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Analysis of Community Adaptation to Climate Change and Natural Hazards

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Abstract

This study investigates novelty ideas on the topic's natural hazards and community adaptation using bibliometric analysis. This study uses six bibliometric indicators; time trends, geographic distribution, relevant authors and publications, and repeating keywords. The increasing interest in studies on climate change and its consequences on human life reflects the significance of the theme and is the primary motivation for this study. In total, 304 indexed documents published between 2012 to 2022 were selected from the scopus database and analyzed through VOSViewer software. Results showed that climate change, adaptability, and vulnerability were frequently investigated subjects linked to natural hazards and community adaptation. The recommendation for several exciting topics will be studied in the future, such as migration, indigenous knowledge. For example, migration studies could highlight why individuals settle or leave disaster-prone areas. Meanwhile, local wisdom will highlight the strength of local communities in facing natural hazards. The implication of study can helpfully researches, especially academics, give idea for fresh perspectives on the topic of community adaptation to natural hazards. The study can motivate researcher from developing countries to contribute so that it can provide a comprehensive study from developed and developing countries on the topic of natural disasters and community adaptation.

Keywords: Natural disaster; Climate change; Community adaptation; Bibliometrics

1. Introduction

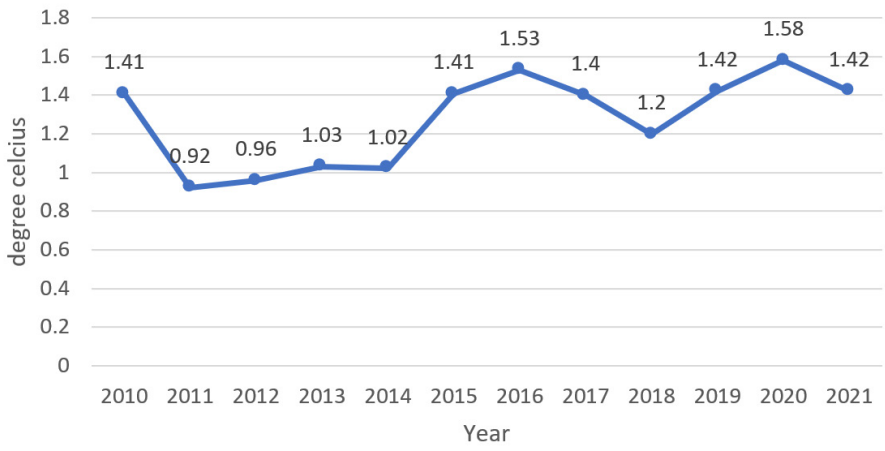
The Intergovernmental Panel on Climate Change (IPCC) reported that climate change had happened, the indicator as shown by global temperature exceeding 1.5 ºC (Figure 1) (IPCC, 2021). According to Portner *et al.* (2022), increasing global temperatures caused by greenhouse gas emissions from human activities, including deforestation, industrialization, and fossil fuel burning, accounted for 1.1 ºC during 1850 - 1900. The other indicator climate change shown by sea height achieve around 100 mm.

Climate change impacts livelihoods through resource degradation, unavailability of essential ecological services, low agricultural productivity, rising disease, physical injury, property loss, hindering children's education, and food insecurity

(Islam *et al.,* 2020; Peñalba *et al.,* 2021; Portner *et al.,* 2022; Shahzad *et al.,* 2019). Exposure, vulnerability, and the capacity to predict, overcome, and recover from challenges have all altered adversely owing to climate change and environmental degradation (Depietri, 2020). The discussion of vulnerability can be the basis for implementing adaptation actions and strategies (Jara *et al.,* 2020). However, the discussion of exposure has not undergone enough changes, where resilience is one component of the discussion of natural hazards. The complexity of uncertainty and rapid change require strategies to reduce vulnerability by building resilience (Nayak & Berkes, 2019).

