bid Scholarly journal published by the University of Barcelona's Faculty of Information and Audiovisual Media
ISSN 1575-5886

BiD 53 (December 2024)
DOI: 10.1344/bid2024.53.03

ORIGINAL ARTICLE

A Bibliometric Analysis of the Past 25 Years at *International Journal of Geographical Information Science*

*Anàlisi bibliomètrica dels últims 25 anys a l'*International Journal of Geographical Information Science

Jesús Cascón-Katchadourian
Universidad de Zaragoza
jcascon@unizar.es

Adolfo Quesada-Román
Universidad de Costa Rica
adolfo.quesada@gmail.com

María-Ángeles Martínez-Sánchez
Universidad de Granada
mundodesilencio@ugr.es

Manuel-Jesús Cobo
Universidad de Granada
mjcobo@decsai.ugr.es

Received: 10-09-2024
Accepted: 18-12-2024

Abstract

The article provides a comprehensive analysis of the evolution and impact of the *International Journal of Geographic Information Science* (IJGIS) over the past 25 years. IJGIS, the first journal exclusively dedicated to Geographic Information Science (GIS), has significantly expanded its publication output to meet the growing demand for GIS research. Utilizing conceptual science mapping analysis, the study traces the thematic evolution of the journal by collecting scientific papers from the *Web of Science* database from 1997 to 2021. Bibliometric performance indicators were employed to highlight its influence and thematic development. The primary themes covered include error modeling, digital elevation models, simulation, conservation, and land-use change. Furthermore, IJGIS has broadened its scope to include emerging topics such as volunteered geographic information, the integration of big data techniques, and artificial intelligence. Geographically, contributions are predominantly from the USA, followed by China and the UK, underscoring the journal's international recognition and impact. Compared to global averages, IJGIS consistently maintains a high normalized impact within its thematic area. In conclusion, IJGIS has undergone significant evolution, adapting to GIS field changes, and expanding its global influence with prospects for further diversification and technological integration.

Keywords

bibliometrics; science mapping; citations; co-word analysis; h-index

Resum

Aquest article ofereix una anàlisi exhaustiva de l'evolució i l'impacte de l'*International Journal of Geographical Information Science* (IJGIS) durant els últims 25 anys. L'IJGIS, la primera revista dedicada exclusivament a la Ciència de la Informació Geogràfica (GIS), ha ampliat significativament la seva producció per satisfer la creixent demanda d'investigació en GIS. Utilitzant l'anàlisi de mapatge conceptual de la ciència, l'estudi traça l'evolució temàtica de la revista recopilant articles científics de la base de dades *Web of Science* des de 1997 fins al 2021. Es van emprar indicadors de rendiment bibliomètric per destacar la seva influència i desenvolupament temàtic. Els temes principals inclouen el modelatge d'errors, els models digitals d'elevació, la simulació, la conservació i el canvi en l'ús del sòl. A més, l'IJGIS ha ampliat el seu abast per incloure temàtiques emergents com la informació geogràfica voluntària, la integració de tècniques de *big data* i la intel·ligència artificial. Geogràficament, les contribucions provenen majoritàriament dels EUA, seguits de la Xina i el Regne Unit, fet que subratlla el reconeixement i l'impacte internacional de la revista. En comparació amb les mitjanes globals, l'IJGIS manté constantment un alt impacte normalitzat dins la seva àrea temàtica. En conclusió, l'IJGIS ha experimentat una evolució significativa, adaptant-se als canvis del camp GIS i ampliant la seva influència global, amb perspectives de diversificació i integració tecnològica futures.

Paraules clau

bibliometria, mapatge científic, citacions, anàlisi de co-paraules, índex h

Recommended citation

Cascón-Katchadourian, Jesús, Quesada-Román, Adolfo, Martínez-Sánchez, María-Ángeles, and Cobo, Manuel-Jesús (2024). Research on research online visibility. *BiD*, 53. https://doi.org/10.1344/bid2024.53.03

1. Introduction

Geography, as a discipline, encompasses the examination of Earth's landscapes, environments, and the interactions between people and their surroundings (Creswell, 2024). It bridges the social sciences with the natural sciences, providing a holistic view of the world by investigating the physical characteristics of the Earth's surface and the human communities distributed across it (Schiewe, 2021). This field has long been essential for understanding spatial relationships and patterns, aiding in various endeavors from urban planning to environmental conservation. A fundamental component of geography is cartography, the art and science of map-making. Cartography has been instrumental in visualizing spatial information, allowing for the representation and analysis of geographical data (Kraak and Ormeling, 2020). Through maps, complex spatial information is distilled into a comprehensible format, making it easier to understand and utilize.

In recent decades, Geographic Information Systems (GIS), also known as GIScience, have revolutionized the field of geography and cartography. GIS technology enables the collection, storage, analysis, and visualization of spatial data in ways that were previously unimaginable. It integrates various data sources and allows for the layering of information to uncover patterns and relationships that are crucial for decision-making processes (Peterson, 2020). In professional contexts, GIS supports urban planning, environmental management, disaster response, and transportation logistics, among other fields. It also permeates daily life, enhancing navigation systems, improving public service delivery, and supporting location-based services on mobile devices. The broader field of Geographic Information Science (GIScience) explores not only the technological aspects of GIS but also the theoretical and conceptual foundations of spatial data representation, geospatial analysis, and geographic modeling (Sowmiya Narayanan and Manimaran, 2024). It is an interdisciplinary domain that intersects computer science, geography, mathematics, and social sciences, fostering innovation in spatial thinking and addressing complex problems like climate change, urban sprawl, and resource management (Goodchild, 2010). The integration of GIS in geospatial sciences has thus become indispensable, driving innovation and efficiency in both academic research and practical applications. This transformative impact underscores the importance of platforms like the International Journal of Geographic Information Science (IJGIS), which has played a pivotal role in advancing GIS research and its applications over the past 25 years.

Since its inception, Geographic Information Science (GIS) has undergone significant growth, transitioning from an exclusive technology available to only a few institutions to a widely accessible platform for the general public. The establishment of the International Journal of Geographic Information Systems (IJGIS) in 1987 marked a significant milestone by establishing the first academic journal dedicated "solely to advancing research and knowledge in GIS" (Yuan 2017, p. 425).

The founders of IJGIS, Terry Coppock and Eric Anderson, aimed to attract an international and diverse audience "of researchers, developers, users, and decision-makers to share and advance knowledge on GIS" (Yuan 2017, p. 425). Over the years, IJGIS has increased its annual publication output to meet the growing demand for research in the field, expanding its editorial team and increasing the number of pages published. At the beginning, 4 issues were published, then six issues in 1992–1995, eight issues in 1996–2004, 10 issues in 2005–2007, and 12 issues since 2008 (Yuan 2017, p. 426).

Along its history, IJGIS has been instrumental in disseminating groundbreaking research and advancing the GIS field. It has published numerous seminal papers that have laid the conceptual and computational foundations for theories, methods, applications, and technologies associated with geographical information (Yuan 2017, p. 427). Additionally, IJGIS has promoted discourse on the definition and scope of the term "GIS", advocating for a broader approach beyond the use of specific commercial software packages. In relation to this, in 1997 it changed its name due, among other things, to a very influential article by Goodchild (1992), in which he presented "a coherent and influential argument that it was the science underlying the system that was important" (Fisher, 1997, p. 1).

Today, IJGIS faces new challenges and opportunities as the GIS field continues to evolve and diversify. To remain relevant, IJGIS is committed to facilitating the publication of innovative, emerging, and cutting-edge research, as well as fostering collaboration and knowledge exchange within the GIS community.

Since its foundation, IJGIS has evolved through time, covering a wide variety of topics, from more technical topics such as mathematical models or algorithms at its beginning, to less technical and more conceptual topics such as dynamic GIS with space, and time variables in recent years. By means of an approach based on science mapping analysis, its thematic evolution could be exposed, allowing a better understanding of the journal, and the global GIS field, and how the different concepts have been treated. There are several bibliometric or literature review studies on the topic of GIS (Biljecki, 2016; Liu *et al.*, 2016; Huang, 2022; Melo and Queiroz, 2019; Juhasz, 2024 and Wu *et al.*, 2023), but none specifically address this journal. In any case, these studies and ours complement each other for a better understanding of this field.

The main objective of this paper is to conduct a comprehensive bibliometric analysis of the research published in the International Journal of Geographical Information Science. To achieve this objective, a series of specific objectives and research questions have been set.

Specific Objectives:

- To assess the bibliometric performance of IJGIS through key indicators such as publications, citations, h-index, and normalized impact.
- To analyze the conceptual evolution of key research themes using science mapping techniques with SciMAT.
- To identify trends and emerging areas within the GIS discipline as reflected in IJGIS.

Research Questions:

- How has the impact of IJGIS evolved since its inception in terms of citations, impact factor, and normalized impact?
- What are the most prominent research themes, and how have they conceptually evolved over time?
- What trends and emerging areas can be observed within the GIS discipline through the articles published in IJGIS?

On the one hand, a performance bibliometric analysis is provided, featuring data on key performance indicators. On the other hand, using SciMAT, a science mapping analysis based on co-word networks is performed to uncover the most significant research themes addressed in the journal and their conceptual evolution over the studied period.

2. Methodology

To carry out the performance analysis and the science maps, first and foremost, the scientific papers published by IJGIS must be collected. The documents were downloaded from Clarivate's *Web of Science* (WoS). To achieve this, an advanced search was conducted using the following search query: SO=("International Journal of Geographical Information Science"). This search filtered by document type (ARTICLE OR REVIEW) from 1997 to 2021, both inclusive, retrieved a total of 1,947 in that time frame. The citations received by those documents in this time frame were also used; the data were downloaded on 11/10/2022.

