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Review

Developing Countries in the Lead: A Bibliometric Approach to Green Finance

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Abstract: In recent years, green finance has become a popular method for dealing with environmental issues. However, it remains to be seen whether green financing is effective in addressing current global environmental issues. In this article, we, therefore, analyze the diffusion patterns of green finance publications in the Global South and Global North to identify which section of the globe is under-researched from this perspective. The study tried to highlight the overall trends of research publications on green finance, continent, most contributing authors, countries, and journals. The study used a bibliometric approach with the help of R studio software. The Scopus database was used for extracting the resources and 522 documents utilized in this bibliometric analysis. The result demonstrates that the diffusion of green finance is more common in the Global North than in the Global South. However, the number of scientific studies produced over time, the number of active authors, and affiliations of the Global South have contributed more than the Global North. More specifically, at the continental level, Asia and the Pacific are playing a lion's share in providing scientific research publications on the green-finance-related issue. Meanwhile, the Arab states and Africa are the lowest contributing continent. China has the highest number of publications worldwide. However, this reality may be different if another approach (per capita contribution) is used to investigate the issue of green finance. Hence, we call for future studies to consider this fact in investigating the issue of green finance across the world. Furthermore, the study proposes further studies to be conducted on what are the factors that drive the Global South to lead. Finally, it is also better if the future studies take into account the status of each country in terms of green finance mobilization and capital contribution to share the specific experience of that country and lessons taken from that country.

Keywords: green finance; developing countries; a bibliometric approach

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1. Introduction

Since the 19th century, human activities have been the main driver of climate change, primarily due to burning fossil fuels, such as coal, oil, and gas. Burning fossil fuels generates greenhouse gas emissions that lead to raising temperatures [1]. As a result, the Earth is now about 1.1 °C warmer than it was in the 19th century. The last decade (2011–2020) was the warmest on record [2]. In a series of UN reports, thousands of scientists and government reviewers agreed that limiting global temperature rise to no more than 1.5 °C would help the world to avoid the worst climate impacts and maintain a livable climate [3]. One of the strategies adopted to mitigate the impact of climate change is enhancing the level of green growth across the globe. Green growth is a term to describe a path of economic growth that is environmentally, socially, and economically sustainable [4]. As such, green growth is closely related to the concepts of low-carbon or sustainable development [5,6]. The investment in green energy is quite imperative to mitigate climate change impacts [7–9].

Particularly, investment in new renewable energy production capacity. Furthermore, different countries used different strategies to mitigate the impact of climate change. As evidence, Brazil has long supported the development of an industrial biofuel sector. China has subsidized R&D and industrial production of photovoltaic (PV) panels. Morocco is investing public funds in the production of concentrated solar power and intends to sell renewable energy to Europe [10]. All of these activities require having a cleaner environment and mitigating climate change effects [11].

In recent years, in order to overcome the environmental issues, de-carbonizing the economy found a nonalternative strategy [12]. In doing so, several new methods of financing projects have emerged. Those financing methods are green bonds [13], green credit [14], climate finance [15], carbon finance [16], sustainable finance [17], green banks [18], and so on. The scope and content of financing methods are different; however, they are all similar in terms of objective, as all of them introduced to finance those green projects [19]. These financing methods are collectively known as green finance. Green finance is a financing method that prioritizes green projects that are helpful in mitigating the impact of climate changes [11]. However, whether green financing is effective in addressing current global environmental issues remains to be seen, since the green investment gap was discovered to be very large [20].

According to a recent 2021 report published by United Nations Environment Programme [21], the current investments in green projects amount to USD 133 billion, most of which comes from public sources, and found not enough to achieve the objective of sustainable development. The report suggests that it needs to close a USD 4.1 trillion financing gap by 2050. The study calls for green investments to triple by 2030 and to increase four-fold by 2050 from the current level. Furthermore, the study highlights the need for there to be a significant increase in private sector investment in green projects. A major concern in the transition to low-carbon energy provision, therefore, is how to obtain sufficient finance to fill the required green investment.

Among many arguments on factors currently preventing economic resources from flowing in larger amounts to green investments, the initial and critical factor is the nature of green investments regarding risk and returns trade-off. In this case, the perception of risks related to technology evolution and market development is the concern of green investors [19]. The consequence creates low investment levels in the economy and prevents a lack of confidence among private investors [22,23]. Secondly, banks consider most green investment projects to be risky; as a result, they are reluctant to finance them [10]. As a result, a large green finance gap is observed. Hence, there is a big call for all stakeholders to look for new channels of financing in this sector to fill the financing gap for such projects [24]. Regarding the issue, the most pioneering study was first conducted in 1997 by [25] to show the increasing collaboration of nongovernmental organizations' partnership with the public and for-profit sectors in terms of environmental finance. The finding of the study implies that Global-North-based NGOs are the organizations that noticed environmental finance requirement, and calls all stakeholders, both government and nongovernment organizations, to enhance such capital. Despite a big call on the issue, the green financing gap is still observed across the world, and an amount of USD 4.1 trillion is required to close the financing gap as of 2050 [21]. Having this in mind, many studies are conducted across the world to investigate the way forward to fill the finance gap. However, the practical evidence shows that the level of the green finance gap is increasing every year. Previously conducted studies highlight different reasons for the green finance gap, and one of the leading factors is lack of equal attention among countries across the globe to mitigate climate change [26].

As a result, the current study attempts to review previously conducted studies and contributions made across the world by specific continents, countries, affiliations, and authors in both Global North and Global South countries by using a bibliometric approach analysis. In doing so, the study is interested to see how diffusion between the Global

North and Global South networked for collaboration in producing green-finance-related scientific publications.

The countries are categorized based on the Organization for Economic Cooperation and Development (OECD) Development Assistance Committee's list of countries eligible for Official Development Assistance [27]. The concept of Global North and Global South (or North–South divide in a global context) is used to describe a grouping of countries along with socio-economic and political characteristics. The Global South is a term often used to identify the regions of Latin America, Asia, Africa, and Oceania. It is one of a family of terms, including "Third World" and "Periphery", that denote regions outside Europe and North America, mostly (though not all) low-income and often politically or culturally marginalized countries on one side of the so-called divide, the other side being the countries of the Global North (often equated with developed countries).

The first scientific study was published by an author [25] affiliated with the United States (Global North) in 1997; since then, many countries in the Global North have contributed more research and development of products that are highly related to environmental issues. However, following the Paris Agreement, it appears that the position has shifted to the Global South, as China is investing profoundly in environmental research and development [10]. More specifically, among the top 10 countries leading in contributing scientific production to green finance, aggregate developing countries, such as China, Pakistan, India, and Malaysia, contributed twice that of developed countries (United Kingdom, Germany, Japan, United States, Italy, and Australia). Nonetheless, no scientific study has been conducted to determine which parts of the world pay more attention to environmental issues. This rationale motivated the researchers to conduct this study. The main contribution of this study is to provide empirical literature to existing studies on green finance that indicate which global region is highly focused on the issue of environmental finance. This study has an impact in assisting future studies to consider the status of each country in terms of green finance mobilization and capital contribution. The following Section 2 of the study discusses the methodological approach followed in this specific review. Section 3 discusses the overall result and interpretation using a bibliometric approach. Finally, the last section (Section 4) highlights the discussion of the result and provides future research suggestions.

