International Journal of Environment, Architecture, and Societies
Vol. 03, No. 01, February 2023, pp. 17-33
ISSN: 2775-8540
DOI: 10.26418/ijeas.2023.3.01.17-33

Linking Flood and Flood Resilience Through Scientometric Review for Future Research

Anthony Peter [1], Roshida Binti Abdul Majid [2)], Nor Izura Binti Tukiman[3)]

[1, 2), 3)] Department of Architecture, Universiti Teknologi Malaysia, Johor, Malaysia

Manuscript received:
September 8, 2022.

Manuscript revised:
January 16, 2023.

Manuscript accepted:
February 19, 2023.

Date of publication:
February 28, 2023.

Corresponding author:
Anthony Peter
peter@graduate.utm.my

Abstract – Flood resilience architecture is riddled with challenging and complicated issues. Few studies, meanwhile, have attempted to map the global research on this crucial area. The objectives of the study are connections among the stakeholders, the main areas of research, and the available direction in the body of knowledge. 635 document-related bibliographic records that were collected from Scopus were systematically and quantitatively analysed using the scientific mapping method. The findings showed that the top 3 keywords most frequently used in the field were floods, flood control, and flooding. The top 3 least discussed topics/issues were decision-making, rain, and urban resilience. This study's main contribution and distinction come from its status as the first to present an inclusive, comprehensive, and overall overview of the examined literature. By identifying key research topics, journals, institutions, and countries, as well as how these are connected within currently accessible studies on the sector, this study adds value to the existing literature. The findings highlight the limitations in the existing research and offer directions for future study, where they suggested that as a way of resilience to the problems, future study potential lies in the least studied topics. For the world of practice, the study provides a convenient point of reference for practitioners, decision-makers, and new researchers in the field. Therefore, this study increases the level of awareness of flood and flood resiliency in the housing sector.

Keywords: *architecture, flooding, flood resilience, scientometric review.*

I. INTRODUCTION

Floods typically occur when a large body of water overflows or erupts over dry land from a variety of sources, most commonly due to an extended period of severe rainfall (Adetunji & Oyeleye, 2018; Daniel & Udo, 2019; Femi & Israel., 2019; Onwuemele, 2018). It is an unusual weather occurrence that is naturally brought on by an increase in the average global temperature, which causes heavy rain, ocean thermal expansion, and glacier melt. These factors together generate a rise in sea level, which causes water to inundate coastal areas. Flooding submerges and damages living things, property, people, buildings, infrastructure, people's livelihoods, and the environment (Ani et al., 2020; Sholihah et al., 2020; Ujene & Oguike, 2020). This is a result of poorly implemented planning policies, blocked streams and channels from people's careless trash disposal practices, activities in flood plains, and ineffective implementation of planning policies (Evans, et al., 2018). To prevent flooding, which is a potential environmental danger, proper precautions must be put in place, especially at the design stage (Mfon et al., 2022). To combat the negative consequences of flooding, developing resilience to floods and flood

risk is of utmost importance (Abdulmajid, 2020; Njoku et al., 2020; Nnodim et al., 2020). Knowledge-based decisions use available information relating to flooding to conclude possible strategies to be adopted for tackling flooding. The search for an efficient strategy to tackle flood resilience is the core of this study. Flood and flood resilience communication aims at creating awareness of flooding and its impacts on stakeholders and the public.

Flood resilience can be implemented in at least two methods. Resilience is defined therefore in the first, the more traditional definition used in engineering. It is defined as a system's ability to withstand or absorb disturbances such as storm surges and cloudbursts, as well as continue to operate under a wide variety of flood waves or downpour intensities. In this meaning, continuing operation entails either surviving flood waves or recovering quickly and with minimal impact after being subjected to flood water, such as owing to a flood defence system crash (De Bruijn, 2004; Gersonius et al., 2010) with the end purpose of avoiding impacts that are exceedingly hard to overcome after (Mens et al., 2011). Here, robustness, or the ability to sustain a disturbance without losing functionality, duplication, or the degree to which system components can be replaced, and speed, or the ability to recover the system quickly, are all important(Bruneau et al., 2003; Liao, 2012). Secondly, the use of flood-resilient design and technologies to adapt or construct structures that remain undamaged or unaffected by floodwater is becoming increasingly common in the domains of architecture and building technology(Garvin, 2012). It is already being employed in the field of disaster relief, to recover from shocks while keeping the status quo (Mayunga, 2007). Based on the ecological paradigm of multi-equilibrium or non-equilibrium Holling (1973) asserts that resilience has grown into a wider idea of socio-ecological resilience in the second definition, which is often articulated from a comprehensive system's perspective.

Earlier reviews of the area by Barroca and Serre (2012) and Miguez et al., (2017) have provided useful inputs. They are the foundation of the current study. They do, however, have some restrictions. First, they relied on qualitative manual evaluations. As a result, they may be greatly affected by personal biases, a lack of reproducibility, and decreased reliability (Yu & Liao, 2016). Markoulli et al., (2017) demonstrated that manual reviews focus on the "trees" rather than giving a comprehensive picture of the "forest." There is yet to be a study that provides a comprehensive picture of flood and flood resilience. The current review study stands out as an effort to close this gap since it is the first to thoroughly evaluate the intellectual landscape and corpus of common knowledge on flood and flood resilience using a quantitative method. The issue is crucial in affecting flood resilience efforts as detailed in the next paragraph.

By defining the breadth and evaluating the quality of the body of existing information, identifying gaps and shortcomings, and deciding where to concentrate future research efforts, this study makes several contributions to the area. Consequently, the paper is a useful and current resource for advancing the knowledge of policymakers and practitioners and aiding them in organising and funding initiatives related to adopting flood and flood resilience. Based on the study's motivation, the following three key research questions will be addressed in this research: (1) What are the connections among the stakeholders (2) What are the main areas of research (3) What is the available direction in the body of knowledge?

II. METHODOLOGY

To accomplish the goal of this study, a thorough literature review has been performed using a combination of bibliometric analysis, scientometric analysis, and content analysis. This is crucial for defining the study's scope, research gaps, and limitations(Comerio & Strozzi, 2019). Saunders et al., (2009), state that a systematic literature review involves a cycle of interactively selecting appropriate search terms, looking for relevant papers, and carrying out content analysis. The Scopus database has been used as the primary data source for this research. Zhao and Strotmann (2015), argue that the Scopus database, which is larger than the Web of Science and encompasses about 60% of the citation index, is the most widely utilised database for citations. Once more, it is a more comprehensive database with more published journals (Darko et al., 2020; Saka & Chan, 2020; Shukra & Zhou, 2020).

The systematic literature review strategy was initially used to gather important information and data by separating the articles in the study area of flood and flood resilience according to the keywords, language, document formats, and so on. Second, a quantitative study termed bibliometric analysis has

been carried out to improve influential research and pinpoint research trends. By establishing research categories, assessing relevant sectors, and monitoring research disciplines, bibliometric analysis is essential for analyzing and better understanding the study(Olawumi et al., 2017). Thirdly, to accomplish the objectives of this study, the structural process of content analysis categorises the literature. Finally, a scientometric analysis was carried out using text mining tools to improve the results from the bibliometric and content analyses.

