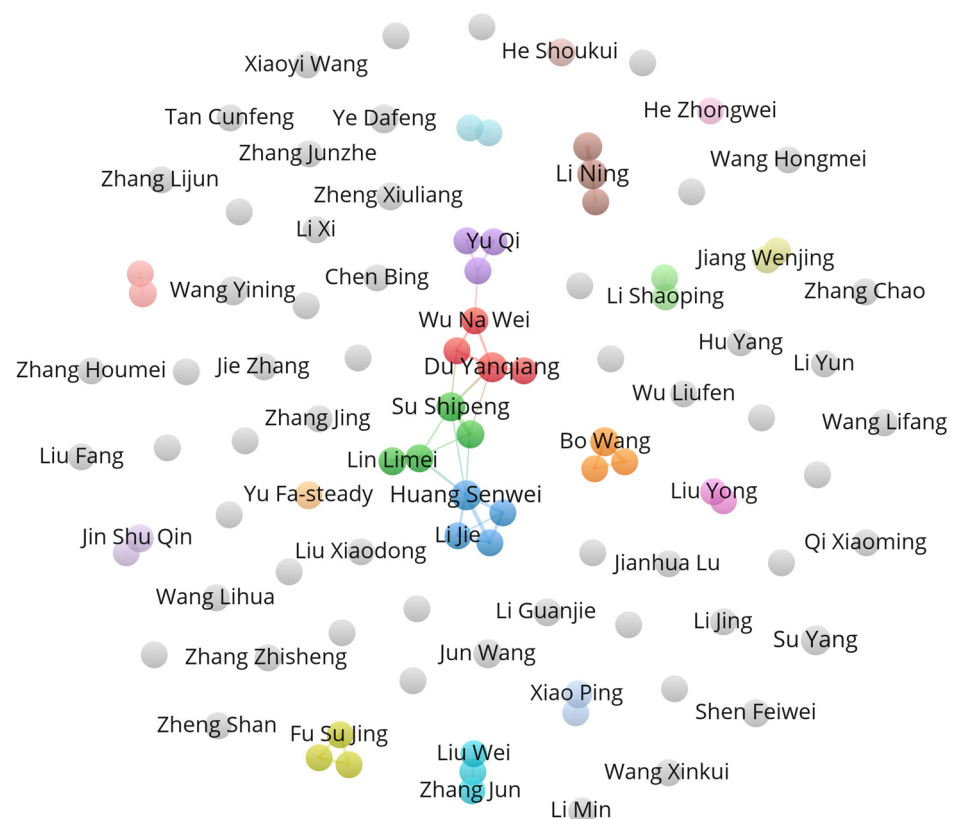


Figure 9. Author co-occurrence collaboration map of Chinese REM studies in CNKI.

Figure 10 illustrates the co-occurrence collaboration network of authors in Chinese REM research as recorded in the WOS database. Han Zhiyong stands out as a central node with a vast network spanning various research teams and areas. His strong ties with scholars like Zhang F. S. and Wang Fei denote an interdisciplinary team specializing in agricultural waste management [60] and rural water resource conservation [61]. Chen Liding, another key figure, has established an intensive network with Kong Shaofei and Qi Shihua, focusing primarily on soil erosion [62], farmland water management [63], and other land management-related environmental issues [64,65]. The research endeavors of Liu Ying, Zhang Minghua, and Ye Jie are largely directed towards rural sustainable development [66], the construction of ecological civilization, and the assessment of environmental policies [67]. Figure 7 provides valuable insights into the author collaboration network and prevailing trends in China's REM field, playing a vital role in recognizing key researchers and their specific areas of focus.

