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Bibliometric analysis of global publications related to drought risk and resilience using the Scopus database

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ABSTRACT

Drought can be realised as a significant natural hazard and has a high potential to transform into a disaster. Drought is different from other environmental hazards. It can happen worldwide without considering climatic regions resulting in many socio-economic and environmental impacts. This study was conducted to identify the global trend related to drought risk and resilience research. Bibliometric analysis was performed using the data retrieved from the Scopus database. The period covered from 1934 to December 2021. Ten thousand one hundred ninety-three documents were analysed using both software of biblioshiny and VosViewer mainly under six themes, i.e. sources, authors, institutions, countries, documents, and keywords. The results highlighted that the Journal of Science of the Total Environment (198), Journal of Water (157), and Journal of Hydrology (136) are the three leading journals in terms of publishing articles related to drought risk and resilience by December 2021. Wang, Y. (93), Zhang, Q. (81), and Zhang, J. (79) are the top three prominent authors related to producing documents. Singh, V.P. (26) and Zhang, Q. (26) are the top authors regarding the local impact H index value. The University of Chinese Academy is the top institution for citation by the organisation. The USA (56546), China (17543) and the United Kingdom (17248) are the top three countries receiving citations. Forest, Ecology and Management, published by Allen, C.D. (2010), is the highest globally cited document. ‘‘Drought", "Climate Change", and "Risk Assessment" are the top three keywords used in the documents. "Drought", "Climate Change", "Risk", "Adaptation", and "Vulnerability" are the main five themes that show the rapidly growing trend in the field of research on drought hazards throughout the world. The results of this paper will help drought researchers to determine the future direction of their research.

KEYWORDS: *Climate Change, Drought Hazard, Risk, Resilience, Bibliometric Analysis.*

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1. INTRODUCTION

Drought can be realised as the most important natural hazard (Adisa et al., 2020; Alamgir et al., 2019; Badripour, 2007; Fu et al., 2013; Hayes et al., 2004; Keshavarz & Karami, 2016; Valverde-Arias et al., 2018; Wilhite, 2021; Wilhite et al., 2007; Zarafshani et al., 2012). Drought is a normal feature of climate (Wilhite, 2021). During the past few decades, the frequency of occurrence, intensity, severity, and duration of dry periods of droughts have increased massively (Jordaan et al., 2018; Kahraman & Kaya, 2009; Lal et al., 2012; Nam et al., 2015) because of rapid climate change (Bokal et al., 2014; Hao et al., 2012; Jarraud & Steiner, 2014; Kamali et al., 2019; LI et al., 2017; Yildirim et al., 2022). Drought can occur in any climatic region of the world (Wilhite et al., 2007), and it creates many adverse effects or much damage to the economy, society and the environment around the globe, irrespective of the level of development achieved by the countries (Badripour, 2007; Belle et al., 2017; Ifejika Speranza et al., 2008; Jordaan et al., 2018; Keshavarz & Karami, 2016; Knutson et al., 2011; Li et al., 2019; Truelove et al., 2015; Valverde-Arias et al., 2018; Wilhite, 2021; Wilhite et al., 2007; Yu et al., 2014; Zarafshani et al., 2012; Q. Zhang et al., 2015). Agriculture is the most vulnerable sector to drought in many regions of the world (Chengot et al., 2021; Jordaan et al., 2018; Salmoral et al., 2020; Vignaroli, 2017; F. Zhang et al., 2019) and frequently, droughts are transformed into disasters creating loss of livelihoods, crops damages, an increase in food insecurity, and the people's lives etc.(Bokal et al., 2014; Knutson et al., 2011; Pantanahiran, 2018).