2. Methodology

The primary goal of this study was to evaluate previous studies on green finance research topics and to identify keywords associated with green finance, forming a network. Previously, systematic review research was developed with the major group, and only a few studies used evaluative and relational bibliometric studies. The development of a bibliometric approach differs from the traditional systematic literature review [28]. It is the best method for conducting research that originates knowledge in the library and science [29]. Bibliometric science is used to analyze all documents dealing with green finance, such as green bonds [13], green credit [14], climate finance [15], carbon finance [16], sustainable finance [17], green banks [18], in the fields of business and economics, social sciences, environmental sciences, and other multidisciplinary fields. It allows for the creation of network analyses, which provide a clear picture of the various links between scientific studies, countries, authors, and keywords. It also determines the co-occurrence of keywords and provides an overview of the evolution of the various themes [30].

For this specific review, we developed a search strategy to identify relevant literature on the specific study. This search strategy was mainly from the Scopus database. The rationale for using this database is that it is considered the widest and most recommended source by previous studies [31]. It includes the top three ranked citation indices that are most acknowledged and universally cited [32]. The term green finance is defined in different ways by many scholars; however, the scope and content of the definitions, on the other hand, are similar [33]. Because of the breadth of the terminologies used in green finance, we have narrowed them down to green finance, carbon finance, green fund, green

credit, sustainability, sustainable finance, and climate financing based on the contents of the papers and their usefulness.

Following the identification of the best-related scope of green finance that was useful for our review, we extracted the resource using keywords All = (("green finance" or "green financing") and ("climate" or "climate finance" or "carbon finance") AND ("sustainability" or "sustainable finance" or "sustainable financing" or "green fund")) from the database that was identified (Scopus). We established criteria for including and excluding articles for review in the proposed study. In doing so, those studies written in the English language are included and others excluded. Those documents presented as articles, proceeding journals, and reviews finalized are included and other types of documents and articles in the press are excluded. The selection criteria are based on the PRISMA statement [25]. Generally, 1316 documents were discovered through Scopus; after screening those relevant studies under the scope of the review, 522 studies were acknowledged for the review. The following Figure 1 of the study shows the methodological approach in selecting documents extracted from the database.

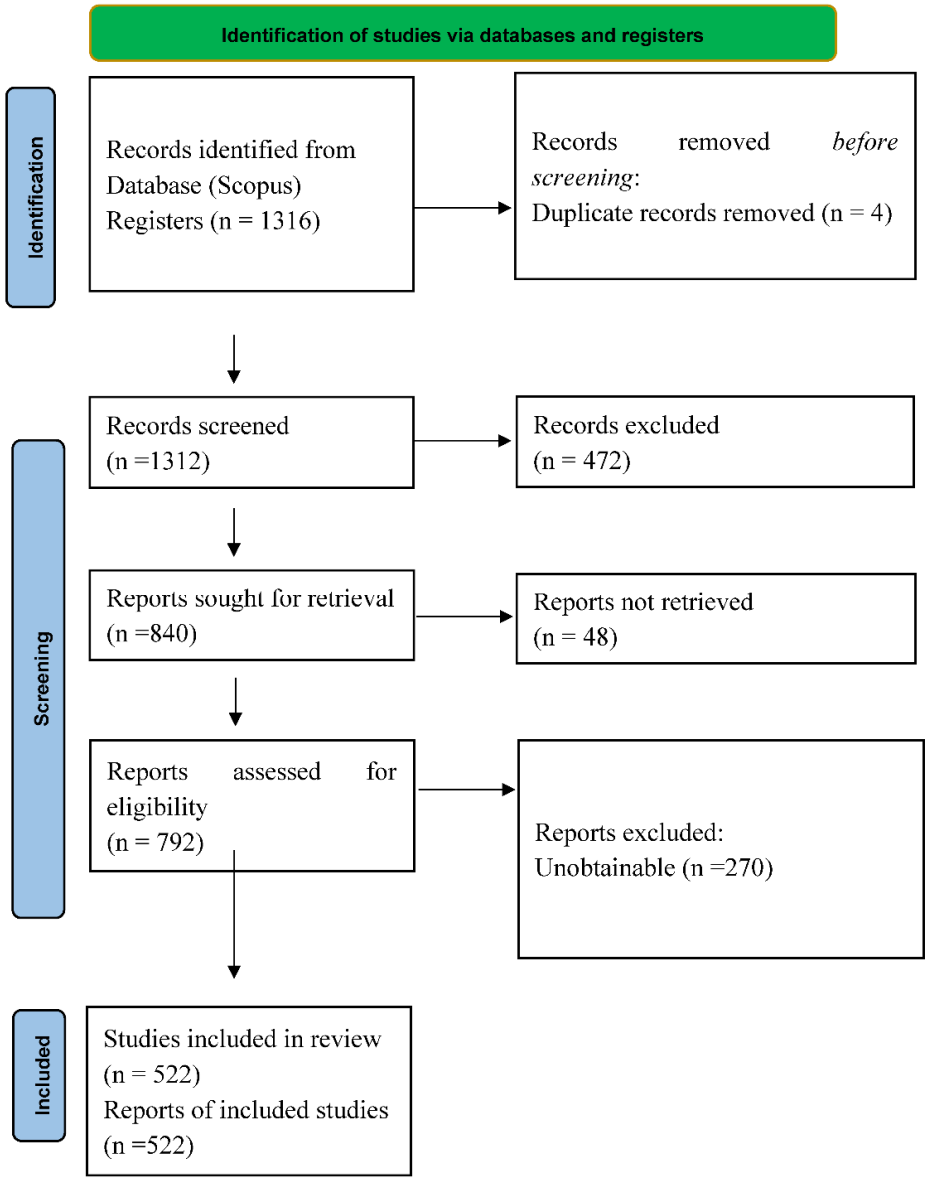

Figure 1. Study selection process flowchart.

The analyzed documents used in this study have been extracted from Scopus with an advanced search on 1 May 2022 using the identified keywords. The inputs are the downloaded papers from Scopus. R Studio version 3.5.3 (https://rstudio.com/products/rstudio/download/, accessed on 6 May 2022) free open-source software was used for data analysis. To conduct this specific review, the study used the Bibliometric package (http://www.bibliometrix.org, version 3.0.1, accessed on 6 May 2022). More specifically, the Microsoft Excel spreadsheet was used to crosscheck the authors' names, the titles of the documents, the keywords, and the abstract of the study. Zotero reference manager was used to ensure that citations and documents were properly accounted for throughout the process.

