A Bibliometric Analysis of Governance and Sustainable Development Research during the Period of 1992 to 2022*

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Abstract

Governance plays a significant role in attaining sustainable development. The recent significant increase in academic and research literature regarding the role of good governance in achieving sustainable development is the primary motivation for conducting this study. A bibliometric analysis of 8,193 documents published between 1992 and 2022 was conducted. The data was collected from the Web of Science (WoS) database and analyzed using Stata, VOSviewer, and Bibliometrix R-Package. The findings indicate that China has the highest share of publications, followed by the United Kingdom and the United States. The most productive institutions are the University of London, Wageningen University & Research, and Utrecht University.

Moreover, exploration of further research directions has been proposed, including rural revitalization, smart agriculture, environmental quality, green economy, green finance, and innovation. Besides, future research could focus more on big data-driven intelligence governance. Integrating modern technologies- big data, artificial intelligence and the internet of Things- is crucial for achieving sustainable development and environmental protection and thus accomplishing the sustainable development goals (SDGs) by 2030.

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1. Introduction

Governance and Sustainable Development are highly related concepts. They are gaining importance from the research community, government, and international bodies. Governance is vital to achieving society's sustainable development goals (SDGs) and how sustainable development is built. The objective of governance is to encourage the transformation of societies and cities to be more sustainable and to guarantee the quality of life of individuals and the welfare of societies. Progress in achieving the SDGs reflects the implementation of good governance practices. Given the significance of this research area, this paper will utilize a bibliometric analysis to conduct a knowledge analysis of research on "Governance and Sustainable Development."

Many bibliometric studies have been published, offering retrospectives on similar and related research topics, such as environmental, social, and governance management research (Siao et al., 2022), smart public governance research (Vujković et al., 2022), global research trends on COVID-19 linked to Sustainable Development Goals (Zyoud, 2022); contributions toward sustainable development (Effah et al., 2023); corporate governance and environmental sustainability (Enciso-Alfaro and García-Sánchez, 2023); ecotourism and sustainable development (Xu et al., 2023); and Sustainable Development Goals (Yamaguchi et al., 2023). These studies employ a variety of bibliometric techniques, text mining methods, and analysis and visualization approaches, including the performance of research constituents and the themes underpinning the conceptual and intellectual structure.

To the best of the authors' knowledge, no comprehensive, methodologically grounded bibliometric and qualitative literature reviews combining governance with sustainable development have been published so far. Therefore, this paper

is intended to fill this gap. That is through (1) investigating the broad and multiple interlinkages between the two concepts "Governance" and "Sustainable Development" and many other related concepts, such as sustainability, sustainable societies, and green growth, and (2) analyzing related literature and uncovering the hotspots topics under this research area and directions for future research. To achieve this objective, the following research questions (RQs) are pursued:

- How well is the progress in governance and sustainable development research?
- Which research channels have made the most contributions or had the greatest impact in this field?
- Who are the most contributing authors to this research area?
- What are the core and hotspot topics in this field of research? Are they interconnected?
- What are the emerging future trends that can provide researchers with new paths for exploration?

The rest of the paper is organized as follows. Section 2 presents the literature background. Material and methods are presented in Section 3, followed by bibliometric results and discussion in Section 4. Finally, Section 5 summarizes and concludes the paper.

2. Literature Background

How are governance and sustainable development significantly related? How efficient is governance in achieving sustainable development and enhancing the quality of life? According to *Our Common Future* (also known as the Brundtland Report), issued by the World Commission on Environment and Development (WCED), sustainable development is consistently associated with governance. Sustainable development is described as: "Humanity can make development

sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs. The concept of sustainable development does imply limits - not absolute limits but limitations imposed by the present state of technology and social organization on environmental resources and by the ability of the biosphere to absorb the effects of human activities." (WCED, 1987).

Improving and managing technology and social organization can create a new era of inclusive socio-economic expansion, alleviating poverty, and ensuring environmental sustainability. In this line, sustainable development requires meeting essential needs and extending the opportunity to fulfil the aspirations for a better life for all. As a result, public participation in the decision-making process on environmental and development issues is crucial. That is to achieve development goals, including meeting the needs of the poor and marginalized people, protecting the environment and poor regions that are always prone to ecological and other catastrophes, and respecting the welfare of future generations (Zeini et al. 2023).

The report views the environmental and development challenges *"the world has faced—and continues to face—as a single problem that must be handled by cooperative global action rather than the pursuit of national self-interest."* It addresses issues such as poverty and population growth, food security, species and ecosystems, energy, industry, and the 'urban challenge' of people living in built environments. Additionally, the report develops common approaches to:

1. Managing the commons (e.g., space, oceans, and Antarctica).
2. Addressing peace, security, development, and the environment.
3. Facilitating common action through proposals for institutional and legal change (WCED, 1987).

Achieving sustainable development goals involves logical planning, management, and coordination, which lie at the core of the "governance" concept.

Governance encompasses the ability to plan and establish the necessary organizations to support sustainable development (UNDP, 2015).

Many scholars argued that the governance concept covers public institutions upholding citizens' rights and the democratic process. However, the concept of governance is difficult to define. In the mid of the 1980s, the concept of "good governance" emerged, along with the wide, complex, and multi-faceted concept of "governance". The emergence of such a notion has accelerated with a change in expectations of public authority and social order, to promote building peaceful and protected societies with the stability needed to attract and sustain development investments (World Bank, 1991; DAC-OECD, 1993). Accordingly, the term governance includes features like efficiency and effectiveness, rule of law, participation, accountability, transparency, respect for human rights, fighting corruption, tolerance of diversity, and social equality. It plays a significant role in inclusive sustainable development (Griggs et al., 2013, Zeini and Okasha, 2024).

In 2015, the Member States of the United Nations approved the 2030 Agenda for Sustainable Development, which is in line with what was previously mentioned in the report "*Our Common Future*" and the common challenges and endeavors. With its 17 Sustainable Development Goals (SDGs), the agenda demonstrates the international commitment to achieve worldwide sustainable development in its social, economic, and environmental dimension. Unlike the 2015 MDGs, which concentrated on eradicating extreme poverty and the worst forms of human deprivation in developing countries (Tawfik et al., 2011), the SDGs broadened the scope to include universal goals such as reducing inequalities, boosting economic growth, providing decent jobs, sustainable cities and human settlements, industrialization, addressing ecosystems, oceans, and climate change, promoting sustainable consumption and production, and

fostering peace and bolstering justice and institutions (United Nations, 2015; Zeini et al., 2023).

Achieving the 17 Sustainable Development Goals (SDGs) requires good governance practices to:

1. Promote an enabling environment that fosters common goals through collective action.
2. Create a shared vision of sustainable development.
3. Ensure accountability among the multiple actors involved.
4. Maximize synergies between goals, targets, and dimensions.
5. Address emerging complex trade-offs both between and within the goals.

In this context, governance is considered the fourth pillar of sustainable development (Kroll et al., 2019). Governance can be defined as a collection of rules, stakeholder involvement, and processes aimed at fulfilling a common goal. It serves as a mechanism to steer the sustainable development process, which can be mapped along a continuum between environmental/ecological sustainability and quality of life (Zeijl-Rozema et al., 2008; Zeini et al., 2023).

3. Materials and Methods

Bibliometric analysis is a methodology through which a wide range of quantitative techniques are implemented on bibliometric data such as citation analysis, co-keyword analysis, co-authorship analysis, and bibliographic coupling (Donthu et al., 2021). The research methodology and its three phases are presented in **Figure 1**.