More than 100 definitions for drought can be found provided by different researchers worldwide but a universally accepted definition cannot be found because of the complexity of drought hazard (Wilhite et al., 2007; 2021; Li et al., 2019;). Drought differs from other sudden environmental hazards such as cyclones, tsunamis, earthquakes etc. Drought is a slowly growing hazard with no clear start, exit or end. It can be spread from a local to a regional or global level without limiting it to a specific geographic area. Drought's impacts differ between developing and developed countries because though people living in developing countries undergo death due to lack of food insecurity, death does not happen in developed countries except for economic loss. The impacts of drought cannot be quantified correctly and efficiently due to the inherent complexity because even after drought, effects will cascade for an extended period. The frequent recurrence of drought is a big challenge for any community (Belle et al., 2017; Etemadi & Karami, 2016). As drought occurs in different climatic regions, definitions differ from region to region (Badripour, 2007; Kchouk et al., 2021; Smith, 2013; Wilhite, 2021), and perceptions are also different from community to community (DeChano-Cook, 2018). However, drought is generally identified as a lack of precipitation expected for an extended period or a temporally deviation from average precipitation, which is enough to create

a loss (Fu et al., 2013; Kahraman & Kaya, 2009).

Drought can be defined as either conceptual or operational (Kchouk et al., 2021), and operational drought definitions describe more details about the drought phenomenon, such as frequency, severity, duration etc., than the conceptual definitions (Wilhite & Glantz, 2019). Many researchers have accepted the four significant types of droughts as meteorological, hydrological, agricultural and socio-economic or famine. Meteorological drought is mainly identified using a lack of precipitation or deviation from the total average precipitation in a specific time and area. The lack of surface and underground water to supply the water demand is identified as a hydrological drought. Agricultural drought is captured using a lack of soil moisture to sustain crop demand. Socio-economic or famine drought is occurred later, resulting in accumulated effects of meteorological, hydrological and agricultural droughts such as price increases of goods and services, scarcity of food and drinking water etc. (Badripour, 2007; Smith, 2013; Hagenlocher et al., 2019; Raksapatcharawong & Veerakachen, 2019; Wilhite & Glantz, 2019; Kchouk et al., 2021). Measuring drought is challenging, but identifying drought severity is a primary step for managing drought risk and achieving resilience. Hence, various researchers in different disciplines have developed different drought indices, i.e. environmental science, engineering, disaster management, social sciences, etc. The four major operational droughts are measured by adapting many drought indices. For example, meteorological droughts are measured using the Standardised Precipitation Index (SPI) and Palmer Drought Severity Index (PDSI), where major input parameters are rainfall and temperature (Chandrasekara et al., 2021; Wang et al., 2020). Most developing countries use a reactive approach to drought management and given less attention (Neisi et al., 2020). Therefore, drought risk identification is an essential task of a proactive drought management process that helps achieve resilience(Fu et al., 2013). Drought risk comprises the accumulation of drought hazards and vulnerability (Alamgir et al., 2019; Hayes et al., 2004; Smith, 2013). Drought hazard is measured using various indices where some characteristics are considered, such as frequency of occurrence, intensity, duration, geographical extent, etc. Vulnerability is measured using socioeconomics and environmental characteristics (Wilhite, 2021). Drought resilience copes with drought effects or returns to normal after drought occurrence. Many studies used a reactive approach, but a proactive management approach is needed to build drought resilience(Fu et al., 2013).

The bibliographic method is a quantitative method that can be used to analyse the scientific output of a field, such as the number of publications by country level, the trend of keywords, the trend of topics, authors' affiliations by institutions and countries, the nature of publications etc., Hence, finally, it will help to identify the gaps and the trend of any research field (Adisa et al., 2020; Barnes et

al., 2019). Further, bibliometric analysis can be used to identify the highest research articles related to some research fields in terms of citations, co-citations, and their authors, countries, institutions, networking among countries or regions, networking of authors, institutions, keywords, the historical development of publishing articles, trend etc.(Álvarez-García et al., 2018; Rana, 2020; Zhang et al., 2019). Therefore, there is a huge trend to perform bibliometric analysis in other research fields. However, there is no agreement regarding the number of publications or documents that should be utilised to perform bibliometric analysis. However, some researchers have argued that too low or too many documents are not suitable for bibliometric analysis because too low a number can mislead the results, and too many publications may not be able to manage effectively. Hence, a manageable number of documents may be suitable for bibliometric analysis(Barnes et al., 2019).

