

**Original Article**



# Literature Mining and Analysis of Plant Carbon Sink Studies: Discovering Carbon Sequestration Potential and Ecological Effects

Yuhe Zhu<sup>1</sup>, Guandi He<sup>1,2,3,\*</sup>, Zhuoyan Zhong<sup>1</sup>, Ren Yang<sup>1</sup>, Haojie Ni<sup>1</sup>, Tengbing He<sup>1</sup>, Siew Ling Lee<sup>2,3,\*\*</sup>

<sup>1</sup>College of Agriculture, Guizhou University, Guiyang 550025, China

<sup>2</sup>Department of Chemistry, Faculty of Science, Universiti Teknologi Malaysia, UTM Johor Bahru 81310, Johor, Malaysia

<sup>3</sup>Centre for Sustainable Nanomaterials, Universiti Teknologi Malaysia, UTM Johor Bahru 81310, Johor, Malaysia

\*Corresponding Author at: College of Agriculture, Guizhou University, Guiyang 550025, China.

\*\*Corresponding Author at: Department of Chemistry, Faculty of Science, Universiti Teknologi Malaysia, UTM Johor Bahru 81310, Johor, Malaysia.

\*Corresponding Author: Guandi He, Siew Ling Lee

## Abstract:

There has been a growing interest in studying the potential of plant carbon sequestration, and to better understand this field, a bibliometric and visualization analysis was conducted using various tools such as CiteSpace, VOSviewer, HistCite, GraphPad Prism, and Bibliometric. This analysis covered literature published from 2008 to 2022, revealing global trends, the distribution of research strengths, and hotspots within the field. The results indicate a steady increase in publications on plant carbon sequestration potential during this period, with the United States and China leading in terms of national publications, accounting for 38.12% of total publications. Close collaborations were also observed among the top ten countries, institutions, and researchers based on publication volume ranking. Research hotspots within this field include thermodynamic analysis and global warming trends. To effectively promote and protect plant communities, targeted measures are required, such as strengthening regulation, promoting afforestation, and undertaking ecological restoration. By adopting a combination of measures, we can effectively achieve the goal of plant carbon sequestration and mitigate the impact of global climate change.

**Keywords:** carbon sequestration; potential; plants; web of Science; bibliometric; climate change; greenhouse effect; carbon dioxide

## 1. Introduction

Climate change has become a global challenge of unprecedented scale, with broad implications for both human culture and the environment. The issue of global warming, in particular, has sparked widespread concern across the international community [1-3]. Burning of fossil fuels releases man-made greenhouse gases, primarily CO<sub>2</sub>, into the atmosphere leading to an alarming increase in

global temperatures [4,5]. This phenomenon of global warming is a crucial component of climate change that poses a significant threat to both humans and the natural environment [6]. This phenomenon poses a serious threat to both the environment and humans, intensifying weather events such as floods, droughts, dust storms, and sandstorms [7], leading to sea level rise that

endangers coastal cities and islands [8], and triggering ecosystem instability that threatens species extinction and ecosystem collapse [9]. Furthermore, evidence shows that climate change is dramatically impacting global food supplies and prices, posing additional challenges to agricultural production in the future [10,11]. Comprehensive environmental protection policies must incorporate actions aimed at reducing emissions in this sector because agricultural greenhouse gas emissions considerably contribute to global warming [12]. The impacts of climate change extend to disease transmission, human health, and global socio-economic stability [13,14]. As global warming continues to pose significant threats, it is critical for us to take proactive measures towards mitigation and adaptation. One of the most direct and fundamental solutions to combat the severe impacts of climate change is reducing greenhouse gas emissions [15].

Large-scale afforestation has been implemented as a means to mitigate the disastrous effects of climate change [16]. Among the different types of vegetation, mangroves have been found to be particularly efficient at carbon storage [17]. Research has shown that plant carbon sequestration is a viable and cost-effective means of reducing carbon emissions. Furthermore, bamboo in forest ecosystems can be managed sustainably to create long-lasting carbon sinks. Urban green spaces have also emerged as a solution for offsetting CO<sub>2</sub> emissions and mitigating the effects of urban climate change, while planting herbaceous plants can help achieve rapid carbon sequestration and reduce the ecological impact [18-21]. These findings highlight the potential of various types of vegetation to contribute to carbon reduction efforts and underscore the importance of implementing sustainable land-use management practices for creating a more resilient and sustainable future.

Through the process of photosynthesis, plants absorb carbon dioxide from the atmosphere and convert it into organic matter which is stored within their tissues - this process is known as plant carbon sequestration [22-24]. During photosynthesis, plants utilize carbon dioxide as one of their raw materials, and the organic matter produced is then stored within their tissues. After the plant dies, this stored organic matter can effectively fix carbon dioxide into the soil for extended periods, thus reducing its concentration in the air - highlighting

the critical role that plant carbon sequestration plays in mitigating greenhouse gas accumulation and restoring soil quality, while maintaining ecological balance. Additionally, plants release oxygen, which helps improve air quality and is beneficial for human health [25].

In essence, climate change has a profound impact on plant photosynthesis, carbon sequestration, and overall ecosystem health. The process of plant carbon sequestration, which involves converting CO<sub>2</sub> into organic matter, is a significant measure to combat global climate change. Therefore, it is necessary to adopt various strategies to enhance the effectiveness of plant carbon sequestration in response to climate change, including improving plant light energy utilization, soil quality, and promoting plant diversity management.

