

# Climate Change and Rural Development: A Bibliometric Review

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**Abstract.** This study addresses the gaps in the current literature by reviewing the intellectual structure and research trends on climate change and rural development. This research aims to identify contributed authors, journals, countries, articles, and key topics in these research areas. We used a bibliometric approach to analyse the performance of the literature and knowledge structure of the issues from 492 articles from 1996 to 2023 indexed by the Web of Science. Our findings reveal that *Land Use Policy* is the leading journal of publications and citations, reflecting its prominent role in disseminating research on climate change and rural development. Silva emerges as an influential author, contributing significantly to the discourse. Geographically, the United States leads in research output, highlighting its strong focus on addressing rural development challenges in the context of climate change. Using co-occurrence analysis, we reveal several terms in climate change and rural development research, including energy, vulnerability, biodiversity, and biomass. This study systematically reviews these issues and contributes to climate change and rural development.

## 1 Introduction

Climate change is a crucial issue in human civilization [1]. Climate change refers to an alteration of the atmosphere's concentration and the fluctuation of the environmental temperature across similar time intervals caused by anthropogenic activity, either active or passive [2]. Global warming is raising the mean temperature of the Greenhouse effect in seas and land. Although the effect is faced in the long term, several indications have been perceived by humankind, such as increasing the seawater surface, changing harvest season,

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increasing earth temperature, etc. Therefore, scholars and governments worldwide have paid particular attention to climate change and global warming [3].

Climate change has received special attention from scholars across disciplines in recent decades. Researchers have carried out many bibliometric reviews on the topics in social science perspectives, such as mitigation, resilience, and adaptation [4–6]; migration [7,8], tourism [9,10]; organization [11]; vulnerability [12–14]; insurance [15]; economic impact [16,17]; gender issue [18]; communication [19], social protection [20]; and cultural heritage [21,22]. Most reviews did not limit the topics based on such subject area or category of discipline. Instead of focusing on such subject areas, past studies included all sorts of while searching the data. Therefore, all subject matters are entirely identified by the previous scholars.

Although climate change affects the rural environment and development, no scholarly reviews focused on the issues. Rural development refers to enhancing living standards and financial prosperity for individuals residing in rural regions, typically remote and thinly populated areas [23]. According to Olmedo and O'Shaughnessy, rural areas are critical to improving people's quality of life and economic status in remote and sparsely populated regions [24]. However, rural communities in the Southeast are at risk due to their reliance on agriculture, seafood, and forest industries. With rising temperatures, droughts, and changing weather patterns, climate change will adversely affect these industries and labor productivity. In addition, rural areas, already struggling with poverty and limited healthcare access, will find it difficult to cope with the challenges posed by climate change [2]. Chirisa and Nel suggest climate change already affects rural areas with warming, climate volatility, extreme weather events, and environmental change in the United States [25]. This poses considerable risks to infrastructure, livelihoods, and quality of life in many rural communities. Despite these challenges, investing in climate mitigation efforts such as land management and restoration, renewable energy infrastructure, and remediation of out-of-use oil and gas wells can create job opportunities, enhance social and ecological health, and improve rural regions' overall quality of life [25].

While there is a growing body of literature explaining the effect of climate change on rural development, there is still a significant lack of research on the specific mechanisms through which climate change affects rural economies, livelihoods, and ecosystems, especially in vulnerable regions. Additionally, we highlight that existing studies often overlook the importance of integrating local knowledge and adaptation strategies into rural development planning, leaving a gap in understanding how to address these challenges in the context of climate change sustainably. Therefore, we need a review of the literature on the topic of climate change and rural development.

The current study makes a novel in three ways. First, we contribute to the recent literature by reviewing the concept of climate change and rural development. Second, Second, we used a bibliometric approach to identify and visualise the article to describe the intellectual landscape of the research, including the author, citation, and trending topics. Finally, according to our recommendations, this research is helpful to the scholars who will design research on related topics

Based on the current literature gaps, this study's problems can be formulated as follows: (1) How does the historical development of articles and topics in the study of climate change and rural development? (2) who are the most impactful authors, journals, and countries? (3) How are intellectual discourse and relationships developed within these two concepts?

2 Methods

This study used a bibliometric approach to a systematic literature review (SLR) [26]. We employed descriptive quantitative bibliometrics. Bibliometric was a method of reviewing scientific papers systematically using statistical analysis [27] to identify the structure and crucial pattern of scientific knowledge based on their evolution [28]. It was also ordinarily used to map the article, citation, and trending topics. It was more advanced than a narrative and traditional systematic review because it can identify and scrutinize the article based on influential author, journal, affiliation, country, and topic.