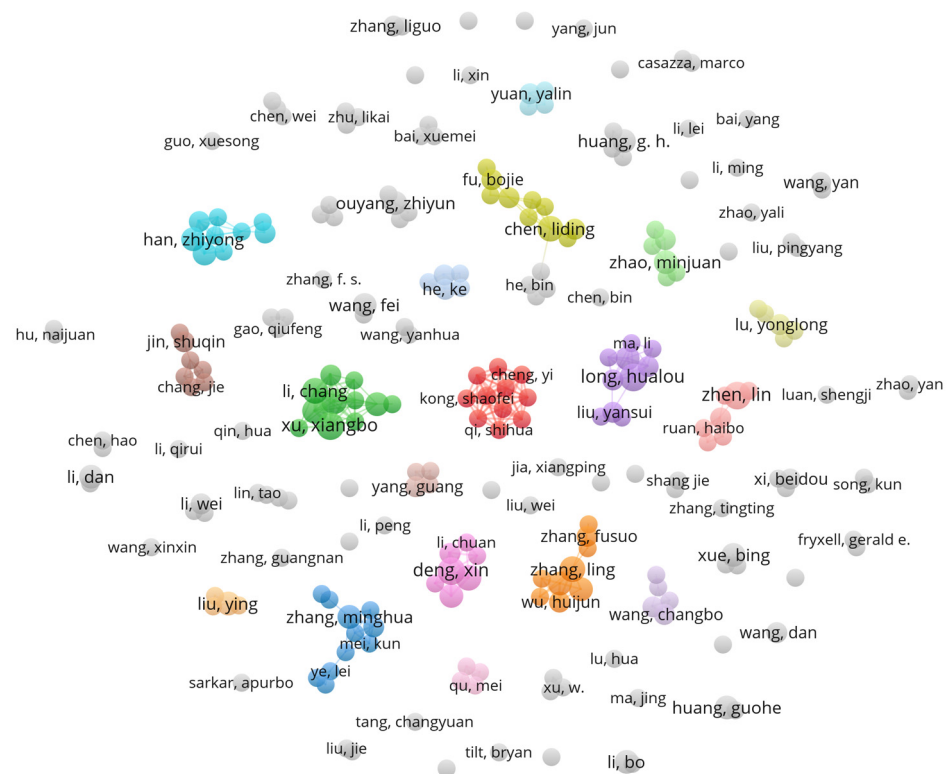


Figure 10. Author co-occurrence collaboration map of Chinese REM studies in WOS.

5.4. Analysis of Cooperation of Issuing Bodies

Data analysis using VOSviewer software unveiled the cooperation network and node dynamics among institutions in China's REM research field. As illustrated in Figure 11, the primary contributors to REM research within our nation are predominantly universities and scientific institutions, including Zhengzhou University, Nanchang University, the Chinese Academy of Sciences, and Tongji University. These entities hold central roles in the network, underscoring their critical function in the collaborative framework. Central institutions, equipped with extensive research resources, effectively engage in collaborations with other academic entities. For instance, Zhengzhou University's strategic position in the network, highlighted by its numerous connections to various educational and research institutions, signifies its integral role in facilitating widespread cooperative endeavors, likely attributed to its robust environmental science research and comprehensive project partnerships. Moreover, Figure 12 discloses international cooperation trends, exemplified by links between entities like the Australian National University and Chinese research institutions, illustrating the global reach and collaborative efforts of China's REM research with the international academic fraternity. This network encapsulates the extensive collaborative efforts and knowledge exchange in China's REM research across global universities, research institutes, and corporations, mirroring the field's collective vigor and evolving trends. Such collaborative models are pivotal in consolidating resources, disseminating knowledge, addressing rural environmental challenges, and catalyzing scientific research progression.

The ArcGIS software was utilized to create a heatmap representing the research units' 3370 publications in this study (Figure 13). Geographically, the analysis reveals that Beijing, Jiangsu, and Hebei have the highest volume of publications. These provinces are in China's economically advanced eastern regions. Conversely, the Tibet Autonomous Region, Hainan Province, Qinghai, and Ningxia Hui Autonomous Region, located in the economically less developed central and western regions of China, exhibit the lowest publication volumes.