Bibliometrics refers to a set of methods and techniques used to measure or study texts and information, which can be applied to analyze the body of knowledge across various disciplines [26]. Visualization technology can present large amounts of data through graphs and charts, etc., thus visually displaying research results and trends [27]. In the era of big data, the focus on visualization techniques that can process and analyze data has increased [28]. By using bibliometric analysis in conjunction with web visualization software [29], this paper mines and analyzes the relevant literature in the field of plant carbon sequestration research to sort out existing research, determine its current status, reveal existing problems and frontier research directions, and explore the contribution of plant communities to carbon sequestration.

## 2. Formation and Mechanism of Plant Carbon Sink

### 2.1. The process of carbon dioxide uptake by plants

Through the processes of photosynthesis and root uptake, plants play a vital role in mitigating global climate change by transforming atmospheric carbon dioxide into organic matter and simultaneously releasing oxygen [30,31]. During photosynthesis, chlorophyll absorbs energy from sunlight, which is then used to convert carbon dioxide and water into organic molecules, such as glucose. In this process, oxygen is also released into the atmosphere. The root systems of plants and microorganisms form a complex ecosystem in which dead plant and animal tissues are broken down, releasing organic matter and gases, including carbon dioxide, which is

absorbed by the plant's root system and converted into organic matter to provide energy for plant growth [32,33].

Plant photosynthesis and carbon sequestration are significantly influenced by the concentration of carbon dioxide in the atmosphere. As CO<sub>2</sub> concentration increases, the photosynthetic rate of plants also increases, allowing plants to use more CO<sub>2</sub> for photosynthesis and convert it into greater amounts of organic matter [31]. Thus, the ability of plants to sequester carbon also increases. While the concentration of carbon dioxide in the atmosphere is crucial to plant photosynthesis and carbon sequestration, it's important to note that excessively high levels of CO<sub>2</sub> can negatively affect plant health. For instance, high CO<sub>2</sub> concentrations may reduce the nutrient absorption capabilities of roots and hinder leaf transpiration [34]. Therefore, it is important to strike a balance between increased carbon sequestration and maintaining the overall health of plant ecosystems in response to changes in CO<sub>2</sub> concentration caused by climate change.

## 2.2. Mechanism of Carbon Sequestration and Its Ecological Effects

The two most significant types of carbon storage are organic carbon storage in plants and soil organic carbon storage [35]. Plants utilize photosynthesis to transform carbon dioxide into various forms of organic matter, such as glucose and amyloplasts, which can be used or accumulate within the plant. When plants die, their residues, roots, and fallen leaves enter the soil and become a source of soil organic carbon. Furthermore, soil microorganisms decompose organic matter, converting some of it into carbon dioxide and water, with the remaining carbon being stored in their own bodies as organic matter.

Carbon sequestration has ecological effects, including reducing atmospheric carbon dioxide content [36], improving soil quality [37], conserving biodiversity [38], and decreasing greenhouse gas emissions [39]. Carbon sequestration technology converts carbon dioxide in the atmosphere into organic matter, thereby reducing carbon dioxide concentrations and mitigating global warming. Additionally, some carbon sequestration technologies can improve soil physical, chemical, and biological properties, promote plant growth and development, and increase crop yields by increasing the organic

matter content of the soil. Carbon sequestration also improves land use efficiency, prevents land degradation and desertification, maintains ecological balance, and protects biodiversity by increasing land cover and water retention. Finally, carbon sequestration can reduce greenhouse gas emissions from human activities, which is crucial for managing global climate change. Therefore, carbon sequestration can not only mitigate climate change but also yield positive impacts on ecosystems and human societies.

## 3. Data Sources and Research Methods

### 3.1. Data Sources

The data used in this study were sourced from the Web of Science (WoS) Core Collection - the world's most extensive and comprehensive information resource that contains ten sub-datasets frequently utilized in academic research across over 271 WoS categories [40,41]. To conduct the search, the keywords "carbon sequestration" or "carbon storage," "potential," and "plants" were employed. Literature types considered included review papers and data papers without limitations on language, spanning from 2008 to 2022.

### 3.2. Research Methods

To conduct this study, in order to examine the annual publishing volume of the literature collected from the database, the WoS analysis search results tool was employed. A variety of analysis tools were then employed, including Bibliometric, CiteSpace, Excel, Gephi, GraphPad Prism, HistCite, and VOSviewer, to analyze and visualize the literature on plant carbon sequestration potential studies in the WoS database from 2008 to 2022.

The methods used in this paper included analyzing the annual publication volume to understand both domestic and international interest in this field of research. The identification of research hotspots in this area was facilitated by analyzing the keywords used, while mapping the collaborative networks among leading countries, institutions, authors, journals, and keywords employing VOSviewer enabled us to analyze the primary research forces in this direction. CiteSpace was used to analyze burst words in the literature over the last five years as well as speculate on future research hotspots. The resulting data were visualized to provide insights into the field of plant carbon sequestration potential

studies. Figure 1 illustrates the reasoning behind this study's bibliometric analysis.