This research was conducted in four phases, as illustrated in Figure 1. First, we collected the details of relevant articles from the Clarivate Analytics Web of Science (WoS) collection, the most reputable database utilised by many scholars performing bibliometric analysis [29]. It was begun on 22 May 2023. We used a combination of strings while tracking the data, ((“climat\* chang\*” OR “global warm\*” OR “climat\* warming\*” OR “climat\* model\*” OR “climat\* emergenc\*” OR “environment\* chang\*” OR “global chang\*” OR “climat\* variability and change” OR “greenhouse gas” OR “greenhouse effect\*” OR “carbon emission\*” OR “global temperature\*” OR “anthropogenic warming\*” OR “anthropogenic emission\*” OR “CO2 omission\*”)) AND ((“rural development\*”)), generated from previous literature [6], [11], [15], [30].

We used inclusion and exclusion criteria when choosing the literature. Specifically, we included peer-reviewed articles that focused on the intersection of climate change and rural development, covering empirical studies and case studies relevant to adaptation, mitigation, and sustainable rural development. We excluded non-peer-reviewed literature, articles unrelated to climate change and rural development, non-English, and studies lacking sufficient methodological details.

We found 752 articles. Second, we included the journal's original article in English in the following query. Third, we only incorporated the Social Science Citation Index (SSCI), Science Citation Index Expanded (SCIE), and Art and Humanities Citation Index (AHCI) from the WoS category. We excluded others, specifically the Emerging Sources Citation Index (ESCI) and Conference Proceedings Citation Index (CPCI). As a result, we obtained 492 articles. Finally, these articles were retained for further analysis.

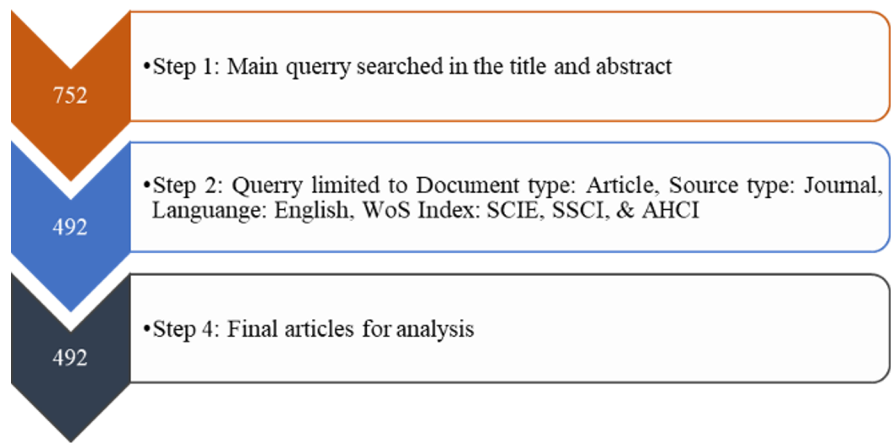


Fig. 1. Data Gathering Steps

### 3 Results and Discussion

#### 3.1 Findings

##### 3.1.1 Data Overview

The bibliometric analysis encompasses a comprehensive dataset from 1996 to 2023, covering 492 documents sourced from 213 distinct outlets. Over this period, the field has experienced a significant expansion, as reflected by an annual growth rate of 10.55%, demonstrating the increasing scholarly interest in the intersection of climate change and rural development.

The average age of the documents included in this dataset is 5.75 years, indicating a relatively recent body of research that continues to evolve rapidly. Each document has received an average of 22.19 citations, underscoring the relevance and impact of the publications within this research domain.

The dataset comprises 30,239 references, highlighting the extensive use of prior work in contributing to this field. The analysis also captures a broad range of thematic diversity, with 1,422 distinct Keywords Plus (ID) and 1,716 Author's Keywords (DE), reflecting the multidisciplinary nature of research in climate change and rural development.

##### 3.1.2 Development of Articles and Topics

The first research question is, how does the historical development of articles and topics affect the study of climate change and rural development? The question is answered by describing the scientific production of the articles. The annual scientific output on climate change and rural development has experienced significant fluctuations from 1996 to 2023 (Figure 2). In the early years (1996-2005), research output was relatively sparse, with some years having no publications. However, notable exceptions include 1999 and 2000, where individual papers achieved high impact, particularly in 2000, with a remarkable 144, indicating that the few studies published in that period had substantial academic influence. From 2006 onward, there was a gradual rise in the number of publications, reflecting growing interest in the subject. By 2013, the field saw a notable increase, with 26 publications in that year alone, maintaining a relatively strong citation impact.