Secondly, the analysis was performed based on bibliometric performance indicators for which the following indicators were used: published papers, citations received, the journal impact factor (Garfield, 1972), normalized impact, journal's h-index (Alonso *et al.*, 2009; Hirsch, 2005), and data on the geographical distribution of publications.

The IJGIS impact factor is published by Clarivate Analytics through its InCites Journal Citation Reports (JCR). The impact factor is calculated considering the previous two years, the latest impact factor available is for the year 2021. As for the normalized impact (Waltman *et al.*, 2011), this measure relates the journal's performance to the average number of citations of scientific production worldwide in the same period and thematic area. If the normalized impact is greater than 1, it follows that the impact of the journal's publications is higher than the global average in its thematic area for that year. Finally, the h-index is one of the main bibliometric indicators of scientific production and quality. It was designed by Hirsch (Hirsch, 2005) to measure the performance of researchers (Alonso *et al.*, 2009). In its original definition we see how this indicator was first developed to measure the scientific output of researchers:

"A scientist has index h if h of his or her Np papers have at least h citations each and the other (Np – h) papers have < h citations h".

Np is the total number of papers or articles.

Furthermore, the h-index has also been used to evaluate the performance of various scientific entities (Alonso *et al.*, 2009), such as journals (Braun *et al.*, 2006), countries (Guan and Gao, 2008), and research centers or universities (Schubert, 2007). In this case, it will be used to measure the performance of the IJGIS for the entire period under study, from 1997 to 2021.

Thirdly, a science mapping analysis, also known as bibliometric mapping, entails visually representing the interconnectedness among disciplines, fields, specialties, documents, or authors (Small, 1999). Its utility lies in revealing concealed key elements within various research domains (Cascón-Katchadourian *et al.*, 2020; Gao-Yong *et al.*, 2012; Montero-Díaz *et al.*, 2018; Raeeszadeh and Karamali, 2018).

Different software tools facilitate science mapping analysis (Cobo *et al.*, 2011). Notably, SciMAT was introduced as a robust tool integrating the advantages of existing software tools (Cobo *et al.*, 2011b), (Cobo *et al.*, 2012). Developed following the approach outlined in Cobo *et al.* (2011a), SciMAT is freely accessible under the GPLv3 license and can be downloaded, customized, and shared from its website (http://sci2s.ugr.es/scimat).

The original documents were downloaded from WoS in plain text format, containing the complete records. This text file was then imported into SciMAT to build the database that would be used to create the science maps subsequently. To enhance the data quality, an authority control procedure was implemented, using authors' keywords and ISI KeyWords Plus as the units of analysis. Similarly, terms representing identical concepts were clustered through a comparable process. Additionally, irrelevant keywords in this context, such as stop words, were eliminated. Lastly, the authors and their affiliations were preprocessed.

Next, using SciMAT's period manager, three consecutive periods were established to show the conceptual evolution of IJGIS in the analysis of science maps. To avoid data dispersion that would prevent comparison, the best option would have been to choose one-year periods. However, insufficient data were generated in the one-year time frame to obtain good results with science map analysis. For this reason, the original time frame (1997–2021) was subdivided into three periods with all periods having the same number of keywords. As our time frame is 25 years, the decision was made to consider a first period of fifteen years (1997–2011), and a second and third period of five years (2012–2016 and 2017–-2021) as the best way to meet the above criteria. Therefore, the data were divided into three consecutive periods with 815, 590, and 542 documents and

2,411, 2,854, and 2,663 keywords. Evidently, the first period is much larger in terms of years and somewhat larger in documents, however, it has fewer keywords.

Cobo *et al.* (2011a) introduced a bibliometric method that merges performance analysis with science mapping tools to examine a research area, identifying and visualizing its conceptual subdomains and thematic development. This method utilizes co-word analysis (Callon *et al.*, 1983) and the h-index (Hirsch, 2005).

The method involves three stages for analyzing a research field longitudinally:

- Detection of research themes: Utilizing co-word analysis on raw data from published documents, themes are identified for each period, followed by keyword clustering to reveal interconnected networks corresponding to areas of significant interest. The Equivalence index (Callon *et al.*, 1991) is used to determine keyword similarity.
- Visualizing research themes and thematic networks: Themes are characterized by centrality and density values. A strategic diagram and thematic network show research themes, categorized into quadrants based on their development (density) and importance within the field (centrality). Thus, according to their density and centrality, the detected themes could be classified into four different categories: motor (upper-right), highly developed and isolated (upper-left), emerging or declining (lower-left), and basic and transversal (lower-right)
- Performance analysis: The contribution of research themes and thematic areas to the overall research field is quantitatively and qualitatively assessed to identify prominent and impactful subfields. Bibliometric indicators such as the number of published documents and citations, as well as various forms of the h-index, are used. Document mapping assigns documents to detected themes, enabling the assessment of performance measures and indicators. Since documents may be associated with multiple themes, and thematic areas may share themes and documents, a comprehensive analysis is conducted to evaluate research field performance.

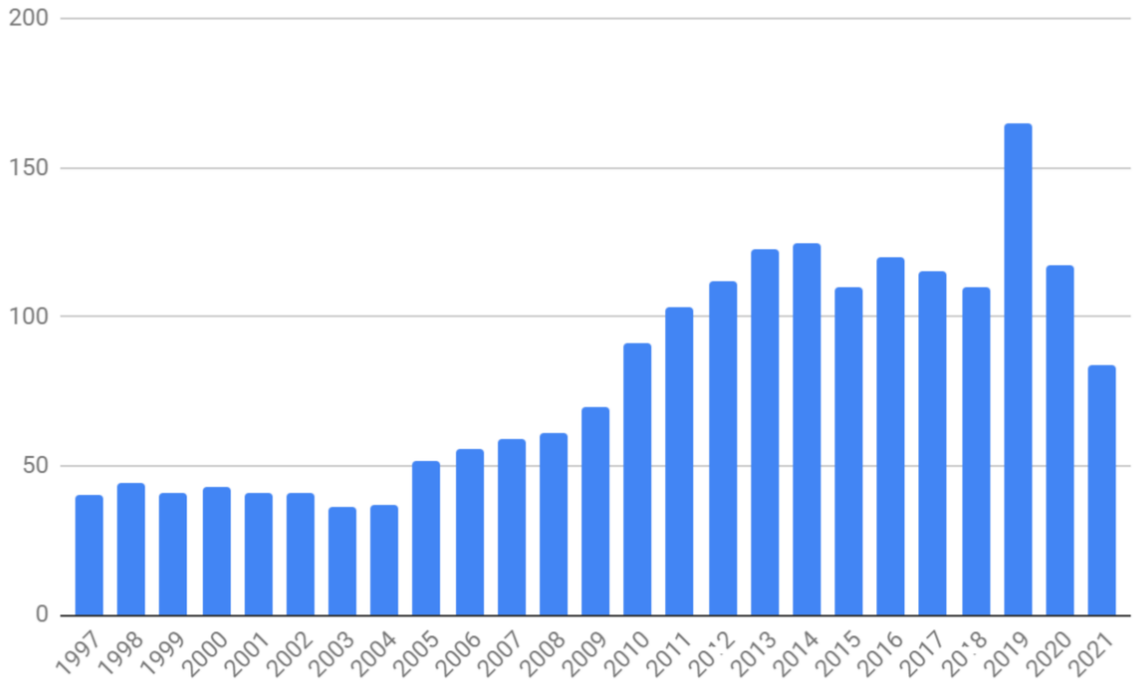
3. Results

3.1. Performance bibliometric analysis of the IJGIS

3.1.1. Publications and citations

In line with the first part of the research's main objective, a performance bibliometric analysis has been conducted. Within this analysis, the distribution of publications per year is shown in Figure 1. As can be observed, the number of publications in IJGIS remained relatively stable from 1997 to 2004, with between 36 and 44 articles per year. Starting from this point, during the period 2005–2009, it gradually and slightly increased each year from 52 to 70 records. From the year 2010 until 2021, there was a considerable increase in the number of documents, fluctuating between 90 and 125 documents, with exceptions in the year 2019 experiencing a significant rise to 165 documents, and in 2021 dropping to 84 documents. One possible explanation for these increases is that the journal transitioned from 8 issues per year from 1997 to 2004, to 10 issues per year in the period 2005–2007, and finally to the current 12 issues per year since 2008. This is also related to the three periods we have used in this study for thematic science mapping: 1997–2011, 2012–2016, and 2017–2021. The first period is longer temporally but with a lower number of articles per year, especially in the beginning, while the following two periods have a shorter temporal duration but a higher number of articles per year.

Figure 1. Number of records in the WoS per year of publication of IJGIS.