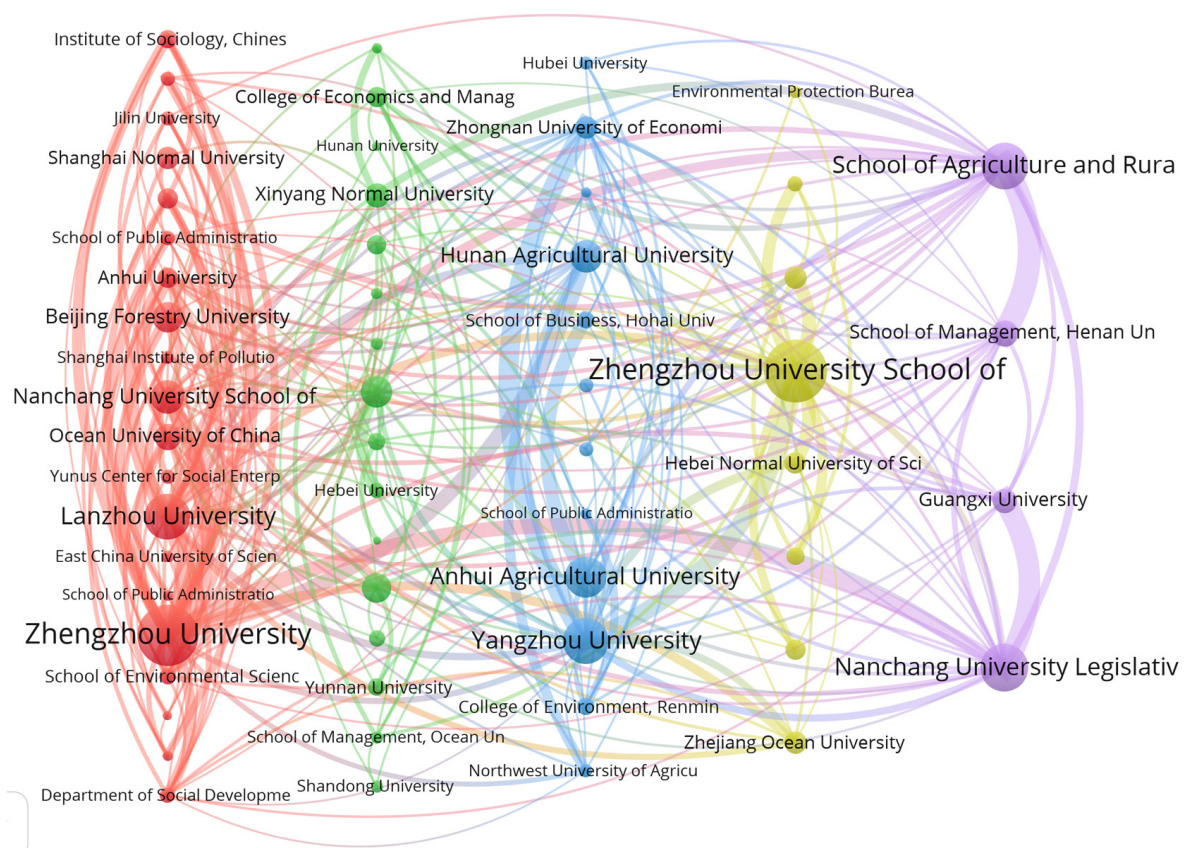


Figure 11. Institutional co-occurrence of REM research in China by CNKI.