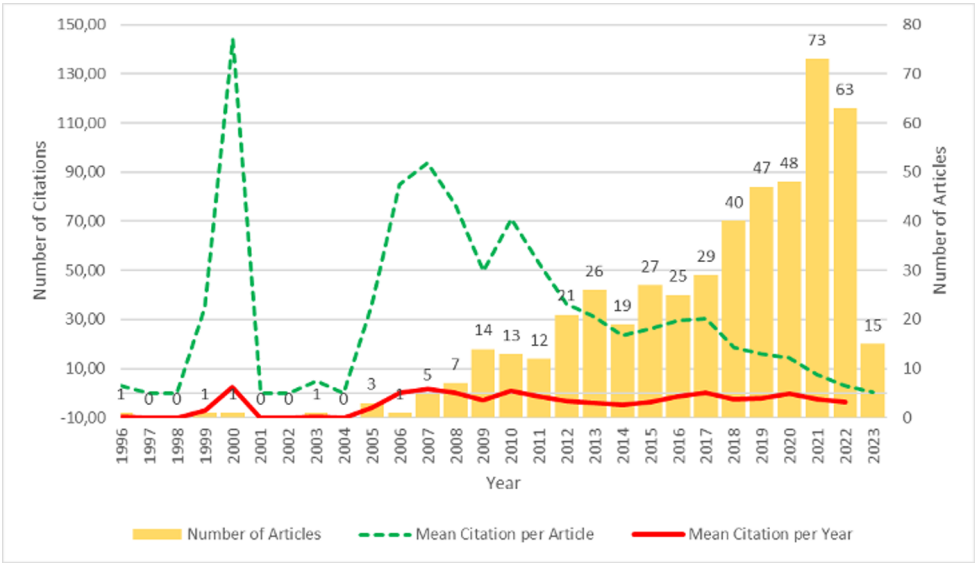


Fig. 2. Trends of Published Article

The period between 2014 and 2020 marked a phase of expansion, with the number of publications steadily increasing each year. In 2020, a total of 48 papers were published. However, the average citation per article began to show a slight decline compared to earlier years, indicating that while more research was being produced, the impact per article was somewhat diluted. Despite this, the consistent values demonstrate that the research maintained relevance over time. In 2021, the field peak in publication output, with 73 articles published, though the average number of citations per article declined further, suggesting a shift towards broader research coverage. In recent years (2022-2023), while the number of publications has remained substantial, there has been a notable reduction in citation impact, particularly in 2023, where the dropped significantly to 0.40, reflecting the recent nature of these works and the time lag typically observed before citation accumulation.

3.1.3 The Most Impactful Journal

The second research question is: who are the most impactful authors, journals, and countries? This question is answered in this section, followed by the next section below. Based on total citations, the most influential journals in climate change and rural development reveal a clear dominance of high-impact, multidisciplinary publications. Land Use Policy ranks first, with 502 citations across 24 articles published by Elsevier. This journal’s focus on land use and its intersection with environmental and socio-economic factors likely contributes to its high citation count, given the relevance of these topics to climate change and rural development. Second is World Development, with 438 citations from only 5 articles, also published by Elsevier, reflecting its status as a premier journal for global development issues, including climate impacts on rural areas.

Table 1. The Most Influential Journal

Rank	Sources	Citations	Article	Publisher
1	Land Use Policy	502	24	Elsevier
2	World Development	438	5	Elsevier
3	Global Environmental Change	433	5	Elsevier
4	Science	350	1	AAAS
5	Energy Policy	313	10	Elsevier
6	Sustainability	299	44	MDPI
7	Renewable and Sustainable Energy Review	296	3	Elsevier
8	Ecological Economics	263	6	Elsevier
9	Journal of Cleaner Production	255	10	Elsevier
10	Journal of Rural Studies	235	16	Elsevier

Note: Sorted by total citations

Following closely is Global Environmental Change, with 433 citations from 5 articles, highlighting the journal's role in disseminating critical research on climate change's broader environmental impacts. Notably, Science, a highly prestigious journal published by the AAAS, ranks fourth despite having only a single article in this dataset, receiving 350 citations, demonstrating the significant influence of individual papers published in this outlet. Energy Policy and Sustainability, with 313 and 299 citations, respectively, also feature prominently. Energy Policy’s 10 articles focus on energy transition issues. In contrast, Sustainability, published by MDPI with 44 articles, reflects its broad scope and open-access reach, making it widely cited despite its lower impact factor.