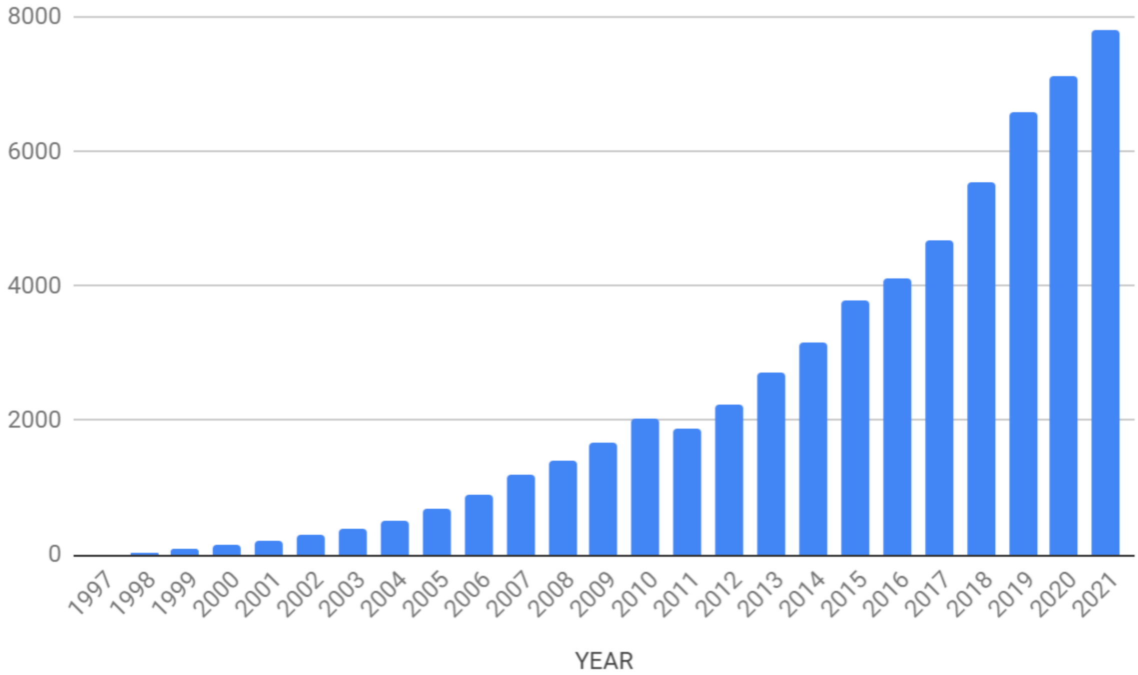


The distribution of the citation count obtained by these documents is shown in Figure 2. Data taken directly from the WoS are considered –– for example, for the year 2019, the citations received by the journal (all its articles published in all years) in that year by the rest of the journals indexed in the WoS are shown. Therefore, this measure demonstrates whether a journal is being cited more (of more interest) in some years than in others. In Figure 2, it can be seen how the increase in citations has been progressive by the journal since its inception. Only in the year 2011, there was a slight setback (2010: 2036; 2011: 1884), which speaks to the well-sustained evolution in terms of the journal's impact and its consolidation as one of the benchmarks in the field. It is worth noting the acceleration of the journal's impact in recent years, which is reflected in various data. From the year 2015 to 2021, citations doubled (from 3,782 to 7,802), with the years 2018 and 2019 standing out for their increase in citations, estimated at around 1,000 citations more than the previous year.

When comparing the number of published documents to the number of citations they receive, the following observations are

made. Although, as observed, the number of documents from 1997 to 2004 was stable, the number of citations progressively increased from 6 to 505. From 2005 to 2009, although the number of documents increased gradually, the number of citations tripled more forcefully from 505 citations to 1,665. Next, curiously from 2010 to 2013, when the number of documents published per year increased most forcefully, citations per year stagnated, rising "only" from 2,036 to 2,711; even in 2011, the mentioned decrease in citations occurred, which, as later reflected, led to a decrease in quartile. Finally, although it has already been stated that in the recent years of the journal (2010-2021), the number of publications is high and stable, it is true that from the year 2014 to 2021, the number of documents decreased slightly (except the year 2019); however, the rate of increase in citations accelerated, going from 3,173 to 7,802.

Figure 2. Number of citations received by IJGIS each year.

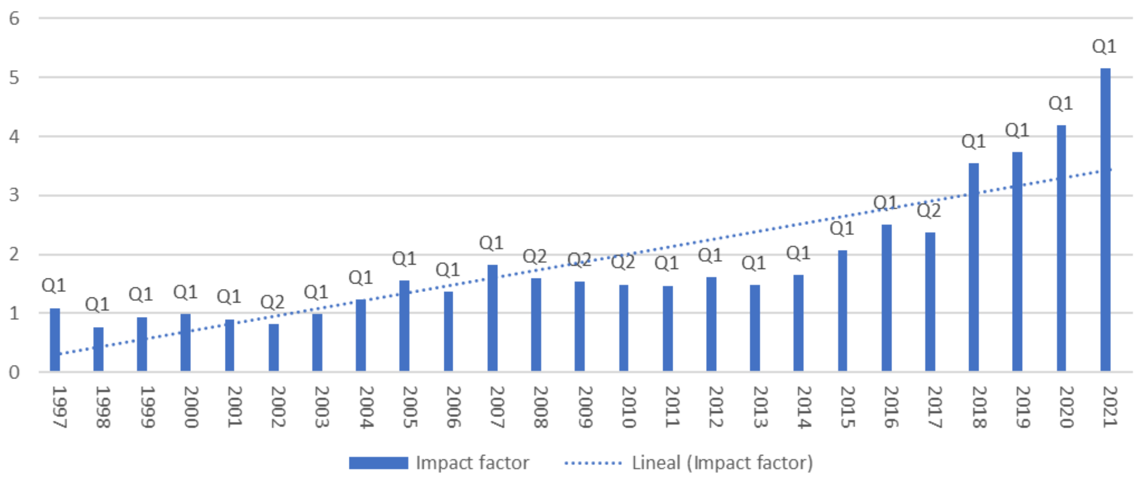


3.1.2. Impact factor

Figure 3 shows the impact factor from the year 1997 to 2021. Information regarding the position (quartile) is included in the graph. Considering that the journal is listed in multiple categories of the Journal Citation Reports (Information Science & Library Science – SSCI; Geography – SSCI; Geography, Physical – SCIE; Computer Science, Information Systems – SCIE), in this case, Figure 3 shows the highest quartile position achieved by the journal in any of those categories. Subsequently, Table 1 will present the quartiles attained by the journal in the 4 categories in which it has appeared in the last 10 years.

The column chart illustrates how the journal's impact factor was around 1 from 1997 to 2004 with occasional fluctuations. From the year 2005, the impact factor rose to around 1.5 with slight variations until 2014. Starting from 2015, the first year in which the impact factor exceeded 2, until 2021, the increase in the impact factor is highly noticeable, reaching an impact factor higher than 5. Only the year 2017 presents a lower impact factor than the previous year. As shown in Figure 3, the linear increase in the impact factor is considerable over these 25 years.

Figure 3. Impact factor of IJGIS each year.



Secondly, this research has compiled the following quartile table. It is noteworthy that out of 40 possibilities (4 categories per 10 years displayed), the journal is in Q1 in 23 instances (57.5%). In the remaining cases, it is in Q2, except for 4 instances where it is in Q3 in the Physical Geography category, although it has significantly improved in that category since 2015. Secondly, in an analysis of the last 5 years, out of 20 possibilities (4 categories per 5 years), it is in Q1 in 13 instances and in Q2 in 7 instances. The percentage of Q1 increases to 65 percent, and consequently, Q3 disappears. In a more recent analysis, in the last available year as of the date of this study, 2021, the journal is in Q1 in all categories. All the aforementioned data demonstrate that this journal has consistently been well-positioned in all categories and has progressively settled in the first quartile. The most remarkable progress has been made in the Physical Geography category, moving from the third quartile to nearly reaching the first decile of the category. It is worth noting that in none of the aforementioned 40 possibilities is the journal situated in the first decile in the different categories. This would be an area for improvement in the coming years, to achieve that level of excellence.

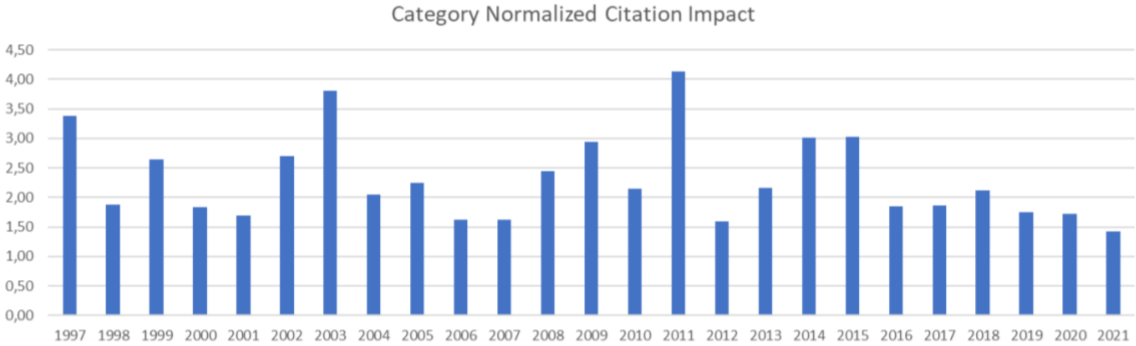
Table 1. Impact factor and Quartile by year and category.