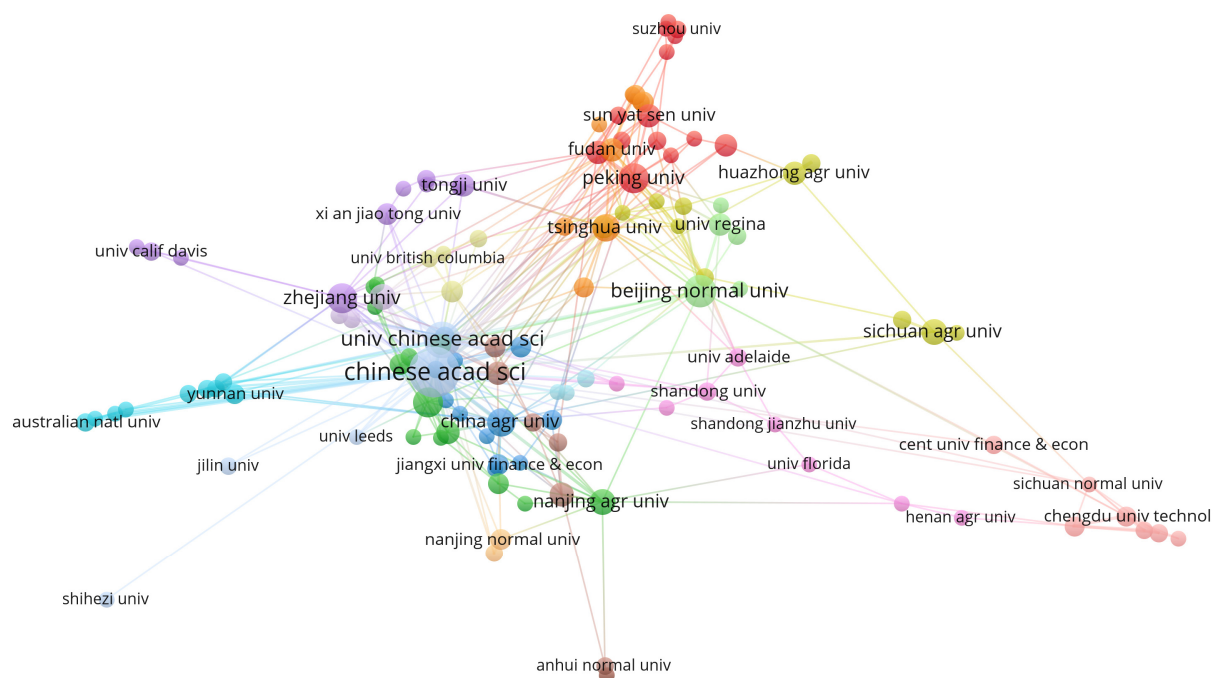


Figure 12. Institutional co-occurrence of REM research in China by WOS.

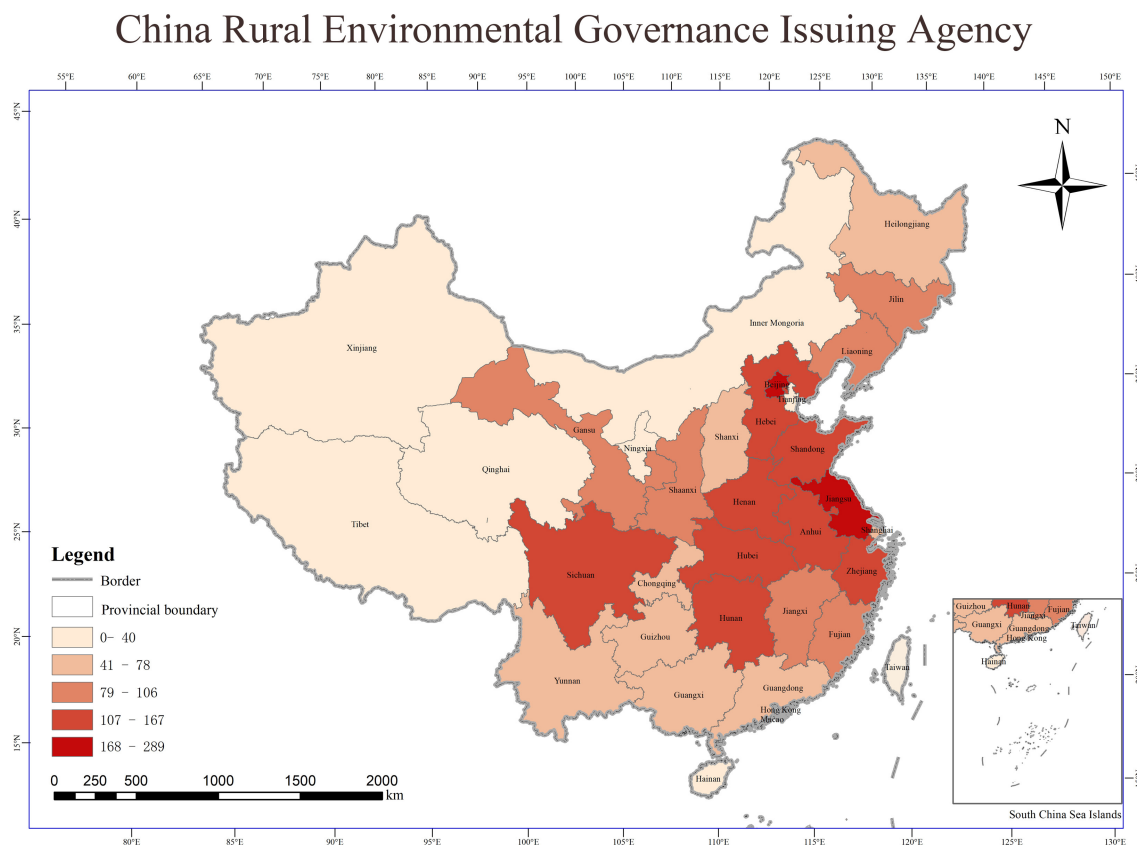


Figure 13. Heat map of REM-issuing organizations in China.