Other influential journals include Renewable and Sustainable Energy Review (296 citations), Ecological Economics (263 citations), and the Journal of Cleaner Production (255 citations), all published by Elsevier. These journals focus on renewable energy, ecological sustainability, and cleaner production methods, key areas at the intersection of climate change and rural development. The Journal of Rural Studies is rounding out the list, with 235 citations from 16 articles, underscoring its specific focus on rural issues, making it a critical outlet for this domain. Overall, Elsevier’s dominance in publishing key journals in this field is evident, reflecting its wide reach in environmental and development-related research. The most influential journal is summarized in Table 1.

3.1.4 The Most Impactful Authors

The ranking of the most influential authors in climate change and rural development reveals significant contributions from a select group of researchers (Table 2). Silva JS leads the list, whose two articles have collectively garnered 425 global citations, representing 0.4% of the total records in the dataset. This high citation count underscores Silva’s pivotal role in advancing research on the intersection of climate change and rural development. Following closely, Borma LS, with a single article, has accrued 377 citations, highlighting the profound impact of this particular study. In addition, Cardoso M, Castilla-Rubio JC, Nobre CA, and Sampaio G have one highly cited article with the same total of 377 citations, suggesting they may have collaborated on a critical piece of research that has significantly influenced the field.

This group of authors stands out for their contributions and considerable reach and relevance, as indicated by the high citation numbers despite the limited number of articles they have produced. The high impact of these authors' publications points to the importance of groundbreaking studies that resonate broadly across the academic community.

Table 2. The Most Influential Author

Rank	Author	Recs	Percent	TGCS
1	Silva JS	2	0.4	425
2	Borma LS	1	0.2	377
3	Cardoso M	1	0.2	377
4	Castilla-Rubio JC	1	0.2	377
5	Nobre CA	1	0.2	377
6	Sampaio G	1	0.2	377
7	Pingali P	2	0.4	320
8	Pretty J	2	0.4	320
9	Rabbinge R	2	0.4	320
10	Ravindranath NH	2	0.4	320

Note: Sorted by total global citations (TGCS)

3.1.5 The Most Impactful Countries

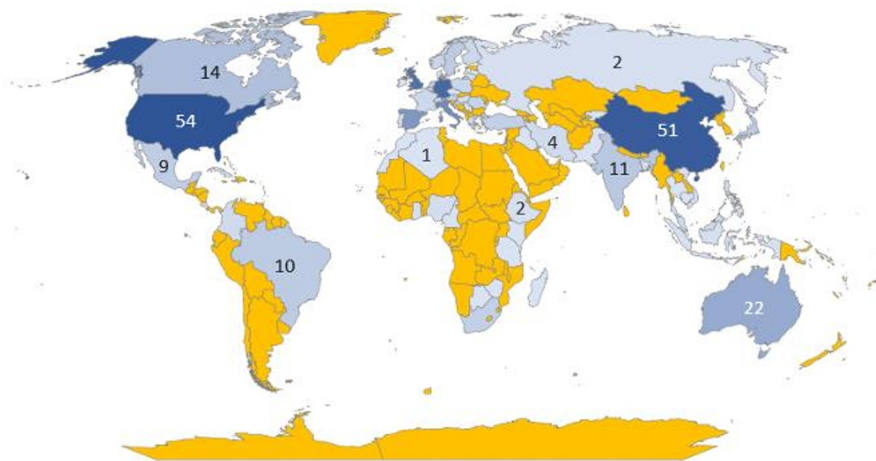
The analysis of the most influential countries in climate change and rural development highlights the dominant role of several major nations in shaping the research landscape. The United States leads with 54 published articles, reflecting its well-established academic infrastructure and broad interest in climate-related issues, particularly in rural development. The high output from the U.S. may also be attributed to the country's diverse geography, where climate change and rural livelihoods are key policy concerns. China follows closely

with 51 articles, demonstrating its growing investment in environmental research and rural development, especially as the country faces significant climate impacts on its vast rural populations.