Though considerable research has been carried out on drought worldwide, minimal research on drought risk and resilience is conducted using bibliometric analysis. Therefore, the main research problem of this study was to explore whether there is a growing trend of research on drought risk and resilience in terms of common indicators of bibliometric analysis. The central research questions were to analyse what and who are the highest sources, authors, institutions, countries, documents, and keywords in terms of different aspects i.e. citations, number of documents, networking, occurrence, H index, and trends within the context of documents related to drought risk and resilience, published from 1934 to 31st December 2021 in the Scopus database. Hence, this study aimed to analyse the trend of pioneer sources, authors, institutions, countries, documents and keywords related to drought risk and resilience research.

2. MATERIAL AND METHODS

In order to perform a bibliometric analysis on drought risk and resilience, documents drawn from the Scopus database were defined with the keywords "KEY (drought AND hazard OR drought AND risk OR “Drought resilience”). "Then limited to English Language documents. Ten thousand one hundred ninety-three documents related to drought risk and resilience from 1934 to 31st December 2021 were published. The database was accessed on 29th January 2022. Scopus can export full 2000 documents per time; therefore, we must export several times to complete 10193 documents, including research articles, conference papers, review papers, book chapters, books and short communications. However, most were research articles equal to 7693(75%). Data were exported using CSV and BibTeX file formats because we used Vosviewer and Biblioshiny softwares to analyse documents. CSV format is required for Vosviewer Software BibTeX file format is compatible with Biblioshiny R Studio software. After exporting several CSV files, All CSV format files were merged as one file with the support of the command prompt, and all BibTeX files were merged into one file using

Texmaker software. Results were generated by analysing documents using Biblioshiny and Vosviewer software under different categories such as authors, documents, sources, institutions, countries, and keywords. Both softwares were used for analysing documents because of different advantages; for example, Vosviewer helps to generate excellent graphical visualisation of data. Biblioshiny allows different features and many options for the researcher to analyse documents under different subcategories such as dataset, sources, authors, documents, clustering, conceptual structure, intellectual structure, and social structure. Figure 01 shows the methodological workflow of the bibliometric analysis used by researchers.

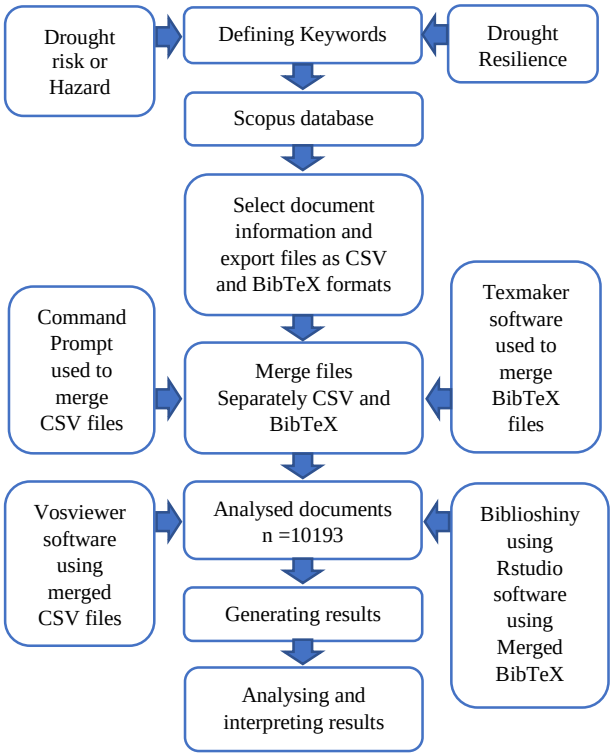

Figure 01. Workflow of bibliometric analysis.

3. RESULTS AND DISCUSSION

When analysing 10193 documents regarding the trend of sources, authors, institutions, countries, documents and keywords related to research conducted on drought risk and resilience, it is crucial to consider each theme to identify the trend.

3.1 Sources

Figures 02, 03, 04, and 05 show the most relevant sources related to drought risk and resilience. Figure 02 indicates the top twenty journals contributing to publishing drought risk and resilience-related articles. Journal of Science of the Total Environment (198), Water (157), and Journal of Hydrology (136) have become the first, second and third place in terms of publishing the majority of articles related to drought risk and resilience, respectively. International Journal of Environmental Research (53) is the last of the top twenty but has published over 50 articles.