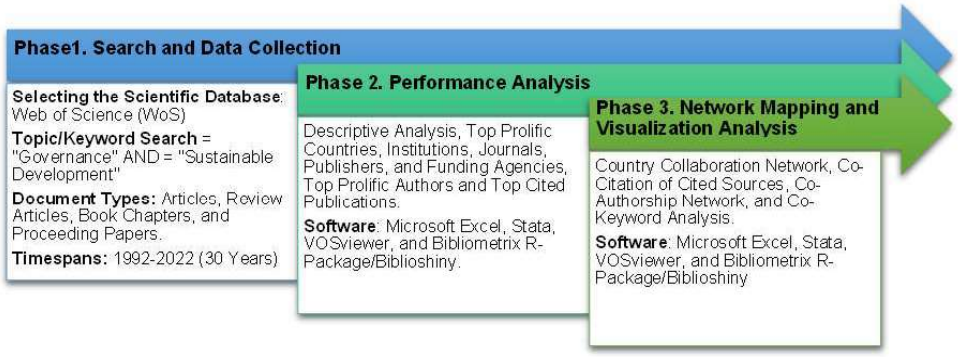

Figure (1): Research Methodology Phases

- ***Phase 1. Search and Data Collection.*** The data source for this analysis was the Clarivate Analytics' Web of Science (WoS) core collection database of the Institute for Scientific Information (ISI, Philadelphia, PA). WoS is a well-known, rich, and widely used scientific literature database for bibliometric analysis studies (Falagas et al., 2008). Documents were retrieved by searching (Topic Search = "Governance" AND = "Sustainable Development") in the field "Topic", which searches in the title, abstract, author keywords, and keywords plus. The search was conducted on January 1, 2023, and filtered to include articles, review articles, book chapters, and proceeding papers, resulting in 8,193 documents, which span 30 years of scientific output (1992-2022). All available information (metadata) regarding the published documents- abstract, keywords, author(s), affiliations information, publication year, subject area(s), journals/publication titles, publishers, and funding agencies- were extracted.
- ***Phase 2. Performance Analysis***. In this phase, a performance analysis was carried out on the retrieved documents to evaluate the contributions of the research constituents under study (Donthu et al., 2021). Various software tools were utilized in this and subsequent phases to manage, process, and analyze the extracted bibliometric data, including Stata, VOSviewer, and the Bibliometrix R-package. VOSviewer, a free tool designed for constructing and visualizing bibliometric networks, was used to generate co-citation, co-

country, and co-word networks (Van Eck and Waltman, 2020). The R programming environment was employed to run the open-source packages Bibliometrix and Biblioshiny. Bibliometrix facilitates a comprehensive analysis and processing of scientific literature, while Biblioshiny, a web-based application, enables users to perform detailed bibliometric and visual analyses (Aria and Cuccurullo, 2017).

- ***Phase 3. Network Mapping and Visualization Analysis.*** This stage utilizes science mapping techniques to look at the intellectual structure through bibliometric maps and goes in depth in analyzing the intellectual interaction and uncovering the structural connections among research constituents (Andersen, 2021; Donthu et al., 2021).

4. Results and Discussion

4.1 General Descriptive Analysis

With an average annual growth rate of 23.4%, 8,193 research publications on "Governance and Sustainable Development" have been released, which span 30 years of scientific output (1992-2022) and resulting in more than 135,400 citations (on average 16.5 citations per document). Despite the research period spanning 30 years of scientific output, the number of publications has increased dramatically during the last five years (2018-2022), representing more than 60% of the total publications (TP). **Figure 2** indicates a considerable increasing trend in total publications (TC) and yearly citations. A more descriptive analysis of the publication and citation structure is presented in **Table 1**.

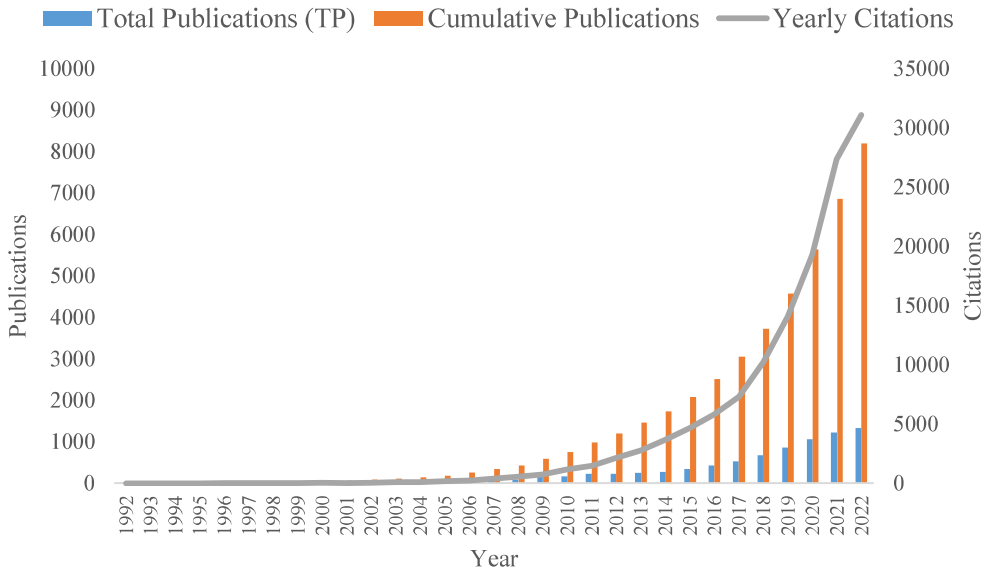

Figure (2). Times Cited and Publications Over Time

Table (1): Governance and Sustainable Development's Publications and Citation Structure

Year	TP	% of 8,193	TC	ATC Per Doc.	ATC Per Year
1992	1	0.01	40	40	1.29
1993	0	0.00	0	0	0.00
1994	3	0.04	11	3.67	0.13
1995	3	0.04	37	12.33	0.44
1996	3	0.04	34	11.33	0.42
1997	9	0.11	127	14.11	0.54
1998	10	0.12	224	22.4	0.90
1999	8	0.10	85	10.63	0.44
2000	15	0.18	1,026	68.4	2.97
2001	16	0.20	419	26.19	1.19
2002	17	0.21	1,927	113.35	5.40
2003	22	0.27	624	28.36	1.42
2004	37	0.45	1,486	40.16	2.11
2005	41	0.50	2,641	64.41	3.58
2006	80	0.98	3,079	38.49	2.26
2007	77	0.94	2,180	28.31	1.77
2008	87	1.06	3,949	45.39	3.03
2009	161	1.97	4,033	25.05	1.79
2010	166	2.03	6,401	38.56	2.97
2011	223	2.72	7,851	35.21	2.93
2012	223	2.72	6,497	29.13	2.65
2013	258	3.15	7,967	30.88	3.09
2014	276	3.37	8,541	30.95	3.44
2015	345	4.21	7,340	21.28	2.66

2016	433	5.29	8,736	20.18	2.88
2017	535	6.53	11,283	21.09	3.52
2018	677	8.27	13,012	19.22	3.84
2019	855	10.44	14,127	16.52	4.13
2020	1,059	12.93	12,508	11.81	3.94
2021	1,219	14.88	7,285	5.98	2.99
2022	1,334	16.28	2,012	1.51	1.51
Total	**8,193**	**100**	**135,482**	**16.5**	**0.53**

Note(s): TP = Total Number of Publications; TC = Total Number of Citations of Publications of Each Year during 1992-2022; ATC Per Doc.= Average Total Citations Per Document; ATC Per Year = Average Total Citations Per Year

4.2 Top Contributors Channels

4.2.1 Prolific Countries and Institutions

Table 2 presents the most productive countries on "Governance and Sustainable Development." Countries are ranked according to TP, and in the case of a tie, TC is used. The findings indicate that China has the highest contribution among all contributing countries, with 1,386 publications, representing around 17% of the TP. The United Kingdom and the United States are the next most productive countries, with 1,069 and 1,066 publications, respectively. Overall, the top 10 countries represent more than 86% of the total publications worldwide. In terms of TC, the United Kingdom has the highest TC, followed by the United States and the Netherlands. Despite China having the highest TP, it has the lowest average total citation per document compared to the top listed countries, and the Netherlands is at the top, followed by Sweden and the United Kingdom. Among the top 10 contributing countries, six belong to Europe, 2 to North America, 1 to Asia, and 1 to Oceania. Countries from South America and Africa are also represented, signifying increasing interest in this field of research worldwide. South Africa ranks 12th and Brazil is 13th. Each generates around 3% of the TP.