With 46 publications, Germany ranks third, indicating its strong focus on sustainable development and its proactive stance on climate change mitigation domestically and internationally. The United Kingdom, with 43 articles, reflects its leading role in global environmental policy and research, particularly in rural development initiatives that address climate resilience. Italy and Spain are also prominent contributors, with 33 and 29 articles, respectively. These southern European countries, which are highly vulnerable to climate change, have focused much of their research on adapting rural agricultural systems to shifting climate conditions.

Australia, with 22 articles, highlights its unique research focus on rural development in the context of climate change, particularly in regions like the Outback and agricultural sectors that are highly susceptible to climate variability. Contributing to 14 articles, Canada focuses on the intersection of climate change and its impact on rural, indigenous, and agricultural communities, leveraging its vast rural areas as a central research focus. India and Brazil, with 11 and 10 articles, respectively, reflect the importance of rural development research in developing nations that face significant climate challenges. Both countries rely heavily on agriculture and rural economies, making research on climate resilience crucial to their national interests.

This distribution of research output indicates that countries with large rural populations and those most affected by climate change are at the forefront of scientific inquiry in this field. However, the leadership of the United States and China suggests a significant global interest in addressing these challenges.



**Fig. 3.** The Leading Countries in Published Articles

**3.1.6 The Most Impactful Articles**

Table 3 shows the most influential articles on climate change and rural development. At the top of the list is Klooster and Masera’s (2000) article titled "Community forest management in Mexico: carbon mitigation and biodiversity conservation through rural development," published in *Global Environmental Change*. This study explores the intersection of community-based forest management with carbon sequestration and biodiversity conservation, demonstrating how rural development efforts in Mexico contribute to global climate mitigation strategies. With 3 local citations, this article has garnered attention for its

integrative approach, addressing environmental and socio-economic outcomes in rural settings.

**Table 3.** The Most Influential Articles

Rank	Author (Year)	Title	Journal	Local Citations
1	Klooster & Masera (2000)	“Community forest management in Mexico: carbon mitigation and biodiversity conservation through rural development”	“Global Environmental Change, Vol. 10, No. 4, pp. 259-272”	3
2	Purohit & Michaelowa (2007)	“CDM potential of bagasse cogeneration in India”	“Energy Policy, Vol. 35, No. 10, pp. 4779-4798”	3
3	Carmenta et al. (2011)	“Understanding human-fire interactions in tropical forest regions: a case for interdisciplinary research across the natural and social sciences”	“Ecology & Society, Vol. 16, No. 1, pp 53-74”	3
4	Godar et al. (2012)	“Who is responsible for deforestation in the Amazon? A spatially explicit analysis along the Transamazon Highway in Brazil”	“Forest Ecology & Management, Vol. 267, No. 1, pp. 58-73”	3
5	Jamshed et al. (2020)	“A conceptual framework to understand the dynamics of rural–Urban linkages for rural flood vulnerability”	“Sustainability, Vol. 12, No. 7, 2894”	3
6	Purohit (2008)	“Small hydro power projects under clean development mechanism in India: A preliminary assessment”	“Energy Policy, Vol. 36, No. 6, pp. 2000-2015”	2
7	Franco et al. (2010)	“Assumptions in the European Union biofuels policy: frictions with experiences in Germany, Brazil and Mozambique”	“Journal of Peasant Studies, Vol 37, No. 4, 661-698”	2
8	Branca (2013)	“Capturing synergies between rural development and agricultural mitigation in Brazil”	“Land Use Policy, Vol. 30, No. 1, 507-518”	2
9	Grote (2014)	“Can we improve global food security? A socio-economic and political perspective”	“Food Security, Vol. 6, pp. 187-200”	2
10	Rantala et al. (2014)	“Multilevel Governance for Forests and Climate Change: Learning from Southern Mexico”	“Forests, Vol. 5, No. 12, pp. 3147-3168”	2

Another influential work is by Purohit and Michaelowa (2007), who in, Energy Policy, examine the potential for bagasse cogeneration in India under the Clean Development Mechanism (CDM). Their study shows how biomass energy, derived from sugarcane waste can contribute to rural electrification while reducing carbon emissions. The article has also received 3 local citations, highlighting its relevance to the energy policy discourse, particularly in developing countries with vast agricultural sectors like India. Similarly, Carmenta et al. (2011) published an interdisciplinary piece in Ecology & Society, titled



"Understanding human-fire interactions in tropical forest regions." This article advocates for a cross-disciplinary research approach examining how human activities influence fire regimes in tropical forests, emphasizing the need to integrate natural and social sciences to mitigate fire-related risks, especially in rural tropical regions.