	Computer Science, Information Systems		Geography		Geography, Physical		Information Science & Library Science	
JCR Year	**JIF Rank**	**Quartile**	**JIF Rank**	**Quartile**	**JIF Rank**	**Quartile**	**JIF Rank**	**Quartile**
2021	40/164	Q1	10/86	Q1	6/50	Q1	21/84	Q1
2020	48/161	Q2	21/85	Q1	10/50	Q1	27/85	Q2
2019	36/156	Q1	10/84	Q1	11/50	Q1	16/87	Q1
2018	34/155	Q1	9/83	Q1	17/50	Q2	12/89	Q1
2017	54/148	Q2	24/84	Q2	24/49	Q2	23/88	Q2
2016	46/146	Q2	14/79	Q1	19/49	Q2	15/85	Q1
2015	30/144	Q1	17/77	Q1	25/49	Q3	18/86	Q1
2014	36/139	Q2	18/76	Q1	26/46	Q3	18/85	Q1
2013	45/135	Q2	22/76	Q2	29/46	Q3	20/84	Q1
2012	29/132	Q1	25/72	Q2	26/45	Q3	16/85	Q1

Normalized impact is next to discuss. In the case of articles belonging to multiple categories (as is the case with IJGIS), a harmonic mean is calculated, providing a single figure per year in the following graph. The initial observation indicates that, in all but one year, the normalized impact is above 1.5, and in 14 out of the 25 years analyzed, it is above 2, which are very positive figures consistent with the journal firmly established in the first quartile. As shown in the graph, there are more striking fluctuations at the beginning and smoother ones from 2016 onwards, but always ranging between 1.4 and 2.1. This coincides with the period when the journal's impact factor rises rapidly. Therefore, it can be concluded that although the normalized impact increases during these years, the journal's impact factor increases to a greater extent.

According to WoS, the journal's h-index over the 25 years analyzed, with the filter of articles and reviews, is 107.

Figure 4. Category Normalized Citation Impact by year.



3.1.3. Geographical distribution of publication

The following table (Table 2) illustrates the geographical distribution of the journal. The table includes all countries with more than 50 documents published in this journal. Topping the list are the USA, followed by the People's Republic of China and the United Kingdom, with notable differences between them. The USA leads China by more than 150 documents, while China surpasses the UK by 121. From the third-ranked country to the fourth, Australia, there is a significant quantitative leap, as the UK publishes more than twice as many documents as Australia. Beyond that point, the figures become more similar among countries. Based on the data, it can be concluded that IJGIS is an internationally renowned journal in terms of impact, as evidenced by the significant number of developed countries publishing a considerable number of documents in it. These include the two leading global powers, the USA and China, as well as various European countries, Hong Kong, Australia, and Canada. Additionally, based on the data, the fact that only articles in English are accepted may influence the results and favor the dominance of certain countries.

Table 2. Geographical distribution of the journal.

Name	***Web of Science* documents**
USA	652
People's Republic of China	497
United Kingdom	376
Australia	144
Netherlands	129
Germany (Fed. Rep. Ger.)	121
Hong Kong	109
Canada	108
Spain	83
France	64
Switzerland	61

Belgium	56
Italy	51

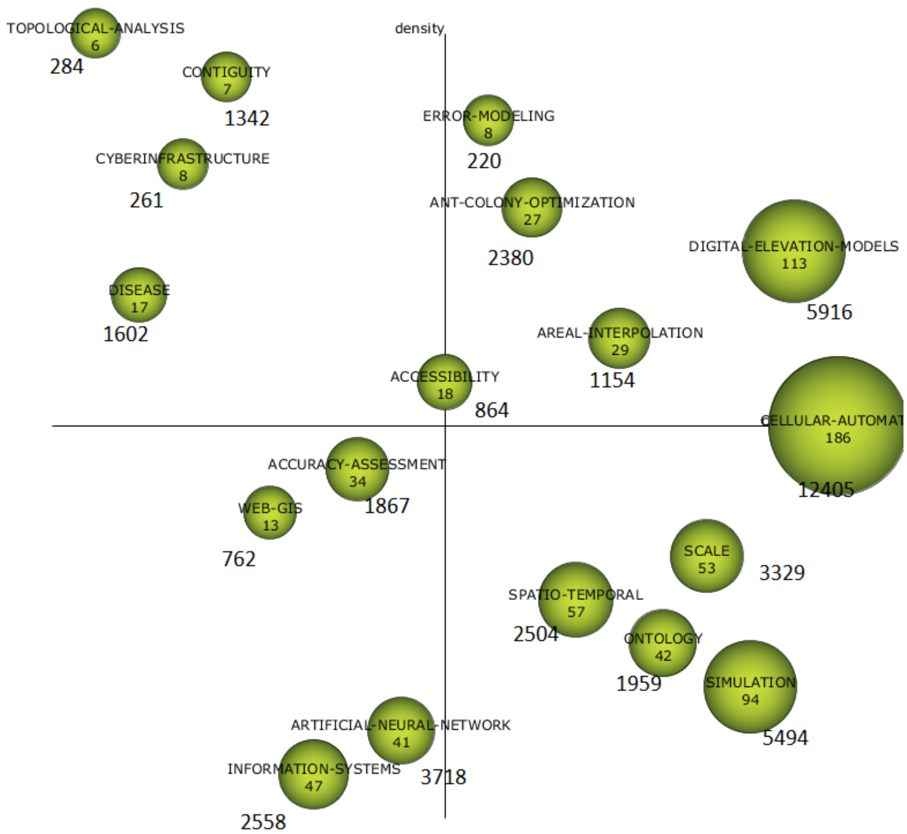
3.2. Science mapping

As for the second part of the research's main objective, a science mapping analysis has been made. The analysis is divided into periods, supported by strategic diagrams that illustrate the journal's most prominent themes. In the strategic diagrams, the size of each research theme sphere corresponds to the number of documents published on that theme, with the number of citations each research theme has received indicated in parentheses.

3.2.1. First period (1997–2011)

As shown in Figure 5, during this initial period, the IJGIS revolves around 18 research themes, as illustrated in Table 3. This table provides performance indicators such as the number of documents, citations obtained by those documents, and the h-index. According to these indicators, it is noteworthy that the main themes by the number of documents are cellular automata, digital elevation models, and simulation, with cellular automata having the highest number of documents by a significant margin (186 compared to 113 for the second-ranked theme). Moreover, they have the highest h-index, with a combined citation count exceeding 23,000. Additionally, the themes such as Scale, Artificial Neural Network, and Contiguity stand out for their high number of citations relative to the number of documents they appear in. The themes of Web-GIS and Accessibility are also noteworthy, as they are the themes that will be further developed in subsequent periods.

Figure 5. Strategic diagram for the 1997–2011 period.



Cellular-Automata is a theme that shows high centrality and medium density, indicating strong connectivity with other networks but moderate internal intensity. This theme is the most significant in the first period, with the highest number of documents (186) by a considerable margin compared to the second-ranked theme (113). It also boasts the highest h-index (56) and the highest sum of citations (12,405). Cellular-Automata was a highly popular theme in the late 1990s and early 21st century, revolving around multi-agent systems and parallel computing techniques for urban simulation and growth (Li and Yeh, 2000) prediction through predictive urban modeling integrated into GIS systems.

The second most important theme is Digital-Elevation-Models, a motor theme that ranks second in terms of the number of documents (113), h-index (47), and number of citations (5,918), albeit with a lower citation count per document compared to Cellular-Automata. This theme is closely related to accuracy and resolution, particularly in measurements provided by tools such as LIDAR (Lloyd and Atkinson, 2006). It involves technical aspects related to terrain models, grid sizes, slope, and drainage networks, among other things.

Simulation is as another prominent theme, characterized as a basic theme with 94 documents and a significant number of citations compared to Digital Elevation Models. Despite having 19 documents less, Simulation is only marginally behind in citation count, indicating considerable centrality, while its density decreases compared to the previous themes. This theme is associated with Agent-Based Modeling (Bone *et al.*, 2011), which examines interactions between multiple elements through computer simulations, touching upon land use, modeling, human or animal behavior, representation, and evolution in time and space, as well as uncertainty and complexity inherent in these systems. Furthermore, the Accessibility theme is also related to the Buffer Operation in spatial analyses of Geographic Information Systems (GIS), which allows for defining an influence zone around a specific element.

With 53 documents, nearly half of the previous theme, Scale also stands out, boasting an h-index of 29 and 3,329 citations, 800 citations more than the Spatio-Temporal theme despite having four more documents. This theme is cited considerably and serves as a basic theme related to topography, climate, hydrology, and biomass. But also with the Scale of the categorical maps and several techniques mentioned below. On the one hand the Multiscale Geographically Weighted Regression, spatial regression technique used in geography, or the autocorrelation used in GPS systems to correct certain errors between the satellite signal and the receiving points of the earth. It is also related to non-stationary time series.

Artificial-Neural-Network is another interesting theme due to its high number of citations compared to the number of documents it appears in –– with only 41 documents it has 3,718 citations, even more than Scale which had 12 more documents and a slightly lower h-index. This is an emerging theme whose evolution will be seen in the next period. Artificial-Neural-Networks are used as a tool to help classify data provided by remote sensing for environmental monitoring or natural resource management.

Another theme worth mentioning, again due to the high number of citations despite the low number of documents, is Contiguity . With only 7 documents, it obtains a total of 1,342 citations and an h-index of 6, a higher number of citations than other themes with double or triple the number of documents. This theme is related to the Programming-Model concepts that seek Spatial-Optimization considering Contiguity as one of the factors to be taken into account for issues such as Land Acquisition.

The next theme to be analyzed is Web-GIS, an emerging theme whose evolution will be discussed in the following period. It appears in 13 documents, with an hindex of 11 and only 762 citations. Therefore, it is an emerging theme in the journal at this time. It is related to the concept used as a synonym for Internet-GIS and usability, which shows the concern in this period that this complex software should be easy to use.

