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A Comprehensive Review of the Geospatial Data Architecture Sharing

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Abstract
Geospatial data has grown at a rapid pace, marking a milestone in the evolution of the global effort to steward progress towards the economic, environmental, and social dimensions of sustainability, recognizing the importance of geospatial data in enabling informed, data-driven decision-making. Influences every aspect of the global community. This paper presents a bibliometric analysis of geospatial data sharing (GDS) research, highlighting the value that geospatial data offers in facilitating informed, data-driven decision-making. It uses bibliometric analysis tools to evaluate valid works on spatial data sharing. A review study of research papers on “geospatial data sharing” or “spatial data sharing” published between 1990 and 2022 was conducted. The newest trend topics related to spatial data sharing include grid computing, E-government application systems, Geographic Information Systems, transportation technologies, smart grids, business development, spatial data infrastructure, spatial data management, E-government, smart cities, and land use. The results show significant impact rates in studies of spatial data sharing. Overall, this study provides a field map, identifies research fronts, and outlines actionable priorities for scholars and policymakers.

Keywords: Bibliometric Study, Spatial Information Infrastructure, Spatial Data Sharing, Meta-Analysis, Information Mapping

1. Introduction

Geospatial data refers to features depicted on maps or arranged in digital databases that are linked to the earth’s surface by coordinates, addresses, or other mechanisms it’s referred to as spatial or geographic information (An *et al*., 2017; Brewer & Buttenfield, 2007; Citation, 2004; Coltekin *et al*., 2020; Islam *et al*., 2020; C. Zhang & Li, 2005) [3, 9, 17, 18, 31, 70]. Over 80% of all data is Geospatial data (A. Chen *et al*., 2010) [12]. Geospatial data can be a home with an address or a geodetic control monument with its latitude and longitude. A budget for an organisation is an example of non-geospatial data. Digitizing maps, classical surveying, and current positioning technologies employing GPS are all options for obtaining geospatial data (Norman & Idris, 2018; Sabah & Şimşek, 2017; Vretanos, 2010) [42, 49, 65]. Remote sensing techniques, such as airborne or space-borne platforms, can also collect geospatial data. They are then used to decide based on the information they have gathered (A. Chen *et al*., 2010) [12].

Satellite, drone, and big data geospatial information (mobile CDR (call details record), GPS trajectory data (Lwin *et al*., 2019) [37], wireless sensor network, and IoT (Internet of Things)) are critical to all disaster management operations, including disaster mitigation, preparedness, response, and mitigation (Lwin *et al*., 2019) [37]. Introducing a worldwide navigation system and wireless communication technologies revolutionised how we live and gain geospatial data in the field (Bai *et al*., 2007; Yeung & Hall, 2007) [7, 68]. For example, many IoT devices may collect and send geospatial data to IoT cloud servers or centralised geodatabases, and a vast amount of geospatial data streams from the data repository as a base map in the field (Lwin *et al*., 2019; Navarro-Carrión *et al*., 2016) [37, 41]. For efficient disaster planning and mitigation, it is critical to gather, share, and visualise all geographic data gained (Christin Walter, 2020; Lwin *et al*., 2019) [16, 37].

Geospatial data and Earth measurements, when coupled with socioeconomic and other statistical data, offer governments a unique source of information for policy development, monitoring, and assessment (*IMPROVING RETENTION OF STEM STUDENTS USING DATA MINING DESIGN : A QUANTITATIVE STUDY by Awatif Amin Copyright 2019 A Dissertation Presented in Partial Fulfillment Of the Requirements for the Degree Doctor of Management in Organizational Leadership with A*, 2019; Singh & Singh, 2014 [54]). These data, coupled with digital breakthroughs and industry innovations, will play a significant role in global stewardship, allowing decision-makers to access quicker, more accurate, and trustworthy information to influence choices, track progress and assess the effectiveness of actions (C. Zhang & Li, 2005) [70].

As a result, the authors ask what they have done scholarly efforts to analyse and characterise the condition of the field in terms of spatial data sharing. This research will concentrate on the present academic discussion and aim to identify important research and academics in the subject, as well as the overall publishing rate. Academics and professionals have been exploring and studying the many features of geospatial data in recent years (Christin Walter, 2020; Lwin *et al*., 2019) [16, 37].

Despite attempts to increase local data integration in spatial data infrastructures and the creation of policies based on public involvement, organisations and governments are familiar with receiving feedback from their stakeholders (Al Shamsi *et al*., 2011; Christin Walter, 2020; Elwood, 2008; Gao *et al*., 2008; Silva *et al*., 2011; Tschirner & Zipf, 2005) [2, 16, 21, 23, 53, 60]. Despite the use of GIS to provide access to geospatial data and technology, grassroots data consumers continue to have problems with the accessibility, quality, and use of local government data resources (Elwood, 2008) [21]. Academic evaluations are another major factor that explains the concern of the requirement of geographic data sharing standards.

The outcomes of publications published in geo-informatics, computers environment and urban systems, optical engineering, digital earth, geoscience and remote sensing, communications in computer and information system journals integrated and summarised in a complete review. Despite what the writers identified through literature evaluation, there is a low level of awareness of the key trends and topics in this field. To the author's knowledge, no previous study has examined articles utilising bibliometrics, particularly biblioshiny by R package to fully comprehend spatial data sharing in trend and their interest in various applications, projects, citizens and stakeholders' requirements (José de Oliveira *et al*., 2019) [34].

Existing review studies on geographic data sharing in various circumstances have been conducted in several countries. However, fewer studies look at prior research in indirect geographical data sharing via social media and direct spatial data sharing by the government, private sector, and organisations (Arshad & Hanifah, 2010; Bai *et al*., 2007; Christin Walter, 2020; Coltekin *et al*., 2020; J. Gong *et al*., 2004) [5, 7, 16, 18, 25]. As a result, the current study assesses the overall impact and productivity of these studies to determine whether other academics are focusing on this research and to highlight thematic areas of weakness.

The key contributions of this study include 1011 papers that contribute to the literature on geospatial data sharing, which is increasingly expanding across all fields. When the concentration on empirical inputs leads to vast, fragmented, and contentious research streams, it has a fit for scientific mapping. And this sort of research has never been done before in this field. To better comprehend the developments in geographic data sharing, many emerging motifs in these numerical variables have been found. By drawing on earlier spatial information sharing research's Bibliometrics discoveries.