He et al., (2017), states that knowledge maps might be created through scientometric analysis, which enables bibliometric data to be converted into fresh insights for research goals based on correct representation and analysis of earlier research efforts. To evaluate the existing state of flooding and flood resilience in the housing area, a scientometric analytic method was employed. This enables the synthesised network based on scientific publications to be statistically analysed and graphically shown to show the conceptual, analytical, and social context of the scientific subject(Zheng et al., 2020). Choosing tools, gathering, processing, analysing, visualising, reading, displaying, and discussing data are all parts of the analysis process. With the first phase being the formation of networks, using keyword co-occurrence analysis, document co-citation analysis, and cluster identification analysis, Xiao et al., (2019), and method offers a quantitative methodology that visualises, charts, and connects research progress to examine the development of a subject field, using high-quality indexes and substantial bibliographic data(Mansuri et al., 2019). This approach makes it possible to determine an overview of the present state and direction of the studies (van Eck & Waltman, 2014) indicated that a variety of text mining software packages, including CitNetExplorer, CiteSpace, Gephi, HistCite, Pajek, Sci2, and VOSviewer, might be utilised to do science mapping analysis. Key findings from the literature were analysed using the VOSviewer programme for this study, and the outcomes will be displayed using scientific mapping along with further critical discussions. The VOSviewer software was chosen above the other software because it is best suited for visualising larger networks (van Eck & Waltman, 2014; Zakka et al., 2021). Secondly, Jin et al., (2018) have also reiterated how this soVftware is being used more and more by construction industry researchers, as is the case with the current study on flooding and flood resilience in the housing area. Thirdly, VOSviewer gives special consideration to the graphic display of bibliometric maps, unlike other bibliometric mapping software. Fourthly, science mapping was used to examine clusters and connections between keywords, researchers, publications, and institutions.

Journal articles, conferences, and documents with just English-language content are all covered by the study. The procedure of the research study is illustrated in Figure 1.

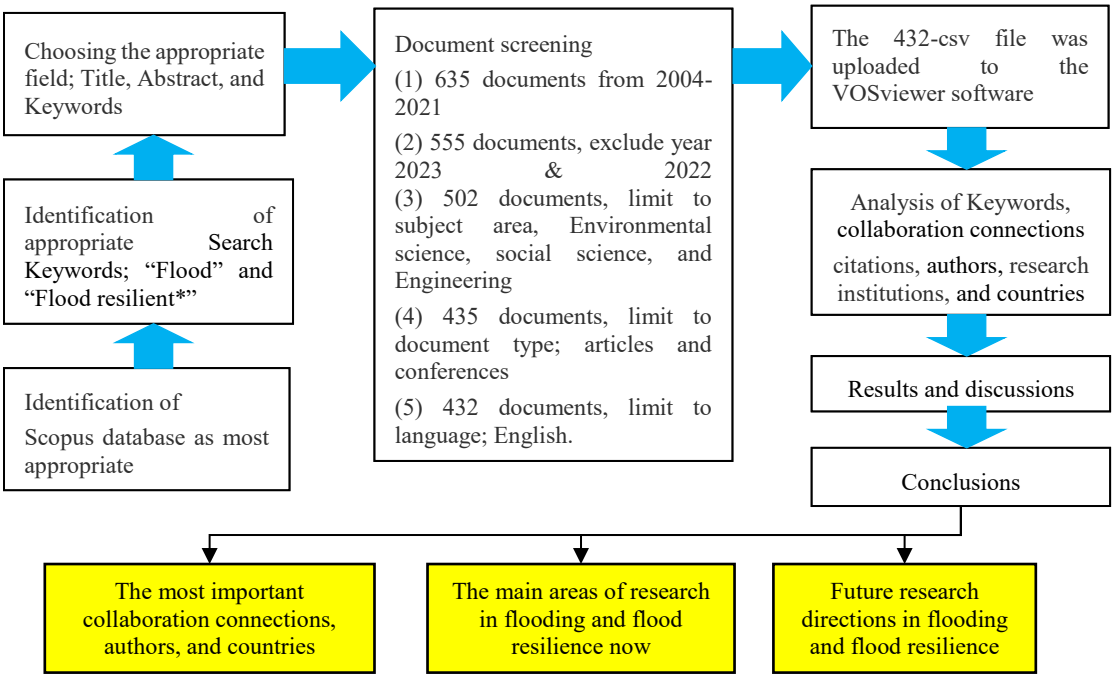

Fig. 1. The Procedure of the Research Study
Source: Authors (2023)

III. RESULTS AND DISCUSSION

Utilizing software platforms, quantified systematic procedures were employed to review the body of literature to eliminate any bias and limitations of the manual review (He et al., 2017; Yalcinkaya & Singh, 2015).

A. Type of Documents

Journal articles and conference papers make up 81.0% and 19.0%, respectively, of the flood and flood resilience research documents in the Scopus database as of 29th July 2022. The review concentrates on journal articles and conference papers as the primary sources because they produce all the results as indicated in Figure 2.

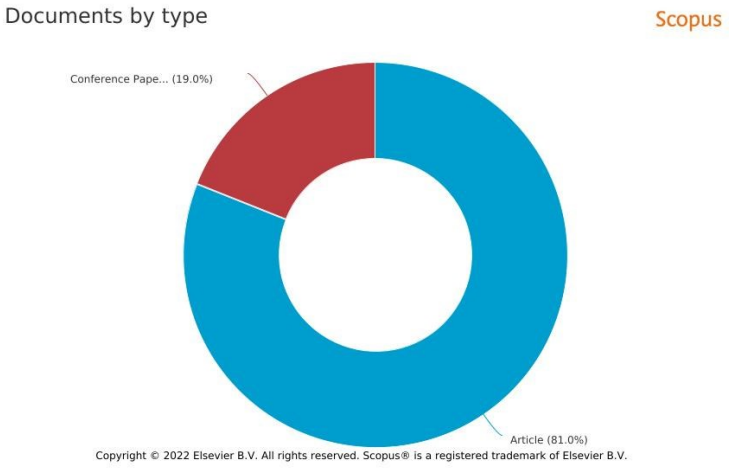

Fig. 2. Documents by Type
Source: Authors (2023)

B. Literature Sample

The entire literature collection's publication dates span the years 2004 to 2021, as seen in Figure 3. 2004 saw the discovery of the first article; 2005 saw none, and 2006 saw one. There are 2 for 2007, 6 for 2008, 3 for 2009, 4 for 2010, 12 for 2011, 8 for 2012,10 for 2013, 13 for 2014, 17 for 2015,34 for 2016, 29 for 2017, 50 for 2018, 58 for 2019,85 for 2020, and 99 for 2021. As a result, from 2007 onward, the quantity of research on the topic of study progressively reached its pinnacle. From that point on, annual growth in publications increased until 2021, when 99 articles were identified. This pattern indicates that academics are becoming increasingly interested in flooding and flood resilience in the housing area, and the trend predicts increased research articles in the next years.

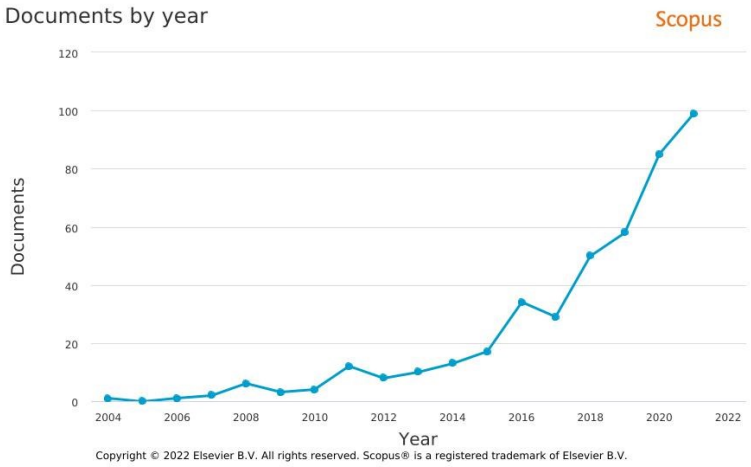

Fig. 3. Documents by Year
Source: Authors (2023)

C. Documents by Subject Area

Environmental science, social science, and engineering were the only subjects for which documents could be retrieved. These made up most of the documents in the subject of research, accounting for 67.6% of all documents. The specifics are shown in Figure 4.