The last theme in this period is Accessibility, a theme almost at the intersection of density and centrality. In terms of the theme's centrality , its interaction with other themes is just average. However, its density is above average, with a slightly high internal network intensity, placing this theme right in the middle between the motor themes and the specific but peripheral themes. It does not stand out in terms of the number of documents (18), h-index (15), or number of citations (864), but it follows an interesting evolution path in the following periods. It is related to the concepts of Time-Geography, Spatio-Temporal, Road-Network, Transportation, and Moving-Objects. Therefore, it handles everything related to Accessibility in Transportation, specifically in Road-Network and taking into account Time-Geography, which is the model used by geographers to understand accessibility.

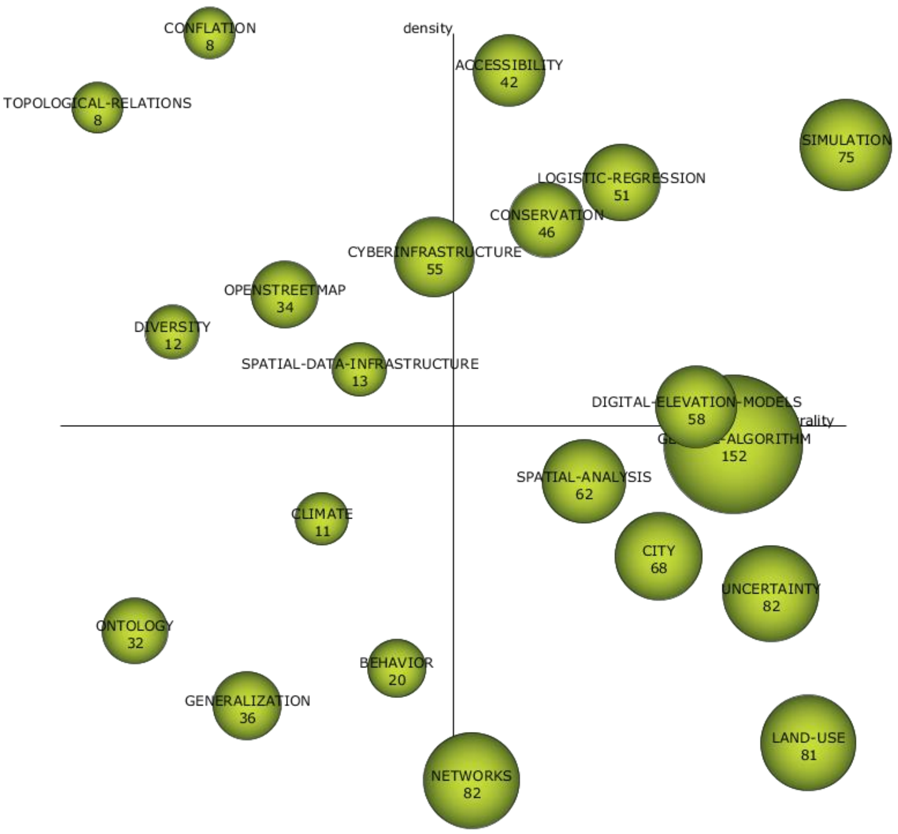
Table 3. Performance indicators of the themes in the 1997–2011 period.

Name	Number of documents	h-Index	Sum Citations
Cellular-Automata	186	56	12,405
Digital-Elevation-Models	113	47	5,918
Simulation	94	43	5,494
Spatio-Temporal	57	27	2,504
Scale	53	29	3,329
Information-Systems	47	28	2,558
Ontology	42	26	1,959
Artificial-Neural Network	41	26	3,718
Accuracy-Assessment	34	24	1,867
Areal-Interpolation	29	19	1,154
Ant-Colony-Optimization	27	20	2,38
Accessibility	18	15	864
Disease	17	13	1,602
Web-Gis	13	11	762
Error-Modeling	8	6	220
Cyberinfrastructure	8	7	261
Contiguity	7	6	1,342
Topological-Analysis	6	6	284

3.2.2. Second period (2012–2016)

As shown in Figure 6, in the second period, the IJGIS focuses on 21 research themes, as illustrated in Table 4, which features performance indicators such as the number of documents, citations obtained by these documents, and the h-index. Based on these metrics, it is worth highlighting by the number of documents as main themes: Genetic Algorithms (152), Networks (82), Uncertainty (82), Land Use (81), and Simulation (75). These themes have the highest number of publications, indicating their popularity as research areas. They also have the highest h-index: Genetic Algorithms (35), Uncertainty, Land Use and Simulation (27), and Networks (26). This indicates that these themes have a higher impact on the research community than others listed in the table. In addition, the total number of citations for these six themes is more than 13,000. On the other hand, themes such as OpenStreetMap and Accessibility stand out for their high number of citations compared to the number of documents in which they appear. Other noteworthy themes include City (related to urban growth) and the involution of Digital Elevation Models (which will be mentioned in the third period).

Figure 6. Strategic diagram for the 2012–2016 period.



Genetic Algorithms is a theme at the intersection of the motor themes and the basic and transversal themes. It has high centrality and medium density, i.e., it is well related to other networks, but the internal intensity of the network is medium. It is the most important theme of the second period since it is the one with the highest number of documents (152), the highest h-index (35), and the highest sum of citations (4,102), quite opposite of the second-ranked (82). This theme deals with evolutionary algorithms as a more general concept. It also includes related concepts such as particle swarm optimization or ant colony optimization (Mi *et al.*, 2015), which are used to optimize and calibrate GIS in their network analysis. All are used to better manage land use allocation.

Next to be analyzed are basic and transversal themes: Networks (82), Uncertainty (82), and Land-Use (81), with almost the same number of documents, and City (62), with a lower number of documents. The penultimate of these, Land-Use, has a high number of citations (2,798). It is a theme with high centrality, but with low density even for basic themes. This theme is related to concepts such as growth, urban, urban form, transportation, and landscape metrics. To a lesser extent, it is related to transition-rules which are used for urban-simulation.

Networks is the third theme in terms of citations (2,323), and the one with the lowest centrality and density, especially density, i.e., it is not internally developed, while centrality occupies a small portion within the right quadrant of the diagram. This theme is related to concepts such as Areal-Interpolation, a geostatistical interpolation technique widely used by the Geographic Information Science literature, both for polygons and imagery, and Clusters, which is used for the analysis of locations, with the help of tools such as Terrain Analysis, Spatial Interaction, Space Syntax, and Spatial-Optimization.

Uncertainty has lower performance in terms of citations (2,171) than the group with 82 documents. It should be noted that it shows high centrality, so it is well-related to other networks. This theme is related, although not very strongly, to many concepts, including the Monte Carlo simulation (Qin *et al.*, 2013), which is a multi-probability simulation for uncertain outcomes, which in turn is related to geostatistics, as well as to sensitivity analysis. It is also worth mentioning the relationship between Uncertainty and two very closely related concepts, such as Individual Accessibility and Constraints of said accessibility. The same can be said for Visualization and Geovisual Analytics, which are related to Uncertainty in the representation of spatial knowledge, and which are also related to Climate Change and the changes in land use it causes.

Finally, from this group of basic and transversal themes, the theme of City has several citations (2,248) similar to the themes with a higher number of documents, indicating a great performance. Like the previous ones, it is in the lower right quadrant, although it has a good performance in terms of centrality. It is related to the following concepts that have to do with algorithms such as head/tail breaks, which is related to Zipf's Law that explains the distribution size of cities. These two keywords appear a good many times with City. It is also related to studies on land cover, urbanization, and urban expansion using multi-criteria evaluation and big data. The latter concept is closely related to head/tail breaks, as this algorithm not only classifies but also visualizes large data sets.

The Simulation theme has a lower number of documents (except City) than the previous ones (75) but with a good performance in terms of h-index (27) and citations (2,178). This theme, already analyzed in the previous period, has had a loss of performance in terms of documents, h-index, and citations, but it has consolidated as a motor theme, improving in centrality but above all in density, being one of those with the highest density for this period. Therefore, it is well related to other external networks and to its internal network. It is the central theme of several simulation models such as Agent-Based Modeling, Modeling Approach, Geosimulation, or the already mentioned Cellular Automata. It is also related to the simulations performed for land-use change, urban growth, land cover change, and evacuation.

The Accessibility theme, already mentioned in the first period, has improved its performance in terms of the number of documents (42), h-index (20), and citations (1,267) and has consolidated its position as a motor theme with a significant growth in terms of density and a slight improvement in centrality. In terms of related concepts, time-geography and space-time and their variants are once again noteworthy. A strongly related concept is the Integrated Approach, which combines Walking, Mobility, Mobile Objects, and Geovisualization.

The last theme to be analyzed is OpenStreetMap, with much fewer documents (34), a good h-index (22), and a high number of citations for its size (1,667). In the upper left quadrant of the diagram is a very specialized theme, a very specific type of map that has little relation to the other themes. This theme deals with the related concepts of crowdsourcing and volunteered geographic information (Jokar Arsanjani, 2013). OpenStreetMap is a community-driven online map, including the concepts of GPS and road networks since these maps are created using geographic information collected with GPS devices.