Table (2): Top 10 Prolific Countries on Governance and Sustainable Development Research

No	Country	Region	TP	% of 8,193	TC	ATC Per Doc.	Most Productive Academic Institution
1	China	Asia	1,386	16.9%	12,892	9.3	Chinese Academy of Sciences
2	United Kingdom	Europe	1,069	13.0%	32,083	30	University of London
3	United States	North America	1,066	13.0%	27,318	25.6	University of California System
4	Australia	Oceania	637	7.8%	17,356	27.3	University of Queensland
5	Germany	Europe	623	7.6%	14,329	23	Helmholtz Association
6	Netherlands	Europe	533	6.5%	18,287	34.3	Wageningen University Research
7	Canada	North America	519	6.3%	13,705	26.4	University of British Columbia
8	Spain	Europe	430	5.2%	8,046	18.7	Autonomous University of Barcelona
9	Italy	Europe	428	5.2%	6,365	14.9	Sapienza University Rome
10	Sweden	Europe	405	4.9%	12,687	31.3	Stockholm University

To investigate and analyze the country collaboration network, VOSviewer was utilized for generating clusters and analyzing the network (**Figure 3**). Countries with a minimum of 5 publications were included, yielding 114 countries and 2,189 connections. The size of each node indicates the number of documents of each country, while lines represent co-occurrence between every two countries and appear in our case when countries co-occur at least once. Clusters represent sets of closely related countries, and countries that co-occur more tend to be closer to each other. Eight clusters were generated. Although the clusters show the diversity of countries that co-occur, there is some categorization according to regional/geographic positioning and language. **Figure 4** depicts the overlaid country collaboration network. Asian and African countries have recently contributed and collaborated with others, including Egypt, Qatar, Saudi Arabia, and Pakistan.