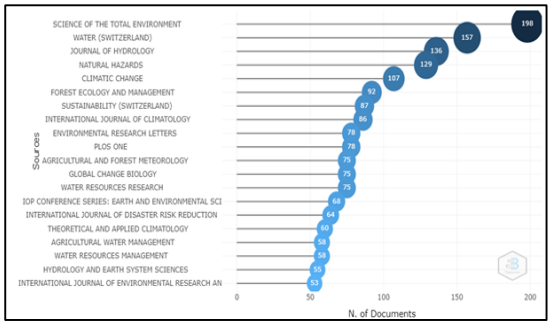

Figure 02. Top 20 most relevant sources for publishing drought risk and resilience documents.

Figure 03 illustrates the local impact journals by H index (Local impact means that the author or document is measured using a standard index such as the H index within the collection of documents used for bibliometric analysis. The H-index value is the number of papers (h) published in a journal cited at least h times. For example, if a journal has published twenty

papers that have each been cited at least twenty times, then the journal's h-index is 20).The Journal of Hydrology had become the first place out of the twenty top local impacts by the H index. Forty is the highest local impact by the H index, which belongs to the Journal of Hydrology, and 37 is the second highest impact number by the H index, which belongs to the Journal of Science of the Total Environment. At the same time, the Journal of Climatic Change is third in terms of most local impact by the H index, which equals 35. Journal of Climate is the last out of the top twenty regarding local impact by the H index, but its value is higher than 20. When analysing sources according to the Total Citation (TC) index, the Journal of Forest Ecology and Management has secured the first place out of the top twenty journals earning a total impact of 8208 total citations. Journal of Nature has become the second place by the local TC index earning 6016 citations. In comparison, Science of the Total Environment is the third, with 5450 total citations by December 2021. Figure 04 compares the top twenty journals in terms of the TC index (Total Citation, TC is a measurement of the quality of the paper used by the scientific community, i.e. the total number of citations related to a particular paper means how many times cited in other scientific articles).

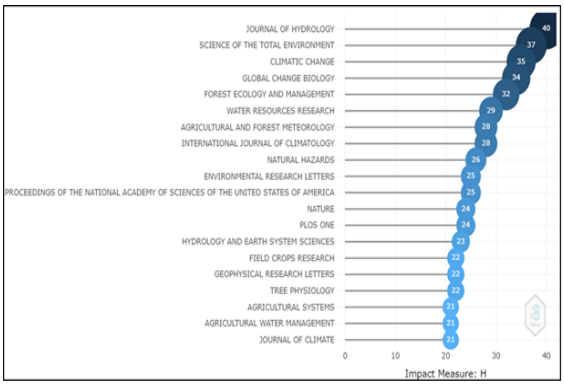

Figure 03. Top 20 Sources in terms of local impact by H index from 1934 to 2021.

Figure 05 illustrates the trend of growing sources from 1934 to 2021 related to drought risk and resilience. The growing journals are Sciences of the Total Environment, Water, Journal of Hydrology, Natural Hazards and Climate Change. All five journals have begun to overgrow since 1989. Sciences of the Total Environment are the first, Journal, Water is the second, the Journal of Hydrology is the third place, Natural hazard is the fourth, and Climate Change is the fifth place regarding rapid growing sources. However, all journals have been growing drastically since 2010.