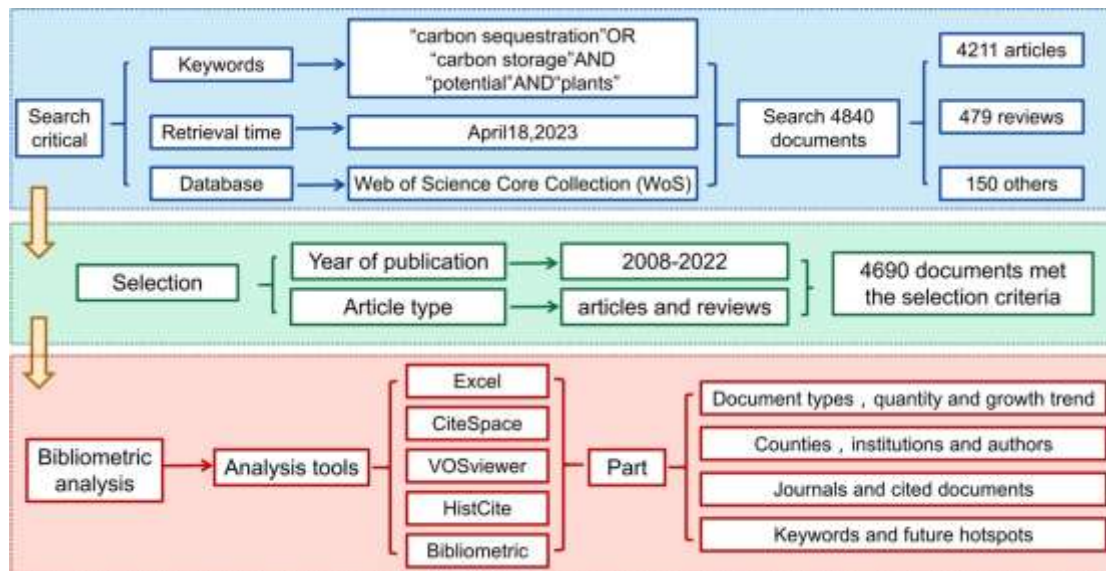


Figure 1. Bibliometric analysis logic

#### 4. Analysis of Results

##### 4.1. Citation Analysis

The bibliometric method of “citation analysis” is utilized to objectively evaluate citation trends in the literature system [42]. This method has become widely adopted for assessing the impact of journals, articles, or authors on their respective fields [43].

As depicted in Figure 2, a total of 4,840 papers were retrieved through keyword search, including 4,211 Articles, accounting for 87.00% of all papers, 479 Review Articles, accounting for 9.90% of the total, and 150 papers of other types, accounting for 3.10% of the total. This study focused on analyzing Articles and Review Article papers, and a total of 4,690 papers were retrieved for literature analysis.

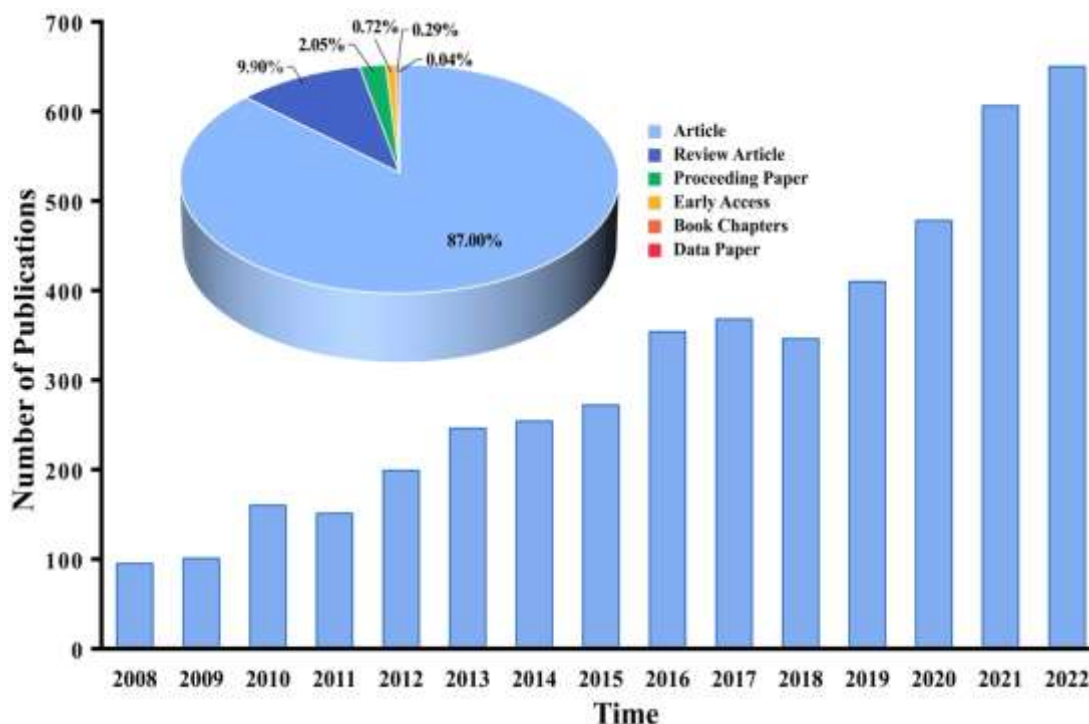


Figure 2. Types and publication volumes of plant carbon sequestration articles in the WoS core collection, 2008~2022.

## 4.2. Number of Articles Issued Per Year

To examine the evolution of plant carbon fixation potential research over the past 15 years, we conducted a search in the WoS Core Collection database, resulting in 4,690 articles on plant carbon sequestration potential. The trend reveals a consistent increase in publications, with only 95 articles published in 2008 and 650 articles published in 2022, indicating a growing interest in research on plant carbon sequestration potential and overall potential for further research and development in this domain.