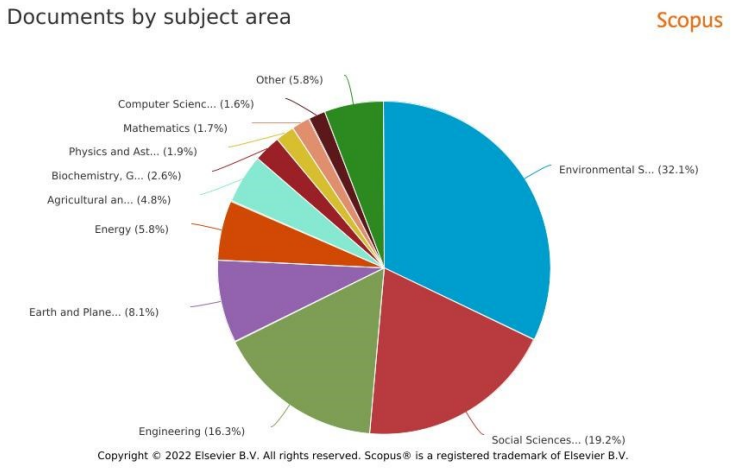

Fig. 4. Documents by Subject Area
Source: Authors (2023)

D. Co-Occurrence of Keywords

The core information in articles is depicted by keywords, which also make evident the variety of subject areas that fall under a certain domain (Su & Lee, 2010). The extracted papers were loaded into VOSviewer under the chosen approach to creating a network of keywords. The associated keywords provide an overview of the subject matter, including its relationships and patterns (van Eck & Waltman, 2014; He et al., 2017).

An analysis of keyword occurrence was carried out using VOSviewer to explore and give a knowledge base of the topics covered in articles related to flooding and flood resilience in the housing area. A keyword connection represents knowledge of the relationships between them and the conceptual structure of the study domain (van Eck & Waltman, 2010). According to the generally recognised recommendations (Oraee et al., 2017; Song et al., 2016; Wang & Zeng, 2010). In VOSViewer, keyword analysis was performed using "Author Keywords" and "Fractional Counting." Keywords are of paramount need and necessary for easy search for researchers in all fields of human endeavours(Butt, 2019). Instead of complete counting, "Fractional Counting" is used to lessen the impact of documents with many authors. The strength of a co-authorship link between two authors is based on both the total number of authors of each co-authored document as well as the number of documents that each author has co-authored. Each of the n co-authorship ties results in a strength of 1/a when one author co-authors a document with another “a” author. The “a” co-authorship links add up to a total link strength of 1. The papers that were filtered in the preceding literature search process provided the keywords used for analysis. The minimum occurrence of keywords was set at 10. 23 met the threshold. See Table 1.

The 23 most important keywords in the domain include climate change, decision-making, drainage, flood, flood control, flood resilience, flood risk management, flooding, floods, rain, resilience, risk assessment, risk management, runoff, storms, sustainability, United Kingdom, united states, urban area, urban design, urban planning, urban resilience, and Water management. The most often occurring keywords in the research articles used for this study are shown in Table 1. Floods, Flood control, Flooding, Flood, Risk assessment, Climate change, flood resilience, and Resilience were the most used eight keywords in the search. The representation of the most frequent keywords and their connectivity to one another based on link strength is shown in Figure 5. Total link strength shows how closely a certain journal and other peer sources are tied to one another. According to the visualisation, "floods," "flood control," and "flooding" are more prevalent than other keywords in the study, and their labels are larger. Additionally, when the lines between two objects get thicker, the overall link strength of the two items gets stronger (van Eck & Waltman, 2019).

Table 1 and Figure 5 make it evident that the study has gaps in its coverage of the keywords with the lowest Occurrences, which calls for additional research. They include Decision making, which has 10 occurrences, with total link strength of 48. Rain, which has 10 occurrences, with total link strength of 55. Urban resilience has 10 occurrences, with total link strength of 41. flood risk management, which has 12 occurrences, with total link strength of 59. Runoff, which has 12 occurrences, with total link strength of 58. Drainage, which has 13 occurrences, with total link strength of 63. Others are Risk management, which has 13 occurrences, with total link strength of 77. Storms, which has 13 occurrences, with total link strength of 66. Sustainability, which has 13 occurrences, with total link strength of 70. Though the study field has fewer publications than other long-established sectors like concrete, blocks, steel, and furniture, those keywords with more occurrences have been more thoroughly studied and as a result require less attention. The top 6 in this category include Floods, which have 70 occurrences, with total link strength of 244. Flood control has 47 occurrences, with total link strength of 219. Flooding, which has 43 occurrences, with total link strength of 162. Flood, which has 32 occurrences, with total link strength of 124. Risk assessment, which has 32 occurrences, with total link strength of 145. Climate Change has 31 occurrences, with total link strength of 125.

Table 1. Co-Occurrence of Keywords in Flood and Flood Resilience Research

SN	Keyword	Occurrences	Total link strength
1	Climate change	31	125
2	Decision making	10	48
3	Drainage	13	63
4	Flood	32	124
5	Flood control	47	219
6	Flood resilience	26	86
7	Flood risk management	12	59
8	Flooding	43	162
9	Floods	70	244
10	Rain	10	55
11	Resilience	26	85
12	Risk assessment	32	145
13	Risk management	13	77
14	Runoff	12	58
15	Storms	13	66
16	Sustainability	13	70
17	United Kingdom	10	44
18	United States	12	45
19	Urban area	20	113
20	Urban design	17	70
21	Urban planning	14	67
22	Urban resilience	10	41
23	Water management	16	80

Source: Authors (2023)

E. Authors With the Highest Impact and Highest Documents

The number of documents that authors have contributed related to flooding and flood resilience in the housing area is analysed. In a certain field, a scholar's level of impact is indicated by the number of citations they receive (Yu & Hayes, 2018). According to a Scopus database extraction, Table 2 displays different authors along with their total number of citations, the number of documents with a single author, and the strength of all links. The evidence above indicates that Butler D. have a total citation of 455, and a document count of 7 giving him an average citation count of 65 per document. Djordjević S. have a total citation of 397, and a document count of 5 giving him an average citation count of 79.4 per document. Chen A.S. has a total citation of 326, and a document count of 5 giving him an average citation count of 65.2 per document. The total number of documents that an author has

published as a sole author or co-author is shown in Figure 5 of the Scopus database. Taking into consideration the average number of citations per document from Table 2 and Figure 6, Djordjević S., Chen A.S., and Butler D. were the 3 most cited researchers with the greatest impact. Djordjević S. is leading, followed by Chen A.S., and Butler D. at the third position. While both Serre D., and Miguez M.G. have 8 documents each, making them the most productive researchers in terms of the number of articles published.