6. Conclusions and Recommendations

6.1. Conclusions and Recommendations of the Study

This study analyzes 3370 Chinese REM publications from the CNKI and WOS databases, utilizing visualization tools like VOSviewer and Bibliometrix to generate keyword co-occurrence, time zone, author co-occurrence, and research institution knowledge maps. China's REM research, driven by national policy and practical developments, has yielded significant outcomes. Recently, China has transitioned from a top-down government-led governance model to one that incorporates public and societal input, fostering varied and collaborative strategies in rural environmental governance [68]. Moreover, REM research must strengthen interdisciplinary dialogue and integration, expanding its breadth and depth. This involves a comprehensive analysis of current trends and the development of effective governance strategies. The research focus has also shifted from macro- to micro-level issues, aligning with China's specific context and national strategies like rural revitalization and sustainable development, prioritizing farmers' interests and the qualitative advancement of rural areas. An examination of the existing literature on rural environmental governance, within the context of China's rural development, points to potential directions for future research in this field.

1. An analysis of publication trends reveals a progressive increase in the volume of Chinese publications pertaining to REM. This escalation can be segmented into four distinct phases: the slow growth phase (2002–2009), the accelerated growth phase (2009–2014), the stable yet rapid growth phase (2014–2021), and the phase of fluctuating decline (2021–2022);
2. In the realm of research discipline distribution, investigations related to REM in China exhibit a discernible trend toward diversification. This phenomenon has garnered the attention of scholars hailing from diverse fields within China. Consequently, research has undergone an evolutionary progression, transitioning from its initial solitary

- disciplinary focus to the embrace of interdisciplinary domains. In its inception, REM research predominantly adhered to qualitative research methodologies. Nevertheless, in recent years, as environmental governance has become increasingly intricate and transboundary in nature, scholars have progressively gravitated towards a synthesis of qualitative and quantitative research approaches. Consequently, the future landscape of rural environmental governance research in China necessitates a fusion of qualitative and quantitative methodologies, accompanied by the assimilation of a multitude of research methodologies. This strategic orientation is aimed at cultivating interdisciplinary and multifaceted investigations, with an active incorporation of a diverse array of knowledge systems to fortify collaborative cross-disciplinary research;
3. From the perspective of research trends, the ecological environment, rural settings, and environmental pollution have consistently held researchers' focus. Concurrently, topics including collaborative governance, the development of new rural areas, the establishment of ecological civilization, and rural revitalization have garnered attention in alignment with national policies and rural development initiatives. Analyzing the evolutionary trajectory of these research areas, the study of rural environmental governance in China has shifted from a macroscopic viewpoint to a micro-level emphasis. Research methodologies have progressively transitioned from qualitative to quantitative approaches, accompanied by a shift in research emphasis from objects to individuals. Notably, subjects like the rural living environment, waste management, ecological governance, and sustainable development have gained prominence. Present-day research predominantly centers on reactive emergency management following environmental challenges, potentially neglecting proactive rural environmental problem prevention. Furthermore, the diverse characteristics of China's rural regions, including ecological contexts and developmental stages, pose a challenge for the application of a single model to Chinese REM [8]. Future research endeavors should consider adapting to the distinctive circumstances of rural society, accounting for local natural resources, social and cultural attributes, and comprehensive efforts to enhance rural environmental quality;
 4. Viewed from the standpoint of publication authors, the REM field in China has indeed cultivated a cohort of core contributors. However, authors with high productivity are comparatively limited in number, and the establishment of cohesive research collaboration teams remains a challenge. Furthermore, within the broader landscape of this field, the prevalence of co-authored articles is relatively modest, underscoring the necessity for bolstering interdisciplinary and cross-disciplinary collaboration among authors. Additionally, it is noteworthy that numerous REM research institutions in China are affiliated with universities, and they tend to engage in collaborative efforts predominantly within their respective domains. Therefore, there is an imperative to foster more robust cooperation that transcends interdisciplinary boundaries;
 5. From the perspective of research institution productivity, Guangxi University, Nanchang University, and Lanzhou University emerge as the leading institutions in this field. Additionally, institutions like Zhengzhou University, Yangzhou University, Lanzhou University, and Anhui Agricultural University have actively participated in extensive collaborative research efforts, facilitating in-depth exploration within the domain of Chinese REM. It is worth noting that overall economic development across various regions of China displays disparities, with the central and western regions generally trailing behind their eastern counterparts. Furthermore, rural development continues to lag behind urban progress, and disparities in funding allocation and management practices are evident within the REM field. In order to effectively address the issues of uneven and inadequate rural development, along with the challenges impeding sustainable economic and social progress in rural areas, innovative strategies for rural environmental governance should be carefully examined. These strategies should be oriented towards addressing the key concerns and complexities within the realm of REM. Moreover, it is imperative to direct increased attention to