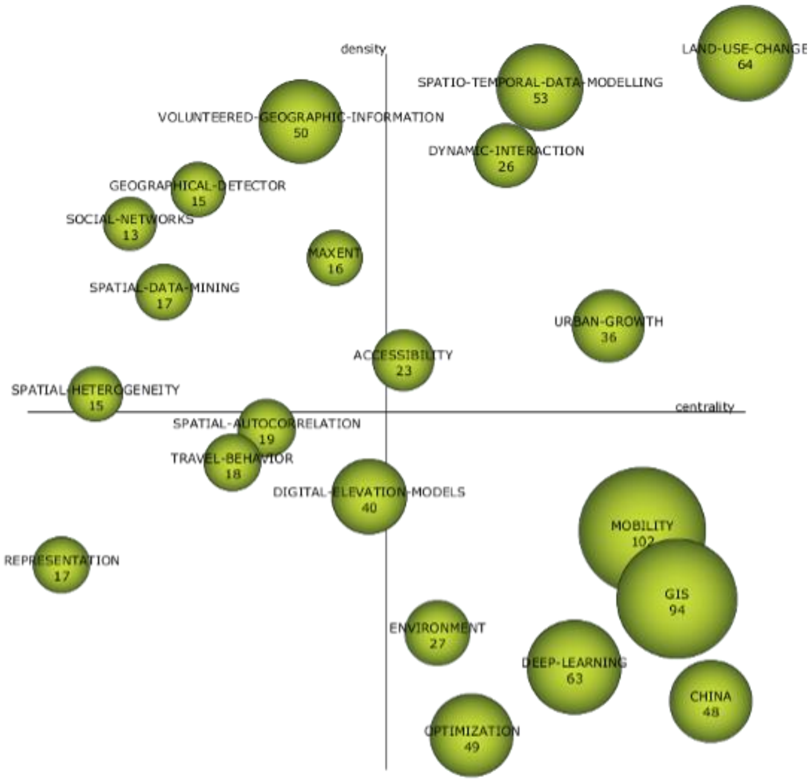
Table 4. Performance indicators of the themes in the 2012–2016 period.

Name	Number of documents	h-Index	Sum Citations
Genetic-Algorithms	152	35	4,102
Uncertainty	82	27	2,171
Networks	82	26	2,323
Land-Use	81	27	2,798
Simulation	75	27	2,178
City	68	24	2,248
Spatial-Analysis	62	20	1,577
Digital-Elevation-Models	58	19	1,075
Cyberinfrastructure	55	21	1,311
Logistic-Regression	51	22	1,524
Conservation	46	17	988
Accessibility	42	20	1,267
Generalization	36	14	811
Openstreetmap	34	22	1,667
Ontology	32	17	890
Behavior	20	13	456
Spatial-Data-Infrastructure	13	8	218
Diversity	12	8	160
Climate	11	9	311
Conflation	8	7	200
Topological-Relations	8	6	114

3.2.3. Third period (2017–2021)

As shown in Figure 7, the IJGIS focuses on around 21 research themes, as illustrated in Table 5, where we can see the performance indicators: number of documents, citations received by these documents, and the h-index. According to these indicators, it is worth highlighting the 4 main themes by number of documents: Mobility, GIS, Land-Use-Change, and Deep Learning, where the first two have the highest number of documents (102 and 94, the third with 64). In addition, they are the ones with the highest h-index and the only ones with an h-index of 20 or higher (except for China). They are also the ones with the highest number of citations and the only ones with more than 1,300 citations each. On the other hand, the themes such as China and Urban Growth stand out for their high number of citations in relation to the number of documents in which they appear. The Spatio-Temporal-Data-Modeling theme will also be analyzed, as it is a motor theme that is well related to other themes.

Figure 7. Strategic diagram for the 2017–2021 period.



Mobility is the most prominent theme in the third period, with the highest number of documents (102), the highest number of citations (1,793), and the second-highest h-index (23). It is a basic theme, but with good centrality, indicating good connectivity with other networks. This theme, successor to City and Accessibility, deals with concepts such as visualization or visual analysis of movement data, trajectories, and finally the spatial interaction and aggregation of spatial data, which can be very large (big data (Zhao *et al.* 2020)) of this mobility of cities.

The second most important theme in terms of the number of documents is GIS (94), not so in terms of citations (1,372) and h-index (20) where it does not perform so well. It is again a basic theme with good centrality, which puts it in contact with other networks. This theme is related to 11 concepts, none of them with great strength, but it is related to a good number of keywords, among which it is worth mentioning: the Genetic Algorithm and the Multicriteria Evaluation (Jelokhani-Niaraki, 2021), which are used in GIS with tools such as the Decision Support System to show the least cost path or the smallest distance between locations. Another interesting point is the public participation in the field of GIS and its integration into society.

The third theme to be analyzed is Land-Use-Change which, with an average number of documents(63), obtains a good performance in terms of citations, where it appears in third place (1,478) and scores the highest h-index (24). In this third period, it is the theme with the highest centrality and density of all, being therefore a motor theme in the upper right corner of the diagram. Proof of this is that the internal graph of Land-Use-Change is a tangle of connections between the concepts with the central theme, but also between them, showing a strong internal cohesion. The theme deals with many of the concepts we have already mentioned above: Simulation, Artificial Neural Networks, Cellular Automata, Logistic Regression or Sensitivity Analysis, and their relationship with the growth and expansion of cities and their simulations. A Markov

Chain process needs to be highlighted as a concept not seen so far, which helps to see the growth of cities as a series of events that occur one after another.

In terms of bibliometric performance, Deep Learning behaves similarly to the previous theme with 62 documents, an h-index of 22, and a very high number of citations, appearing in second place in this period with 1,480 citations. In this case, it is a basic theme with low density but with good centrality. This theme is related to Convolutional Neural Networks (Li and Hsu, 2020), which are considered a central part of Deep Learning algorithms and their performance with multiscale context information. These deep learning algorithms are also used for scene classification, as these algorithms extract features from images to large scale datasets, as they are used for land use.

This research finds the China theme interesting because, with a humble number of documents (48), it obtains a remarkable bibliometric performance with an h-index of 20 and 1,147 citations. It is a basic theme with high centrality, which leads it to be well-related to other networks. Another interesting point is the relationship of the theme with various concepts that have to do with the Evolution of the Population and the Cover Change that this implies, due to the large population growth in China, which is a driving force that generates a Use Dynamics of the Land influenced by a Spatiotemporal Dynamics. All this is studied and analyzed with the Cellular Automata Model, the Geospatial Big Data, and the gravity model that explains, in this subject, the movement of populations between cities or trade between countries.

Urban Growth is another of the themes that is worth highlighting for its good bibliometric performance, with 36 documents receiving a total of 843 citations. It is also a motor theme with good centrality and density. This theme is strongly related to concepts such as the Rules and Calibration of Urban-Growth, as well as with a not-so-pronounced relationship with the Validation, and the Behavior of this Urban Growth and its Neighborhood.

Spatio-Temporal-Data-Modelling is a theme that despite not having a great bibliometric performance, has a solid number of documents (53) and is a motor theme that stands out above all for its high density, while still having good centrality. This theme alludes to concepts related to spatio-temporal models that are widely used in Geographic Information Science and Geocomputation in general. They use Space-Time Prism, Data Model, Moving Objects and Moving Objects Data, as well as Spatial Interpolation to try to predict new data. This can be used for Urban-Applications such as Road Networks. These systems are complex and always have a high uncertainty rate.

Table 5. Performance indicators of the themes in the 2017–2021 period.

Name	Number of documents	h-Index	Sum Citations
Mobility	102	23	1,793
Gis	94	20	1,372
Land-Use-Change	64	24	1,478
Deep-Learning	63	22	1,480
Spatio-Temporal-Data Modelling	53	14	579
Volunteered-Geographic-Information	50	17	1,031
Optimization	49	14	657
China	48	20	1,147
Digital-Elevation-Models	40	14	600
Urban-Growth	36	18	843

Environment	27	14	576
Dynamic-Interaction	26	11	365
Accessibility	23	13	575
Spatial-Autocorrelation	19	8	263
Travel-Behavior	18	12	487
Representation	17	7	149
Spatial-Data-Mining	17	9	276
Maxent	16	7	215
Spatial-Heterogeneity	15	7	219
Geographical-Detector	15	8	157
Social-Networks	13	8	216

3.2.4. Conceptual evolution over the studied period

The final part of the research's main objective, namely the conceptual evolution over the studied period, is described below. We would like to highlight the evolution that has taken place with the two themes that appear in the three periods, namely Digital Elevation Models and Accessibility. Regarding Digital Elevation Models, this research shows that in the first period analyzed in this journal it had a great boom, being the second most important theme in terms of the number of documents, h-index, and citations, but also because it was a motor theme, with good centrality and density. In the second period, it loses importance, dropping substantially in the number of documents and citations, and is maintained in the motor themes, but with a drop in density that makes it close to the basic themes. In the third period, it continues to decline in terms of documents, h-index, and citations and becomes part of the lower left quadrant, where the disappearing themes are located. From the perspective of this research, it seems clear that the enthusiasm for Digital Elevation Models in scientific literature has faded over time.

Accessibility is a theme that does not stand out in the first period, neither in terms of its bibliometric indicators nor in terms of its position in the diagram, since it is located at the intersection of the four quadrants. However, it had a remarkable evolution in the second period, improving in all the bibliometric indicators. Moreover, in the second period, it is a motor theme, with significant growth in terms of density and a slight improvement in centrality. In the third period, although it remains a motor theme, it again decreases significantly in terms of density. In the three periods, it has similar centrality. Likewise, just as it increases in the bibliometric indicators in the second period, it falls in the third period to the previous values of the first period. In other words, accessibility is always an interesting theme for scientific literature, but with a high level of interest.

One of the most prominent themes in this journal is Simulation, which appears in the first two periods and then disappears, but it is worth following its evolution. Although it declines in all bibliometric indicators in the second period, thanks to its improvement in density, it goes from being a basic theme to a motor theme.

4. Discussion

At this point, a summary of the three periods will be made, pointing out the driving and emerging themes in each of them, and finally explaining where we think the journal will evolve in the future.