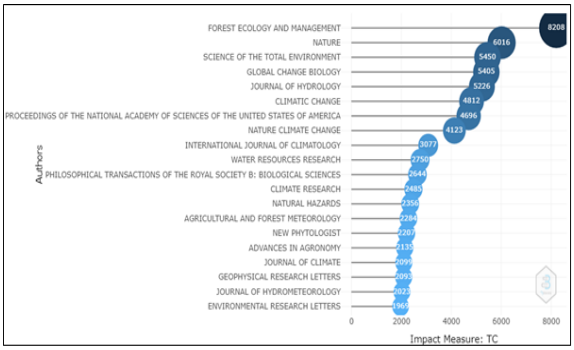

Figure 04. Top 20 Sources in terms of local impact by Total Citations (TC) index from 1934 to 2021

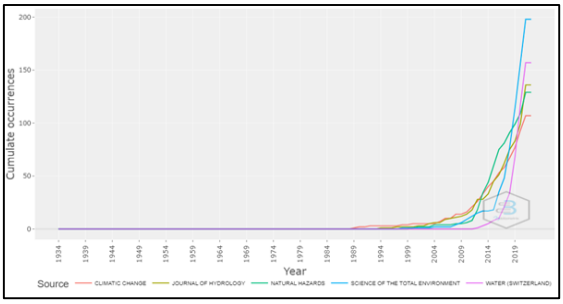

Figure 05. Source growth trend in publishing articles on drought risk and resilience from 1934 to 2021.

3.2 Authors

Figures 06, 07, 08, and 09 show the relationship between the author and their publications on drought risk and resilience. Figure 06 indicates the top twenty authors regarding the number of publications. All top twenty authors have published over 30 articles; among them, Wang.Y. Zhang, Q., and Zhang, J. have become the first, second and third places publishing articles 93, 81, and 79, respectively, by December 2021.

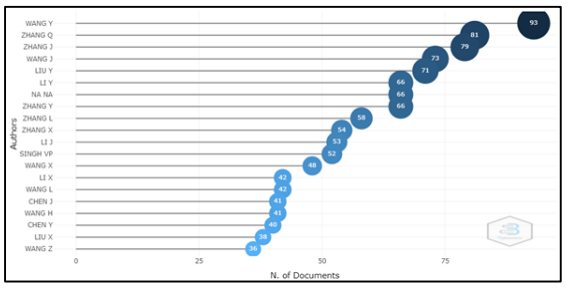

Figure 06. Top 20 most relevant authors in producing drought risk and resilience documents from 1934 to 2021.

When analysing authors in terms of local citations (local citation is a measurement used by the scientific community to determine the quality of a document or an author: it analyses how many times an author or document has been cited within a collection of publications used for bibliometric analysis). Figure 07 shows the top twenty authors where four categories can be identified. Five authors, Amador-Muoz, O., Bravo-Cabrera, J.L., Hernandez-Mena, L., Munive-Coln, Z., and Villalobos-Pietrini, R., have become the first place in terms of receiving local citations because these five authors have received the equal number of citations which is 266. Four authors have earned the second place receiving 257 local citations equally, while another four have become the third place gaining 216 equal local citations. The rest of the authors out of the top twenty have earned less than 136 local citations, but the last of the top twenty authors, Zhang, J., has earned 114 local citations. When comparing authors in terms of local impact by H index, figure 08 shows that the top twenty authors have earned the highest H index. Singh, V.P., Zhang, Q. have secured the first place gaining the highest H index value, i.e. 26. Wang, J. is the second place gaining a 20 H index value, while three authors, namely Lily, J., Wang, Y., and Zhang, Y., have become the third place receiving a 19 H index value. The mean value of the H index among the top twenty authors is 18. Figure 09 points out that the author affiliations where the highest number of authors, i.e.297, have affiliated with the University of California. Secondly, the majority, i.e.281, authors, have affiliated to the Beijing Normal University, and 141 authors have affiliated with the University of Chinese Academy of Sciences, the third place out of the top twenty authors' affiliated institutions. Wuhan University is the last institution out of

the top twenty institutions, but 68 authors have affiliated to the event's top last institution. The 29233 authors have produced ten thousand one hundred ninety-three documents; among them, 2076 authors have affiliated with the top twenty institutions covering 7% of total authors.