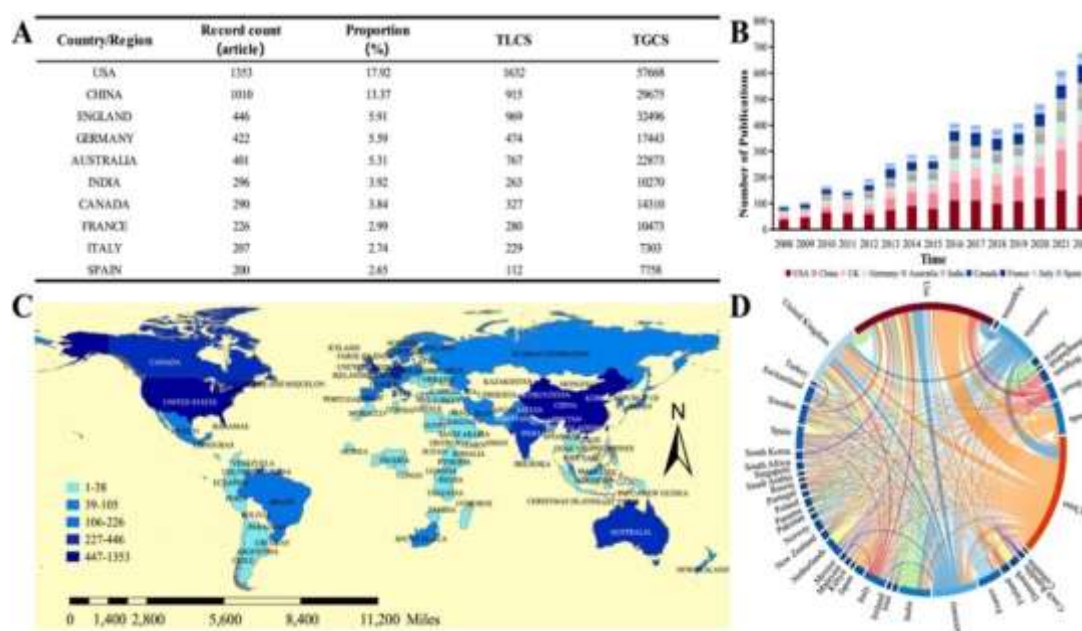
## 4.3. Country of Issue Analysis

The presence of national publications in the WoS database has enabled researchers to examine characteristics related to global research productivity [44]. Our WoS search revealed that scientists from 131 countries have conducted research on carbon sequestration in plants (for details see Supplementary Table S1). Figure 3A indicates the top ten countries in terms of the number of publications related to plant carbon sequestration published between 2008 and 2022. These countries include the USA, China, UK, Germany, Australia, India, Canada, France, Italy, and Spain, collectively responsible for 64.23% of the total publications in this field. The notable difference between the publications of the top two countries, the USA and China, and the third-ranked

country, Germany, highlights a more significant focus on plant carbon sequestration and storage research in these two countries.

From Figure 3B, we can see that the US, which has the most number of publications, has consistently outperformed other countries since 2008, with a slow but steady upward trend in publication numbers until reaching its peak in 2021. China, the second-ranked country in terms of the number of articles published, displays a steep upward trend in publication numbers from 2012 to 2022, with the most significant number of publications in 2021 and 2022, following closely behind the US. The ranking of the top-publishing countries has shifted from 2008 to 2021, with the exception of China and the US, but the number of publications within each ranked country has consistently risen. These findings suggest a growing interest in plant carbon sequestration potential globally.

The Total Local Citation Score (TLCS) and Total Global Citation Score (TGCS) indices provide a more accurate reflection of academic impact for each country, as presented in the table. The US has a notably higher TLCS and TGCS than the next highest-ranked countries. Although China has more than twice as many publications as the UK, its TLCS and TGCS are not as high as those of the UK. Thus, China should focus on publishing high-quality papers in the future to improve the overall academic impact of its research output.



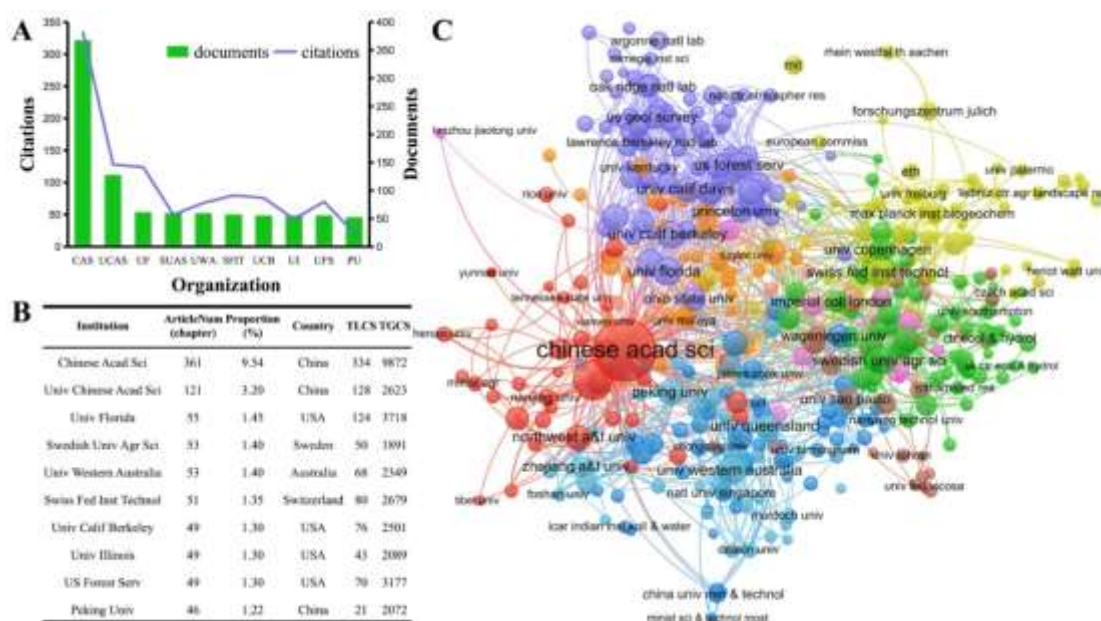
**Figure 3. Analysis of national issuances. A: Top 10 countries in plant carbon sequestration. B: Some countries published articles from 2008 to 2022. C: Distribution of the volume of articles issued in different countries. D: Inter-country cooperation.**