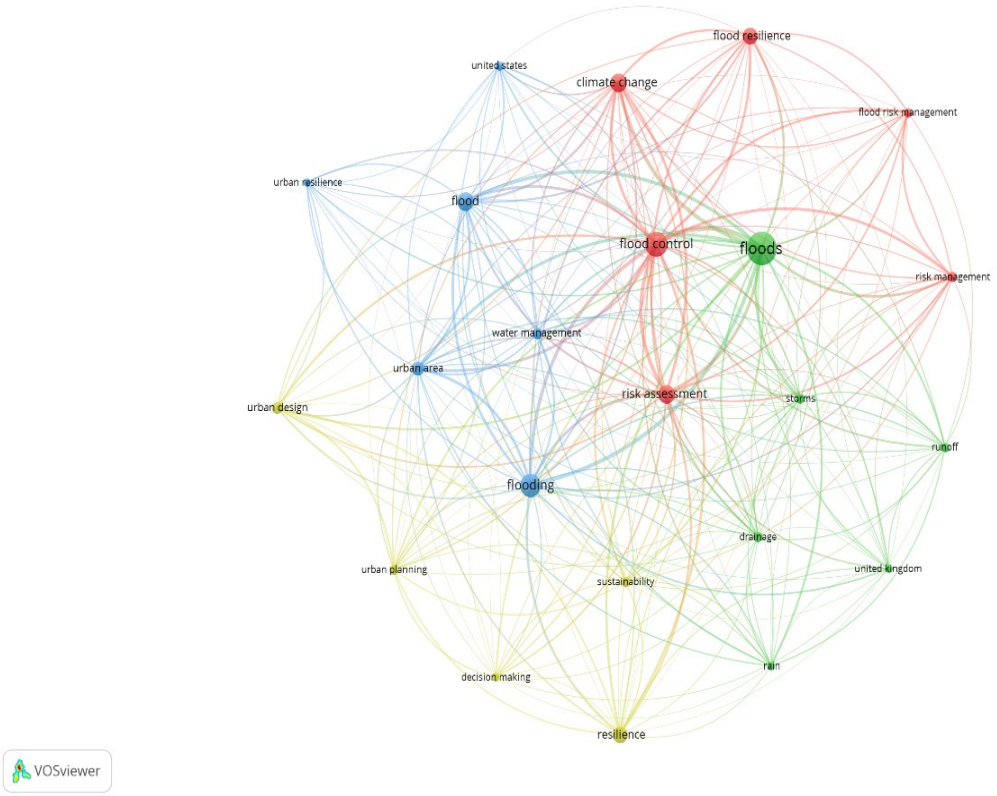

Fig. 5. Visualization of the Most Occurring Keywords
Source: Authors (2023)

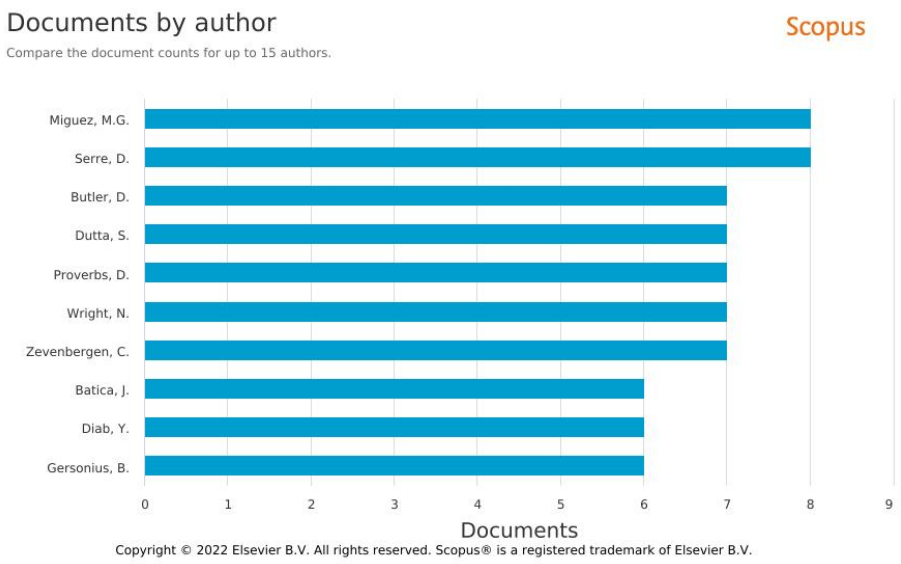

Fig. 6. Author's Documents
Source: Authors (2023)

Table 2 Author's Documents and Citation

SN	Author	Documents	Citations	Total link strength
1	Ahilan S.	5	109	11
2	Barroca B.	5	76	8
3	Batica J.	6	46	8
4	Butler D.	7	455	16
5	Chen A.S.	5	326	10
6	Diab Y.	6	42	9
7	Djordjević S.	5	397	11
8	Dutta S.	7	66	5
9	Gersonius B.	6	74	3
10	Gourbesville P.	6	118	10
11	Karamouz M.	6	52	4
12	Krivtsov V.	5	78	9
13	Lamond J.	6	113	7
14	Mcewen I.	6	145	0
15	Miguez M.G.	8	170	5
16	Proverbs D.	7	27	2
17	Sen M.K.	5	43	5
18	Serre D.	8	87	11
19	Van den brink M.	6	96	3
20	Vercruysse K.	5	71	10
21	Veról A.P.	5	156	5
22	Woltjer J.	6	111	3
23	Wright N.	7	109	12
24	Zahmatkesh Z.	5	66	4
25	Zevenbergen C.	7	70	3

Source: Authors (2023)

F. The Co-Authorship Network

Based on the connections between researchers, the nodes are coloured. There are three groups of collaborative relationships, firstly Butler D. with a link strength of 33, Chen A.S. with a link strength of 29, and Batica J. with a link strength of 9. Secondly Wright N. with a link strength of 26, Ahilan S. with a link strength of 15, and Proverbs D. with a link strength of 12. Again, Serre D. with a link strength of 8, and Diab Y. With a link strength of 2. The connections between researchers and their separation from one another further highlight how their interactions affect one another (Tariq et al., 2021). Figure 7 incorporates three closed-loop circuits that show great working relationships between the researchers working on these circuits. One of these is the circuit of, Butler D., Chen A.S., and Batica J. This show how strong their connection is, which is also evident in the outcomes of their study. Collaborations boost productivity. It is important to note, nonetheless, that the network of research collaborations in the field of flood and flood resilience in the housing sector is quite modest. This shows that authors must collaborate to address the major issues in flood and flood resilience in the housing sector. Table 3 contains specifics.

G. The Co-Authorship Network Among Countries

This, according to the size of the node in Figure 9's co-authorship network among countries, the United Kingdom has the most research on the subject, followed by the United States, the Netherlands, and China. Additionally, because the distance between the nodes is closer together, the co-authorship strength between the United Kingdom, the United States, the Netherlands, and China is higher. Since the total link strength in Table 4 is the highest, the scientific collaboration between the United States and the United Kingdom is extensive. With 2133 citations and 120 documents, the United Kingdom has an overall link strength of 191, as seen in Figure 8, Figure 9, and Table 4. With 929 citations in 96 documents, the United States has a total link strength of 49. With 803 citations and 51 documents, the Netherlands has a total link strength of 144. With 272 citations and 34 documents, China has a total link strength of 96. With 675 citations and 26 documents, Germany has a total link strength of 119. The

United Kingdom, the United States, and the Netherlands are the three countries that have the biggest effects on flooding and flood resilience in the housing area. Regarding documents created in the same order, these major countries continue to be the most relevant. United Kingdom, Netherlands, and Germany are the three most significant countries in terms of total link strength for flooding and flood resilience in the housing area, from highest to lowest, as shown in Table 4. Details of the country's co-authorship networks are shown in Figure 10.