Godar et al.'s (2012) article in *Forest Ecology & Management*, "Who is responsible for deforestation in the Amazon?" takes a spatially explicit approach to analyze deforestation drivers along the Transamazon Highway in Brazil. This work, receiving 3 local citations, is critical in pinpointing the socio-economic and political actors involved in environmental degradation, providing insights into the roles of land tenure, agricultural expansion, and infrastructure development in rural deforestation. Jamshed et al. (2020) in *Sustainability* contribute another highly cited work with their conceptual framework to understand rural-urban linkages in the context of flood vulnerability. This article focuses on the dynamic interactions between rural and urban areas concerning flood risk management, highlighting the necessity of integrated planning to mitigate rural flood impacts.

Further influential works include Purohit's (2008) exploration of small hydropower projects in India under the CDM in Energy Policy, which examines the potential of renewable energy to foster rural development while addressing climate change. Franco et al. (2010), in the *Journal of Peasant Studies*, critically assess the assumptions underlying the European Union's biofuels policy by comparing the experiences of Germany, Brazil, and Mozambique. This article draws attention to the socio-economic frictions that arise from biofuel policies and their impact on rural communities, providing a cross-national perspective on energy and agricultural policy.

Branca's (2013) article in *Land Use Policy* examines the synergies between rural development and agricultural mitigation in Brazil, offering critical insights into how agricultural mitigation measures can concurrently enhance rural economies. Grote's (2014) work on global food security, published in *Food Security*, addresses socio-economic and political perspectives on improving food security, a critical issue for rural development, especially under the pressures of climate change. Lastly, Rantala et al. (2014) in *Forests* examine multiple levels of governance concerning forests and climate change, utilising Southern Mexico as a case study to investigate governance frameworks that facilitate climate mitigation and rural development via sustainable forestry practices.

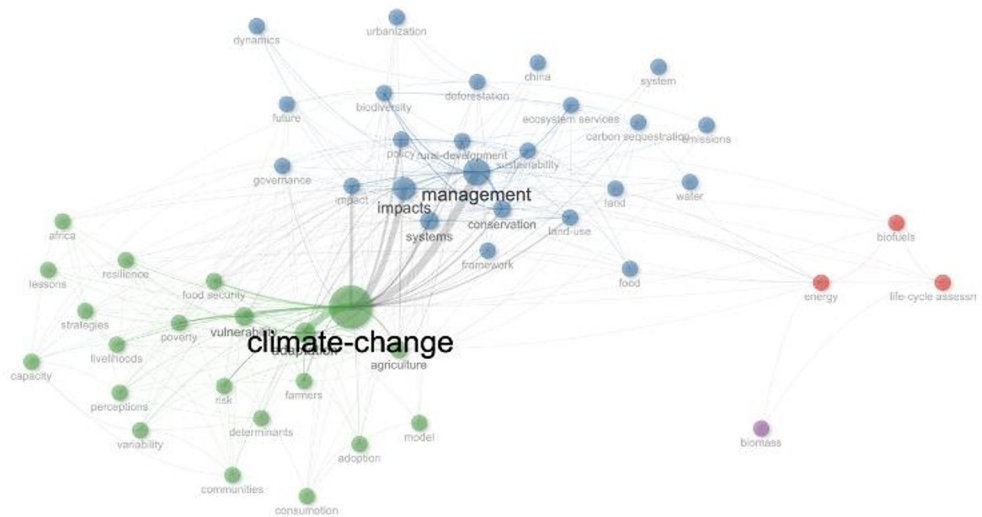
### **3.1.7 Key Topics**

The last research question is how intellectual discourse and relationships are developed within these two concepts. It is explored using key topic analysis. The co-occurrence analysis based on the Biblioshiny results reveals key topics clustered into distinct thematic groups, reflecting the interdisciplinary nature of research on climate change and rural development, as shown in Figure 4. Cluster 1 centers around energy-related topics, with a strong focus on terms such as "energy," "life-cycle assessment," and "biofuels." These results indicate significant research interest in sustainable energy solutions and their role in mitigating climate change impacts on rural areas. These topics are crucial for understanding how renewable energy technologies and assessments of their environmental impacts are integrated into rural development strategies.