The motor themes identified in the first period (1997–2011) are Error-Modeling, Ant-Colony-Optimization, Digital-Elevation-Models, Areal-Interpolation, Accessibility, and Cellular Automata. The latter two are exactly at the edge of the quadrant –– the first because of its centrality and the second because of its density. Therefore, it is evident that, in this first period, the most important and well related to other themes are very technical and focused on mathematical models, algorithms, statistical techniques, or 3D graphics used by GIS software, for example for uses on accessibility in cities, land use or climate. For their part, the emerging topics are Accuracy-Assessment, Web-GIS, Artificial-Neural-Network and Information Systems, in line with the advances occurring in the late 1990s and early 2000s with web-based GIS systems and the creation of the first map APIs, connecting information systems, algorithms or computational models with each other.

The motor themes identified in the second period (2012–2016) are Simulation, Logistic-Regression, Conservation, Digital-Elevation-Model, and Accessibility, with high bibliometric indicators in terms of the number of documents, h-index, and citations. The results suggest that these themes are fundamental for the understanding of different phenomena in areas such as statistics, ecology, environmental conservation, transportation, and accessibility from cartography as a key tool in decision-making. The high number of citations received for these motor themes indicates that they are relevant and of great interest to the scientific community working on cartographic issues. Several emerging themes that were gaining research attention have also been identified. These themes include Generalization, Ontology, Behavior, and Climate. These findings suggest that these themes were emerging as key areas of research in different fields such as geography, computer science, and psychology, among other things. The number of citations received by these emerging themes indicates that they are gaining interest and relevance in the scientific community.

The motor themes identified in the third period (2017–2021) are Land-Use-Change, Spatio-Temporal-Data-Modelling, Dynamic-Interaction, Urban-Growth and Accessibility, as we see themes and concepts not as technical as in previous periods. This Dynamic Interaction and Spatio-Temporal-Data-Modelling have to do with the idea of dynamic GIS and the dynamic nature of these two variables (space and time) that these softwares manage, among other things, to analyze and evaluate the growth of cities, their accessibility and changes in land use. The emerging or disappearing themes are Spatial-Autocorrelation, Travel-Behavior, Digital Elevation Models, and Representation. In this case, as already mentioned, Digital-Elevation-Models is a disappearing theme that was a motor force in previous periods. Emerging themes are travelers' behavior and habits, representation or visualization of data within GIS, and how entities are grouped and dispersed in space, which are crucial to understanding spatial autocorrelation for a representation of travel behavior and, therefore, to elaborate effective transportation policies.

This research aims to give its vision of where the field of GIS may go in the future. In line with this research, it is maintained that themes related to Volunteered Geographic Information and trendy themes such as Travel Behavior, Traffic Flow and Information Visualization will continue to be important in the short term. In both the short and medium term, the future looks promising, and this journal could further diversify its subject matter, including, for example, the analysis of vast amounts of geospatial data using big data techniques. This may include the integration of real-time data from various sources such as remote sensors, mobile devices, etc., which will allow for more dynamic and accurate decision-making. This, together with the convergence of GIS with fields such as artificial intelligence and machine learning, will open up new opportunities for solving complex problems in various domains such as trend prediction and resource optimization.

In fact, the integration of artificial intelligence (AI) has significantly transformed geographical science and the way geographic data is perceived, particularly between 2017 and 2021, by leveraging deep learning and machine learning. Innovations like convolutional neural networks have automated feature detection in remote sensing, enhancing both the accuracy and scalability of spatial analyses. Concurrently, AI has advanced geovisualization techniques, enabling dynamic, interactive, and intuitive tools that improve the accessibility and interpretability of geospatial data.

These developments have fundamentally restructured the discipline, allowing for the analysis of complex problems and large-scale geospatial datasets. AI has facilitated the modeling of intricate spatial, temporal, and contextual relationships, reshaping research priorities and methodologies. As a transformative force, AI has expanded the scope and capabilities of geographical science, equipping it to address global challenges and support sustainable development. Undoubtedly, AI will continue to evolve and further enhance the potential of geographical science in the future.

Contemporary challenges such as climate change, urbanization or urban growth, and the management of natural resources will undoubtedly require the integration of heterogeneous data, as well as its modeling within GIS. This, in turn, will require the development of advanced visualization and spatial communication techniques that will facilitate understanding and informed decision-making by end users, which may include augmented or virtual reality, and these advances will undoubtedly be picked up by the IJGIS. It is also possible that IJGIS will evolve into more interactive and multimedia publication formats, taking advantage of emerging technologies to enhance reader experience and content accessibility. In short, the future of IJGIS will be marked by technological innovation and interdisciplinary collaboration.

The findings of this study have significant implications for researchers, practitioners, and journal editors. For researchers, the study provides a clear roadmap of the thematic evolution in GIScience, highlighting emerging trends and opportunities for future exploration. Themes such as deep learning, mobility, and land-use change signal new directions in the field, enabling researchers to align their work with these cutting-edge areas. Furthermore, the study underscores the interdisciplinary potential of GIS, connecting it to fields like urban planning, environmental management, and social sciences. This presents a valuable opportunity for researchers to collaborate across disciplines, fostering innovation in addressing global challenges such as urbanization and climate change. Additionally, identifying high-impact themes and geographical contributions allows scholars to benchmark their efforts and strategically position their work within the global research landscape.

For practitioners, the study demonstrates the increasing relevance of GIS in solving real-world problems. Themes such as cellular automata, spatial-temporal modelling, and volunteered geographic information (VGI) emphasize the growing advantage of GIS tools in urban planning, transportation optimization, and environmental management. Practitioners can adopt these technologies for predictive analytics, resource allocation, and dynamic decision-making, leveraging innovations such as artificial intelligence and big data integration. This enables the design of targeted, inclusive solutions for challenges like accessibility and mobility, particularly in rapidly urbanizing regions. The study highlights the potential for practitioners to use these insights to stay at the forefront of technological advancements in geospatial analysis.

For journal editors, the findings provide strategic guidance for future editorial directions. The identification of impactful and emerging themes suggests areas where journals like IJGIS can focus their efforts, such as promoting research on dynamic GIS, geospatial big data, and the integration of artificial intelligence. Editors can use this thematic roadmap to curate special issues or calls for papers that reflect the cutting edge of GIS research. Additionally, the geographical distribution of contributions suggests the need to encourage diversity in submissions, particularly from underrepresented regions, to enhance the journal's global reach and inclusivity. The study also points to the necessity of adopting innovative publishing formats, such as interactive or multimedia content, to align with the dynamic and evolving nature of GIS research. Finally, by fostering interdisciplinary collaboration, editors can position their journals as central platforms for addressing complex, multidimensional problems in GIScience.

In summary, the study's findings elucidate key areas of growth and opportunity in GIS research and its applications, offering actionable insights for advancing knowledge, practice, and dissemination in this critical field.

Regarding the limitations, one limitation of this study is that it was conducted on a single journal, which provides a limited view of the field of knowledge. The study does not account for the whole picture, as other journals, books, and articles in different languages are excluded. Another limitation is the temporal scope of the study, as we analyze a specific time window, meaning that newer studies are not considered, creating a static rather than dynamic image. Furthermore, this study did not incorporate alternative metrics, such as those that analyze social impacts, interdisciplinary collaborations, or the influence of the journal on policy formulation and professional practices.

Therefore, future lines of research could include, first, a bibliometric and thematic analysis of the field of Geographic Information Science, analyzing, for example, the leading journals in the area in recent years, or a more exhaustive study considering a larger number of journals, also including articles in other languages or prestigious monographs. Other future research directions include extending the temporal framework for studying this journal or for conducting a broader study of GIS. Finally, these studies could also employ alternative metrics to provide a different perspective on which journals, authors, and documents have the greatest social, professional, or political influence.

5. Conclusions

This paper presents a bibliometric analysis of IJGIS, providing several significant findings:

The journal has consistently captured the attention of the scientific community over the years, evidenced by substantial growth in publications and citations.

The impact factor of IJGIS has progressively increased, culminating in the journal's consolidation within the first quartile of the JCR's category encompassing Computer Science, Information Systems, Geography (Physical), and Information Science and Library Science in recent editions of the Journal Citation Reports. Additionally, the h-index of IJGIS has stood at 107 over the last 25 years, reflecting an outstanding achievement.

In the entire period under analysis, the USA, the People's Republic of China, and the United Kingdom are the most productive countries, with important differences between them.

The publications of IJGIS were divided into the three periods studied. In them we observed an evolution in the discipline that goes from the technical aspects of models, algorithms, and techniques to a second period more influenced by statistics, environmental conservation, and transportation. The third period evolves towards dynamic GIS to evaluate urban growth and their accessibility and changes in land use.

Finally, a perspective on the future of the research field is provided, where travel, traffic, climate change, and urban growth, among other topics, will continue to be important themes. All this will require the analysis of vast amounts of geospatial data that, with the help of big data, artificial intelligence, and machine learning, will provide the necessary keys for more conscious decision-making.