Table 3 Reputable Researchers in the Field

SN	Author	Documents	Citations	Total link strength
1	Ahilan S.	5	109	15
2	Barroca B.	5	76	8
3	Batica J.	6	46	9
4	Butler D.	7	455	33
5	Chen A.S.	5	326	29
6	Diab Y.	6	42	2
7	Djordjević S.	5	397	27
8	Dutta S.	7	66	8
9	Gersonius B.	6	74	18
10	Gourbesville P.	6	118	11
11	Karamouz M.	6	52	6
12	Krivtsov V.	5	78	21
13	Lamond J.	6	113	20
14	Mcewen I.	6	145	7
15	Miguez M.G.	8	170	9
16	Proverbs D.	7	27	12
17	Sen M.K.	5	43	8
18	Serre D.	8	87	8
19	Van den brink M.	6	96	10
20	Vercruysse K.	5	71	30
21	Veról A.P.	5	156	9
22	Woltjer J.	6	111	15
23	Wright N.	7	109	26
24	Zahmatkesh Z.	5	66	6
25	Zevenbergen C.	7	70	3

Source: Authors (2023)

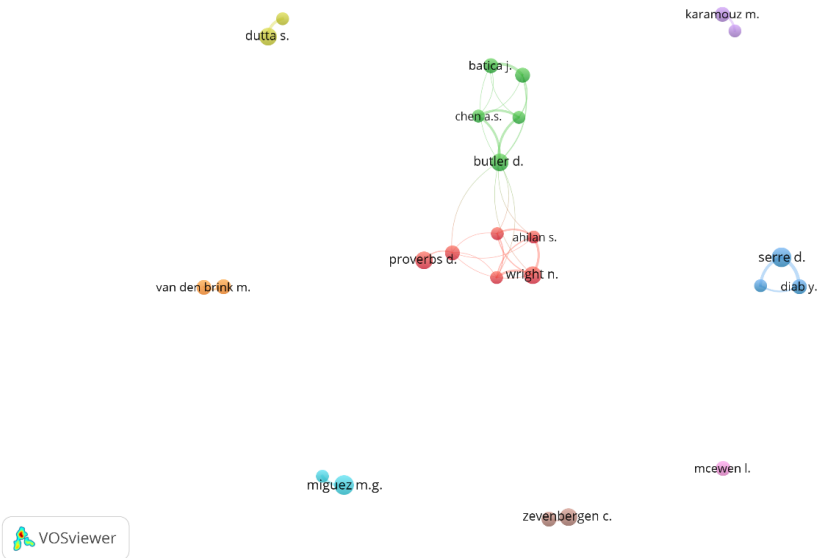

Fig. 7. A Network of Co-Authorship Analysis
Source: Authors (2023)

Table 4 Co-Authorship Among Countries

SN	Country	Documents	Citations	Total link strength
1	Australia	20	217	27
2	Austria	8	103	25
3	Bangladesh	11	86	19
4	Belgium	15	407	78
5	Brazil	13	209	44
6	Canada	26	255	61
7	China	34	272	96
8	France	24	554	68
9	Germany	26	675	119
10	India	15	218	25
11	Indonesia	10	27	2
12	Iran	10	85	23
13	Italy	13	151	45
14	Netherlands	51	803	144
15	New Zealand	9	66	21
16	Spain	9	72	11
17	Sweden	8	274	50
18	Thailand	11	166	13
19	United Kingdom	120	2133	191
20	United States	96	929	46
21	Viet Nam	9	95	12

Source: Authors (2023)

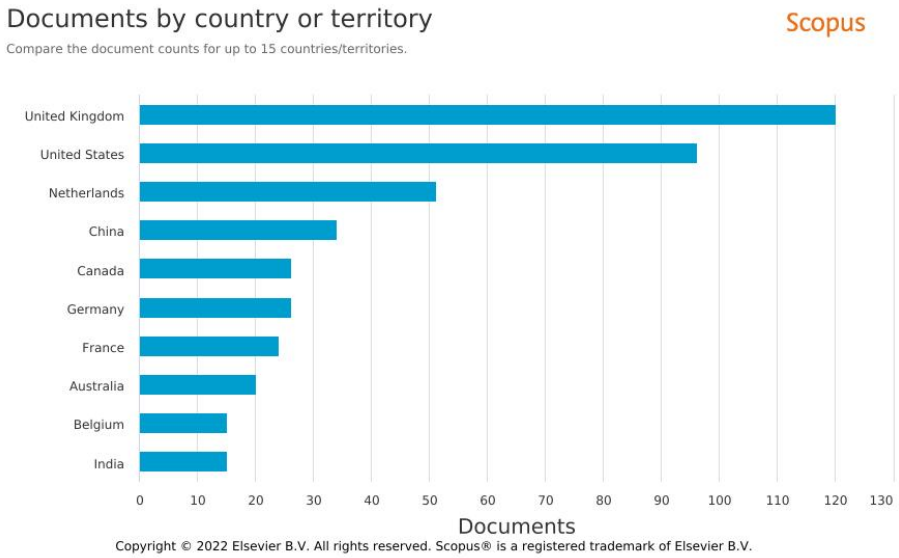

Fig. 8. Documents by Countries
Source: Authors (2023)

H. Articles Citation in Publication Year

In Table 5, the article's citations are included together with the authors and the year of publication. Figure 11 presents the visualisation of an author's publication history. Bertilsson I. in 2019 had 91 citations. Nguyen K.V. in 2013 had 76 citations. Roberts S. in 2008 had a citation of 73. Liao K.H. in 2016 had 63 citations. Venkataramanan V. in 2019 had 58 citations.

Articles belonging to; Bertilsson I., Nguyen K.V., and Roberts S. were identified as the 3 most impactful publications on flooding and flood resilience in the housing area. The complete cited papers are depicted in Table 5 and Figure 11 displays the visualisation of each author's publication. The co-citation network between the authors who contributed to the study of flooding and flood resilience in

the housing area is depicted in the visualisation. In terms of citation, the documents' proximity to one another shows how closely related they are.

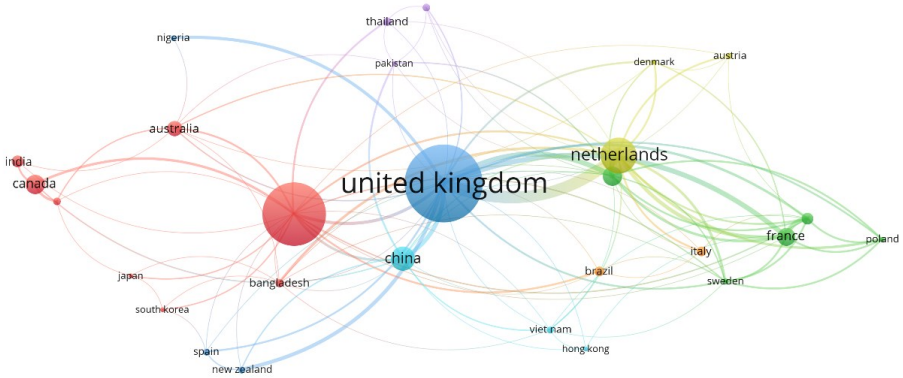

Fig. 9. Country's Co-Authorship Network
Source: Authors (2023)

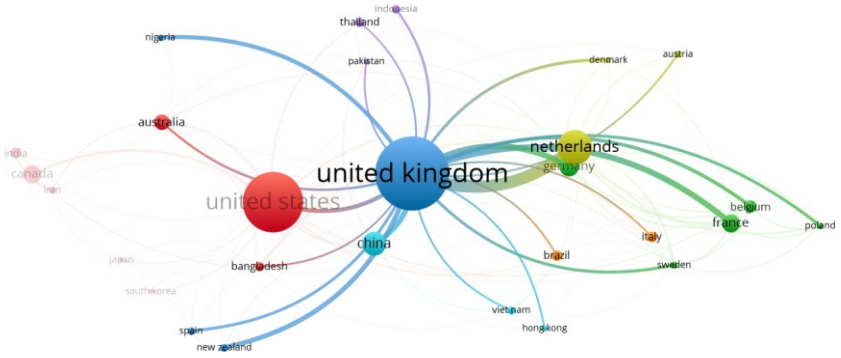

Fig. 10. Country's Co-Authorship Network Detailed
Source: Authors (2023)