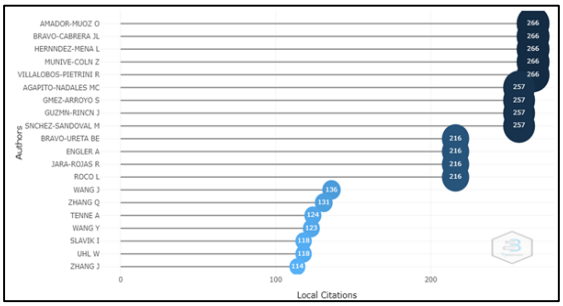

Figure 07. Top 20 most relevant locally cited authors within the collection of 10193 documents from 1934 to 2021.

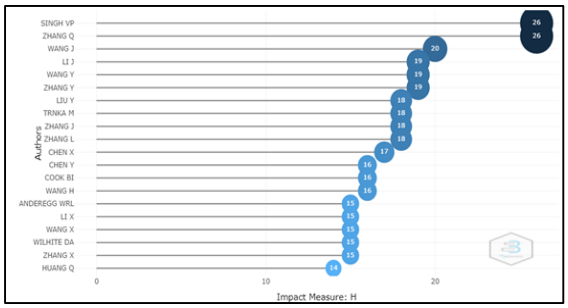

Figure 08. Top 20 authors by local impact by H index from 1934 to 2021.

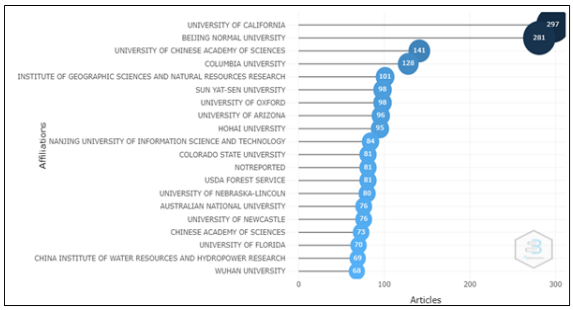

Figure 09. Top 20 universities regarding the highest affiliated authors from 1934 to 2021.

3.3 Institutions

Figure 10 illustrates the complex relationships among the institutions in terms of co-citations (when two different documents are cited together by another document, it is named co-cited). The University of Chinese Academy is the major organisation which contributed to co-citations. The University of Chinese Academy plays a massive role in networking with many institutions. Further, when analysing figure 10, it can be observed that mainly five clusters can be identified using different colours. However, only a few organisations are included in those five clusters. The University of Chinese Academy-related institutions have more co-authorship than other clusters. Further, the size of the circles shows the significance of the relationships, and the thickness of the line between circles shows the strength of the relationships among the network of institutions.

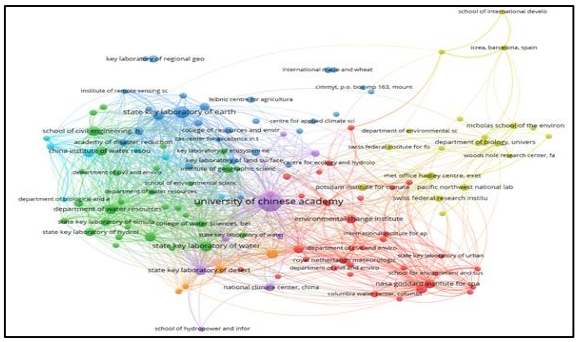

Figure 10. Cocitations owned by organisations related to drought risk and resilience from 1934 to 2021.

3.4 Countries

Figures 11, 12, and 13 illustrate how countries contribute to publishing articles related to drought risk and resilience research. Figure 11 shows the top twenty countries in terms of receiving citations. The United States of America (USA) have received 56546 citations, the highest number of citations gained by a country. China and the United Kingdom have earned 17543 and 17248, respectively, and become the second and third place concerning the citations out of the top twenty countries. All

other top twenty countries except the USA have received less than 20000 citations by December 2021. European countries and Asian countries have gained the majority of citations. Figure 12 denotes the relationship among countries or multi-networking. The highest network has been developed around the USA; the different networks can be found around China, Australia, Netherlands, India, France, Brazil, Italy etc. Figure 13 further explains the collaboration of the countries related to drought risk research where Europe is the central point, and other countries, such as the USA, Australia, China, etc., collaborate more than other countries.