3. Result and Interpretations

3.1. Generation Information

The review was shaped by gathering resources from the database chosen for this study. After all criteria were met, 522 studies were used for the final discussion. As a result, the following section of the study discusses the descriptive analysis of the study.

The below Table 1 of the study provides general information on the content of the study. The documents were collected for those studies conducted between 1977 and 2022.

Table 1. General information.

Document Types	Frequency	Authors	1171
article	387	Author Appearances	1575
book	7	Authors of single-authored documents	85
book chapter	34	Authors of multi-authored documents	1086
conference paper	64	Authors collaboration	
conference review	1	Single-authored documents	93
editorial	5	Documents per Author	0.446
erratum	2	Authors per Document	2.24
note	5	Co-Authors per Documents	3.02
review	17	Collaboration Index	2.53

Source: compiled by authors 2022.

The total documents extracted from the identified database (Scopus) were 522 documents. The documents are written by 1171 authors from 54 different countries across the globe. It was found that single authors write 85 documents, and the remaining documents are written by collaboration among different authors. The collaboration index found 2.53 per document. The majority of the resources used in this study were articles from journals, accounting for 74% of the total. The proceeding papers were the second-largest documents used in the study to analyze the issue of green finance from different perspectives. It is helpful to investigate how far the collaboration among authors and countries on the issue of green finance extended.

Table 2 of the study showed the frequency of countries by published documents. The total number of countries, as extracted documents, was 524. The study classifies those countries into two groups based on OECD global classification (Global North and Global South). According to the data extracted, 34 countries belonged to the Global North and the remaining 20 belonged to the Global South. More specifically, the total number of European countries actively participating in developing a scientific product on green finance was 27. North American countries had the smallest frequency in the Global North. On the other side, Asian and Pacific countries are leading the Global South, as the majority (eight) of countries participated in producing green-finance-related scientific studies. The Arab States were found to have the least contributors of scientific studies from the Global South. From this, it is possible to understand that the frequency of Global North countries is greater

than the frequency of Global South countries in actively involving scientific studies on green finance.

Table 2. Frequency of countries by publication.

Classification	Number of Countries	Global South	Frequency	Global North	Frequency
		Africa	4	Asia and Pacific	5
Global North	34	Arab States	1	Europe	27
Global South	20	Asia and Pacific	8	North America	2
		Middle east	5		
		South/Latin America	2		
Total	54		20		34

Source: compiled by authors 2022.

3.2. Keyword Analysis

Constructing the keywords co-occurrence is a useful tool for identifying the research composition. This method involves the use of correlation measures to reveal the appearance of relationships between words. The co-occurrence network draws a network map by emphasizing the relationship between keywords. To investigate green-finance-related keywords, we present the top 10 ranked keywords based on the number of associations and the intensity level of their relationship. "Green finance" was the first keyword. The following Figure 2 of the study shows the keyword network related to specific studies.

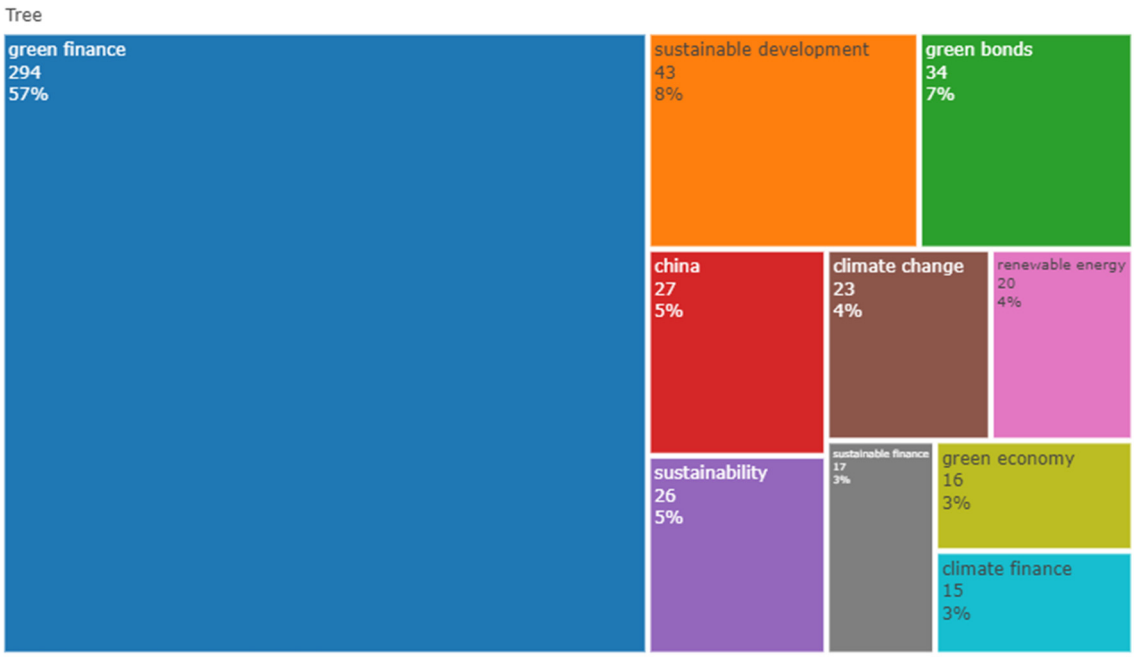

Figure 2. Keyword construction and analysis.

The keywords are a reflection of those words that frequently appear with green finance. The result of keyword analysis implies that, among the documents used in this study, the term green finance was found in the majority (57 percent) of the documents. This term is networked with other keywords, such as sustainable development, green bonds, sustainability, green economy, and climate finance, which have the same purpose but are different in their content and scope [19]. More specifically, as is seen among the identified keywords, it is obvious that China is fundamentally different from other keywords. However, it implies that the majority of studies conducted on green finance are

from China, which can lead the authors to use both China and green finance as keywords together. As the result, China frequently appears with the keyword green finance. The result highly implies that the term green finance is used to study the issue of climate change, sustainable development, renewable energies, green economy, and so on mostly conducted in China. This result provides implications for future studies to realize the driving factors that makes China the most significant country in contributing green finance scientific studies. Furthermore, it provides a clue on untouched areas of study related to green finance. As evidence, one of the best strategies used to mitigate climate change is dealing with new technological innovations; however, wider consideration is not given to this area of study by relating to green finance. Further, the following Figure 3 of the study shows the keywords' growth over time.