#### 4.4. Analysis of Issuing Institutions

Out of the 4,690 publications retrieved, 4559 institutions contributed (see Table S2 in Supplementary Materials). Figure 4A and 4B reveal the top ten institutions with the most publications from 2008 to 2022. VOSviewer analysis was employed to visualize the collaboration among these institutions in Figure 4C, where the circle's size corresponds to the number of publications, and a total of 5,720 connected lines were observed. The thickness of the line between institutions in the visualization indicates the extent of their collaboration, and the color of the circle highlights institutions working closely together in the same cluster.

The Chinese Academy of Sciences (CAS) is the most productive institution with 361 papers, followed by the University of Chinese Academy of Sciences (UCAS) with 121 papers, the

University of Florida (UF) with 55 papers, the Swedish University of Agricultural Sciences (SUAS) and the University of Western Australia (UWA), both with 53 papers. The Swiss Federal Institute of Technology in Zurich (SFIT), University of California Berkeley (UCB), University of Illinois (UI), United States Forest Service (UFS), and Peking University (PU) are the remaining five most productive institutions. Notably, three of the top five most productive institutions are located in France, while Switzerland and Germany host the other two. Additionally, the analysis suggests a relatively close collaboration and communication among the institutions, with the more productive institutions tending to have closer collaborations with other institutions.



**Figure 4.** Analysis of research institutions on plant carbon sequestration potential, 2008-2022. **A:** The total number of articles and citations for the top ten institutions with the most articles published. **B:** The top ten institutions in terms of the number of articles issued. **C:** Inter-institutional cooperation using circle sizes that represent different institutions and proportional to the amount of publication. Connections represent partnerships between different institutions, with color variations indicating different clusters.

#### 4.5. Lead Author Analysis

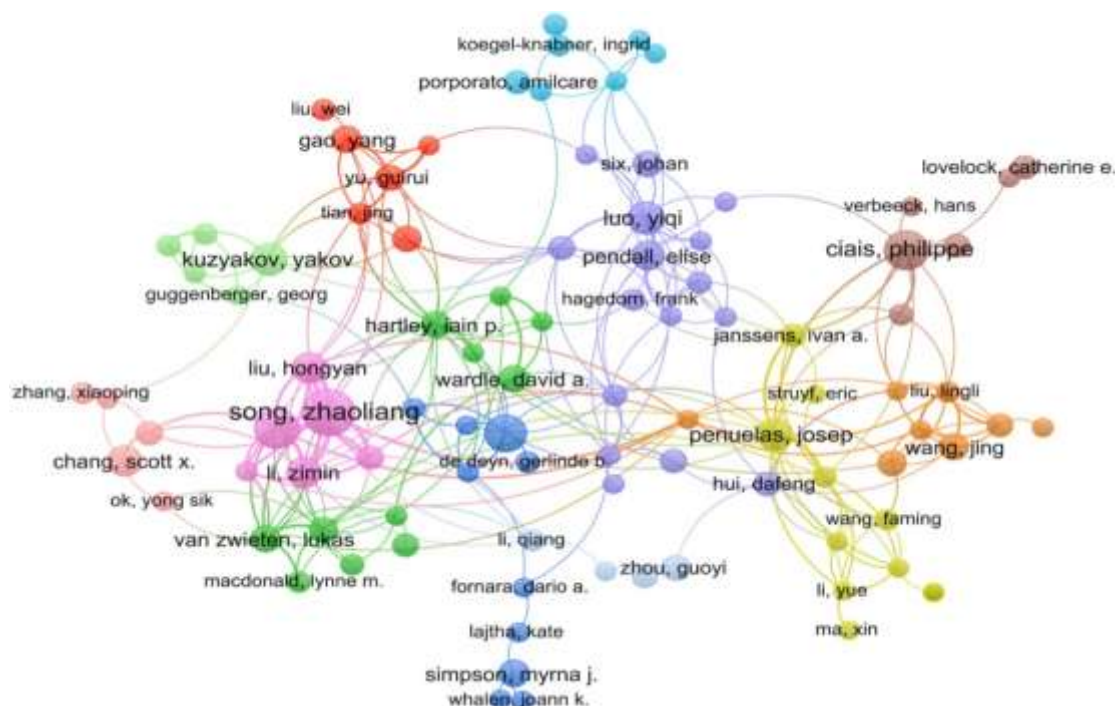
Collaboration can have a positive impact on research productivity [45]. Collaborative network mapping among authors provides insights into the power of researchers' contributions to a field and

their collaborative relationships. To identify the most productive authors in the field of plant carbon sequestration potential research, we ranked them according to their total publications from 2008 to 2022. A word search in the WoS Core Database yielded a total of 18,651 authors involved in articles

included in the database (see Supplementary Table S4 for complete information).