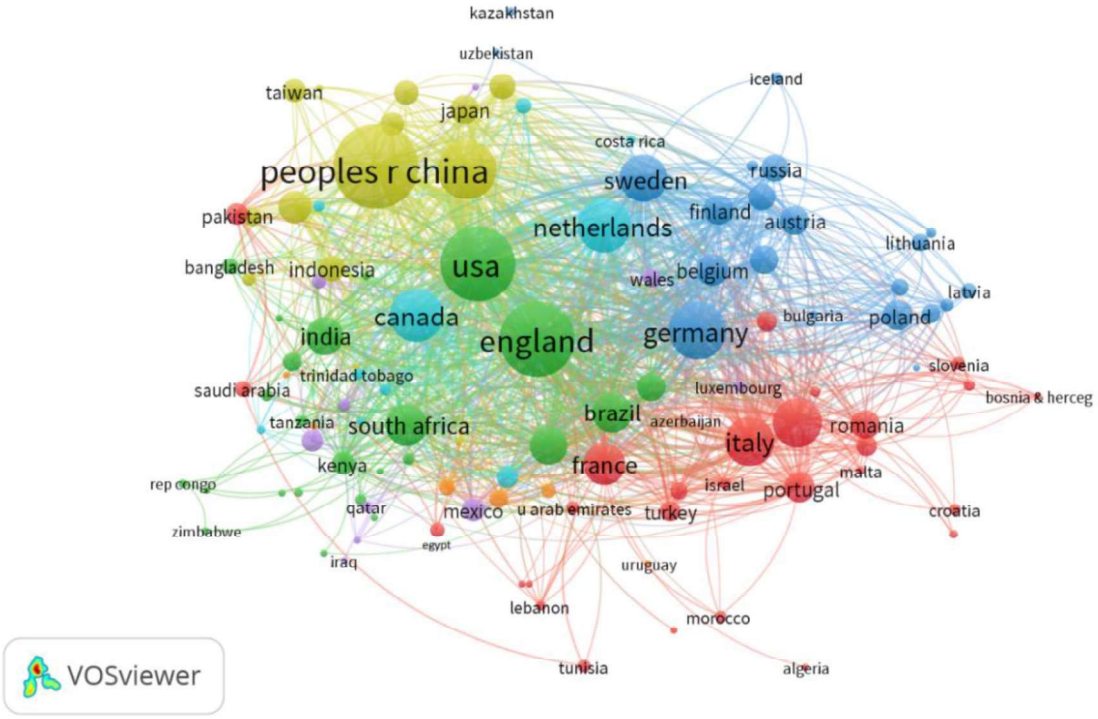

Figure (3). Country collaboration network

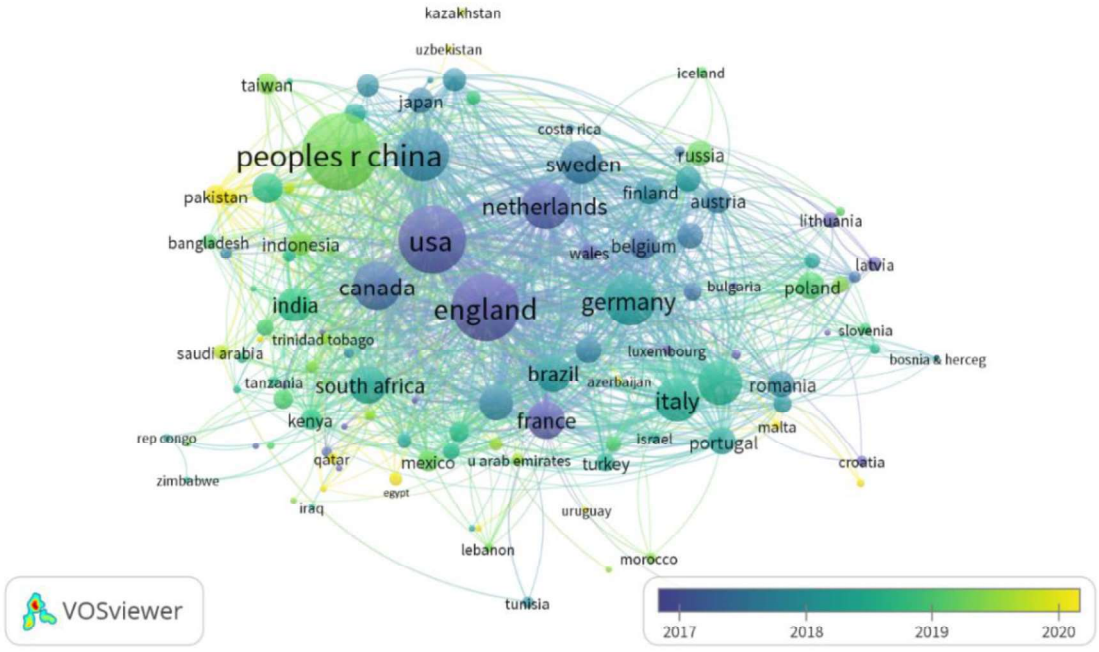

Figure (4). Overlaid country collaboration network

Table 3 presents the ten most productive institutions in terms of TP. The findings indicate that the University of London (United Kingdom) has contributed the highest TP with 171 publications, followed by Wageningen University & Research and Utrecht University (Netherlands) with 113 and 106 publications, respectively. On the other hand, Stockholm University (Sweden) has received the highest number of citations with a total of 4,999, followed by the University of London (United Kingdom) and Wageningen University & Research (Netherlands) with 4,985 and 4,316 citations, respectively. Stockholm University (Sweden) also has the highest average citation per publication, followed by the University of Oxford (United Kingdom), Australian National University (Australia), and the University of Cape Town (South Africa). Regarding the h-index, the publications published by Wageningen University & Research attract the highest H-Index, equal to 34, indicating that of the 113 documents considered for the h-index, 34 have been cited at least 34 times. The 20 top academic and research institutions represent around 19% of the total publications.

Table (3): Top 20 Academic and research institutions.

Rank	Institution	Country	TP	% of 8,193	TC	ATC Per Doc.	H-Index
1	University of London	United Kingdom	171	2.09%	4,985	29.15	33
2	Wageningen University & Research	Netherlands	113	1.38%	4,316	38.19	34
3	Utrecht University	Netherlands	106	1.29%	2,847	26.86	29
4	Chinese Academy of Sciences	China	105	1.28%	1,907	18.16	21
5	Consultative Group for International Agricultural Research (CGIAR)	-	92	1.12%	2,336	25.39	26
6	Helmholtz Association	Germany	84	1.03%	2,264	26.95	27
7	Stockholm University	Sweden	83	1.01%	4,999	60.23	31
8	University of California System	United States	82	1.00%	2,892	35.27	27
9	University of Queensland	Australia	79	0.96%	2,706	34.25	25

Rank	Institution	Country	TP	% of 8,193	TC	ATC Per Doc.	H-Index
10	University of Oxford	United Kingdom	71	0.87%	2,977	41.93	26
11	University College London	United Kingdom	68	0.83%	2,664	39.18	19
12	University of British Columbia	Canada	66	0.81%	2,498	37.85	27
13	Lund University	Sweden	64	0.78%	2,185	34.14	24
14	Australian National University	Australia	61	0.74%	2,426	39.77	23
15	Centre National De La Recherche Scientifique (CNRS)	France	59	0.72%	1,378	23.36	19
16	UDICE French Research Universities	France	58	0.71%	1,632	28.14	17
17	University of Leeds	United Kingdom	58	0.71%	1,774	30.59	21
18	University of Cape Town	South Africa	56	0.68%	2,426	39.77	23
19	University of São Paulo	Brazil	55	0.67%	499	9.07	12
20	University of Waterloo	Canada	55	0.67%	1,651	30.02	19

4.2.2 Productive Journals and Publishers

The 8,193 publications were published in distinct journals, various books, and conference proceedings. **Table 4** presents an overview of the top 20 journals with the highest rates of publications. The top 20 most influential journals published 1,149 articles from 1997 to 2022, roughly accounting for 26% of the TP and resulting in more than 40,000 TGC_{WoS}.

The findings demonstrate that seven journals of the top listed are owned by ELSEVIER, followed by MPDI (4), Wiley (3), Springer (3), Taylor & Francis (1), Resilience Alliance (1), and Frontiers Media (1). The Journal of *Sustainability* (MPDI) is at the top of the list, with the highest number of publications (775, accounting for 9% of TP), followed by the *Journal of Cleaner Production* (Elsevier), and *Sustainable Development* (Wiley), with 204 (2.5%)

and 126 (1.5%), respectively. *Sustainability, and Journal of Cleaner Production* have the highest TGC_{WoS}, followed by *Business Strategy and the Environment* (Wiley) and *Ecology and Society* (Resilience Alliance). Examining the impact factor of these journals, the *Journal of Cleaner Production* (11.07) is in the lead, followed by *Business Strategy* (10.801) and *Science of the Total Environment* (10.754). Despite *Sustainability* having the highest TP and TGC_{WoS}, it is a low-impact journal compared to the other listed journals (4.089) and has ranked 19th on the list. On the other hand, the Journal of *Science of the Total Environment* is among the high-impact journals; however, it ranked 18th in the list based on TP.

Figure 5 shows the journals in which the articles are published and demonstrates the results of co-citation analysis in the governance and sustainable development nexus. This was performed to cluster the journals based on cited sources using VOSviewer. The journals are the units of analysis that are represented by their names in circles. The higher the weight of the journal, the larger the circle and label of the journal (Van Eck and Waltman, 2020). For pictorial brevity, the map was drawn based on a particular criterion, i.e., having at least 100 citations.

The connections among the journals on the map are shown through the lines, and the distance shows the relatedness of journals in terms of co-citations. The journals are grouped into clusters of five colors. It is shown that the governance and sustainable development nexus literature is broadly published in the journals related to the fields of economics, management, and business (green cluster), environmental planning and sustainable development (red cluster), global environmental change (blue cluster), food security and public health (yellow cluster) and sustainable tourism (purple cluster). These results are coherent with **Table 4**.

Finally, the top 10 publishers are presented in **Table 5**. ELSEVIER has the largest TP, with 1,508 (18% of the total publications), followed by MPDI with 1,091 (13%). The 1st five listed publishers accounted for more than 61% of the total publications, namely Taylor & Francis, Sage, Wiley, Elsevier, and Springer Nature. The highest citation is exhibited by ELSEVIER, with 45,112, and it has the greatest H-index (92) among the top 10 publishers, followed by WILEY, with 20,182 TC and H-Index equal to 66.

Table (4): Top 20 most productive journals on Governance and Sustainable Development

Rank	Journal	Publisher	Region	TP	% of 8,193	TGCwos	2021 IF
1	Sustainability	MDPI	SWITZERLAND	775	9.459	8,608	3.889
2	Journal of Cleaner Production	ELSEVIER SCI LTD	USA	204	2.49	6,362	11.07
3	Sustainable Development	WILEY	ENGLAND	126	1.538	2,344	8.562
4	Business Strategy and the Environment	WILEY	USA	103	1.257	3,912	10.80
5	Marine Policy	ELSEVIER SCI LTD	ENGLAND	90	1.098	1,398	4.315
6	Environmental Science & Policy	ELSEVIER SCI LTD	USA	85	1.037	2,798	6.424
7	Corporate Social Responsibility and Environmental Management	WILEY	ENGLAND	79	0.964	2,048	8.464
8	International Journal of Environmental Research and Public Health	MDPI	SWITZERLAND	66	0.806	379	4.614
9	Ecology and Society	RESILIENCE ALLIANCE	CANADA	60	0.732	2,811	4.653
10	Land Use Policy	ELSEVIER SCI LTD	ENGLAND	60	0.732	1,221	6.189
11	Frontiers In Environmental Science	FRONTIERS MEDIA SA	SWITZERLAND	58	0.708	515	5.411
12	Water	MDPI	SWITZERLAND	54	0.659	768	3.530
13	Environmental Science and Pollution Research	SPRINGER HEIDELBERG	GERMANY	53	0.647	306	5.190
14	Land	MDPI	SWITZERLAND	52	0.635	679	3.905
15	Sustainability Science	SPRINGER JAPAN KK	JAPAN	51	0.622	1,673	7.196
16	Ocean & Coastal Management	ELSEVIER SCI LTD	ENGLAND	47	0.574	999	4.295
17	Environment, Development and Sustainability	SPRINGER	NETHERLANDS	46	0.561	389	4.080
18	Science of the Total Environment	ELSEVIER	NETHERLANDS	41	0.5	1,312	10.754
19	Journal of Environmental Management	ACADEMIC PRESS LTD-ELSEVIER SCIENCE LTD	ENGLAND	40	0.488	1,346	8.910
20	Journal of Sustainable Tourism	ROUTLEDGE JOURNALS, TAYLOR & FRANCIS LTD	ENGLAND	38	0.464	1,588	9.470