Cluster 2 encompasses a broad range of interconnected topics, including "management," "conservation," "policy," "land-use," "sustainability," and "biodiversity." This cluster highlights the importance of land management and policy frameworks in promoting sustainable development. Issues such as biodiversity conservation, ecosystem services, and the governance of natural resources are central themes within this cluster, reflecting their critical role in rural sustainability efforts. The presence of terms like "emissions," "carbon sequestration," and "urbanization" indicates a focus on mitigating the environmental impacts of development, particularly climate change and land-use dynamics.

Cluster 3 focuses on adaptation strategies, vulnerability, and agriculture. Topics such as "climate change," "adaptation," "vulnerability," "agriculture," and "food security" dominate this cluster, pointing to research that addresses how rural communities, particularly farmers, adapt to climate variability and the risks posed by changing weather patterns. The inclusion of terms like "poverty," "livelihoods," and "resilience" underscores the socioeconomic dimensions of climate change adaptation in rural areas, with a strong emphasis on enhancing the capacity of communities to withstand environmental shocks. Terms like "farmers," "determinants," and "adoption" suggest an interest in the factors that influence rural populations' adoption of adaptive practices and technologies.

Lastly, Cluster 4 focuses more on specific resources and technologies, with "biomass" as a key node. These findings emphasize the role of biomass energy in rural areas, reflecting ongoing research into the use of agricultural and forest residues for energy production and its potential to support climate change mitigation and rural livelihoods.



**Fig. 4.** Key Topics

### 3.1.8 Future Research Avenue

Based on the findings of this bibliometric review, several key areas for future research on climate change and rural development have emerged. First, there is a need for more region-specific studies, particularly in under-represented regions such as Sub-Saharan Africa and Southeast Asia, where rural communities are highly vulnerable to climate change, but research coverage remains limited. Future research should also adopt interdisciplinary approaches, integrating insights from economics, sociology, and environmental science to holistically address the complex interactions between rural development and climate change. Additionally, more longitudinal studies are needed to track the long-term impacts of climate adaptation strategies on rural livelihoods. Researchers should also explore the role of indigenous knowledge systems and local governance in shaping successful climate resilience strategies, as these are critical for tailoring interventions to local contexts. Finally, there is a growing need to investigate the effectiveness of policy interventions to balance rural development goals with climate mitigation and adaptation efforts. Addressing these gaps will enhance the academic discourse and provide more actionable insights for policymakers and practitioners working in climate-sensitive rural regions.

### 3.2 Discussion

The findings of this bibliometric analysis reveal several important trends and thematic areas in research at the intersection of climate change and rural development. The steady increase in annual scientific production since 1996 highlights the growing recognition of climate change as a critical factor influencing rural areas globally. This increase is particularly pronounced from 2010 onward, coinciding with heightened international attention to climate policy, such as the Paris Agreement and the Sustainable Development Goals. The surge in research output in recent years reflects the urgency of addressing the vulnerabilities rural communities face, particularly regarding food security, agriculture, and livelihoods. While the recent decline in citation impact for individual articles suggests a shift towards broader coverage of the topic, the overall relevance of the field remains strong.

The analysis of the most influential journals underscores the interdisciplinary nature of this research area. Journals such as *Land Use Policy*, *World Development*, and *Global Environmental Change* rank highly due to their focus on land use, environmental sustainability, and development issues, which are critical to understanding climate change impacts on rural areas. The dominance of Elsevier-published journals in the top rankings suggests that this publisher plays a central role in disseminating research in this domain. The presence of open-access journals like *Sustainability* further emphasizes the importance of making research accessible to a wider audience, particularly in developing regions where rural communities are most affected by climate change. This mix of high-impact and open-access journals indicates a balance between academic influence and broader dissemination.

The co-occurrence analysis of key topics reveals several major thematic clusters that dominate the research landscape. The cluster focusing on energy, including terms like "biofuels," "life-cycle assessment," and "renewable energy," highlights the importance of sustainable energy solutions in rural development. The emphasis on bioenergy, particularly in countries like India and Brazil, aligns with efforts to reduce rural dependence on fossil fuels while mitigating climate change. Similarly, the cluster related to land use, conservation, and biodiversity reflects the critical role of natural resource management in rural areas [31,32]. These findings suggest a strong research focus on how rural communities can balance economic development with environmental conservation, particularly in regions facing deforestation and habitat loss.