The analysis of the outcomes of various geoscience and geospatial data sharing research follows the presentation of the key bibliometric statistics, drawing on Bibliometrics findings of earlier geoscience and geospatial data sharing research (van Eck & Waltman, 2014) [62]. Dimension networks, numerous fields such as organisations, groups of stakeholders, non-governmental organisations engaged in local governance, and participation have all been theorised in recent research. GIS stands for Geographic Information System, and it is a functional analysis process of maintaining enormous volumes of shared geographical data.

Bibliometrics may help you figure out what the most important quantitative factors are in a study stream (Lwin *et al*., 2019; Zupic & Čater, 2015) [37, 72]. It's also possible to use the recommended five-step science mapping process (Aria & Cuccurullo, 2017) [4]. It carried out the analysis using the R package "bibliometrix" (Aria & Cuccurullo, 2017) [4]. "Biblioshiny," a Shiny package that provides a web interface for bibliometrix, was also used to construct the subject hierarchical clustering, conceptual map, and trend-theme figure (Van Raan, 2003) [63]. We utilised a conceptual map to choose the major keywords to uncover more particular study subjects and to locate and read the most cited papers, allowing us to assess the most active geographical locations.

Finally, the structure of the document is as follows. The second part lists the most important and interesting works on the topic. Section 2 describes the technical steps. Section 3 presents the findings, Section 4 discusses the results, and Section 5 presents the conclusion and research direction, which cover all the major bibliometric factors. The final portion of the report concludes with future research.

2. Method

2.1 Bibliometric Processing and Mapping

Van Eck & Waltman, (2014) [62] explained that bibliometric mapping is a study issue in bibliometrics. There are two distinct bibliometric aspects: the generation of the bibliometric map and the graphical display of the map. In the bibliometric literature, the construction of bibliometric maps has received a lot of attention, and there is an impact of differences on size similarity as determined by various mapping approaches (van Eck & Waltman, 2010) [61]. Bibliometrics, in its graphical version got little attention, although some academics value graphical representation. Most bibliometric articles rely on computer programmes to generate basic graphical representations (Campra *et al*., 2021) [11]. Scopus is the world's biggest abstract indexing database, which can assist you in avoiding overlooking or excluding relevant publications from your research. This database also covers a wide range of topics and offers complex search capabilities to assist researchers in creating search strings that provide reliable results, particularly in broad domains (Campra *et al*., 2021) [11]. The processes involved in this study are: (1) Study Design, (2) Data Collection, (3) Data Analysis, (4) Data Visualisation, and (5) Data Interpretation.

2.2 Research Design

The research process begins with the formulation of three research questions. It found that the terms "spatial data" or "Geospatial data" and "sharing" are the most important keywords in the Scopus database. The two most prevalent approaches of picking keywords, according to (G. Chen & Xiao, 2016) [13] are, first, to use high-level publishing keywords, and then to use crucial keywords that reflect a broad area of research and its micro-level connections.

Applied the second technique in this paper: the terms "geospatial data" or "spatial data" and "sharing" constitute vast Scopus search categories with numerous results.

The knowledge structure of journal papers in English journals from 1990 to 2022, as well as peer reviewers in peer assessment selection, was the subject of this study. Among the published resources, the analysis could find 1011 relevant documents. The number has fallen because of the limits discussed. Because of the author's linguistic ability and because English is the most often used language in the Scopus database, the study chose articles in English.

Following that, we completely followed the criteria of the application stage; only 927 articles were included, and we checked the abstracts of all papers and deleted those that had no link to each other. The total came to 469 articles.

- Choose a data core. The model is then developed using the open-source statistical programme R in the second stage. The data gathering step allows the ".bib" file to be created, which will be utilised in the next stage.
- In the third phase, the R software, and bibliometrix codes were utilised to create a descriptive bibliometric analysis and matrix table that classifies and organises all the materials investigated. The "biblioshiny," a web-based interface of bibliometrix, was also used to create a network and a conceptual map of co-citations (Janik *et al*., 2020; van Eck & Waltman, 2010) [32, 61].
- Visualisation of data. After the results had been analysed, the data reduction approach was utilised to visualise the results.

After that, the information was analysed and interpreted. By adopting bibliometric analysis, which describes the most important bibliometric statistics, we can get to know the findings of the findings. The research then moves on to the authors' indicators and data. Finally, the countries are taken into consideration(G. Chen & Xiao, 2016; José de Oliveira *et al*., 2019; Ronda-Pupo, 2017; van Eck & Waltman, 2014; Van Raan, 2003) [13, 34, 47, 62, 63].

Following that, each of these primary groups is thoroughly investigated, with particular attention paid to (1) Document type, (2) Annual scientific output, (3) Scientific references, (4) Reference expansion, (5) Number of publications per researcher, (6) Summary Statistics of Scientific Productive output, (7) Author keywords, (8) Content analysis dendrogram, (9) Factorial diagram of the document with the highest contributions. (10) Article citations, (11) Country production, (12) Country citations, (13) Country collaboration map, and (14) Country calibration network.

3. Results

3.1 Bibliometric Analytical Description of the Spatial or Geospatial Data

The primary research from the Scopus database for 1011 papers published between 1990 and 2022. After applying the criteria, the number of articles became 927, as presented in **Table 1**. They publish these papers in 449 sources, most of which are scientific journals. "Keywords plus" refers to the total number of keywords that appear often in the article's title, which is 5257, or four times the number of articles. The research is based on 32 years of scientific output. However, the number of publications has risen considerably in the last 32 years Figure 1. Each publication has an average of 3.44 co-authors per document, and the cooperation index (CI) is 2.69, or 2.47 authors per document.