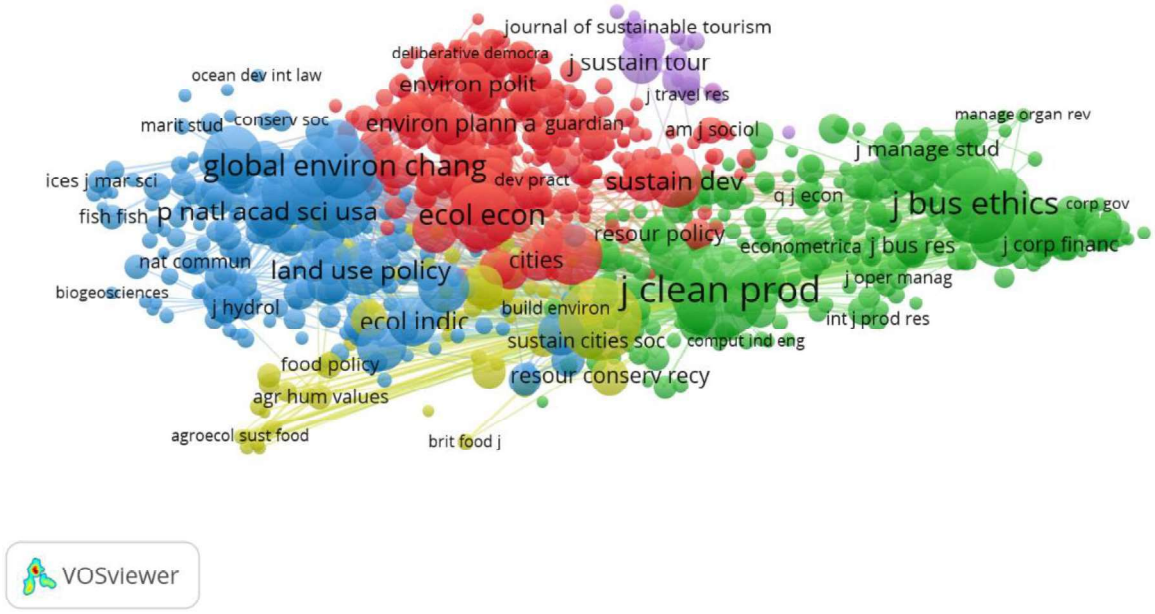

Figure (5). Co-Citation of cited sources

Table (5): Top 10 Publishers by Total Publications

Rank	Publishers	Total Pub.	% of 8,193	TC	H-Index
1	ELSEVIER	1508	18.41	45,112	92
2	MDPI	1091	13.32	10,946	42
3	SPRINGER NATURE	919	11.22	14,746	48
4	TAYLOR & FRANCIS	783	9.56	12,617	48
5	WILEY	714	8.72	20,182	66
6	EMERALD GROUP PUBLISHING	347	4.24	4,547	32
7	SAGE	237	2.89	6,800	38
8	FRONTIERS MEDIA SA	160	1.95	1,382	19
9	CAMBRIDGE UNIV PRESS	83	1.01	740	14
10	ROUTLEDGE	68	0.83	308	6

4.3 Top Prolific Authors

The most prolific authors in terms of publications among the many authors that have contributed to the governance and sustainable development research over time are included in **Table 6**, along with other citation and publication metrics. The authors are ranked according to their TP, and in the case of a tie, TC is used. Biermann has contributed the highest number of publications, with 29 publications with 895 total citations by the scientific community. Gupta and Kim are next on the list, with 17 and 14 publications, respectively. With four articles, Ingrid is the most productive solo

author, followed by Glasbergen Pieter with three solo authorized articles. In terms of citations, Kanie is the most impactful and influential author, with 1,006 citations, followed by Biermann, with 895 citations. Kanie's publications are cited in the scientific community, with an average of 91.45 citations per publication, which is the highest among all listed authors, followed by Garcia-Sanchez, with 80.4 citations per publication, indicating the high impact and influence of both in the scientific community. In terms of the h-index, Biermann has the highest local h-index, followed by Gupta, with 13 and 10, respectively.

Table (6): Top 10 Productive Authors

No	Author	TP	SAP	TC	TC/TP	H-Index
1	Biermann, Frank	29	1	895	30.9	13
2	Gupta, Joyeeta	17	2	450	26.47	10
3	Kim, Rakhyun E.	14	1	646	43.07	9
4	Kalfagianni, Agni	13	1	338	26	5
5	Visseren-Hamakers, Ingrid J.	12	4	289	24.08	10
6	Leal Filho, Walter	12	0	217	18.08	6
7	Kanie, Norichika	11	0	1,006	91.45	9
8	Glasbergen, Pieter	10	3	431	43.1	9
9	Geng, Yong	10	0	150	15	6
10	Garcia-Sanchez, IM	10	0	804	80.4	9

Note(s): TP = Total Publications, SAP = Sole-Authored Publications, TC = Total Citations, TC/TP Citations Per Publication.

Finally, to investigate and analyze the co-authorship network, VOSviewer was utilized for generating clusters and analyzing the network (**Figure 6**). Authors with a minimum of five publications were included, leading to a network of 39 authors representing the most extensive set of connected authors who contributed to the topic. A node represents an author, and lines connecting authors indicate that two authors are co-authors, at least once. The size of each node shows the number of documents of each author. The thicker the link, the greater the cooperation. There are 98 links between the 39 authors, with a total link strength of 170. Clusters represent sets of closely related authors, and authors that co-occur more tend to be closer to each other. The visualization

of the co-authorship network reveals 8 clusters of co-authorship with major clustering around Biermann F. (Utrecht University, Netherlands), with a total link strength of 52. On the other hand, the figure shows isolated clusters to some extent, indicating low cooperation. **Figure 7** depicts the overlaid co-authorship network, confirming the great interest of the scientific community during the last five years.