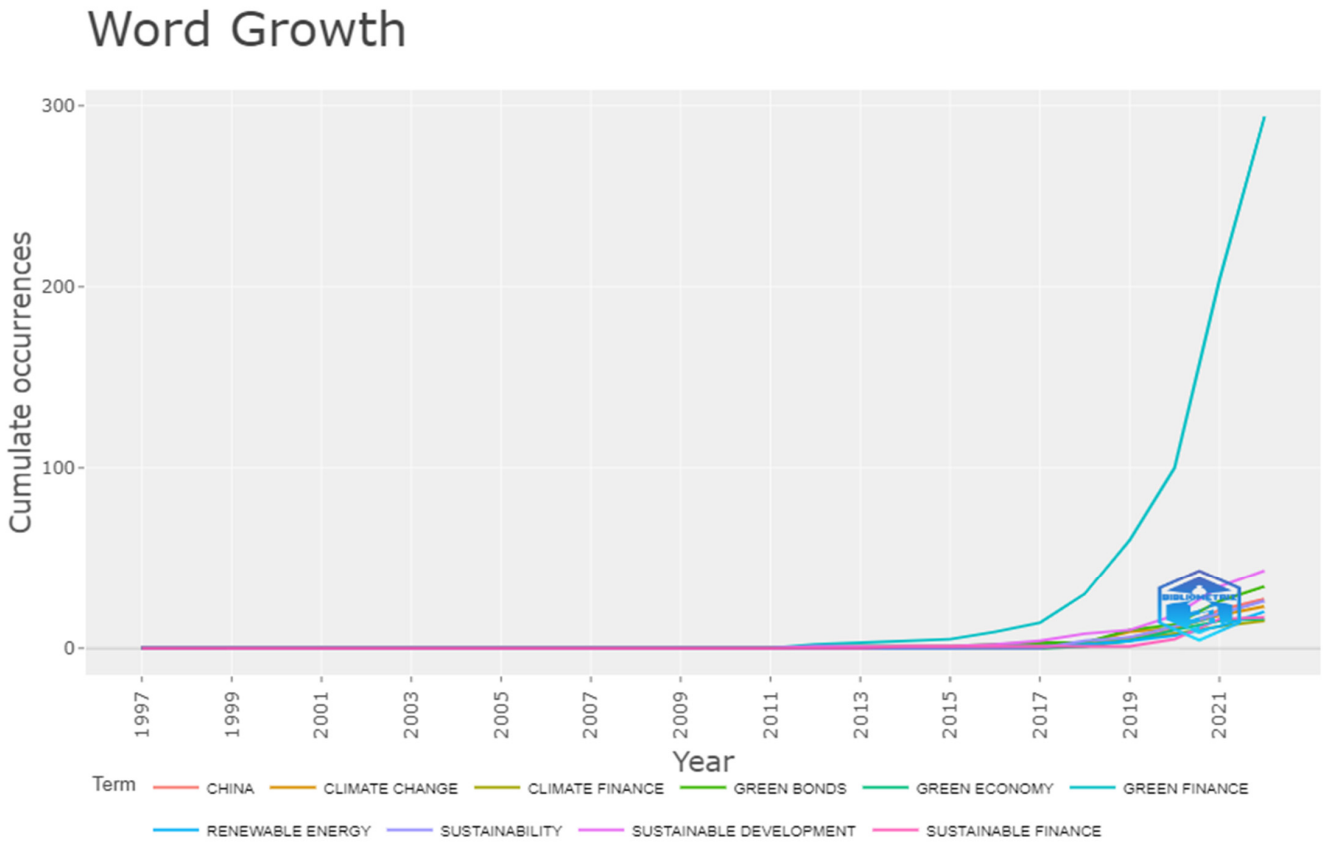

Figure 3. Keywords' growth over time.

From Figure 3, it is possible to understand that the line with an upward curve shows the increasing occurrence of the keyword "green finance" over time. This could imply the area has gained more scholars' attention compared to other keywords that occurred together.

3.3. Publication Trends

The documents extracted for this study ranged from 1997 to 2022. The overall study trend implies that there were a few publications on the study area between 1997 and 2022. The row data extracted show that there were only three publications between the years 1997 and 2010. This could be down to different reasons, as the periods are known as the period of the financial crisis and different economic crises, which could shift the interest of the scholars to a different area of study. As evidence, the Southeast Asian economic crisis in 1997 collapsed currency values, stock markets, and other asset values in many Southeast Asian countries. The subprime mortgage crisis that resulted from 2007 to 2008 created a financial crisis that affected the United States and other countries in the world. At the

same time, different factors, such as COVID-19, smallpox, SARS, and other epidemics on the world, shift the interest of scholars across the globe. Based on the occurrence of these economic crises, it is speculated that the number of green finance studies is affected by these phenomena. However, the rising concern about carbon emissions has gradually led most scholars to study the issue of green finance. This can be evidenced from the following Figure 4 of the study, as the number of publications increased dramatically after the year 2015 and peaked at the maximum in the year 2021 by publishing 164 documents. This may be down to the urgent call of the Paris Agreement [34] because the study area has grown in popularity since the year 2015. The following Figure 4 of the study shows the overall publication trends throughout the study period.