Table 1: Primary researched from the Scopus database

Description	Results
Main Information About Data	
Sources (Journals, Books, etc)	449
Documents	927
Average years from publication	10.1
Average citations per documents	7.401
Average citations per year per doc	0.8002
References	22631
Document Types	
article	340
book	2
book chapter	24
conference paper	533
conference review	1
note	1
review	23
short survey	3
Document Contents	
Keywords Plus (ID)	5257
Author's Keywords (DE)	2138
AUTHORS	
Authors	2287
Author Appearances	3193
Authors of single-authored documents	110
Authors of multi-authored documents	2177
Authors Collaboration	
Single-authored documents	119
Documents per Author	0.405
Authors per Document	2.47
Co-Authors per Documents	3.44
Collaboration Index	2.69

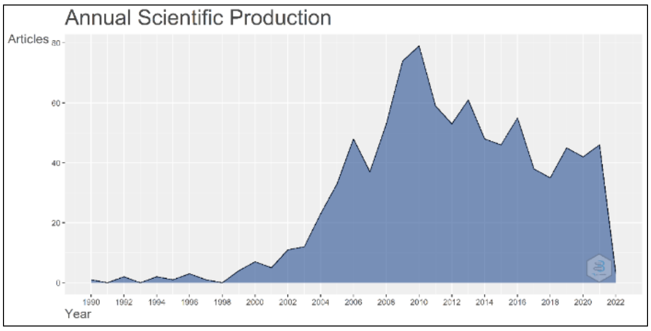

Fig 1: Annual scientific production "spatial data sharing" or "Geospatial data sharing."

There are 927 peer-reviewed scientific publications considered, as we already know. There are no substantial concentrations of items in the distribution. The journals focus on "spatial data" or "geospatial data" and "sharing" innovations; see Table 2. The top journal is "Proceedings of Spie - The International Society for Optical Engineering" as seen in Table 2.

Table 2: Most Relevant Sources, 20 Sources that involve "Spatial data," or "Geospatial data," and "sharing"

Sources	Articles
Proceedings of Spie - The International Society for Optical Engineering	55
International Archives of the Photogrammetry Remote Sensing and Spatial Information Sciences - ISPRS Archives	54
Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)	26
International Journal of Digital Earth	19

ACM International Conference Proceeding Series	16
International Geoscience and Remote Sensing Symposium (IGARSS)	15
IOP Conference Series: Earth and Environmental Science	15
Transactions in GIS	13
2009 17th International Conference on Geoinformatics Geoinformatics 2009	12
Computers and Geosciences	12
Gim International	11
Computers Environment and Urban Systems	10
GEO: Connexion	10
ISPRS International Journal of Geo-Information	10
2010 18th International Conference on Geoinformatics Geoinformatics 2010	9
International Journal of Geographical Information Science	9
GEO-Spatial Information Science	8
Lecture Notes in Geoinformation and Cartography	8
Applied Mechanics and Materials	7
Communications in Computer and Information Science	7

All the other periodicals deal with, Geoscience and geo-informatics, as well as sustainability and sharing. Most of the center of the discussion is on spatial data and on how to exchange information.

Fig 2 illustrates the rise in publications by highlighting journals that specialise in covering the subject and related areas. Between 1990 and 2022, the number of publications produced on this subject will grow

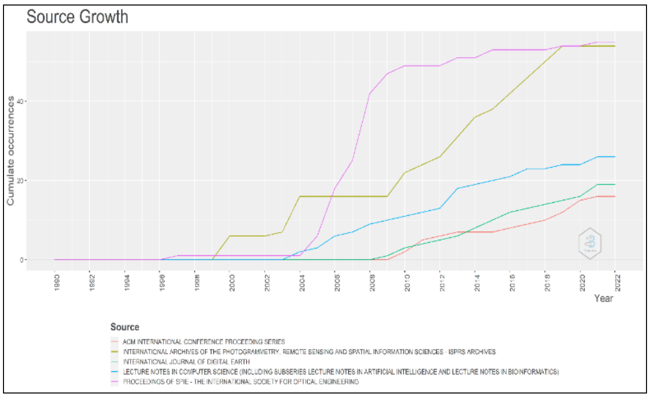

Fig 2: Sources: Dynamic Growth from 1990 to 2022

3.2 Network Analysis

3.2.1 Word, Keyword, and Co-Keyword Analyses This

The most commonly used terms and keywords, the co-occurrence network of author keywords, and the author keyword occurrence dynamic in the SDS or GSDS literature indexed in the Scopus databases are shown in this subsection.

This section contains information between the keywords "spatial data sharing" and "geospatial data". The researchers have included several keywords in the articles. This study is needed to assess the current research trend, identify any gaps in the areas of "spatial data sharing" and "geospatial data", and recommend potential research areas. The total number of keywords per author in the first 20 positions is shown in Table 3. The ranking includes spatial data, geographic information systems, data sharing, and information management. These items are not predictive, and they do not consider the keywords that were stated. However, if we concentrate on the terms listed below, we can identify key features of understanding the characteristics of spatial data sharing involved in geographic information systems, consumers of different applications, as well as a distinction between spatial data infrastructure from the private sector and the general sector, which are considered to be the main approvers of geospatial data sharing.

Table 3: Author keyword Occurrences

Words	Occurrences
spatial data	391
geographic information systems	294
GIS	161
data sharing	157
information management	134
spatial data infrastructure	131
web services	129
geo-spatial data	123
remote sensing	112
interoperability	107
metadata	94
decision making	93
internet	78
world wide web	78
information systems	74
data handling	67
data processing	65
information services	65
database systems	63
websites	62

Fig 3 shows co-occurrence keyword spatial data as appears; main keyword Spatial data, Geographic information systems, web service, spatial data infrastructure, and data sharing management are its high-occurrence keywords. The Tree Map highlights the keyword combinations. We can identify them and use the word cloud to show what they stand for: "spatial data sharing" and 'Geospatial" are areas of study, both shown in Fig 4 in order of magnitude.

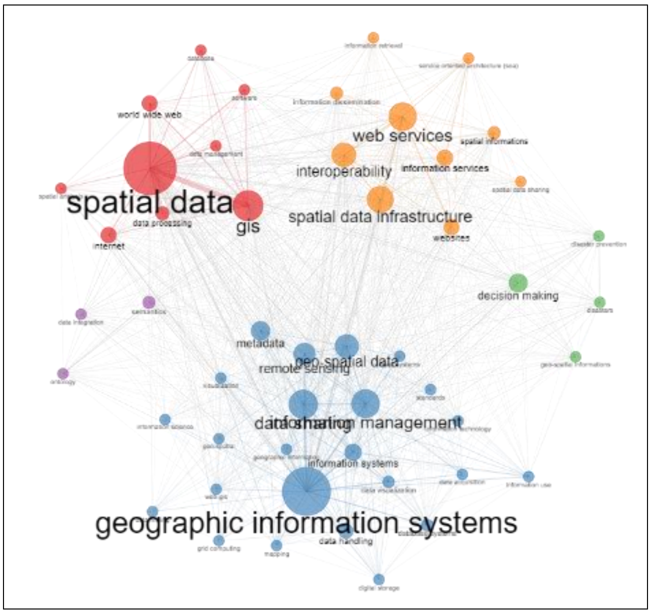

Fig 3: Occurrences keyword

Fig 4: Word Cloud

The red and blue areas in Figure 5 are divided into two parts of the domain. In each area, some words are related to each other. The red area in the above figure shows more and different words that are related to each other. This is included in it and shows that many research publications relate to the words listed in this area. The dendrogram shows the hierarchical order and connections between the concepts identified by hierarchical clustering. The plot assigns a weight to each item based on the clusters and measures the connections between them. Each item is a collection of keywords related to the concepts of "spatial data sharing" and "Geographic, geospatial".