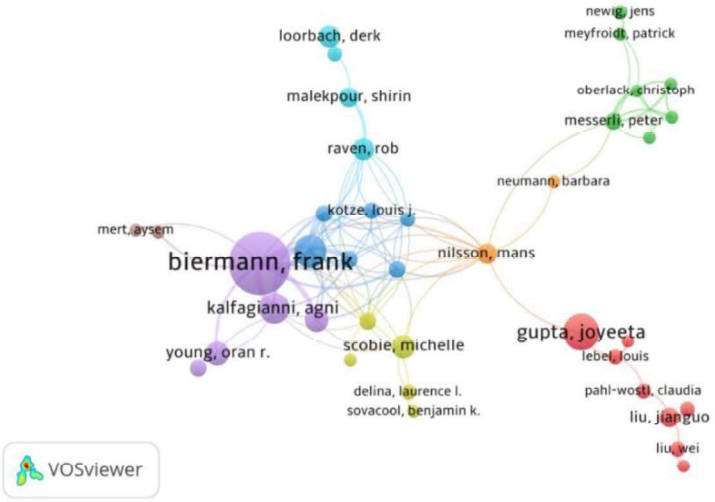

Figure (6). Co-authorship network

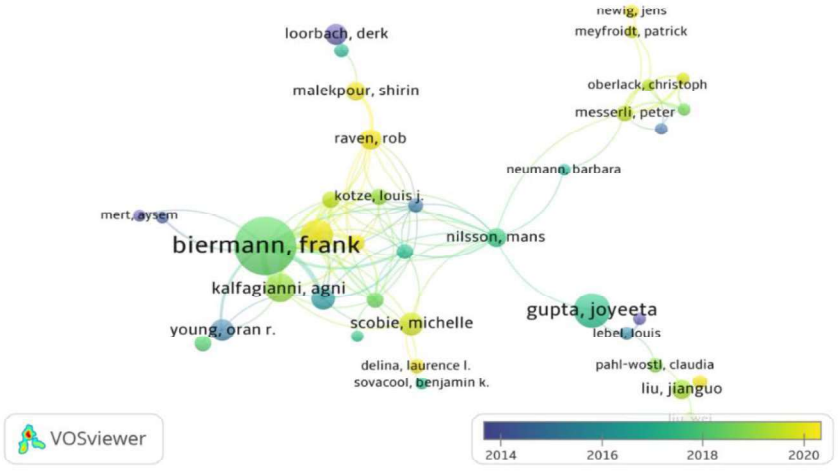

Figure (7). Overlaid co-authorship network

Additionally, the top publications by global citation are presented and ranked in **Table 7**. TC measures a scientific publication's impact or influence on the scientific community. Global citations measure the number of citations a document has received from documents contained in the entire database (WoS). It therefore measures the impact of a document on the whole bibliographic database. TC Per Year is another measure calculated as the total number of citations per year for each article.

The paper "Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations" by Folke et al. (2002) is the most impactful publication among the reviewed articles. It has attracted 1,603 citations and an average of 72.9 citations per year. This article summarizes a report prepared by the Swedish Government's Environmental Advisory Council as input for the World Summit on Sustainable Development (WSSD), which took place in Johannesburg, South Africa, from August 26 to September 4, 2002. Folke employed the idea of resilience-the capacity to adapt, learn, and develop-as a framework for comprehending how to maintain and improve adaptive capacity in a challenging environment of quick changes. They argue that structured scenarios and active adaptive management are two useful tools for resilience-building in social-ecological systems. In addition, these tools need a social environment with adaptable, open institutions and multi-level governance systems that promote learning and boost adaptive ability without restricting alternatives for future development, as well as facilitating such a context.

The study of Frank W. G. (2011)- The Multi-Level Perspective on Sustainability Transitions: Responses to Seven Criticisms- is next on the list. It has garnered a total of 1,272 citations and the highest average of citations per year (97.85). In this article, seven criticisms for the multi-level perspective (MPL) are summarized, rebuttals are made, and recommendations for additional study are made. The criticisms center around the following issues: (1) a lack of agency; (2) operationalization of regimes; (3) bias in favor of bottom-up change models; (4) epistemology and explanatory style; (5) methodology; (6) socio-technical landscape as residual category; and (7) flat ontologies versus hierarchical levels. The 3rd article, entitled "The Governance of Sustainable Socio-

Technical Transitions" by Smith et al. (2005) has gained 1,162 citations and attracted an average of 61.16 citations per year. They discussed how the power to affect change relies on regime membership, the distribution of resources for change, and expectations for the future.

Moreover, to investigate the relationships among citing publications to understand the periodic/ present development of themes in this field of research, a bibliographic coupling network was delineated using VOSviewer. It is a scientific mapping technique, assuming that any two publications that share standard references are similar to some extent in content (Kessler, 1963). Accordingly, it splits publications into thematic clusters according to the shared references (Zupic and Čater, 2015). Unlike co-citation analysis, recent and niche publications can gain visibility through bibliographic coupling. Therefore, this technique is suitable for uncovering a broad spectrum of themes of governance and sustainable development research and its latest developments in a specific time and domain.

Figure 8 depicts the top 50 cited documents. They are divided into 5 clusters. "Transition management," "sustainable transition," and "sustainability" are the core of 1st cluster (red), "adaptive capacity to change through accumulated knowledge" is the core of 2nd cluster (green), "global governance," and "climate change" are the core of the 3rd cluster (blue), "eco-restructuring for sustainable development" is the core of the 4th cluster (yellow), and "corporate social responsibility" is the core of the 5th cluster (purple).

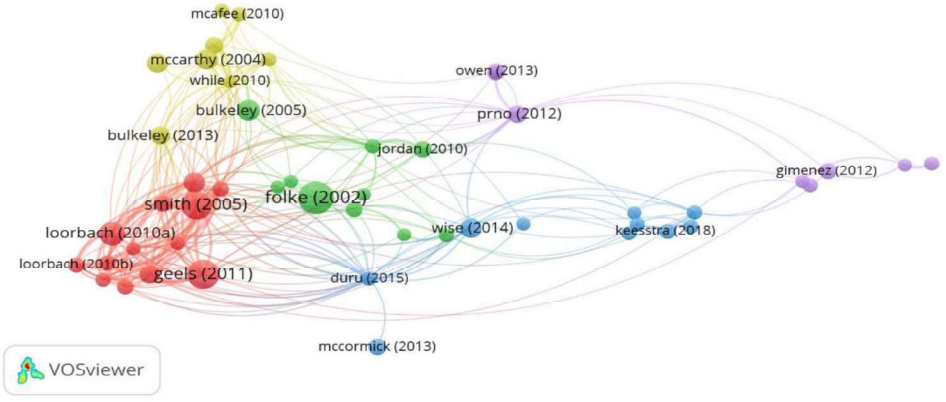

Figure (8). Research themes clusters

Table (7): Top Cited Publications on Governance and Sustainable Development

Rank	Article Title	Author(s)	Pub. Year	Source Title	Publisher	TC (WOS, All Databases)	TC Per Year
1	Resilience and Sustainable Development: Building Adaptive Capacity in A World of Transformations	Folke, C; Carpenter, S; Elmqvist, T; Gunderson, L; Holling, CS; Walker, B	2002	AMBIO: A Journal of the Human Environment	ROYAL SWEDISH ACADEMY OF SCIENCES	(1,603, 1665)	72.86
2	The Multi-Level Perspective on Sustainability Transitions: Responses to Seven Criticisms	Geels, Frank W.	2011	Environmental Innovation and Societal Transitions	ELSEVIER	(1,272, 1,294)	97.85
3	The Governance of Sustainable Socio-Technical Transitions	Smith, A; Stirling, A; Berkhout, F	2005	Research Policy	ELSEVIER	(1,162, 1,178)	61.16
4	Transition Management for Sustainable Development: A Prescriptive, Complexity-Based Governance Framework	Loorbach, Derk	2010	Governance-An International Journal of Policy Administration and Institutions	WILEY	(812,824)	58.00
5	Neoliberal Nature and The Nature of Neoliberalism	McCarthy, J; Prudham, S	2004	GEOFORUM	ELSEVIER	(647, 651)	32.35
6	Reconfiguring Environmental Governance: Towards A Politics of Scales and Networks	Bulkeley, H	2005	Political Geography	ELSEVIER	(620, 635)	32.63
7	Smartmentality: The Smart City as Disciplinary Strategy	Vanolo, Alberto	2014	Urban Studies	SAGE	(573, 586)	57.30
8	What About the Politics? Sustainable Development, Transition Management, And Long-Term Energy Transitions	Meadowcroft, James	2009	Policy Sciences	SPRINGER	(561, 562)	37.40
9	Reconceptualising Adaptation to Climate Change as Part of Pathways of Change and Response	Wise, R. M.; Fazey, I.; Smith, M. Stafford; Park, S. E.; Eakin, H. C.; Van Garderen, E. R. M. Archer; Campbell, B.	2014	Global Environmental Change-Human and Policy Dimensions	ELSEVIER	(555, 560)	55.50
10	Government By Experiment? Global Cities and The Governing of Climate Change	Bulkeley, Harriet; Broto, Vanesa Castan	2013	Transactions of the Institute of British Geographers	WILEY	(541, 549)	49.18