the economically disadvantaged central and western regions, which generally find themselves in a relatively underdeveloped state. These regions constitute a pivotal focus area for future initiatives in rural environmental governance.

Rural regions in China are an integral part of the national demographic, significantly impacting the health and well-being of their residents through environmental quality. As the world's largest developing nation, China's experiences and challenges in rural environmental governance offer lessons of global significance. Recent advancements in China's Resource and Environmental Management (REM) due to a series of policy reforms and philosophical shifts in governance have led to notable successes. A comprehensive review of the past two decades of literature on this topic reveals the diverse impacts of these initiatives: First, practically speaking, the full activation of rural societies' capacities and the establishment of effective village development models contribute to sustainable, healthy, and harmonious rural growth [69]. Second, methodologically, China's pioneering practices and technologies in areas like ecological agriculture and resource recycling serve as valuable models for other developing countries. These efforts ensure the preservation of ecosystems and biodiversity while promoting sustainable agricultural practices globally. Third, from a policy perspective, the government's ability to devise or refine environmental policies specifically for rural areas supports legal and economic frameworks for environmental protection. By thoroughly analyzing specific environmental and resource challenges in rural settings, policymakers and managers can allocate resources strategically, addressing the most pressing environmental concerns first. China is a principal agricultural nation, and its achievements and setbacks in rural environmental governance are of international relevance. Investigating and developing China's strategies for rural environmental governance is critical for its sustainable development and plays a significant role in shaping global rural environmental governance policies. By disseminating experiences, technologies, and strategies, China provides invaluable insights and models for worldwide rural environmental management.

6.2. Discussion

Chinese REM constitutes a complex and significant research domain encompassing multiple disciplines and dimensions, demanding a comprehensive examination of various elements, including nature, society, and economics. This article offers an exhaustive analysis and exploration of Chinese REM research, yet it possesses certain limitations. To begin with, the article exclusively relied on literature from two databases, CNKI and WOS, which somewhat constrained the scope of the study, potentially excluding essential publications from other international or domestic academic journals and conferences. Additionally, this article employed software tools such as VOSviewer, Bibliometrix, and ArcGIS for literature analysis, which furnished valuable insights into research topics and trends but did not engage in an extensive discourse on specific research methodologies and data quality. Lastly, the article identifies deficiencies in interdisciplinary collaboration and academic communication but refrains from conducting a thorough examination of the underlying causes. Whether these shortcomings stem from interdisciplinarity barriers, inadequate academic communication mechanisms, or other factors warrants further comprehensive investigation.

This article engages in a bold hypothesis. Firstly, we utilized ArcGIS software to create a heatmap illustrating the distribution of research institutions among the 3370 articles in this study. From a spatial standpoint, the provinces with the highest publication counts include Beijing, Jiangsu, and Hebei, while those with the fewest publications are the Tibet Autonomous Region, Hainan Province, Qinghai, and Ningxia Hui Autonomous Region. Secondly, we drew upon the '2020 List of Beautiful and Leisurely Rural Formulas in China' issued by the Department of Rural Industry Development within the Chinese Ministry of Agriculture and Rural Affairs [70]. Using ArcGIS software, we generated another heatmap. Among these regions, Jiangsu, Zhejiang, Anhui, Sichuan, and Chongqing boast the highest number of beautiful rural areas, whereas the Tibet Autonomous Region,

Ningxia Hui Autonomous Region, Qinghai Province, and Hainan Province exhibit the fewest. Figure 14 illustrates that the spatial distribution of these two aspects closely aligns. Regions with fewer beautiful rural areas, such as the Tibet Autonomous Region, Ningxia Hui Autonomous Region, Qinghai Province, and Hainan Province, also demonstrate a scarcity of related studies. This article postulates that research within the field of Chinese REM appears to concentrate on regions where environmental governance methods exhibit relative effectiveness, while provinces characterized by less favorable rural environments and average governance efficiency attract comparatively less attention. Future research endeavors may delve deeper into this perspective and explore whether it influences the geographical focus of China's REM research and its correlation with beautiful rural areas in China.