Fig. 11. Citation With Publication Year Visual
Source: Author (2023)

Table 5 Citation With the Publication Year

SN	Document	Citations	Links
1	Roberts S. (2008)	73	0
2	Bosher I. (2009)	52	0
3	Brody S.D. (2011)	40	1
4	Brody S. (2013)	36	1
5	Nguyen K.V. (2013)	76	0
6	Balsells M. (2013)	23	1
7	Gillespie N. (2014)	20	0
8	Salinas rodriguez C.N.A. (2014)	22	1
9	Balsells M. (2015)	16	0
10	Albano R. (2015)	23	0
11	Ryan K. (2016)	30	0
12	Liao K.H. (2016)	63	0
13	Oladokun V.O. (2017)	17	0
14	Charlesworth S.M. (2017)	19	0
15	Vojinovic Z. (2017)	24	0
16	Miguez M.G. (2017)	45	1
17	Serre D. (2018)	29	1
18	Trogrlić R.S. (2018)	22	1
19	Rollason E. (2018)	37	0
20	Pearson J. (2018)	17	0
21	Meyer M.A. (2018)	29	0
22	Joannou D. (2019)	15	0
23	Chen K.F. (2019)	27	0
24	Ahilan S. (2019)	15	0
25	Fenner R. (2019)	20	1
26	Bertilsson I. (2019)	91	1
27	Moura rezende O. (2019)	19	0
28	Venkataramanan V. (2019)	58	0
29	Lamond J. (2019)	46	0
30	O'Donnell E. (2020)	31	1
31	Kapetas I. (2020)	21	0
32	McClymont K. (2020)	15	0

Source: Authors (2023)

I. Impact of Research Organisation

The most influential research Organisation in terms of publication is the school of geography, university of Nottingham, Nottingham, ng7 2nd, United Kingdom, it has 3 documents. While all other research Organisations have 2 publications each. As evidence, see Table 6. Centre for architecture and built environment research (caber), university of the west of England, Bristol, bs16 1qy, United Kingdom has 77 citations with Total link strength of 6. School of geography, university of Nottingham, Nottingham, ng7 2nd, United Kingdom has 59 citations with Total link strength of 11. The duo of Centre for water systems, college of engineering, mathematics and physical sciences, university of Exeter, ex4 4qf, United Kingdom and School of energy, geoscience, infrastructure, and society, heriot-watt university, Edinburgh, eh14 4as, United Kingdom have 51 citations each as well as Total link strength of 9 each. Environment agency, king's meadow house, reading, rg1 8dq, United Kingdom has 39 citations with Total link strength of 8. From the aforementioned, the research Organisation that has the most impact on the scholarly community on flooding and flood resilience in the housing area is the Centre for architecture and built environment research (caber), university of the west of England, Bristol, bs16 1qy, United Kingdom. While the research Organisation with the highest total link strength is the school of geography, university of Nottingham, Nottingham, ng7 2nd, United Kingdom. For further information about the visualisation, see Figure 12.

Table 6 Organisation Impact

N	Organization	Documents	Citations	Total link strength
1	Arup, new jersey, united states	2	0	0
2	Centre for architecture and built environment research (caber), university of the west of England, Bristol, bs16 1qy, United Kingdom	2	77	6
3	Centre for water systems, college of engineering, mathematics and physical sciences, university of Exeter, ex4 4qf, United Kingdom	2	51	9
4	Department of architecture, Brac university, Dhaka, Bangladesh	2	18	0
5	Department of industrial and production engineering, university of Ibadan, Ibadan, Nigeria	2	20	2
6	Environment agency, king's meadow house, reading, rg1 8dq, United Kingdom	2	39	8
7	Faculty of computing, engineering and the built environment, Birmingham city university, Birmingham, United Kingdom	2	20	2
8	School of civil engineering, university of Leeds, Leeds, United Kingdom"	2	25	5
9	School of energy, geoscience, infrastructure, and society, heriot-watt university, Edinburgh, eh14 4as, United Kingdom	2	51	9
10	School of geography, university of Nottingham, Nottingham, ng7 2nd, United Kingdom	3	59	11

Source: Authors (2023)

Fig. 12. Organisation Impact Visual
Source: Author (2023)

J. Impact of Source Journals

In Figure 13, five sources of publications from 2010 to 2021 were found. Water Switzerland= 1 document in 2013, 1 document in 2017, 3 documents in 2018, 8 documents in 2019, and 9 documents in 2021. Sustainability Switzerland=2 documents in 2017, 2 documents in 2019, 8 documents in 2020, and 7 documents in 2021. International Journal of Disaster Risk Reduction= 1 document in 2016, 1 document in 2018, 5 documents in 2019, 2 documents in 2020, and 4 documents in 2021.Journal of Flood Risk management= 1 document each in 2010,2012, and 2015, 9 documents in 2018, 3 documents in 2019, 1 document in 2020, and 5 documents in 2021.Philosophical Transactions of the Royal Society A Mathematical Physical and Engineering Sciences=15 documents in 2020.

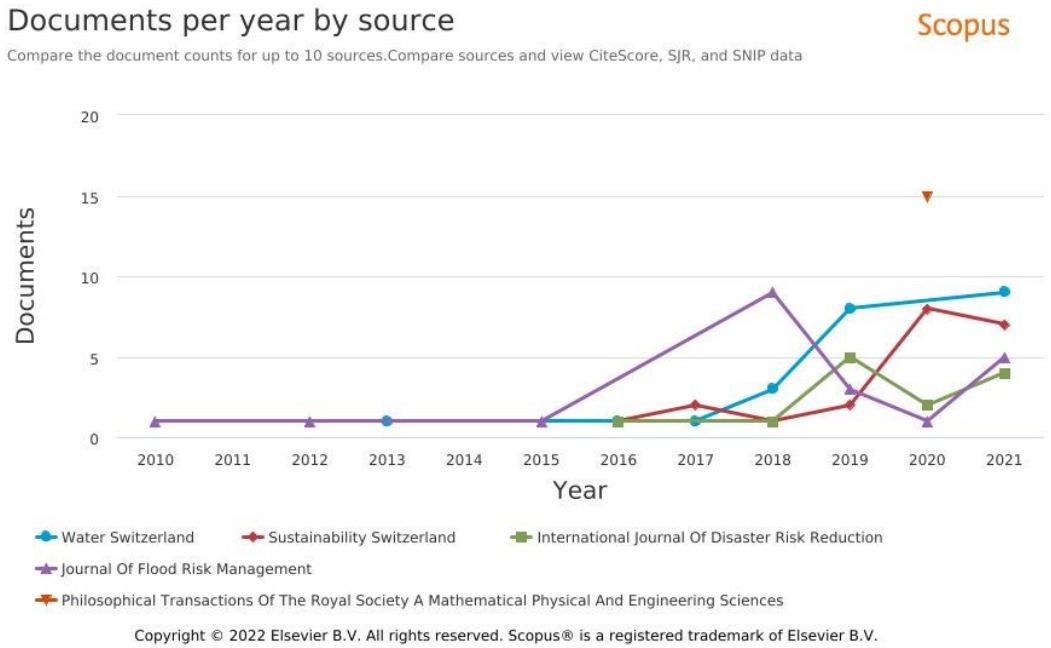

Fig. 13. Publications Per Year by Source
Source: Author (2023)

IV. LIMITATIONS AND A WAY FORWARD

The analysis may be impacted by any inherent constraints of Scopus's coverage of publications as it was based on data that was retrieved from Scopus. Second, specific keywords were used to search the literature. Thirdly, only journal papers and conferences were included in this analysis. Fourthly, only articles written in English were taken into consideration. All these factors could result in outcomes that don't accurately reflect the entire body of research on flooding and flood resilience in the housing area., this study's primary guiding concepts for studying citation networks were those of social network analysis. There may be drawbacks to using citations as the primary measure of the value, significance, and relationships of scholarly works. Every scientific measurement involves some degree of subjective judgement; the methodology, subject, and interpretation of results are all influenced by the researchers' cognitive constraints and values. This research is indeed not an exception.