4.4 Author Keywords, Core Topics, and Hotspots

This subsection presents the core research topics and highlights the emerging trends-hotspots for governance and sustainable development research through co-word analysis techniques using VOSviewer. The keywords and their average year of publication identify the emerging trends-hotspots, while fewer occurrences reveal niche areas (Khudzari et al., 2018). Initially, 496 keywords were recorded, the various synonyms/variants keywords were re-labeled using a thesaurus, and 423 keywords were obtained that met the threshold of a minimum of 10 occurrences and were linked to each other.

The results in Figure 9 reveal that sustainable development with an average publication year of 2017 is the most reflected keyword with 2,045 occurrences, 403 links to other keywords, and a total link strength of 3,579. The 2030 Sustainable Development Goals (SDGs) agenda and governance are next on the list, with 908 (350) and 831 (348) occurrences (links), respectively. These three top keywords are in the center of the network. Similarly, other frequent keywords are sustainability (640), corporate social responsibility (321), climate change (291), stakeholder(s) engagement (184), adaptive capacity (176), corporate governance (152), environmental governance (152), smart cities (101), environmental policies (95), ecosystem services (95), institutional theory (89), innovation (81), sustainable urban development (78), and global governance (77), which are essential keywords connected to the research of governance and sustainable development.

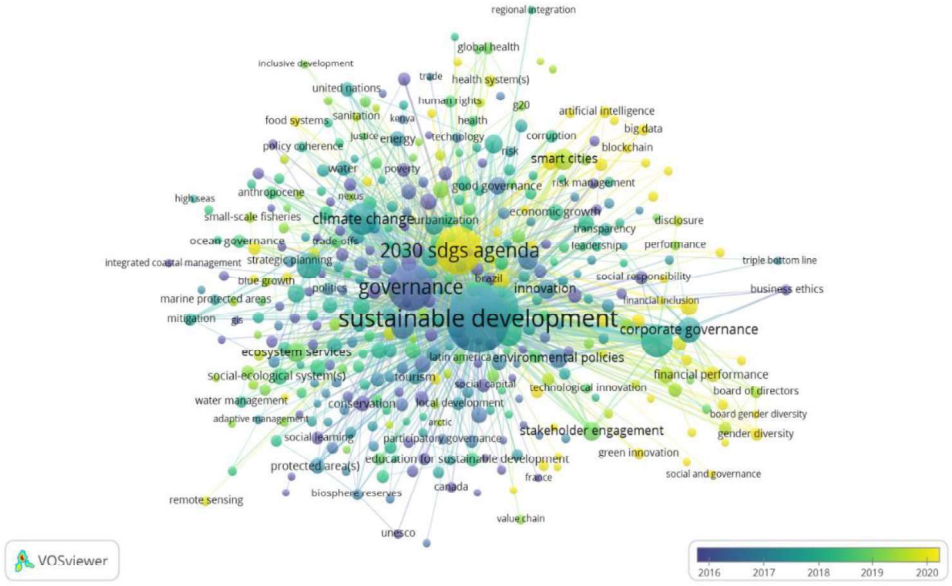

Figure (9). Overlaid author keyword co-occurrence network

Moreover, the link strength between the following keywords is more significant than other keywords: Sustainable Development ⇔ Governance (256), Sustainable Development ⇔ Corporate Social Responsibility (136), Governance ⇔ Sustainability (109), Governance ⇔ the 2030 SDGs Agenda (103), Sustainable Development ⇔ Sustainability (100), Sustainability ⇔ the 2030 SDGs Agenda (86), Sustainable Development ⇔ the 2030 SDGs Agenda (84), Sustainable Development ⇔ Climate Change (82), Sustainable Development ⇔ Stockholder(s) Engagement (80), Sustainable Development ⇔ Corporate Governance (63). This depicts that, among other topics, most of the research is carried out in this connection in the governance and sustainable development nexus. However, while specific keywords are connected through single or several links, others are rarely linked and should be the focus of future research, such as green development, rural revitalization, urban regeneration, spatial governance, reflexive governance, resource governance, and financial inclusion, among others.

Based on the keyword co-occurrence analysis of the bibliometric knowledge maps, Table 8 lists the potential emerging, most recently used, and hotspot topics in the

governance and sustainable development nexus. It highlights various features of the keywords, such as total link strength, number of occurrences, average citations, and average normalized citations.

The findings indicate that *rural revitalization* ranks highest based on the average publication year (2022), with a total link strength of 12 and 10 occurrences. If the number of occurrences, link strength, and the average publication year are low yet very recent, this suggests that the area should be a critical focus for future research avenues.

This is followed by *green innovation* (2021, 32, 26), *green finance* (2021, 30, 13), *COVID-19* (2021, 142, 69), *corporate financial performance* (2021, 23, 12), *smart governance* (2021, 34, 14), *digital transformation* (2021, 74, 30), *machine learning* (2021, 28, 13), *environmental, social, and governance (ESG)* (2021, 180, 89), and *board gender diversity* (2021, 20, 11).

Table (8): Governance and sustainable development nexus hotspots (based on avg. pub. year)

Rank	Keyword/Term	Total Link Strength (Links)	Occurrences	Avg. Pub. Year	Avg. Citations
1	Rural Revitalization	12(8)	10	2022	7.20
2	Green Innovation	32 (17)	26	2021	10.27
3	Green Finance	30 (17)	13	2021	7.69
4	Covid-19	142 (78)	69	2021	6.03
5	Corporate Financial Performance	23 (14)	12	2021	6.58
6	Smart Governance	34 (20)	14	2021	12.29
7	Digital Transformation	74 (45)	30	2021	7.60
8	Machine Learning	28 (20)	13	2021	8.15
9	Environmental, Social, and Governance (ESG)	180 (57)	89	2021	11.03
10	Board Gender Diversity	20 (12)	11	2021	14.55
11	Evolutionary Game	13 (12)	10	2021	8.20
12	Firm Performance	19 (14)	10	2021	18.60
13	Green Development	5 (5)	11	2021	6.09
14	Multi-Stakeholder Partnerships	36 (23)	12	2021	8.42
15	Artificial Intelligence	62 (34)	25	2021	18.88
16	Gender Equality	29 (20)	15	2021	3.53
17	Belt And Road Initiative	22 (16)	10	2021	5.80
18	Inclusive Growth	31 (24)	11	2021	7.36
19	Carbon (CO_2) Emissions	44 (28)	25	2021	5.92
20	Blue Economy	63 (32)	33	2021	13.97

Table 9 depicts the areas that are highly cited in recent research on governance and sustainable development, especially in the last eight years. As shown, transition management is at the top of the list based on average publication year (2014) with a total link strength of (55) and its number of occurrences of (24). Followed by politics (2017, 63, 24), reflexive governance (2016, 31, 10), adaptive management (2017, 31, 12), and science-policy interface (2018, 30, 13). Among the 20 list keywords, the following keywords are the most recent and have high average citations: nature-based solutions (2021, 49, 17), bioeconomy (2020, 52, 20), water-energy-food nexus (2019, 52, 20), agroecology (2019, 31, 11), global reporting initiative (GRI) (2019, 34, 15), sustainability transitions (2018, 31, 23), human well-being (2018, 32, 13), and science-policy interface (2018, 30, 13).