Importing the data into VOSviewer yielded 470 concatenations, with the concatenations representing collaborative relationships between authors. Figure 5 shows the relationship map of the author collaboration co-occurrence network. Several studies have indicated that multi-author collaboration can significantly impact citation frequency compared to single-author publications

[46]. Additionally, the geographical distribution of authors can influence social networks and the citation of their publications, with authors receiving more citations when their collaborators come from a more extensive geographic coverage area [47]. From Figure 5, it can be seen that there are cooperative relationships among individual authors, although not very close. Therefore, strengthening the cooperative relationship between authors could be beneficial.



**Figure 5. Author Co-occurrence Network Relationship Graph. In the analysis of authors on plant carbon sequestration potential, the circle represents the author, with size indicating the number of articles published and proportional to the influence. Collaboration between authors is denoted by wiring, and different colors represent different clusters.**

#### 4.6. Analysis of Journal Sources

Authors inevitably use pertinent literature to bolster their claims and examine sources when composing their papers because scientific literature is interconnected and not separate from one another. Cross-referencing scientific literature highlights the interconnectivity between research studies, while citing scientific literature indicates the progress and application of scientific knowledge, as well as the evolution of science [48]. The journal in which a research article is published has been found to be an important factor in the citation effect [47].

The literature related to plant carbon sequestration potential comprises 905 journals, as recorded in the WoS Core Collection (detailed journal information

is provided in Supplementary Table S3). Table 1 highlights the top ten relevant journals that have published articles on this topic. Overall, these 10 journals published a total of 941 articles, representing 20.06% of the 4,690 publications included in our sample. Science of the Total Environment, based in the Netherlands, is the highest-ranking journal in terms of the number of articles published with 133 publications, and an impressive Impact Factor (IF) of 10.75, placing it at the top of the list. This is followed by the International Journal of Greenhouse Gas Control in the UK, which published 127 articles with an IF value of 4.40, and in third place, Global Change Biology published 107 articles with an IF value of 13.21. In fourth place is Soil Biology and

Biochemistry in the UK. The range of the top ten published journals draws on several research areas and topics, including environmental sciences, agroforestry sciences, agricultural and biological

sciences, and engineering and technology. Thus, the articles published in these journals reflect the diversity, richness, and multidisciplinary nature of research on plant carbon sequestration potential.

**Table 1. Top 10 journals for research on carbon sequestration potential of plants.**

Institution	Country	Article Num (Article)	Proporti on (%)	Impact Factor(2021)
SCIENCE OF THE TOTAL ENVIRONMENT	Netherlands	133	2.84	10.75
INTERNATIONAL JOURNAL OF GREENHOUSE GAS CONTROL	England	127	2.71	4.40
GLOBAL CHANGE BIOLOGY	England	107	2.28	13.21
SOIL BIOLOGY BIOCHEMISTRY	England	95	2.03	8.55
JOURNAL OF CLEANER PRODUCTION	USA	93	1.98	11.07
APPLIED ENERGY	England	91	1.94	11.45
AGRICULTURE ECOSYSTEMS ENVIRONMENT	Netherlands	83	1.77	6.58
FOREST ECOLOGY AND MANAGEMENT	Netherlands	80	1.71	4.38
PLANT AND SOIL	Netherlands	68	1.45	4.99
ENERGIES	Switzerland	64	1.37	3.25

#### 4.7. Keyword Analysis

To determine the popular subjects covered in the bibliometric analysis, a keyword analysis was conducted [49]. A network diagram analysis of the keywords used in the papers published on plant carbon sequestration provides insight into research focus, hotspots, and development trends within this field. Table 2 highlights the top 20 most frequently

used keywords in the selected 4,690 papers (details are provided in Supplementary Table S5). It is noteworthy that the common themes in most papers are “carbon sequestration,” “nitrogen,” “biomass,” “carbon,” and “climate change.” This indicates that the impact of carbon and nitrogen accumulation on climate change remains a hot topic of research in this field.