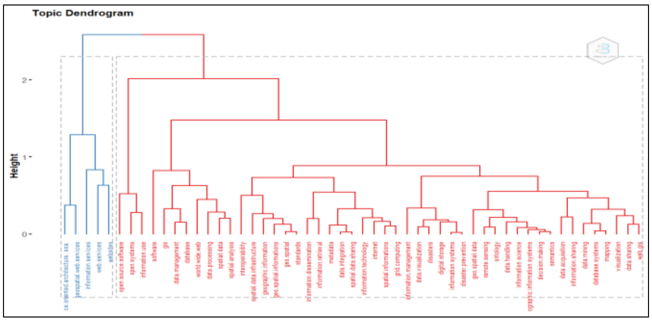

Fig 5: The Dendrogram and hierarchical order

3.2.2 Authors

The most frequently mentioned writers in the "spatial data or geospatial data" and "sharing" categories are included in this section. In this area, you can also look at the authors' keywords and the overall number of citations. Table 3 lists the writers and their papers in the top 10 places. DI L has the most publications (20), LI W has 16, GONG J and YUE P both have 15, WANG Y has 11, while others LI X, Liu, RAJABIFARD A, and ZHANG X each have 11 publications, CHEN Z, HONG J-H, ZHANG C, ZHANG Y, and ZHU Y each have 10. As a result, the former writers have considerable topic knowledge and in-depth Geospatial processing that has been upgraded throughout time. Although some authors were the first to publish their work, most of them were co-authors.

Table 4: Most Relevant Authors

Authors	Articles	Articles Fractionalized
DI L	20	4.22
LI W	16	5.10
GONG J	15	3.63
YUE P	15	4.24
WANG Y	13	3.93
LI X	11	3.00
RAJABIFARD A	11	3.28
ZHANG X	11	2.85
CHEN Z	10	2.02
HONG J-H	10	4.50
ZHANG C	10	3.62
ZHANG Y	10	3.38
ZHU Y	10	2.57
LI G	9	3.36
ZHANG J	9	1.95
ZHU X	9	2.95
GIULIANI G	8	1.54
LIU Y	8	1.70
WANG X	8	1.90
WEI Y	8	1.70

As a result, early writers have considerable topic knowledge and in-depth Geospatial Processing that has been refined over time. Although some authors were the first to publish their work, most of them were co-authors. The distribution of Lotka's Law is the frequency distribution of scientific productivity.

3.3 Top Authors, Sources, and Keywords Relations

The Three Fields Plot was used to depict the relationships between the primary writers' keywords, authors, and sources. Therefore, in case rectangles of a different colour represented the relevant elements in the diagram. The value of the total of the relations occurring between both the component that the rectangular represents (one element in the authors' keyword, author, and source diagram) and the diagram of other components determined the height of the rectangles. The higher the rectangle depicting the element, the more relations it had.

Fig 6 also depicts the relationships between the keywords, sources, and referenced sources of the primary writers. This figure depicts the organisation of better attention (as the source and referenced source) in creating knowledge in the SDS/GSDS literature's core issues. The authors' keywords reflected the themes, and the number of correct relations denoted the relevance of the source or referenced source. Based on their contribution to the investigation of the GSDS/SDS literature's core subjects, the research revealed that the important sources of publications were Sustainable geographic information science, geospatial data, and cloud computing, the Journal of Digital Earth, and Computer and Urban Sustainability.

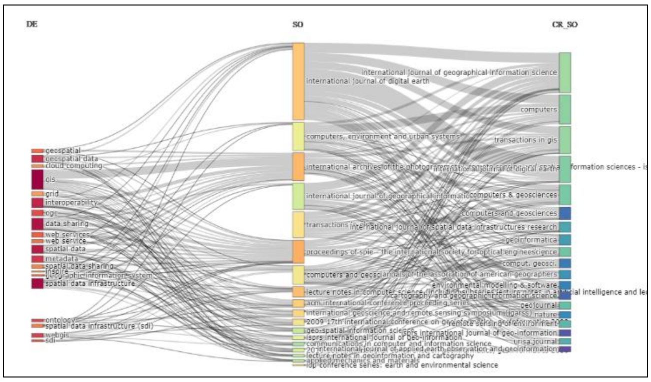

Fig 6: Relations between sources (middle), author keywords (left), and cited sources (right) for SDS literature

3.4 Clusters by Document Coupling

The found clusters were sorted into three groups. The researchers clearly separated into three strands in the first category, one concentrating on the characteristics of geographical data exchange and the other on concerns of geographic analysis and information analysis. The first strand looked at motivation to determine if it had an influence on information searching and to better explain the effects of geographic data sharing, spatial data - conf 21.4%, Geographic information systems - conf 26.9% GIS - conf 24.6% **Table 5**. The second segment was split into three halves of spatial data - conf 33.9%, geographic information systems - conf 41.8%, gis-conf 38.5%. The first dealt with variables affecting geographic information and information analysis, while the second focused on information challenges in the domains of information services and geospatial data. The first portion looked at data processing and information analysis regarding geographic data to see what influence they have, and the second segment looked at how they are connected to service support, such as information sharing features, spatial data - conf 44.6%, spatial data infrastructure - conf 49.1%, data sharing - conf 64.9%.