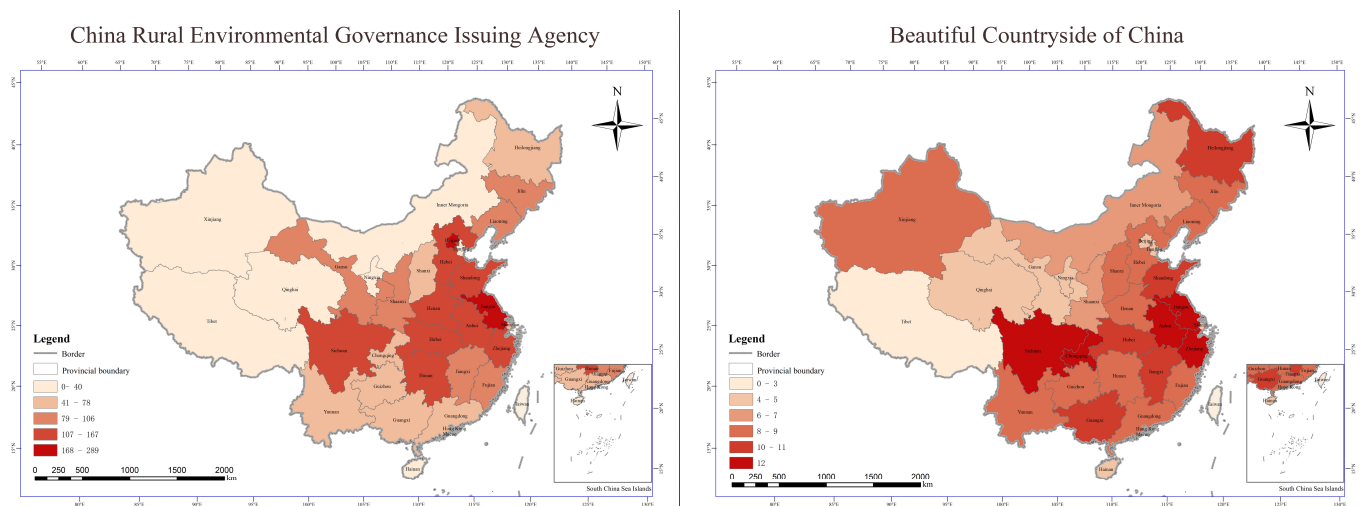


Figure 14. Hotspot map of spatial distribution of REM-issuing organizations and beautiful villages in China.

6.3. Research Challenges and Prospects

Research on rural environmental governance presents significant challenges yet offers considerable innovative potential. The primary challenge is the acquisition of accurate, comprehensive, and timely data on rural environmental conditions, hindered by inadequate monitoring infrastructure in many rural regions and often unsystematic data collection and updates. Additionally, some rural areas lack the advanced technology and financial resources necessary for supporting effective research and practice in environmental governance. Despite numerous environmental protection policies and regulations enacted globally, discrepancies persist between policy intent and local implementation, influenced by local government enforcement, budget allocations, and prioritization, which can undermine policy efficacy. Moreover, the inherent contradictions between economic and environmental objectives in rural settings—such as the tensions between agricultural production and resource conservation, and the need to balance local economic growth with environmental sustainability—demand focused attention in research.

Future research in rural environmental governance will benefit from harnessing modern technologies, including remote sensing, big data, and artificial intelligence, to enhance the monitoring and management of rural areas. Promoting sustainable agricultural practices such as ecological farming and organic cultivation is essential, as these methods improve soil and water quality and enhance the quality of agricultural products, thereby benefiting the long-term health of rural environments. Moreover, the development and implementation of scientifically robust and comprehensive environmental policies, especially innovative local initiatives, are crucial for addressing rural environmental challenges. Engaging community members actively in environmental protection and increasing envi-

ronmental awareness and education in rural areas are vital strategies for improving policy acceptance and effectiveness.

Overall, despite ongoing challenges, the scope and depth of research on rural environmental governance are poised to grow, driven by technological progress and policy enhancements.

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