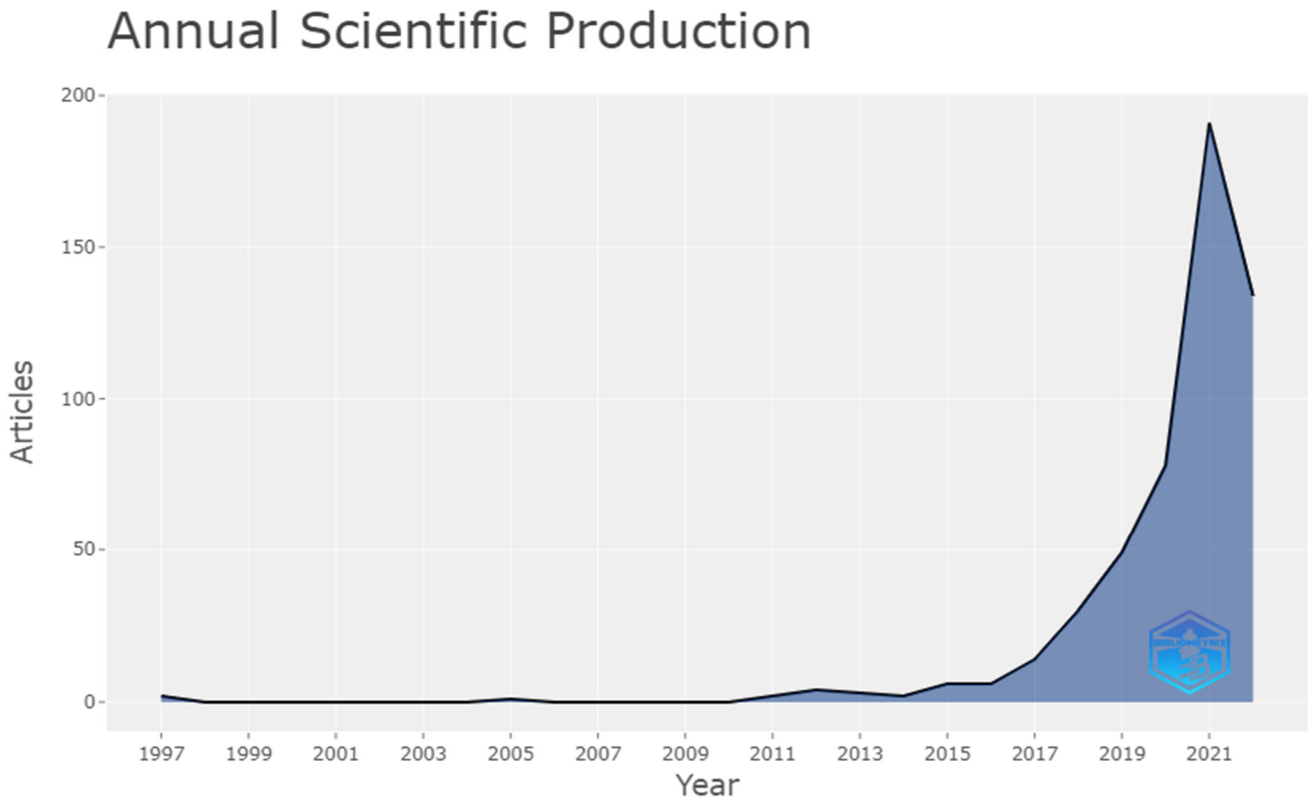

Figure 4. Trends in annual publication over time.

More specifically, it found that those countries from the Global North have contributed 447 scientific productions, whereas the Global South has contributed 976 scientific productions. Asia and the Pacific were found as the leading continent in contributing a high number of scientific productions, whereas Arab states are the lowest contributor from the Global South side. On the other hand, Europe was found to be the leading continent in contributing scientific studies, whereas North America is the lowest contributor from the Global North side. This result implies that the number of scientific studies produced by those Global South countries are greater than the Global North. Furthermore, it can be understood that those 34 countries that participated from the Global North did not produce enough scientific publications compared to those 20 countries that participated from the Global South. The following Tables 3 and 4 of the study show production frequency of scientific studies on green finance contributed by continents and countries, respectively.

Table 3. Production frequency by continent.

Classification	Number of Publications	Global South	Frequency	Global North	Frequency
		Africa	21	Asia and Pacific	84
Global North	447	Arab States	1	Europe	307
Global South	976	Asia and Pacific	935	North America	56
		Middle east	13		
		South/Latin America	6		
Total	1423		976		447

Source: compiled by authors 2022.

Table 4. Production frequency by countries.

Countries	China	UK	India	Germany	Pakistan	Malaysia	Japan	USA	Italy	Australia
Frequency	777	63	52	48	44	40	39	37	28	24

Source: compiled by authors 2022.

Table 4 of the study shows the frequency of specific countries in producing scientific studies over time. In doing so, the study was only interested in investigating the top 10 leading countries. As a result, China was found to be the leading country in producing green-finance-related scientific studies. More specifically, among the top 10 countries leading in contributing scientific production to green finance, aggregate developing countries (913), such as China, Pakistan, India, and Malaysia, contributed more than threefold that of developed countries (239) (United Kingdom, Germany, Japan, United States, Italy, and Australia). It is expected that the numbers can be inflated, since a single document is written by more than two authors that could lead the number of countries and affiliations to be inflated. In this study, we clearly underline that the study is dependent on previously conducted studies. The study found China as a highest contributing country to green finance scientific studies; however, this reality may be different if another approach (per capita contribution) is used to investigate the issue of green finance. Hence, academic readers should take into account that the result is based on document analysis rather than per capita contribution. Furthermore, we call future studies to consider this fact in investigating the issue of green finance across the world. Based on the data used for this study, the following Figure 5 of the study shows overall distribution of scientific studies across the globe. Blue color represents those countries who made scientific contribution to the specific study area. As can be seen, parts of African countries, Asia, South America, and others are contributing scientific studies to the specific study area.

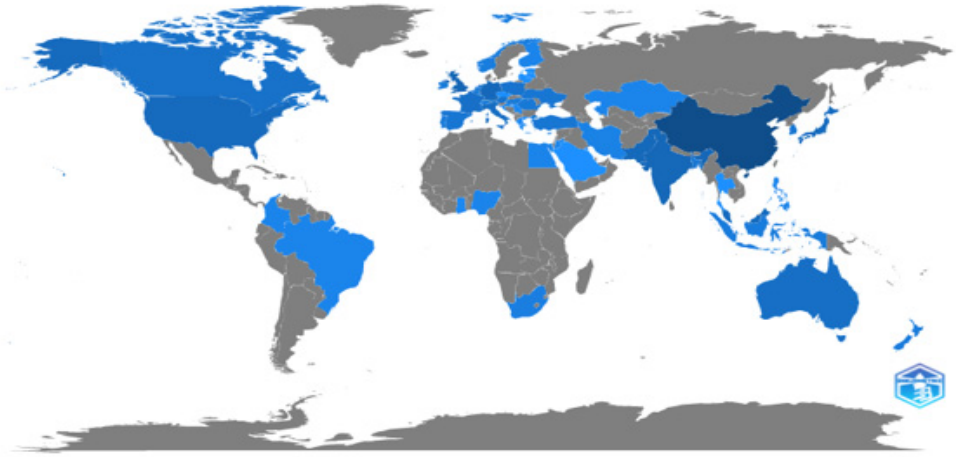

Figure 5. Scientific distribution across the globe.

3.4. Citation Analysis

Citation analysis is a method of determining an author's, article's, or publication's relative importance or impact by counting the number of times that author, article, or publication has been cited by other works. It is primarily useful in determining the impact of a particular work by identifying which other authors based their work on it or cited it in their papers. Furthermore, identifying seminal works in a field or topic can aid in learning more about that field or topic. To determine the impact of a specific author or title on green finance, we used citation analysis for both article and title, as well as countries. The following Tables 5 and 6 of the study show how many times specific titles and authors, and countries are cited in the field of green finance.

Table 5. Citation based on documents.

Paper	Citations	Authors	G/N/S
The way to induce private participation in green finance and investment	154	[35]	GN
The Role of Green Finance in Environmental Protection: Two Aspects of Market Mechanism and Policies	109	[36]	GS
Public spending and green economic growth in BRI region: Mediating role of green finance	105	[37]	GN&S
A bibliometric analysis on green finance: Current status, development, and future directions	101	[38]	GN&S
Sustainable Solutions for Green Financing and Investment in Renewable Energy Projects	78	[39]	GN
Can green financial development promote renewable energy investment efficiency? A consideration of bank credit	72	[40]	GS
Islamic finance and ethical investment	72	[41]	GN
Fostering green investments and tackling climate-related financial risks: Which role for macro prudential policies?	61	[42]	GN
The Impact of Green Lending on Credit Risk in China	60	[43]	GS
Greening of the financial system and fueling a sustainability transition: A discursive approach to assess landscape pressures on the Italian financial system	58	[44]	GN

Note: GN—Global North. GS—Global south. GN&S—Global North and South.