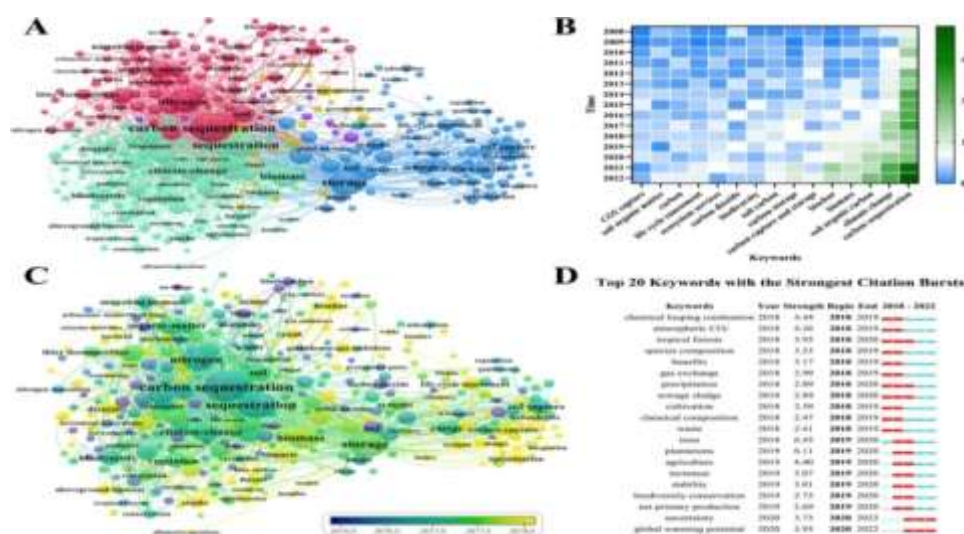
**Table 2. WoS core ensemble 2008–2022 plant carbon sequestration row Top20 keywords. Understanding the most popular keywords in each period**

Numbering	Keyword	Occurrences	Numbering	Keyword	Occurrences
1	carbon sequestration	749	11	decomposition	242
2	nitrogen	464	12	plant	241
3	biomass	432	13	CO <sub>2</sub> capture	227
4	carbon	386	14	carbon storage	220
5	climate-change	334	15	energy	212
6	dynamics	327	16	biodiversity	203
7	growth	311	17	emissions	200
8	management	283	18	forest	200
9	organic-matter	277	19	organic-carbon	199
10	climate change	257	20	CO <sub>2</sub>	177

can show the hotspots of research in this field, as shown in Figures 6A, B, and C. Between 2008 and 2022, "carbon sequestration" has been the most frequently appeared keyword, indicating that it's a hot topic in this field. The frequency of keywords such as "biomass" and "biochar" gradually increased, indicating that these research fields are gaining more attention from scientists.

To gain a clearer picture of bursts in the field of plant carbon sequestration and to speculate on future research hotspots, CiteSpace's Bursts feature can be used to analyze the bursts, which vary from 2018 to 2022, as seen in Figure 6D. In 2018-2019, scientists focused more on "chemical fuels,"

"tropical forests," "species composition," "gas exchange," among others. In 2019-2020, "agroforestry," "deforestation," "pyrolysis," and "net primary production" were the hot topics. According to the figure, it can be inferred that researchers in this field have conducted numerous experiments and investigations from various aspects in the past three years, and the research on plant carbon sequestration has started exploring different perspectives. The latest research hotspots are "thermodynamic analysis," "uncertainty," and "global warming potential." It is expected that future research will follow the current hotspots and conduct more in-depth experiments.



**Figure 6. Keyword analysis of plant carbon sequestration in the WoS core collection. A: Keyword network graph. B: Number of occurrences of some keywords. C: Keyword changes in different periods. D: Burst words at different stages from 2018 to 2022. Notes: In A and B, nodes represent keywords with their size indicating the frequency they appear. The keyword parameter threshold is set at 25, meaning that a keyword must appear at least 25 times to be included. Different colors in A represent different clusters, while different colors in B represent the timeline of when keywords appear. Note that this figure only shows 1,000 lines out of 21,117 connections. In D, strength denotes the frequency with which the keyword appears, with higher values indicating more frequent usage. The year represents the starting point in time, with the blue line representing the timeline from 2018 to 2022, and the red line indicates the time interval between the rise and fall years of the keyword.**

## 5. Discussion

With the development of industry, more and more greenhouse gases are emitted into the atmosphere, and along with the increasing global warming, the carbon cycle has attracted the attention of many scientists and has become one of the focal points of climate change [50]. Fixing carbon has become a question for researchers to ponder, and some studies have shown that plants can be used to sequester carbon [51-55]. Bibliometrics can provide

an accurate understanding of the research context and make predictions for future research directions.

In this paper, we employ bibliometric analysis and visualization to summarize nearly 15 years of research on plant carbon sequestration potential from 2008 to 2022. Using CiteSpace, VOSviewer, History of Cite (HistCite), Bibliometric, and GraphPad Prism, we conducted a bibliometric analysis of 4,690 papers on plant carbon sequestration potential in the Core Collection of the Web of Science (WoS) database. Our analysis

covered 133 countries, 4,078 institutions, 18,651 authors, and 905 journals to understand the current and future trends in plant carbon sequestration potential research. The objective of our study is to provide a reference for researchers in this field, and to understand the current status and future trends of plant carbon sequestration potential research.

The carbon sequestration potential of plants has been a topic of research for several decades. The first article in the WoS database on this topic was published in 1995 by Norby *et al.* in *THE NEW PHYTOLOGIST*, in which the authors explored the increased growth efficiency of white oak (*Quercus alba*) in an atmosphere of elevated CO<sub>2</sub> concentration and its potential impacts on the environment and ecosystems [56]. In 1997, Polley *et al.* published a related article in *TREE PHYSIOL*, which investigated the leaf physiology, yield, water use, and nitrogen dynamics of the grassland invasive *Acacia smallii* under conditions of elevated CO<sub>2</sub> concentration and explored the potential impacts on the environment and ecosystems. This study provided information on desertification and ecosystem change, as well as how to respond to climate change [57]. In the same year, Berntson *et al.* showed that elevated CO<sub>2</sub> concentrations can promote plant growth and carbon uptake but inhibit microbial decomposition of soil organic matter and nitrogen conversion processes. Therefore, despite better plant growth, soil nitrogen content may decrease, which affects the nutrient cycling of the whole ecosystem. This study provided important insights into the effects of global climate change on forest ecosystems [58]. The number of publications on plant carbon sequestration potential has steadily increased over the past 15 years. In 2008, only 95 such publications were published, but since then, there has been significant growth in this field, with a large number of publications every year.