Table 5: Clustering by Coupling

Label	Group	Freq.	Centrality	Impact
spatial data - conf 21.4% geographic information systems - conf 26.9% GIS - conf 24.6%	1	56	0.421732883	2.456589488
spatial data - conf 33.9% geographic information systems - conf 41.8% GIS - conf 38.5%	2	82	0.360988719	3.129838271
spatial data - conf 44.6% spatial data infrastructure - conf 49.1% data sharing - conf 64.9%	3	112	0.417695389	1.770367128

Data from service-oriented architecture, web services, and website studies were part of the study. The geographical traits and qualities of the sample under study were discovered to be connected to the constituents of the second subcluster. The second cluster brings together competitiveness factors in online services connected to "spatial data exchange" and "spatial analysis," see Fig 7. In the second cluster, information technology is separated into two target subgroups: "spatial information exchange" and "geospatial.". The second cluster brings together competitiveness factors in online services connected to "spatial data exchange" and "spatial analysis." In the second cluster, information technology is separated into two target subgroups: "spatial information exchange" and "geospatial."

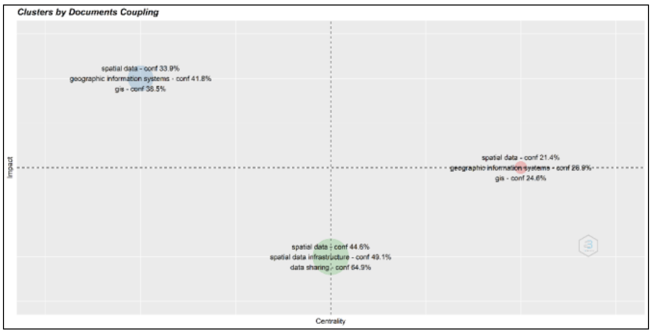

Fig 7: Clusters by documents coupling

The evolution of the "spatial data" or "geospatial data" and "sharing" topic across time. Between 2002 and 2020, key topics such as machine learning governance methods and information management, sharing, and image processing were related to "spatial data" and "sharing." Since 2010, it has highlighted another important component in "spatial data sharing" and "geospatial data sharing," notably the web service, metadata, and data processing. Data sharing, remote sensing, information systems, websites, and geographical data were among the most popular themes in 2012, according to a study. Between 2012 and 2014, new subjects directly connected to information management, geographic data infrastructure, decision making, data processing, and visualisation were investigated. Many themes linked to "Geospatial analysis, location-based services, information use, geographical data," including spatial data analysis and spatial data sharing, between 2016 and 2018. The researchers are super concerned about "spatial data sharing" and demographic factors. From 2018 to 2020, the focus will be on activities related to "spatial data sharing," such as the use of spatial data in various governance approaches, the use of open data, big data, and Geo-spatial data analysis techniques to evaluate and measure the categorisation and organisation and governorate.

3.5 Total Citations

Table 6 illustrates how numerous citations each of the top twenty papers receives. It shows that particular papers were mentioned only in specific years. In a variety of topics, several writers have included knowledge sharing. This has a major influence on the quantity of citations, especially when spatial data findings are connected to concepts like geospatial sharing, geographic information systems (GIS), and information search and availability. GRAHAM CH, 2008, is the most referenced paper to date, with 345 citations. The second paper, published in 2011, is CHOW CY, which has been referenced 168 times, according to Google Scholar. On other topics, more articles have been mentioned. This shows that the papers are important since they give information and designate "spatial data sharing," "information sharing," and "geospatial data sharing" as community-shared research areas.

Table 6: Total citation top 20 articles

Paper	*DOI*	*Total Citations*	*TC per Year*	*Normalized TC*
Graham CH, 2008, J Appl Ecol	10.1111/j.1365-2664.2007.01408.x	345	23	24.1546
Chow CY, 2011, Geoinformatica	10.1007/s10707-009-0099-y	168	14	19.5889
Mansourian A, 2006, Comput Geosci	10.1016/j.cageo.2005.06.017	133	7.8235	11.9551
Goodchild MF, 2007, Ann Assoc AM Geogr	10.1111/j.1467-8306.2007.00534.x	114	7.125	12.4059
Wilson MW, 2012, Geoforum	10.1016/j.geoforum.2012.03.014	105	9.5455	18.9932
Elwood S, 2008, Int J Geogr Inf Sci	10.1080/13658810701348971	98	6.5333	6.8613

Rajabifard A, 2002, Int J Appl Earth Obs Geoinformation	10.1016/S0303-2434(02)00002-8	91	4.3333	6.4581
Evangelidis K, 2014, Comput Geosci	10.1016/j.cageo.2013.10.007	88	9.7778	11.766
Harvey F, 2006, Int J Geogr Inf Sci	10.1080/13658810600661607	88	5.1765	7.9101
Kitchin R, 2015, Geojournal	10.1007/s10708-014-9601-7	86	10.75	5.9758
Haworth B, 2015, Geogr Compass	10.1111/gec3.12213	86	10.75	5.9758
Oliveira SRM, 2004, Lect Notes Comput Sci	10.1007/978-3-540-30073-1_6	83	4.3684	10.7853
Karan EP, 2016, J Comput Civ Eng	10.1061/(ASCE)CP.1943-5487.0000519	81	11.5714	9.3006
Soranno PA, 2015, Gigascience	10.1186/s13742-015-0067-4	81	10.125	5.6284
Yang C, 2013, INT J Digit Earth	10.1080/17538947.2013.769783	76	7.6	12.5978
Pybus OG, 2015, Proc R Soc B Biol Sci	10.1098/rspb.2014.2878	75	9.375	5.2115
Zhou X, 2015, Comput Environ Urban Syst	10.1016/j.compenvurbsys.2015.07.006	72	9	5.003
Gao S, 2008, Int J Health Geogr	10.1186/1476-072X-7-8	70	4.6667	4.9009
Liu B, 2005, Proc Int Conf Distrib Comput Syst	NA	67	3.7222	7.5979
Lv Z, 2016, IEEE Internet Things J	10.1109/JIOT.2016.2546307	65	9.2857	7.4635

The findings demonstrate the citations come from a variety of journals see **Table 7**, with the Journal of INTERNATIONAL JOURNAL OF GEOGRAPHICAL INFORMATION being the most referenced and having the highest TC (408). COMPUTERS AND GEOSCIENCES, another publication, provided an average of 397) TC **Table 8**. The previous journal is primarily concerned with geographic information sharing and spatial data, as well as the satisfaction strategy and comprehending geographic information sharing. It includes research papers, discussions of current issues, and case studies from the fields of computing and geotechnical engineering. The second section takes an academic approach to the incentives underlying information sharing. It also covers geographical data, computerised system and geographic information publicity. The subjects and substance are centred on information distribution.