Table (9): Governance and sustainable development nexus hotspots (based on avg. citations)

Rank	Keyword/Term	Total Link Strength (Links)	Occurrences	Avg. Pub. Year	Avg. Citations
1	Transition Management	55(37)	24	2014	130.46
2	Politics	63 (44)	24	2017	75.08
3	Reflexive Governance	17 (11)	10	2016	71.90
4	Adaptive Management	31 (24)	12	2017	66.25
5	Science-Policy Interface	30 (21)	13	2018	51.23
6	Sustainability Transitions	31 (29)	23	2018	51.00
7	Political Ecology	57 (40)	23	2017	47.39
8	Water-Energy-Food Nexus	52 (32)	20	2019	46.50
9	Mitigation	87 (32)	28	2018	46.29
10	Agro-ecology	31 (26)	11	2019	46.09
11	Environmental Policy Integration	34 (29)	12	2015	45.75
12	Bioeconomy	27 (20)	16	2020	45.63
13	Political Economy	27 (22)	13	2016	45.62
14	Policy Coherence	48 (27)	19	2018	43.84
15	Nature-Based Solutions	49 (31)	17	2021	43.59
16	Human Well-Being	32 (19)	13	2018	42.62
17	Sustainable Consumption and Production	35 (25)	20	2018	42.60
18	Supply Chain Management	70 (39)	31	2017	41.74
19	Co-Production	44 (27)	14	2018	41.50
20	Global Reporting Initiative (GRI)	34 (19)	15	2019	41.40

4.5 Directions for Future Research

Through bibliometrics, insights into future research directions on governance and sustainable development are investigated in this study. Future studies can discuss more governance strategies and tools for monitoring and evaluating performance in different sectors, representing the core of more than one of the SDGs. For instance, smart governance is one of the trendy topics. It is about the use of technology and innovation for facilitating and supporting enhanced decision-making and planning through smart strategies. It is one of the smart cities' components, including a smart economy, smart mobility, smart environment, smart quality of life and smart people (Giffinger et al., 2007), related to the 2030 SDGs agenda. Accordingly, there is ample room for more research that tackles "Smart/Sustainable Cities," "Smart Governance," "e-governance," "e-government," "Citizen Participation," "Open Data and Transparency," and "Digital Transformation". Future studies could explore the impact of adopting e-governance on institutional performance across various sectors, with a specific focus on improving transparency, efficiency, and citizen engagement.

Social change and socio-economic inequalities in the communities that result from a society organized by hierarchies of class, race, and gender that unequally distributed access to services, resources, and rights, must be addressed. That is without neglecting the effect of new technology, which can be positive or negative. The impact of the environmental challenges on social life and the world economy can also be discussed. In this line, terms such as "green technology innovation," "green growth," "environmental governance," and "environmental goals" can be addressed. Therefore, the "green economy" is a good topic of research. Additionally, the terms "Rural Development," "Rural Revitalization," and "Smart Agriculture," can be more addressed in future research. These areas offer significant potential for contributing to SDGs by integrating innovative governance and digitalization strategies that address the needs of rural communities, not just the urban ones.

There is also ample room for more research on the linkage of "green economy," "green finance," "digital finance," "digital divide," and "technology." In addition, the terms "Blue Economy," "Blue Finance," and "Ocean Governance" are among the trendy and recent topics in this field, aiming to propose innovative ocean financing strategies for mitigating the effects of environmental challenges and unsustainable practices on ocean and coastal ecosystem-reliant communities and sectors.

Finally, "Big Data," "Artificial Intelligence (AI)," "the Internet of Things (IoT)," "GIS technologies," and "Geo-spatial tools" are among the emerging topics in governance, development, and innovation. Utilizing such modern technologies can improve governance and development outcomes by addressing country-level and global-level challenges more effectively. They offer pathways to a more equitable and efficient future of government and public administration. By using these tools, governments, policy makers, and stakeholders can make better-informed decisions through data-driven insights, ultimately contributing to a more sustainable and inclusive future. In addition, "Organizational Cybernetics (OC)," and "Big Data Cybernetics" for "Intelligence Governance" can also be applied further in this field of research for monitoring and evaluating global and local policies with the aim of achieving sustainable development: they can have a big impact on governance. The aim behind the concept of "cybernetics" is to understand and formalize the underlying principles of systems such as the living system and to employ feedback control and its vital mechanism to achieve its main purpose of survival (Zeini, 2023). In this line, concepts such as "Data Governance," "Data-Driven Policymaking," and "Knowledge for Governance" have emerged in recent studies. Indeed, the role of these technologies and tools in sustainable development and environmental protection is crucial. It is an open area of research.

5. Conclusion

Learning how the academic community is responding to the need for governance to achieve sustainable development is the objective of this study. This study aims, therefore, to comprehensively analyze the body of literature resulting from more than 30 years of research on the interlinkage between governance and sustainable development, to reveal the dynamics, trends, and progress over time, and to support researchers by identifying research gaps and opportunities for a future research agenda. Through a bibliometric analysis of 8,193 articles retrieved from the Web of Science (WoS) database, the key findings reveal that the dual theme is a fast-growing field with a trend in the diversification of research areas. The publications have increased dramatically in the last five years (2018-2022), representing more than 60% of the total publications. The research diversification reveals the multi-disciplinary nature of this field to enhance the overall quality of life of societies and individuals, which relates to the three pillars of sustainability: social, economic, and environmental sustainability, along with cultural sustainability.

Accordingly, this study suggests several avenues for future research, including rural revitalization, smart agriculture, environmental quality, smart quality of life, green economy and growth, green finance, green technology, innovation, spatial governance for inclusive development and growth, and e-governance in policy governance and sustainability toward sustainable development and the 2030 SDGs. In addition, future research could further explore "Big Data-driven Intelligence Governance" and "Big Data Cybernetics," as integrating modern technologies—such as big data, artificial intelligence (AI), and the Internet of Things (IoT)—is crucial for achieving sustainable development and environmental protection, and thus accomplishing the Sustainable Development Goals (SDGs) by 2030.

Finally, this paper has some limitations. On one hand, it remains limited to the precision of the bibliometric data gained for WOS. It may exclude valuable results that can be extracted from other scientific databases such as Scopus, Google Scholar, and

non-mainstream journals. On the other hand, the research from high-income countries is overrepresented in the WoS database, while low and middle-income countries are more marginalized. Low and middle-income countries usually face financial and linguistic barriers to accessing mainstream journals, that is, journals perceived to publish excellent research, which is typically indexed by the citation databases WoS and Scopus. Low and middle countries therefore publish in non-mainstream journals. Therefore, assigning greater value to non-mainstream journals should be considered. They have a role in bringing and disseminating potentially useful and novel knowledge. In addition, there is a need for a unified and consistent database that collects such databases effectively, which will lead to providing a larger range of results.

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