Future research studies should consider the limitations by utilising all literature kinds, all languages, data from different sources, and a variety of indicators for evaluating the effect, quality, and relationships in the literature.

V. CONCLUSIONS

The goal of this study on flooding and flood resilience in the housing area was to examine the relationships between the prominent stakeholders, the primary research areas, and the direction of the body of knowledge. 635 bibliographic documents in all were produced by the Scopus core collection database.

Presentations were made using the study's objectives as the basis for bibliometric, content and scientometric analysis. Keywords gave the direction for the study, wherein 23 were filtered. Djordjević S., Chen A.S., and Butler D. were the 3 most cited researchers with the greatest impact. While both Serre D., and Miguez M.G. were the most productive researchers in terms of the number of publications. There are three groups of collaborative relationships; firstly Butler D., Chen A.S, and Batica J. Secondly Wright N., Ahilan S., and Proverbs D. Thirdly, Serre D., and Diab Y. The United Kingdom has the most research on flood and flood resilience in the housing sector, followed by the United States, the Netherlands, and China. Articles belonging to; Bertilsson I., Nguyen K.V., and Roberts S. were identified as the 3 most impactful publications on flooding and flood resilience in the housing area. The most influential research Organisation in terms of publication is the school of geography, university of

Nottingham, Nottingham, ng7 2nd, United Kingdom. The five most impactful journals are Water Switzerland, Sustainability Switzerland, International Journal of Disaster Risk Reduction, Journal of Flood Risk management, and Philosophical Transactions of the Royal Society A Mathematical Physical and Engineering Sciences. The main current areas of research are Floods, Flood control, Flooding, Flood, Risk assessment, Climate change, flood resilience, and Resilience. While additional research and more scholarly attention in future are needed in; Decision making, Rain, Urban resilience, flood risk management, Runoff, Drainage, Risk management, Storms, and Sustainability.

This study would serve as the basis for further research into flooding and flood resilience in the housing area. The study's findings have identified present gaps that need to be filled, popular topics, and areas where future efforts should focus.

REFERENCES

Abdulmajid, R. (2020). Household Preparedness to Flood Hazard in Nigeria. *International Journal of Science, Environment and Technology*, *9*(3), 473–478.

Adetunji, M. A., & Oyeleye, O. I. (2018). Assessment and Control Measures of Flood Risk in Ajibode Area of Ibadan, Oyo State, Nigeria. *International Journal of Physical and Human Geography*, *6*(1), 1–16. www.eajournals.org

Ani, C. N., Ezeagu, C. A., Nwaiwu, N. K., & Ekenta, O. (2020). Analysis of Factors Influencing Flooding and Vulnerability Assessment of Awka and Its Environs. *American Journal of Engineering Research*, *9*(5), 34–45.

Barroca, B. & Serre, D. (2012). 'De la ville qui sépare à la ville qui intègre', *Travaux*, *886*, 32–35.

Bruneau, M., Chang, S. E., Eguchi, R. T., Lee, G. C., O'Rourke, T. D., Reinhorn, A. M., Shinozuka, M., Tierney, K., Wallace, W. A., & Von Winterfeldt, D. (2003). A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities. *Earthquake Spectra*, *19*(4), 733–752. https://doi.org/10.1193/1.1623497

Butt, A. (2019). *Factors Influencing Student's Decision to Dropout from E-Learning*. [Thesis, COMSATS University Islamabad]. https://doi.org/10.1128/MMBR.00009-08

Comerio, N., & Strozzi, F. (2019). Tourism and Its Economic Impact: a Literature Review Using Bibliometric Tools. *Tourism Economics*, *25*(1), 109–131. https://doi.org/10.1177/1354816618793762

Daniel, E. E. & Udo, R. (2019). Human-Environment Interactions. In Ibok, E., Daniel, E., and Atakpa, O. (eds). *The Politics of Global Environmental Policies*. University of Calabar Press.

Darko, A., Chan, A. P. C., Adabre, M. A., Edwards, D. J., Hosseini, M. R., & Ameyaw, E. E. (2020). Artificial Intelligence in the AEC industry: Scientometric Analysis and Visualization of Research Activities. *Automation in Construction*, *112*(May 2019), 103081. https://doi.org/10.1016/j.autcon.2020.103081

De Bruijn, K. M. (2004). Resilience and Flood Risk Management. *Water Policy*, *6*(1), 53–66.

Evans, U. F., Dominic, K. O., Evans, G. U & Utting, C. (2018). Analysis of the Relative Contributions of Climatic Elements and Environmental Variables to Flood Disaster in Uyo, AkwaIbom State, Nigeria. *International Journal of Environmental Sciences and Natural Resources*, *6*(2), 52–56.

Femi, O., & Israel, A. (2019). Flood Disaster Vulnerability in North Central Nigeria. *International Journal of Research and Innovation in Social Science*, *3*(9), 364–371.

Garvin, S. (2012). *Flood Resilient Building – Part 2: Building in Flood-Risk Areas and Designing Flood Resilient Buildings*. Watford: BRE Press.

Gersonius, B., Ashley, R., Pathirana, A., & Zevenbergen, C. (2010). Managing the Flooding System's Resiliency to Climate Change. *Proceedings of the Institution of Civil Engineers: Engineering Sustainability*, *163*(1), 15–22. https://doi.org/10.1680/ensu.2010.163.1.15

He, Q., Wang, G., Luo, L., Shi, Q., Xie, J., & Meng, X. (2017). Mapping the Managerial Areas of Building Information Modeling (BIM) Using Scientometric Analysis. *International Journal of Project Management*, *35*(4), 670–685. https://doi.org/10.1016/j.ijproman.2016.08.001

Holling, C. S. (1973). Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics*, *4*(1973), 1–23. http://www.jstor.org/stable/2096802%5Cnhttp://www.jstor.org/page/info/about/policies/terms.jsp%5Cnhtt

p://www.jstor.org

Mfon, I.E, Oguike, M.C., Eteng, S.U., & Etim, N.M. (2022). Causes and Effects of Flooding in Nigeria: A Review. *East Asian Journal of Multidisciplinary Research*, *1*(9), 1777–1792. https://doi.org/10.55927/eajmr.v1i9.1261

Jin, R., Gao, S., Cheshmehzangi, A., & Aboagye-Nimo, E. (2018). A Holistic Review of Off-Site Construction Literature Published Between 2008 and 2018. *Journal of Cleaner Production*, *202*(August), 1202–1219. https://doi.org/10.1016/j.jclepro.2018.08.195

Liao, K. H. (2012). A Theory on Urban Resilience to Floods-a Basis for Alternative Planning Practices. *Ecology and Society*, *17*(4). https://doi.org/10.5751/ES-05231-170448

Mansuri, L., Udeaja, C., Trillo, C., Kwasi, G., Patel, D., Jha, K., Makore, C. B., & Gupta, S. (2019). Scientometric Analysis and Mapping of Digital Technologies Used in Cultural Heritage Field. Association of Researchers in Construction Management, ARCOM 2019 - *Proceedings of the 35th Annual Conference*, 255–264.