Table 7: Citation from a variety journal

Element	*h_index*	*g_index*	*m_index*	*TC*	*NP*	*PY_start*
International Journal of Geographical Information Science	8	9	0.44	408	9	2005
Computers and Geosciences	8	12	0.44	397	12	2005
Journal of Applied Ecology	1	1	0.07	345	1	2008
Computers, Environment and Urban Systems	8	10	0.44	288	10	2005
Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)	9	16	0.47	266	21	2004
Geoinformatica	5	5	0.29	231	5	2006
International Journal of Digital Earth	8	14	0.57	224	17	2009
Transactions in GIS	7	12	0.35	196	12	2003
International Journal of Applied Earth Observation and Geoinformation	4	4	0.19	171	4	2002
International Journal of Health Geographics	4	4	0.27	146	4	2008
Annals of the Association of American Geographers	2	2	0.13	137	2	2007
Journal of Computing in Civil Engineering	2	2	0.13	130	2	2007
Geojournal	4	5	0.31	106	5	2010
Geoforum	1	1	0.09	105	1	2012
Environmental Modelling and Software	3	3	0.18	104	3	2006
International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives	4	6	0.17	93	35	2000
ISPRS International Journal of Geo-Information	5	9	0.45	91	9	2012
Future Generation Computer Systems	3	3	0.21	88	3	2009
Geography Compass	1	1	0.13	86	1	2015
Cartography and Geographic Information Science	4	4	0.19	85	4	2002

Table 8: Number of articles per source

Sources	*Articles*
International Journal of Geographical Information Science	271
Transactions in GIS	143
Computers	138
International Journal of Digital Earth	131
Computers & Geosciences	114
Science	92
Int J Geogr Inf Sci	84
Comput Geosci	75
Geojournal	74
Remote Sensing of Environment	72
URISA Journal	72
International Journal of Spatial Data Infrastructures Research	68
Geoinformatica	65
Annals of the Association of American Geographers	61

Nature	59
Environmental Modelling & Software	55
Computers and Geosciences	49
Cartography and Geographic Information Science	47
Comput Environ Urban Syst	45
ISPRS International Journal of Geo-Information	42

3.6 Mapping Scientific Collaboration

This part will discuss the countries in which the publications were discovered, the number of papers published, the total number of citations, and the establishment of scientific networks when looking at the geographical distribution of spatial data sharing and geospatial data sharing publications. The following section discusses the total number of articles published.

3.6.1 Most cited countries

A total number of articles by country, to show the total number of nations whose articles were studied for the themes "spatial data," "geospatial data," and "sharing" see Table 9. China is in top place (535). According to several sources, CHINA is the country most affected by this problem, with numerous inhabitants moving to less developed countries where treatment costs are substantially lower for the same or equivalent quality. The United States (331) and Italy (67) are the second and third nations, respectively, in terms of the development and diffusion of geographical data exchange via information and communication technology.

Table 9: Top 10 cited countries

region	*Freq*
China	535
USA	331
Italy	67
Canada	65
Australia	56
India	50
UK	48
Brazil	46
Malaysia	43
Switzerland	43

As a result, local governments and various academics have investigated the phenomena, focusing on features that have spatial data infrastructure. Several countries are considered lower in the globe than they are Fig 8. "Spatial data sharing" and "geo-spatial data sharing" are still growing slowly in this area. Canada (65), Australia (56), India (50), the United Kingdom (48), and Brazil (65). (46). Most of the research was done in developed and developing nations, and the usage of information distribution technologies on various internet platforms was investigated globally.

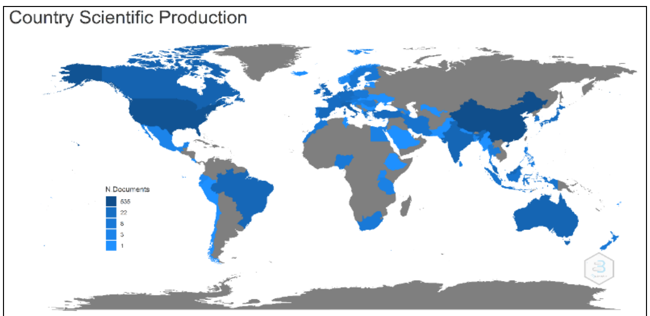

Fig 8: Country Scientific production

3.6.2 Collaboration map and country publications

Publications on "spatial data sharing" and "geospatial data sharing" are addressed, with single or several publications in each nation being considered. It also intends to chronicle international partnerships and networking amongst researchers working on the same issue. **Table 10** displays the average number of citations for each nation. The US, China and AUSTRALIA retain their leading roles.

Table 10: Average number of citations per country

Country	Total Citations	Average Article Citations
USA	2112	22.468
China	800	3.065
Australia	614	29.238
Canada	394	12.312
Switzerland	283	21.769
Italy	238	7.677
United Kingdom	160	10
Ireland	150	30
Spain	125	11.364
Greece	122	30.5
Brazil	112	7
Germany	111	9.25
Turkey	104	7.429
Netherlands	87	6.692
Georgia	72	72
Hong Kong	71	23.667
Denmark	68	17
Austria	62	12.4
India	48	2.824
Korea	48	6

However, MALAYSIA, SWITZERLAND, THE NETHERLANDS, SPAIN, and TURKEY have recorded a substantial number of citations. Countries are affected by the phenomena for a variety of reasons: On the one hand, some are currently fighting to develop some type of "spatial data sharing" and "geospatial data sharing"; other nations have already established virtuous cycles that have favored the emergence of "spatial data sharing" and "geospatial data sharing."

Table 10 depicts the path of global cooperation: the blue colour on the map denotes worldwide research networks. The nations with the most publications on "spatial data sharing" and "geospatial data sharing" also have a higher rate of collaboration, showing that they have exchanged information and worked together to produce scientifically relevant discoveries. Because of policies and practises, the CHINA had the greatest rates of networking with other nations, followed by ITALY, SWITZERLAND, and SWITZERLAND to GREECE.