Table 6. Citation based on countries.

Country	Total Citations	AAC	Classification	Total Citation	AAC
Japan	447	37.25	Global North	1177	124.85
United Kingdom	264	15.53			
Italy	179	16.27			
Germany	141	9.40			
Canada	77	11.00			
Australia	42	8.40			
Norway	27	27.00			
China	1417	6.50	Global South	1551	21.39
Pakistan	88	9.78			
India	46	5.11			

Source: compiled by authors 2022. Note: AAC—average article citation per year.

As can be seen in the above Tables 5 and 6, the study is interested in investigating the top 10 most cited documents and countries. The result of the global citation analysis implies that those studies conducted in the Global South are more cited compared to

the Global North in terms of total citation till this study is conducted (June 2022). More specifically, the studies conducted in China are leading the Global South in terms of citation, and Japan has more studies cited from the Global North. Regarding the documents most cited, the study conducted by [35] from the Global North on "The way to induce private participation in green finance and investment" is the leading document in terms of total citation. The study conducted by [36] from the Global South on "The Role of Green Finance in Environmental Protection: Two Aspects of Market Mechanism and Policies" is the second leading document in terms of total citation. The following Figure 6 of the study shows the relationship between those most cited documents, authors, and countries by creating a single map with the help of r studio.

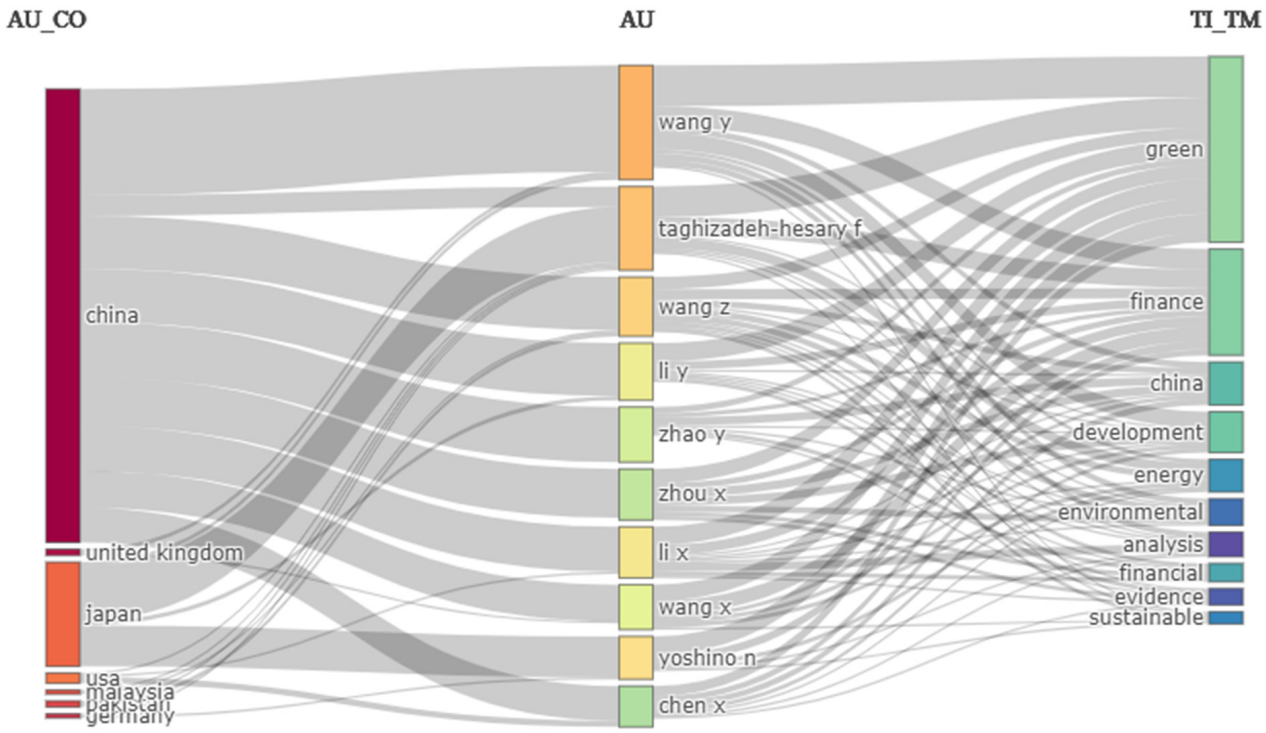

Figure 6. Mapping citation analysis. Note: Left side: countries. Middle side: authors name. Right side: title. The left side of the figure shows those authors and document countries most cited in specific study area (china, United Kingdom, Japan, USA, Malaysia, Pakistan, and Germany).

Table 7 of the study shows the most frequently published affiliations in the study area (green finance). The study is interested in seeing the top 10 leading affiliations across the globe in terms of scientific publication. The overall study result implies that the Global South affiliations are leading by contributing scientific studies on green finance. More specifically, China University of Mining and Technology is the leading affiliation by publishing 23 documents in the area of green finance. Furthermore, the study finding implies that the majority of affiliations producing scientific production on the specific study area are universities. The study found only one research institute that ranked in the top 10 by contributing scientific studies. In fact, universities are the main article-publishing institutions; however, there is a big call for those research institutes (International Institute of Green Finance, Green Finance & Development Center, Green Finance Institute), initially established to conduct research on green-related activities and providing consultancy and capacity building.

Table 7. Frequency of affiliations.

Affiliations	Articles	Global South/North
China University of Mining and Technology	23	Global South
Jiangsu University	20	Global South
Southwestern University of Finance and Economics	20	Global South
Anhui University of Finance and Economics	13	Global South
Jinan University	11	Global South
Sichuan Agricultural University	11	Global South
Tianjin University of Finance and Economics	11	Global South
International Institute for Applied Systems Analysis (IIASA)	10	Global North
Nanjing Xiao Zhuang University	10	Global South
Tokai university	10	Global North

Source: compiled by authors 2022.

3.5. Major Journals Contributing to Green Finance

The 522 documents used in this study were published in different publishers and different journals. We chose the top 10 journals that published relevant articles (see summary in Table 8). These journals together published 163 documents, which translates to 31% of all documents used in this study. Sustainability (Switzerland) is the leading journal, having published 39 articles on green-finance-related studies. The second and third most contributing journals to green-finance-related studies were found to be the Journal of "Environmental Science and Pollution Research" and "Journal of Cleaner Production". Furthermore, the publishing capacity of these journals is increasing from time to time. The following Figure 7 of the study shows the overall trends of the top 10 publishing journals.

Table 8. Major journals contributing to green finance.