References

Alonso, Salvador, Francisco J. Cabrerizo, Enrique Herrera-Viedma, and Francisco Herrera. 2009. "h-Index: A review focused in its variants, computation and standardization for different scientific fields." *Journal of Informetrics* 3 (4): 273–289. https://doi.org/10.1016/j.joi.2009.04.001

Biljecki, Filip. 2016. "A scientometric analysis of selected GIScience journals." *International Journal of Geographical Information Science* 30 (7): 1302–1335. https://doi.org/10.1080/13658816.2015.1130831

Bone, Christopher, Suzana Dragicevic, and Rodney White. 2011. "Modeling-in-the-middle: Bridging the gap between agent-based modeling and multi-objective decision-making for land use change." *International Journal of Geographical Information Science* 25 (5): 717–737. https://doi.org/10.1080/13658816.2010.495076

Braun, Tibor, Wolfgang Glänzel, and András Schubert. 2006. "A Hirsch-type index for journals." *Scientometrics* 69 (1): 169–173. https://doi.org/10.1007/s11192-006-0147-4

Callon, Michel, Jean-Pierre Courtial, William A. Turner, and Serge Bauin. 1983. "From translations to problematic networks: An introduction to co-word analysis." *Social Science Information* 22 (2): 191–235. https://doi.org/10.1177/053901883022002

Callon, Michel, Jean Pierre Courtial, and Francoise Laville. 1991. "Co-Word Analysis as a Tool for Describing the Network of Interactions between Basic and Technological Research: The Case of Polymer Chemsitry". Scientometrics 22 (1): 155-205. https://doi.org/10.1007/BF02019280

Cascón Katchadourian, José Daniel, José A. Moral Muñoz, Huan Liao, and Manuel J. Cobo. 2020. "Análisis bibliométrico de la Revista Española de Documentación Científica desde su inclusión en la Web of Science (2008–2018)." *Revista Española de Documentación Científica* 43 (3): 1. http://dx.doi.org/10.4067/S0718-07642020000400199

Cobo, Manuel J., Alejandro G. López-Herrera, Enrique Herrera-Viedma, and Francisco Herrera. 2012. "SciMAT: A new science mapping analysis software tool." *Journal of the American Society for Information Science and Technology* 63 (8): 1609–1630. https://doi.org/10.1002/asi.22688

Cobo, Manuel J., Alejandro G. López-Herrera, Enrique Herrera-Viedma, and Francisco Herrera. 2011a. "An approach for detecting, quantifying, and visualizing the evolution of a research field: A practical application to the fuzzy sets theory field." *Journal of Informetrics* 5 (1): 146–166. https://doi.org/10.1016/j.joi.2010.10.002

Cobo, Manuel J., Alejandro G. López-Herrera, Enrique Herrera-Viedma, and Francisco Herrera. 2011b. "Science mapping software tools: Review, analysis, and cooperative study among tools." *Journal of the American Society for Information Science and Technology* 62 (7): 1382–1402. https://doi.org/10.1002/asi.21525

Cresswell, Tim. 2024. *Geographic thought: A critical introduction*. John Wiley & Sons.

Fisher, Peter. 1997. "Editorial." *International Journal of Geographical Information Science*.

Garfield, Eugene. 1972. "Citation analysis as a tool in journal evaluation." *Science* 178 (4060): 471–479.

Goodchild, Michael F. 1992. "Geographical information science." *International Journal of Geographical Information Systems* 6 (1): 31–45. https://doi.org/10.1080/02693799208901893

Goodchild, Michael F. 2010. "Towards geodesign: Repurposing cartography and GIS?" *Cartographic Perspectives* (66): 7–22. https://doi.org/10.14714/CP66.93

Guan, Jiancheng, and Xiaohui Gao. 2008. "Comparison and evaluation of Chinese research performance in the field of bioinformatics." *Scientometrics* 75 (2): 357–379. https://doi.org/10.1007/s11192-007-1871-0

Hirsch, Jorge E. 2005. "An index to quantify an individual's scientific research output." *Proceedings of the National Academy of Sciences* 102 (46): 16569–16572. https://doi.org/10.1073/pnas.0507655102

Huang, Wei. 2022. "What were GIScience scholars interested in during the past decades?" *Journal of Geovisualization and Spatial Analysis* 6 (1): 7. https://doi.org/10.1007/s41651-021-00098-3

Jelokhani-Niaraki, Mohammad. 2021. "Collaborative spatial multicriteria evaluation: A review and directions for future research." *International Journal of Geographical Information Science* 35 (1): 9–42. ttps://doi.org/10.1080/13658816.2020.1776870

Jokar Arsanjani, Jamal, Marc Helbich, Mohammed Bakillah, Johannes Hagenauer, and Alexander Zipf. 2013. "Toward mapping land-use patterns from volunteered geographic information." *International Journal of Geographical Information Science* 27 (12): 2264–2278. https://doi.org/10.1080/13658816.2013.800871

Juhász, Levente. 2024. "Assessing publication trends in selected GIScience journals." *International Journal of Geographical Information Science*: 1–25. https://doi.org/10.1080/13658816.2024.2347306

Kraak, Menno-Jan, and Ferjan Ormeling. 2020. *Cartography: Visualization of geospatial data.* CRC Press.

Li, Wei, and Chien-Yi Hsu. 2020. "Automated terrain feature identification from remote sensing imagery: A deep learning approach." *International Journal of Geographical Information Science* 34 (4): 637–660. https://doi.org/10.1080/13658816.2018.1542697

Li, Xia, and Anthony G. O. Yeh. 2000. "Modelling sustainable urban development by the integration of constrained cellular automata and GIS." *International Journal of Geographical Information Science*. https://doi.org/10.1080/136588100240886

Liu, Fang, Aimin Lin, Hui Wang, Yonghua Peng, and Shanghong Hong. 2016. "Global research trends of geographical information system from 1961 to 2010: A bibliometric analysis." *Scientometrics* 106 (2): 751–768. https://doi.org/10.1007/s11192-015-1789-x.

Liu, Gao-Yong, Ji-Ming Hu, and Hiu-Ling Wang. 2011. "A co-word analysis of digital library field in China." *Scientometrics* 91 (1): 203–217. https://doi.org/10.1007/s11192-011-0586-4

Lloyd, Christopher D., and Peter M. Atkinson. 2006. "Deriving ground surface digital elevation models from LiDAR data with geostatistics." *International Journal of Geographical Information Science* 20 (5): 535–563. https://doi.org/10.1080/13658810600607337

Melo, Alexandre Vastella Ferreira de, and Alfredo Pereira de Queiroz. 2019. "Bibliometric mapping of papers on geographical information systems (2007–2016)." Boletim de Ciências Geodésicas 25 (3): e2019015. https://doi.org/10.1590/s1982-21702019000300015

Mi, Ning, Jia Hou, Wenjing Mi, and Na Song. 2015. "Optimal spatial land-use allocation for limited development ecological zones based on the geographic information system and a genetic ant colony algorithm." *International Journal of Geographical Information Science* 29 (12): 2174–2193. https://doi.org/10.1080/13658816.2015.1070411

Montero-Díaz, Julio, Manuel J. Cobo, Marta Gutiérrez-Salcedo, Francisco Segado-Boj, and Enrique Herrera-Viedma. 2018. "Mapeo científico de la categoría «Comunicación» en WoS (1980–2013)." *Comunicar: Revista Científica de Comunicación y Educación* 26 (55): 81–91.

Peterson, Gretchen N. 2020. *GIS cartography: A guide to effective map design.* CRC Press.

Qin, Cheng-Zhi, Li-Li Bao, Ai-Xiang Zhu, Rui-Xiang Wang, and Xiao-Min Hu. 2013. "Uncertainty due to DEM error in landslide susceptibility mapping." *International Journal of Geographical Information Science* 27 (7): 1364–1380. https://doi.org/10.1080/13658816.2013.770515

Raeeszadeh, Mahdi, and Mahmood Karamali. 2018. "Scientific mapping of military trauma papers using co-word analysis in Medline." *Journal of Military Medicine* 20 (5): 476–487.

Schiewe, Jochen. 2021. "The need for disciplinarity, interdisciplinarity and scientific societies—the cartographic perspective." *Geo-spatial Information Science* 24 (1): 160–166.

Schubert, András. 2007. "Successive h-indices." *Scientometrics* 70 (1): 201–205. https://doi.org/10.1080/10095020.2020.1863748

Small, Henry. 1999. "Visualizing science by citation mapping." *Journal of the American Society for Information Science* 50 (9): 799–813. https://doi.org/10.1002/(SICI)1097-4571(1999)50:9<799::AID-ASI9>3.0.CO;2-G

Sowmiya Narayanan, K. J., and A. Manimaran. 2024. "Recent developments in geographic information systems across different application domains: A review." *Knowledge and Information Systems* 66 (3): 1523–1547. https://doi.org/10.1007/s10115-023-01969-5

Waltman, Ludo, Nees Jan van Eck, Thed N. van Leeuwen, Martijn S. Visser, and Anthony F. J. van Raan. 2011. "Towards a new crown indicator: An empirical analysis." *Scientometrics* 87 (3): 467–481. https://doi.org/10.1007/s11192-011-0354-5

Wu, Xiaohui, Weixing Dong, Liang Wu, and Yan Liu. 2023. "Research themes of geographical information science during 1991–2020: A retrospective bibliometric analysis." *International Journal of Geographical Information Science* 37 (2): 243–275. https://doi.org/10.1080/13658816.2022.2119476.

Yuan, May. 2017. "30 years of IJGIS: The changing landscape of geographical information science and the road ahead." *International Journal of Geographical Information Science* 31 (3): 425–434. https://doi.org/10.1080/13658816.2016.1236928

Zhao, Pengjun, Xiaoping Liu, Wenxue Shi, Tao Jia, Wenfei Li, and Mengyuan Chen. 2020. "An empirical study on the intra-urban goods movement patterns using logistics big data." *International Journal of Geographical Information Science* 34 (6): 1089–1116. https://doi.org/10.1080/13658816.2018.1520236