The third major thematic cluster centers on climate change adaptation, vulnerability, and resilience, particularly in agriculture. This cluster reflects the centrality of agriculture in rural livelihoods and the severe impact that climate variability has on food security [33]. Studies focusing on adaptation strategies, such as improving agricultural resilience or diversifying livelihoods, are critical in regions heavily reliant on farming. The frequent appearance of terms like "poverty," "food security," and "livelihoods" indicates a focus on the socio-economic dimensions of climate change, emphasizing the need for inclusive development policies that protect the most vulnerable rural populations. Research on farmers' adoption of new technologies and practices in response to climate risks is another significant area of focus, pointing to the importance of understanding local contexts and capacities in adaptation efforts.

The analysis of influential authors and countries highlights the global nature of this research field, with contributions from both developed and developing nations. The United States and China are the two most prominent countries in research output, reflecting their substantial investments in climate-related research and rural development. However, significant contributions from countries like Brazil, India, and Australia indicate that research is also being driven by nations directly confronting the challenges of climate change in rural areas. The diversity of geographical contributions suggests that this field is informed by various local contexts, each contributing unique insights into the global issue of climate change [34].

The most influential articles in this field emphasize the interdisciplinary approach necessary to address climate change in rural development. Studies like Klooster and Masera's (2000) work on community forest management in Mexico show how rural development can contribute to carbon mitigation and biodiversity conservation, highlighting the potential for synergistic outcomes in climate and rural policies. Similarly, research on biofuels, small-scale hydroelectric power, and renewable energy solutions emphasizes the role of clean energy in fostering sustainable rural economies. The focus on adaptation strategies, particularly in agriculture, also points to the importance of resilience in rural communities as they face increasingly unpredictable climate conditions.

In conclusion, the findings of this bibliometric review provide a comprehensive overview of the research landscape at the intersection of climate change and rural development. The increasing volume of research, combined with the diversity of topics covered, suggests that this field will continue to grow in importance as rural areas face mounting climate challenges. Future research should continue to explore the socio-economic and policy dimensions of climate change adaptation in rural areas, particularly in the context of food security and poverty reduction. There is also a need for more research into innovative energy solutions that can both reduce emissions and foster rural economic development. Finally, greater attention should be paid to the governance and institutional frameworks that support sustainable rural development in the face of climate change.

### ***3.2.1 Theoretical and Practical Implications***

This bibliometric review's findings offer theoretical and practical implications for the study of climate change and rural development. Theoretically, the review provides a comprehensive overview of the intellectual landscape, highlighting key authors, journals, and countries that have shaped the discourse. This helps identify prevailing theories and conceptual frameworks that have influenced the understanding of climate change and rural development. Additionally, the review points to emerging areas of research that require further theoretical exploration, particularly in underrepresented regions and interdisciplinary approaches.

From a practical perspective, the insights gained from the review can inform policy and decision-making processes. By identifying the most impactful studies and regions where climate change adaptation and mitigation strategies have been successful, this review offers valuable guidance for developing locally tailored policies. Policymakers can leverage these findings to prioritize areas for intervention, foster international collaboration, and promote best practices in rural development that are responsive to climate change. Moreover, the review's findings can guide future research agendas, ensuring that gaps in the literature, particularly in vulnerable rural communities, are addressed.

### ***3.2.2 Limitations of the Bibliometric Review***

While this bibliometric review provides valuable insights into the intersection of climate change and rural development, several limitations should be acknowledged. First, our analysis is limited to studies indexed in specific databases, primarily Web of Science, which may have excluded relevant research published in other databases or less widely indexed journals. This could lead to a geographical or disciplinary bias in the results. Second, the selection of keywords, though carefully chosen, may have influenced the scope of the review, as different terminologies or variations in phrasing across studies could result in the omission of pertinent literature. Additionally, despite our efforts to capture a wide temporal range, the analysis may not fully reflect rapidly emerging research in the field. These limitations highlight the need for caution in interpreting the findings, and they suggest that future studies could benefit from expanding the database sources and refining keyword strategies.

## 4 Conclusion

This bibliometric review highlights the growing body of research at the intersection of climate change and rural development, emphasizing key themes such as sustainable energy, land-use management, climate change adaptation, and the socio-economic impacts on rural communities. The increasing scientific production, particularly in the past decade, reflects the global urgency to address climate-related vulnerabilities in rural areas. Influential research is concentrated in high-impact journals, with significant contributions from countries like the United States, China, and Brazil, indicating the widespread concern across developed and developing regions. As climate challenges intensify, future research should focus on innovative adaptation strategies, governance frameworks, and sustainable technologies that support rural livelihoods and promote environmental sustainability.

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