Sources	Articles
Sustainability (Switzerland)	39
Environmental Science and Pollution Research	34
Journal of Cleaner Production	15
E3S web of conferences	14
Resources Policy	12
Journal of Sustainable Finance and Investment	11
Energies	10
Energy Policy	10
IOP Conference Series: Earth and Environmental Science	10
Frontiers in Environmental Science	8

Source: compiled by authors 2022.

As is seen in the above Figure 7, the study was interested in investigating the top 10 source growth over time. This translates to how publishing journals' trend over time looks in publishing those studies related to green finance. Generally, the journals, such as Energies, Energies Policy, E38 web of conferences, Environmental science and pollution research, frontiers in environmental science, IOP conference series, resource policy, and sustainability, were found to be the top 10 leading journals. The result of current data implies that sustainability journal (Switzerland), and environmental science and pollution research journal were found to be the leading journals in growing, with different publications related to the green finance topic. More specifically, the data on hand imply the journals'

contribution to scientific production was highly increased after 2017. As evidence, the number of scientific productions before 2017 was found to be insignificant, with only four publications produced collectively from both journals. However, the scientific contribution after 2017 was found to be significant. This could be down to the result that the scholars' attention was highly shifted to the green finance issue after the 2015 Paris Agreement.

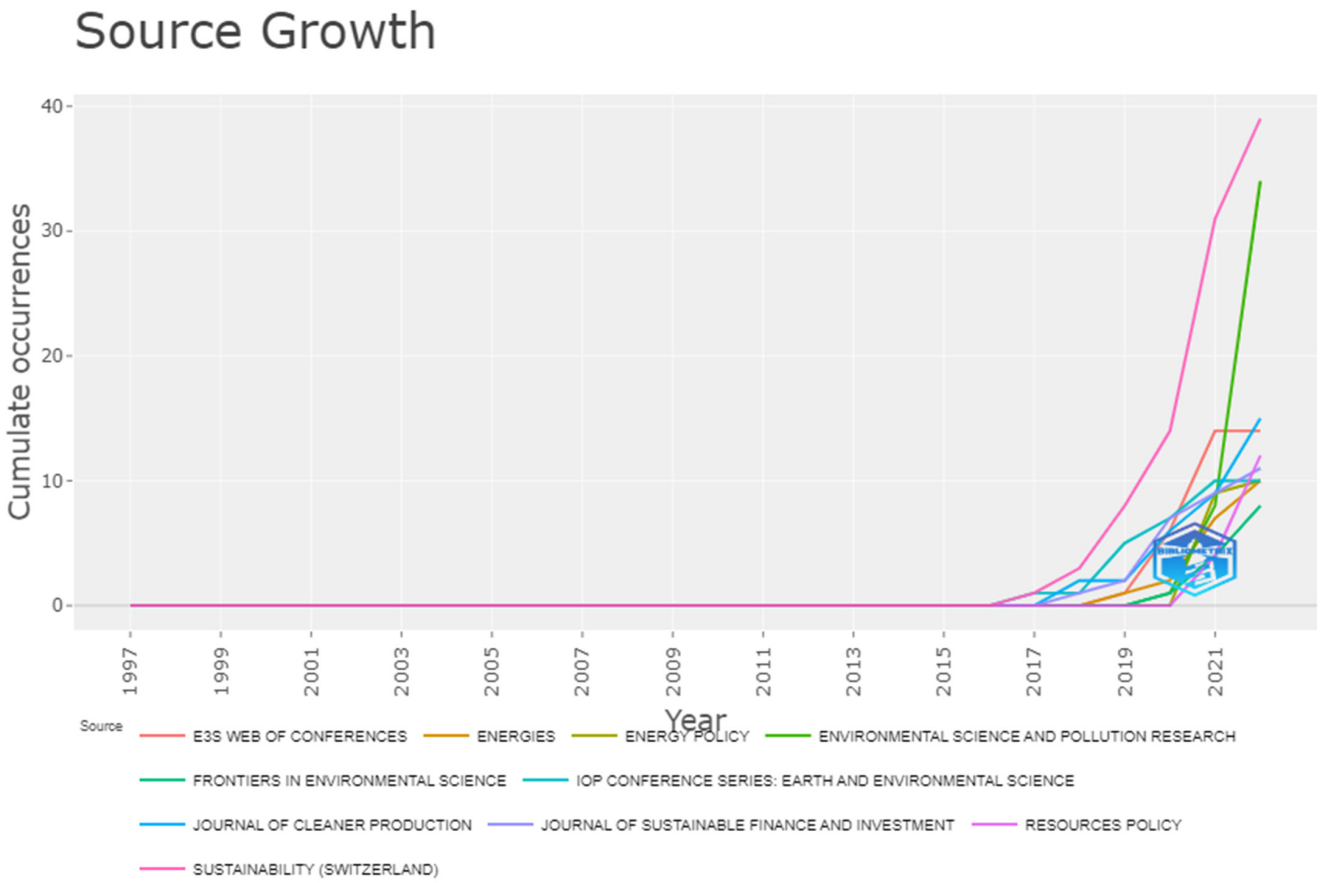

Figure 7. Source growth over time.

3.6. Country's Collaboration Network

Figure 8 shows a collaboration network across the globe. The networking is marked by red and blue colors. The blue color represents those countries that contributed to green-finance-related scientific studies across the globe, whereas the red color shows a collaboration network among those countries. As can be evidenced from the map, Africa, South America, and parts of Asia have lagged in creating collaboration with the rest of the globe in producing a scientific publication on green finance. However, Europe, North America, parts of Asia, and Australia have created collaboration on the issue of the study area. More specifically, the result of networking implies that China has made many collaborations with different countries. According to the study's findings, China, Japan, the United States, and the United Kingdom are the top countries leading the collaboration, as the diffusion of networking is mainly dependent on them.