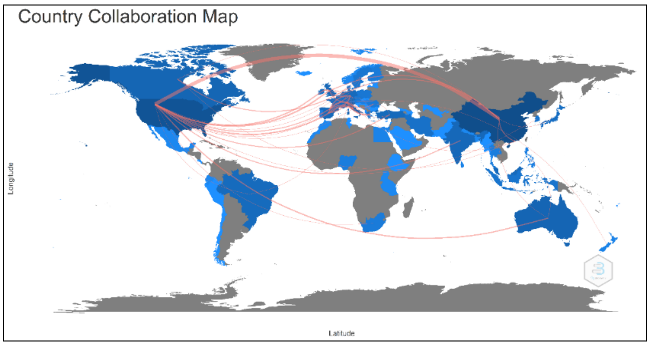

Fig 9: Country Collaboration Map

4. Discussion

The ultimate focus of this bibliometric study is to determine how studies have evolved in terms of authors, journals, citations, and themes. Three authors were discovered to have the most publications on the researched topic(3): DI L, LI W, and GONG J have all contributed to the research of "spatial data exchange," with various focuses:

1- DI.L investigates through this chief article sharing geoscience, the development of a geospatial data grid, geo-processing and sharing and reuse of service based on geospatial sharing processing, and the main articles are: "Grid computing enabled geospatial data sharing through web services", "Sharing geoscience algorithms in a Web service-oriented environment (GRASS GIS example)", "Sharing geospatial provenance in a service-oriented environment" and "The development of a geospatial data grid by integrating OGC web services with globusbased Grid technology, Geoscience data provenance" (Bai *et al.*, 2007; A. Chen *et al.*, 2010; X. Li *et al.*, 2010; Yue *et al.*, 2011) [7, 12, 36, 69].

2- LI W aims to determine the factors that motivate users to share geospatial data using geospatial semantic web technologies, Spatial Web Portals, Geomatics Informatization technology system, An interoperable Spatial Decision Support System, real-time spatial feature sharing, and WebGIS, as well as a semantic search engine for Spatial Web Portals. Most articles for LI W, are: "Open source software approach for Internet GIS and its application", "A semantic search engine for Spatial Web Portals" and the "A high-level architecture for a Geomatics Informatization technology system: The Chinese case" (Jing *et al.*, 2008; W. Li & Yang, 2008; J. Zhang *et al.*, 2011) [33, 35, 71].

3- GONG J, Finally, GONG J focuses on spatial data sharing in a service-oriented environment, geo-spatial information integration and sharing in Virtual globe, geo-processing, Microsoft cloud computing platform, Geospatial service web, Multi-source geospatial information integration, and more. The title of the most article is: "Sharing geospatial provenance in a service-oriented environment", "Geo-processing on the Amazon cloud computing platform AWS" and "Multi-source geospatial information integration and sharing in Virtual Globes" (J. Y. Gong *et al.*, 2010; Shao *et al.*, 2012; Yue *et al.*, 2011) [27, 51, 69].

According to the study's findings, Applied Ecology, Geo-Informatica Computers and Geosciences and computer science journals are the most actively taking part in the research, with other publications in the top 10 of spatial data sharing research. The most frequently mentioned papers on this topic, as well as the journals in which they appeared, are included in **Table 6**. The journal with the most papers on geographic information and spatial data exchange is "Geographical Information Science". In comparison, the Journal of "International Journal of Geographical Information Science, Transactions In Gis, and Computers & Geosciences" gets more citations from publications that are not in the top 20. **Table 2**, shows how interdisciplinary the subject is. Geo-science in Computing Systems and The Development of a Geospatial Data are two periodicals that investigate and expand geographical data exchange using information and communication technology. The ideas of determination and maintenance are at the heart of both "spatial data sharing" and "geospatial data sharing." As a result, except for one journal that focuses on spatial sharing in an open computing environment for earth science exploration and applications for sustainability, data sharing, GIS, urbanisation, and service processing, the major publications on this topic are often published in a journal that focuses more on one topic or the others.

Regarding bibliometric analysis, Stieglitz's all-encompassing method resulted in the work's publishing with the most citations (Stieglitz & Dang-Xuan, 2013) [56]. The presumed models for "spatial data sharing" may be deduced from the keywords employed and considered while evaluating the regions of environment and GIS information distribution. This research adds to research and practice. First, we discuss the function of information and communication technology in the exchange of geographical data. It is shown that (positive or negative) geographical data sharing is linked to geospatial data dissemination, not only in terms of quantity but also in terms of strength. This find has a wide range of geoscience and environmental implications.

The Government and private sectors must focus more on analysis concerning their SDI "Spatial Data Infrastructure" and commodities spatial data exchange in communications (Al Shamsi *et al.*, 2011; Elwood, 2008; Silva *et al.*, 2011) [2, 21, 53] They should also create infrastructure information on geographic data sharing since this type of content is more likely to be shared (Goodchild *et al.*, 2007) [28] scale economies in manufacturing and the need for motivations for sharing. From an early disorderly period, though one based on national governments as the principal providers of geographic information, to the current somewhat chaotic network of producers and consumers, the history of sharing may be understood in a three-phase conceptual framework (Goodchild *et al.*, 2007) [28]. Collaboration across these lines is difficult because of the huge disparities in nomenclature, conceptual frameworks, and techniques for creating theory in these distinct areas of Geo-science study. Collaboration across these lines is difficult because of the huge disparities in nomenclature, conceptual frameworks, and techniques for creating theory in these distinct areas of geoscience study (Gao *et al.*, 2008; X. Li *et al.*, 2010; Navarro-Carrión *et al.*, 2016; Satapathy *et al.*, 2014; Singh & Singh, 2014) [23, 36, 41, 50, 54].

For example, Elwood at (2008) [21] discovered that geoscience research on interoperability, SDIs, cognition, and other relevant areas involves terminologies, programming languages, and system architectures that are not part of many GIS and Society researchers' conceptual and applied repertoires, just as these researchers' social theory constructs are not always a common lexicon across GIS-science. However, we must continue our attempts to interact across these divides. As the number of shared geospatial data resources grows, user diversity grows, and grassroots organisations play a larger role in urban governance, challenges of local data integration and accessibility become increasingly important for grassroots groups, government, and society (Elwood, 2008) [21].

Local-government requirements, regulation, and political discretion should all be considered when promoting technology in second-generation SDI to promote data sharing at the local level unless it is likewise restrained by limited local-government acceptance. Local governments should share data to fulfil statutory and required tasks, not to improve data sharing, according to policy development (Abu Hanifah, 2008; Čada & Janečka, 2016; Corti *et al*., 2018; Folger, 2011; Harvey & Tulloch, 2006; Vinet & Zhedanov, 2011) [1, 10, 19, 22, 29, 64].