Markoulli, M. P., Lee, C. I. S. G., Byington, E., & Felps, W. A. (2017). Mapping Human Resource Management: Reviewing The Field and Charting Future Directions. *Human Resource Management Review, 27*(3), 367–396. https://doi.org/10.1016/j.hrmr.2016.10.001

Mayunga, J. S. (2007). Understanding and Applying the Concept of Community Disaster Resilience: A capital-based approach. *Summer Academy for Social Vulnerability and Resilience Building*, July, 1–16. http://www.ehs.unu.edu/file/get/3761.pdf

Mens, M. J. P., Klijn, F., de Bruijn, K. M., & van Beek, E. (2011). The Meaning of System Robustness for Flood Risk Management. *Environmental Science and Policy*, *14*(8), 1121–1131. https://doi.org/10.1016/j.envsci.2011.08.003

Miguez, M.G., Battemarco, B.P., De Sousa, M.M., Rezende, O.M., Verol, A.P., & Gusmaroli, G. (2017). Urban Flood Simulation Using MODCEL: An Alternative Quasi- 2D Conceptual Model. *Water*, *9*(6), 445.

Njoku, C. G., Efiong, J., & Ayara, N. A. N. (2020). A Geospatial Expose of Flood-Risk and Vulnerable Areas in Nigeria. *International Journal of Applied Geospatial Research, 11*(3), 87–110. https://doi.org/10.4018/IJAGR.20200701.oa1

Nnodim, A. U. & E. C. (2020). Perceived Impact of Perennial Flooding on Livelihood Activities of Rural Dwellers of Orashi Region of Rivers State. *International Journal of Innovative Human Ecology & Nature Studies, 8*(2), 12–18.

Olawumi, T. O., Chan, D. W. M., & Wong, J. K. W. (2017). Evolution in the intellectual structure of BIM research: a bibliometric analysis. *Journal of Civil Engineering and Management, 23*(8), 1060–1081. https://doi.org/10.3846/13923730.2017.1374301

Onwuemele, A. (2018). Public Perception of Flood Risks and Disaster Preparedness in Lagos Megacity, Nigeria. *Academic Journal of Interdisciplinary Studies, 7*(3), 179–185. https://doi.org/10.2478/ajis-2018-0068

Oraee, M., Hosseini, M. R., Papadonikolaki, E., Palliyaguru, R., & Arashpour, M. (2017). Collaboration in BIM-Based Construction Networks: a Bibliometric-Qualitative Literature Review. *International Journal of Project Management, 35*(7), 1288–1301. https://doi.org/10.1016/j.ijproman.2017.07.001

Saka, A. B., & Chan, D. W. M. (2020). Adoption and Implementation of Building Information Modelling (BIM) in Small and Medium-Sized Enterprises (Smes): A Review and Conceptualization. *Engineering, Construction and Architectural Management, 28*(7), 1829–1862. https://doi.org/10.1108/ECAM-06-2019-0332

Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research Methods for Business Students Fifth Editon*. In Pearson: Vol. Fifth Edit (Issue 1). Pearson Education Limited. https://eclass.teicrete.gr/modules/document/file.php/DLH105/Research Methods for Business Students%2C 5th Edition.pdf

Sholihah, Q., Kuncoro, W., Wahyuni, S., Suwandi, S.P, & Feditasari, E.D. (2020). The Analysis of the Causes of Flood Disasters and Their Impacts in the Perspective of Environmental Law. *IOP Conference Series: Earth and Environmental Science, 437*(1), 012056. https://doi.org/10.1088/1755-1315/437/1/012056

Shukra, Z. A., & Zhou, Y. (2020). Holistic Green BIM: A Scientometrics and Mixed Review. *Engineering, Construction and Architectural Management, 28*(9), 2273–2299. https://doi.org/10.1108/ECAM-05-2020-0377

Song, J., Zhang, H., & Dong, W. (2016). A Review of Emerging Trends in Global PPP Research: Analysis and

Visualization. *Scientometrics, 107*(3), 1111–1147. https://doi.org/10.1007/s11192-016-1918-1

Su, H. N., & Lee, P. C. (2010). Mapping Knowledge Structure by Keyword Co-Occurrence: A First Look at Journal Papers in Technology Foresight. *Scientometrics, 85*(1), 65–79. https://doi.org/10.1007/s11192-010-0259-8

Tariq, S., Hu, Z., & Zayed, T. (2021). Micro-Electromechanical Systems-Based Technologies for Leak Detection and Localization in Water Supply Networks: a Bibliometric and Systematic Review. *Journal of Cleaner Production, 289*, 125751. https://doi.org/10.1016/j.jclepro.2020.125751

Ujene, A.O. & Oguike, M. C. (2020). Mitigating Buildings Flood Hazards Through Environmental Sustainable Road Design and Construction" In Umoren, V. and Atser, J. (eds), *Land Use Management & Environmental Sustainability in Nigeria.*

van Eck, N. J., & Waltman, L. (2010). Software Survey: Vosviewer, a Computer Program for Bibliometric Mapping. *Scientometrics, 84*(2), 523–538. https://doi.org/10.1007/s11192-009-0146-3

van Eck, N. J., & Waltman, L. (2019). VOSviewer Manual. *In CWTS Meaningful metrics* (Issue January). https://www.vosviewer.com/documentation/Manual_VOSviewer_1.6.10.pdf

van Eck, N.J., & Waltman, L. (2014). Visualizing Bibliometric Networks. In: Ding, Y., Rousseau, R., Wolfram, D. (eds) *Measuring Scholarly Impact*. Springer, Cham. https://doi.org/10.1007/978-3-319-10377-8_13

Wang, H. J., & Zeng, Z. T. (2010). A Multi-Objective Decision-Making Process for Reuse Selection of Historic Buildings. *Expert Systems With Applications, 37*(2), 1241–1249. https://doi.org/10.1016/j.eswa.2009.06.034

Xiao, X., Skitmore, M., Li, H., & Xia, B. (2019). Mapping Knowledge in the Economic Areas of Green Building Using Scientometric Analysis. *Energies, 14*(15), 3011. https://doi.org/10.3390/en12153011

Yalcinkaya, M., & Singh, V. (2015). Patterns and Trends in Building Information Modeling (BIM) Research: a Latent Semantic Analysis. *Automation in Construction, 59*, 68–80. https://doi.org/10.1016/j.autcon.2015.07.012

Yu, D., & Liao, H. (2016). Visualization and Quantitative Research on Intuitionistic Fuzzy Studies. *Journal of Intelligent and Fuzzy Systems, 30*(6), 3653–3663. https://doi.org/10.3233/IFS-162111

Yu, F., & Hayes, B. (2018). Applying Data Analytics and Visualization to Assessing the Research Impact of the Cancer Cell Biology (CCB) Program at the University of North Carolina at Chapel Hill. *Journal of EScience Librarianship, 7*(1), e1123. https://doi.org/10.7191/jeslib.2018.1123

Zakka, W. P., Abdul Shukor Lim, N. H., & Chau Khun, M. (2021). A Scientometric Review of Geopolymer Concrete. *Journal of Cleaner Production, 280*(1). https://doi.org/10.1016/j.jclepro.2020.124353

Zhao, D .&, & Strotmann, A. (2015). Analysis and Visualization of Citation Networks. *In Synthesis Lectures on Visualization*, *3*(2). https://doi.org/10.2200/s00688ed1v01y201512vis006

Zheng, C., Yuan, J., Zhu, L., Zhang, Y., & Shao, Q. (2020). From Digital to Sustainable: A Scientometric Review of Smart City Literature Between 1990 and 2019. *Journal of Cleaner Production, 258*, 120689. https://doi.org/10.1016/j.jclepro.2020.120689