The trend of publications in the field of plant carbon sequestration has been steadily increasing over the past fifteen years, indicating an increase in global attention on this topic. The United States has been a leader in this research area, with the largest number of publications from 2008 to 2017, accounting for one-third of the world's publications. However, the number of publications from China has surpassed that of the United States since 2021 and 2022, making China the country with the most intensive scientific research in this field. The

Chinese institution, CHINESE ACADEMY OF SCIENCES, is significantly ahead of other institutions in terms of total global citation score (TGCS) with a score of 9872.

Collaboration between different research institutions is relatively low, with publications mainly concentrated in the *SCIENCE OF THE TOTAL ENVIRONMENT*, *INTERNATIONAL JOURNAL OF GREENHOUSE GAS CONTROL*, and *GLOBAL CHANGE BIOLOGY* journals. Keyword analysis revealed that "carbon sequestration", "nitrogen", "biomass", "carbon", and "climate change" are the most frequent keywords in plant carbon sequestration research. By analyzing burst words, it is found that before 2020, scientists focused more on "chemical fuels", "tropical forests", "species composition" and "gas exchange", among other research aspects. After 2020, "agroforestry complex", "deforestation", "pyrolysis" and "net primary production," among other topics, became hot topics for researchers in the field.

Although there has been significant growth in the field of plant carbon sequestration research, there is still a lack of interdisciplinary collaboration in this area. In the future, researchers can conduct collaborative, interdisciplinary research to discover new ideas and tackle current challenges. According to statistics, the global plant biomass reaches  $4.5 \times 10^{11}$  tons/year. To reduce the waste of resources, a large number of plants can be used for more valuable purposes. The main components of plants are carbohydrates and other forms of biopolymers, which are abundant, inexpensive, and have unique intrinsic pore structures that can be used to adsorb carbon. However, finding plants that are highly enriched in carbon and dealing with ever-changing environmental issues remain significant challenges for scientists. It also suggests that there are still many problems in this field that need to be addressed through further research and innovation.

## 6. Conclusion

In conclusion, the bibliometric and visual analysis of papers published on plant carbon sequestration potential from 2008 to 2022 has provided valuable insights into the current state of research in this field. The United States, China, and the United Kingdom are the top three countries in terms of the number of publications, reflecting global interest in

this topic. Noteworthy is the cooperation between countries, institutions, and authors, with three of the top ten publishing institutions belonging to France, two to China, and one each from Germany and Switzerland. The top ten journals in terms of the number of articles published are based in the Netherlands, the United Kingdom, the United States, and Switzerland, indicating the significance of this research field and international contributions made. The focus on plant carbon sequestration continues to increase year by year, with emphasis placed on its potential for coping with the increasing concentration of CO<sub>2</sub>. While there may be challenges and limitations to be addressed, continued research and innovation in this area hold promise for mitigating the impacts of climate change and promoting sustainable development.

## 7. Outlook

The “double carbon” goal proposed by China to achieve carbon neutrality by 2060 is a significant step towards a low-carbon global economy. In order to achieve this goal, it is necessary to focus on green development, industrial transformation and upgrading, and changes in production and consumption patterns. As a result, terms such as “energy conservation and emission reduction,” “low-carbon,” and “environmental protection” have become popular around the world. Future research in the field of plant carbon sequestration will focus on breeding new, highly carbon-enriched plant varieties using transgenic technology with high adaptability, short growth cycles, and higher economic benefits. It will also explore highly carbon-enriched plants suitable for local soil conditions, and investigate synergistic effects between microorganisms and plants for carbon sequestration. Other areas of focus include selecting non-edible and ornamental plants for carbon sequestration to increase economic benefits. Plant carbon sequestration faces multiple challenges, such as competition for land use rights, destruction by natural disasters, habitat loss, and the effects of climate warming. Therefore, targeted measures are needed to enhance and protect plant communities, such as strengthening regulation, promoting afforestation, and carrying out ecological restoration. By adopting a combination of measures, the goal of plant carbon sequestration can be better achieved, and the global climate change problem can be effectively mitigated.

**Supplementary Materials:** The following supporting information can be downloaded at: [docs.qq.com](https://docs.qq.com) Table S1: Number of publications by countries; Table S2 Number of documents issued by the organizations; Table S3 Number of articles published in journals; Table S4 Number of keyword occurrences; Table S5 Number of keywords in three different time periods.

**Author Contributions:** **Yuhe Zhu:** Writing – original draft, Formal analysis, Data curation. **Guandi He:** Writing – review & editing, Supervision, Methodology, Funding acquisition. **Zhuoyan Zhong:** Formal analysis, Validation. **Ren Yang:** Formal analysis, Validation. **Haojie Ni:** Formal analysis, Validation. **Tengbing He:** Writing – review & editing, Methodology, Funding acquisition. **Siew Ling Lee:** Writing – review & editing, Supervision, Methodology, Funding acquisition. All authors have read and agreed to the published version of the manuscript.

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