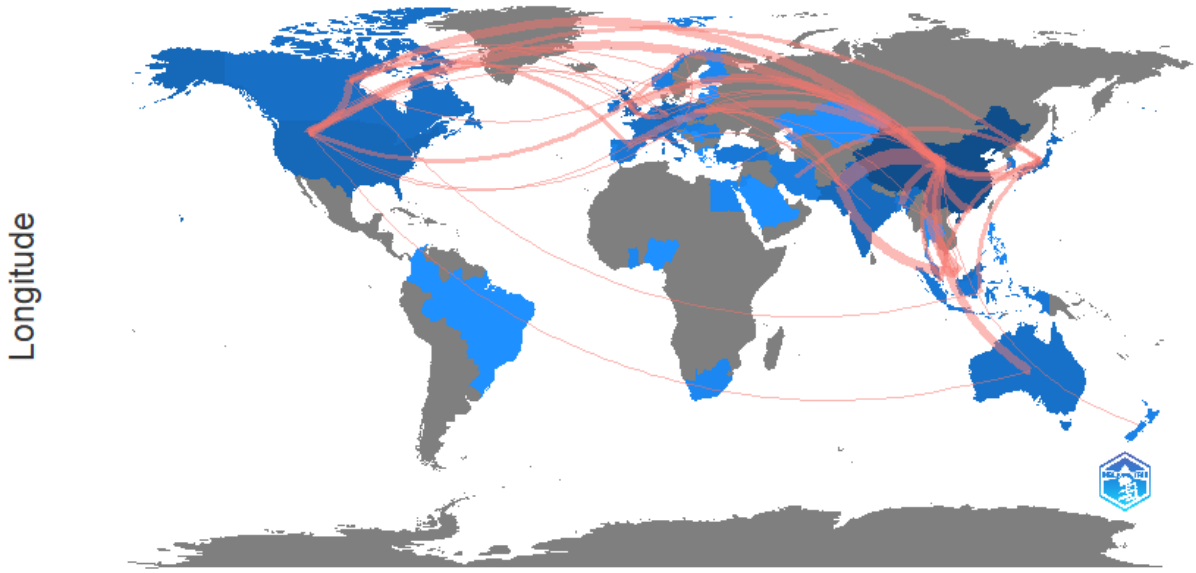

Figure 8. Countries' collaboration map.

4. Discussion

In general, the study highlights the overall trends in research publication on green finance, as well as the progress required to close the green finance gap. It also provides information on the most contributing parts of the globe, continents, countries, affiliations, journals, and authors from around the world using bibliometric analysis. Collaboration among countries was specifically investigated. The geographic distribution of scientific studies collected in terms of countries that participated in producing scientific publications on green finance demonstrates that the diffusion of green finance is more common in the Global North than in the Global South. This implies that public pressure through the press could have influenced the spread of policies in the Global North, as they have more press freedom than the Global South. However, the number of scientific studies produced over time is much greater in the Global South than Global North. More specifically, at the continental level, Asia and the Pacific are playing a lion's share in providing scientific research publications on the green-finance-related issue, whereas the Arab states are the lowest contributing continent. To this end, the Global South authors and affiliations are also leading in contributing scientific publications compared to the Global North. More specifically, among the top 10 countries leading in contributing scientific production to green finance, aggregate developing countries, such as China, Pakistan, India, and Malaysia, contributed twice that of developed countries (United Kingdom, Germany, Japan, United States, Italy, and Australia).

Even though the Global South produces a large number of scientific publications on green finance, the number of countries involved in producing the publications are low in comparison to the Global North. In this case, it is possible to understand that a high number of countries with a low frequency of publications is observed in Global North, whereas a low number of countries with high-frequency publications is observed in Global South.

It was discovered that China has the highest number of publications worldwide (Appendix A). The European and North American continents are the next leading continent next to Asia and the Pacific. The overall result may raise the question of "why the global south is more focused than the global north on environmental issues". To this end, despite the progress in the research areas, the financial gap for making a green investment is still found to be huge and no way to fix this gap is found [40]. It has been argued that the credit provided by the financial sector is insufficient to achieve the green financing gap [45]. According to the findings of earlier studies [46], private investors are far behind in terms of financial contribution to green investment. Private capital will be required in

large amounts. However, a variety of microeconomic challenges, such as internalizing environmental externalities [47], information asymmetry [48], issuers' and investors' analytical capacity [49], and risk–return trade-offs, are some of the problems, among others. As a result, it is recommended that the government and central banks shall play an active role in attracting private investors [46]. The co-ordination among large and small businesses in terms of loans and investment is also required to provide the required response to the green finance gap [15].

Tax breaks and minimum cost of capital as an option to attract private investors was recommended by different scholars [35,37,47,50–56]. However, no change has been experienced yet, as the green finance gap is increasing from time to time. Based on the review result, this study recommends that future studies be conducted on how to enhance green finance for green investment that could deliberately affect green growth. At the same time, it is good to see what would be possible incentives that could initiate private investors to make green investments, and what additional green financing methods shall be introduced to fill the financing gap. The study found China as a highest contributing country to green finance scientific studies; however, this reality may be different if another approach (per capita contribution) is used to investigate the issue of green finance. Hence, we call future studies to consider this fact in investigating the issue of green finance across the world.

Finally, it is also better if the future studies take into account the status of each country in terms of green finance mobilization and capital contribution to share the specific experience of that country and lessons taken from that country. At the same time, special consideration shall be given to those Arab states and African countries that contributed less research and development to environmental issues.

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Appendix A

Table A1. Frequency of published documents across the globe.

Countries	Continent	Globe	Publication
Austria	Europe	Global North	16
Australia	Asia and Pacific	Global North	24
Bahrain	Arab States	Global South	1
Bangladesh	Asia and Pacific	Global South	11
Belgium	Europe	Global North	8
Brazil	South/Latin America	Global South	3
Canada	North America	Global North	19
China	Asia and Pacific	Global South	777
Colombia	South/Latin America	Global South	3

Table A1. *Cont.*

Countries	Continent	Globe	Publication
Croatia	Europe	Global North	2
Cyprus	Europe	Global North	3
Czech Republic	Europe	Global North	1
Egypt	Middle east	Global South	3
Estonia	Europe	Global North	1
Finland	Europe	Global North	3
France	Europe	Global North	22
Germany	Europe	Global North	48
Ghana	Africa	Global South	2
Greece	Europe	Global North	2
Hungary	Europe	Global North	8
India	Asia and Pacific	Global South	52
Indonesia	Asia and Pacific	Global South	7
Iran	Middle east	Global South	4
Ireland	Europe	Global North	8
Italy	Europe	Global North	28
Japan	Asia and Pacific	Global North	39
Jordan	Middle east	Global South	3
Kazakhstan	Asia and Pacific	Global North	3
Kuwait	Middle east	Global South	2
Latvia	Europe	Global North	1
Lithuania	Europe	Global North	1
Luxembourg	Europe	Global North	2
Malaysia	Asia and Pacific	Global South	40
Netherlands	Europe	Global North	10
New Zealand	Asia and Pacific	Global North	7
Nigeria	Africa	Global South	3
Norway	Europe	Global North	6
Pakistan	Asia and Pacific	Global South	44
Philippines	Asia and Pacific	Global South	3
Poland	Europe	Global North	15
Portugal	Europe	Global North	8
Romania	Europe	Global North	9
Saudi Arabia	Middle east	Global South	1
Serbia	Europe	Global North	2
Singapore	Asia and Pacific	Global North	11
South Africa	Africa	Global South	5
South korea	Asia and Pacific	Global North	11
Spain	Europe	Global North	11

Table A1. *Cont.*

Countries	Continent	Globe	Publication
Switzerland	Europe	Global North	7
Thailand	Asia and Pacific	Global South	1
Turkey	Europe	Global North	11
United kingdom	Europe	Global North	63
Ukraine	Europe	Global North	11
United States	North America	Global North	37

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