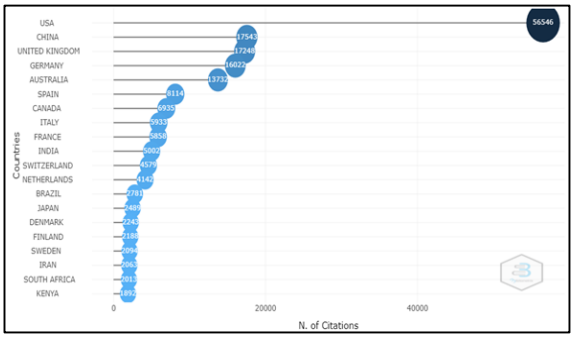

Figure 11. Top 20 countries by citations related to drought risk and resilience documents from 1934 to 2021.

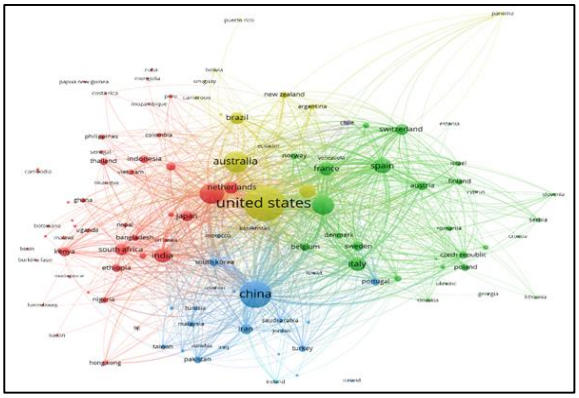

Figure 12. Bibliometric coupling by countries from 1934 to 2021.

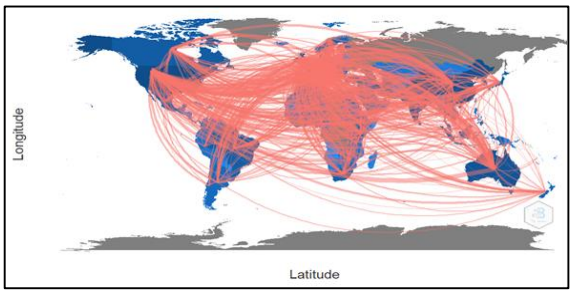

Figure 13. Country collaboration map related to drought risk and resilience research from 1934 to 2021.

3.5. Documents

Figure 14 explains the top most cited and the number of documents published by the various countries. Forest, Ecology and Management, published by Allen, C.D. (2010), is the highest globally cited document by December 2021. Nature Climate Change, published by Dai, A. (2013), is the second-highest document that received global citations. Figure 14 further shows the relationships among the documents, representing the different colours and sizes of the points.

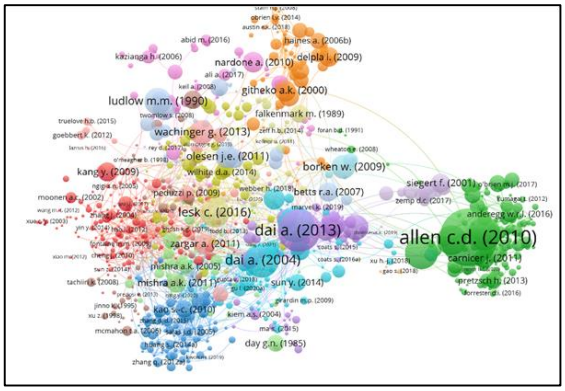

Figure 14. Most cited documents published related to drought risk and resilience from 1934 to 2021.

3.6. Keywords

Figures 15 and 16 show the frequently used words related to drought risk and resilience and