Study, depicts two periods of debate in terms of the subject dendrogram (or topic tree). The first is a diagram of a motivating zone that has been studied to determine its potential influence on information seeking and to comprehend the phenomena of "Spatial Data Sharing." The second categorisation looks at new information and online service features. The issue emphasised in result. depicts the emergence of an emerging topic connected to data sharing, metadata communication through a platform such as GIS, online services, and knowledge management and viewpoint during the period from 1992 to 2022.

Several topics connected to "information sharing" and "education technology compact" were proposed between 2005 and 2021. Qualitative methods were also employed to assess and quantify the occurrence, as well as to classify and categorise data. Spatial data and Sector of education (Al Shamsi *et al*., 2011; Cheng *et al*., 2015; Chou *et al*., 2011; J. Gong *et al*., 2014; Purves *et al*., 2005; Satapathy *et al*., 2014; Sutanta *et al*., 2016; Wan *et al*., 2021) [2, 14, 15, 26, 43, 50, 57, 66] offer a new "Geospatial Service Platform for Education and Research" to share cutting-edge accomplishments of a geospatial service platform with students and researchers from different nations for education about spatial data sharing (J. Gong *et al*., 2014) [26]. Students will be taught about geospatial Web services, service-oriented design, geo-processing modelling and chaining, and problem-solving with geospatial services. It will be "hands-on" training with several minor exercises on geospatial Web platforms such as OpenRS, GeoPW, GeoChaining, GeoSquare, GeoJModelBuilder, and Windows Azure.

They organised the Critical Successful Factors as an organisation, coordination and organisational agreements, strategic planning, communication and computing infrastructure, online project-based and web mapping, awareness, general standards, financial support, and spatial data availability through their research. Other medium-priority factors for the CFSs model include legal, market demand, and the need for service provision, policies, effective mechanisms, vision, participants, leadership, and political commitment, new technologies, user satisfaction, and user support, education, expertise, system integration, socio-political stability, culture, economic, and living standards, information availability, metadata availability via the internet, and data updating (Al Shamsi *et al*., 2011; Crompvoets *et al*., 2008; Montalvo, 2010; Monteiro *et al*., 2018; Rajabidfard A, 2009; Rwanyiziri *et al*., 2020; Tarmidi, 2016) [2, 20, 38, 39, 45, 48, 59].

Xiaolin at 2006 [67] and (Al Shamsi, Ahmad, and Desa 2011a; Shukla 2016; Tah, Oti, and Abanda 2017; Roca 2014) [2, 52, 58, 46] gives an explanation about the method of obtaining, sharing, distributing, and evaluating data has altered because of recent improvements in web-based GIS applications. Web-based GIS makes use of the Online platform to access and send data, as well as analysis tools to improve spatial data presentation and integration (Roca, 2014; Shukla, 2016; Tah *et al*., 2017; Xiaolin, 2006) [46, 52, 58, 67]. Users using Multimedia GIS may also explore a wide range of multimedia content. Users may study and view both geographical data and associated multimedia material on the Internet thanks to the integration of web-based GIS and multimedia (Ayeni *et al*., 1991; Moreno-Sánchez *et al*., 1996; Soomro *et al*., 1999) [6, 40, 55].

From 2003 to 2019, there are studies from researchers that explain through their study that; people grow more mobile, and geographical data is becoming increasingly important. In today's fast-paced world, it's critical to make massive and complicated data relevant through social network analysis. Open-source software will be widely used in meaningful data generated because of the use of open-source software in analytical procedures. Spatial data infrastructure framework for better geospatial health data analysis. like GeoFog4Health, a Fog-based SDI framework for mining analytics from geo-health big data was created and evaluated in geo-health data analysis by incorporating local processing into cloud computing environments. In several sectors, such as emergency management, human health and the environment, relief efforts, mobility, and land information systems, analysing government data with geographical data has shown considerable promise. As a result, integrating geographical data for decision-making processes in public health practice might be quite beneficial. Using Open Geospatial Consortium (OGC) technologies made it easier to analyse, map, and share health data online (Barik *et al*., 2019; Gao *et al*., 2008, 2009; Rahman *et al*., 2003; Sabah & Şimşek, 2017; Xiaolin, 2006) [8, 23, 24, 44, 49, 67].

In terms of nations, the countries with the most publications on "spatial data sharing" and "geospatial data sharing" also have a greater rate of collaboration, showing that they've exchanged information and helped each other achieve scientifically relevant outcomes. Because of regulations and practices, the United States, China, Canada, and Australia have the greatest rates of networking with other nations.

5. Conclusions and Directions for the Future

This bibliometric study identifies the phenomena of "spatial data sharing" and "geospatial data sharing" as well as the paucity of publications on the different countries, from different sources, and by different authors, but all English language, studies are rarely of spatial data sharing, which revealed a major vacuum in the literature that needs to be filled. The "spatial data exchange" between nations, as well as the connection between the US, China, and other countries, were assessed. It shows that "spatial data sharing" and "geo-spatial data sharing" research has risen year after year. Meanwhile, the phrases "spatial data sharing", "GIS', and "geo-spatial data sharing" are commonly employed in this research. Grid computing, E-government application system, Geographic Information Systems, technologies of railway, agricultural data management, smart grid, digital transformation, developing businesses, agriculture spatiotemporal business intelligence, spatial data infrastructure, spatial information in agricultural data management, railway geographical information and land use are some of the most recent trend topics. As a result, “spatial data sharing” study is becoming increasingly popular, study on this topic must be continued, considering the increasing growth of spatial sharing behaviour in urbanised areas.

According to the experts, geospatial data has become more important in sharing available information for practically all sectors, ranging from conventional libraries to today’s enormous volumes of digital data/information, particularly satellite photos.

According to the study’s introduction, this analysis is based on Scopus data, which is considered the most reliable data source; however, other databases such as WebofScience (wos/wok), dimensions, Lensorg, Pubmed, and the Cochrane library can be used as a replacement, and bibliographic analysis can be performed in R packages. The bibliometric analysis suggested in this study may be used to databases other than the SCI/SSCI index, and data from various time periods. Second, no other software was employed in this investigation, such as VOSviewer. To learn more about this subject, more research is needed. Finally, just “spatial data exchange” is mentioned in introducing the extracted data.

Future research can be more detailed by using terminology such as “Spatial data infrastructure SDI” and “Spatial data directly or indirectly sources” which are yet to be investigated. Further research might be done on individual nations to investigate spatial data sharing from a distinct cultural perspective.

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