their trend. Figure 15 shows the top 1000 co-occurrence keywords in networking, drought, and climate change are the most frequent co-occurrence words out of 1000. This result is consistent with the previous research conducted by Adisa et al., (2020) in Africa on methods and tools for drought monitoring and prediction where the highest co-occurrence keyword is drought (Adisa et al., 2020). Further, the size of the letters and bubbles show the impact of words according to frequency and different colours, and the thinner lines show the different clusters and their networking. Figure 15 shows five red, blue, green, yellow and purple clusters. Figure 16 indicates the top 50 words regarding the number and percentage values. Drought has been used 5846 times by December 2021 within the 10193 documents and 16 per cent and is the first place out of the top 50 words used in titles. Climate change is the second word used in titles frequently, accounting for 3843(10%), and risk assessment is the third most frequently used word in titles, accounting for 2837(8%) out of 50 top words. When analysing the first 50 words used in research titles, the first three words, i.e. drought, climate change, and risk assessment, have been used more frequently. The following three words i.e. water supply, article, and China, have been used frequently. However, their contribution is 3 % within the 10193 documents and other rest of the words out of 50 have been contributed as 2 and 1 per cent respectively. On the other hand, the top fifty words used in research titles are responsible for more than 95% out of all words used in research titles within the 10193 documents.

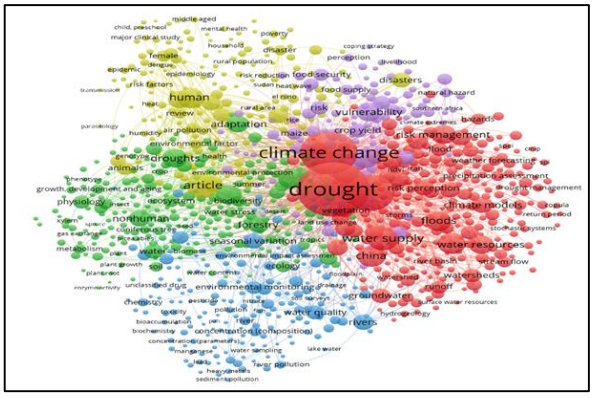

Figure 15.Top 1000 Co-occurrence keywords within the 10193 documents.

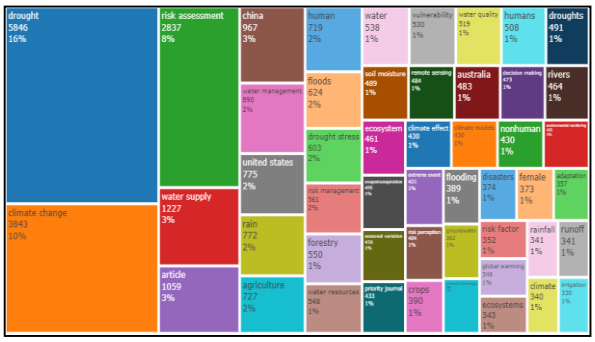

Figure 16. Top 50 words used in research titles about drought risk and resilience.

4 CONCLUSIONS

According to the analysis, the Journal of Science of the Total Environment, Journal of Water and Journal of Hydrology are the most relevant sources for publishing articles, with 198,157 and 136 documents published by December 2021. Journal of Science is the first of all documents in terms of most locally cited sources (5200). The Forest, Ecology and Management journal is the primary source of local impact by total citation index (8208). The most outstanding journal is the Science of the Total Environment in terms of rapidly growing. Wang Y., Zhang, Q., and Zhang, J., are the top three authors related to the number of documents published, and they have published 93, 81 and 79 articles, respectively, by

December 2021. Singh, V.P., and Zhang, Q., are the top authors with reference to the local impact by H index, and both of them have received a 26 H index value. The University of Chinese Academy is the first place regarding citations by organisations. The USA, China, and the United Kingdom are the top countries receiving citations, with 56546, 17543, and 17248 citations, respectively. Forest, Ecology and Management, published by Allen, C.D. (2010), is the highest globally cited document, which received 4216 citations by December 2021. The words "drought'', "climate change", and "risk assessment" are the most relevant and frequently used words within the 10193 documents. Of the top three frequently used words, "Drought" is the first. Moreover, "Drought" is the most frequently used keyword by the authors and titles. Hence, the themes of " Drought", "Climate Change", " Risk", "Adaptation", and " Vulnerability " have been on a growing trend since the 1980s, but it is observed that the themes are rapidly growing after 2010, the global wide. Therefore, drought risk and resilience research have a rapid growth trend worldwide. This trend suggests that more research on drought risk, climate change, vulnerability and adaptation is needed.

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