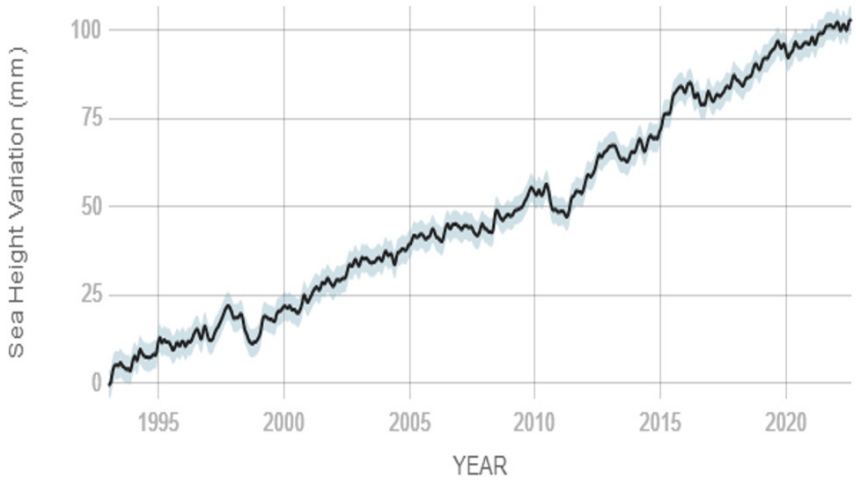
Resilience builds capabilities and creates resilience to better adaptation Skouloudis *et al.* (2020) to reduce hazards or maximize possibilities due to climate change and its ramifications (Rouse *et al.,* 2017). Community initiatives are essential to explain the phenomenon of community vulnerability in the face of natural disasters (Pandey *et al.,* 2018; Skouloudis *et al.,* 2020). Delaporte & Maurel (2018) say early studies on climate change focused more on effect and mitigation than adaptation. However, after natural hazards and climate change generated a worldwide rise in vulnerability, adaptation to climate change became a hot issue. Adaptations developed to stress will minimize vulnerability (Jentoft & Chuenpagdee, 2009). Adaptation studies investigate public engagement in building situations and use the ideas of resilience, vulnerability, and adaptive capacity. Understanding society's adaptability to environmental and social changes became a popular idea for scholars researching the complexity of human natural systems (Dias *et al.,* 2022; Endfield, 2012). This research to find out the development of community adaptation studies the impacts of climate change (i.e. natural hazards).

This study uses bibliometric analysis to map and decode accumulated scientific knowledge. Therefore, generating a big picture of the topic, finding gaps, and getting research suggestions. This examination explores a specific area's intellectual structure and subjective data (Lima & Bonetti, 2020). Unlike systematic literature reviews (qualitative tool), bibliometric analysis and meta-analysis utilize quantitative tools to minimize or reduce bias (Donthu *et al.,* 2021). Bibliometrics is superior since it has more heterogeneity in current research and publications than meta-analysis. The study compared initial research ideas with theories from numerous disciplines of study relevant to natural disaster-adaptive society. Therefore, this study is to obtain an overview of currently available scientific literature on community adaptation and natural hazards and evaluate the evolution and development of community adaptation and climate change.



Source : Statista (2022)

Figure 1. Global land surface temperatures



Source : NASA, (2020)

Figure 2. Sea level

2. Research Methodology

The bibliometric analysis focuses on the quantitative proximity of article attributes (publications, keywords, contributors, and publishers) and their relationship to each other (Tamala *et al.,* 2022). This study uses bibliometric analysis by exploring the current scientific literature and identifying knowledge gaps (Donthu *et al.,* 2021). Data collection using the Scopus Database on "adaptation of society" and "natural hazards".

Data was collected on August 22, 2022, totalling 304 documents. Data collection was carried out in three stages (Figure 3), namely: the first stage, selected only the last ten years (2012 - 2022); in the second stage, the selected field of study was articles within the subject area of environmental science (65%), social sciences (50%), earth and planetary science (39%) %), agricultural and biological sciences (12%), economics, econometrics and finance (5%), multidisciplinary (3%), business, management and accounting (2%); and articles within the following categories: article journal (87.2%), article review (8.2%), conference paper (4.6%).

Data analysis in this study is divided into three parts: the first part, trend growth (annual trends, authors who contribute the most, and affiliates who contribute the most); the second part, co-event mapping; the third part, co-authorship mapping. Co-occurrence and co-authorship were analyzed with Vos viewer visualization. The co-occurrence analysis includes network visualization, overlay, and density, while the co-authorship analysis used is network visualization (Sundari *et al.,* 2022).

3. Results and Discussion

3.1 Trend Growth

Figure 4 shows natural hazards and community adaptation research advancements. Most journal articles were published in 2018, with 37. In 2019, there were 32 research papers, five fewer than in 2018 and 47 more in 2021. In addition to yearly publishing patterns, sources, nations, and affiliations for the 304 papers analyzed are essential. Figure 5 displays the ten nations with the most cited publications. Most cited documents are country-based. Spain's few documents are cited often. Canada has few citations while having many papers. Figure 4b reveals that the top five developed nations are the United States, Australia, the United Kingdom, Germany, and Canada.

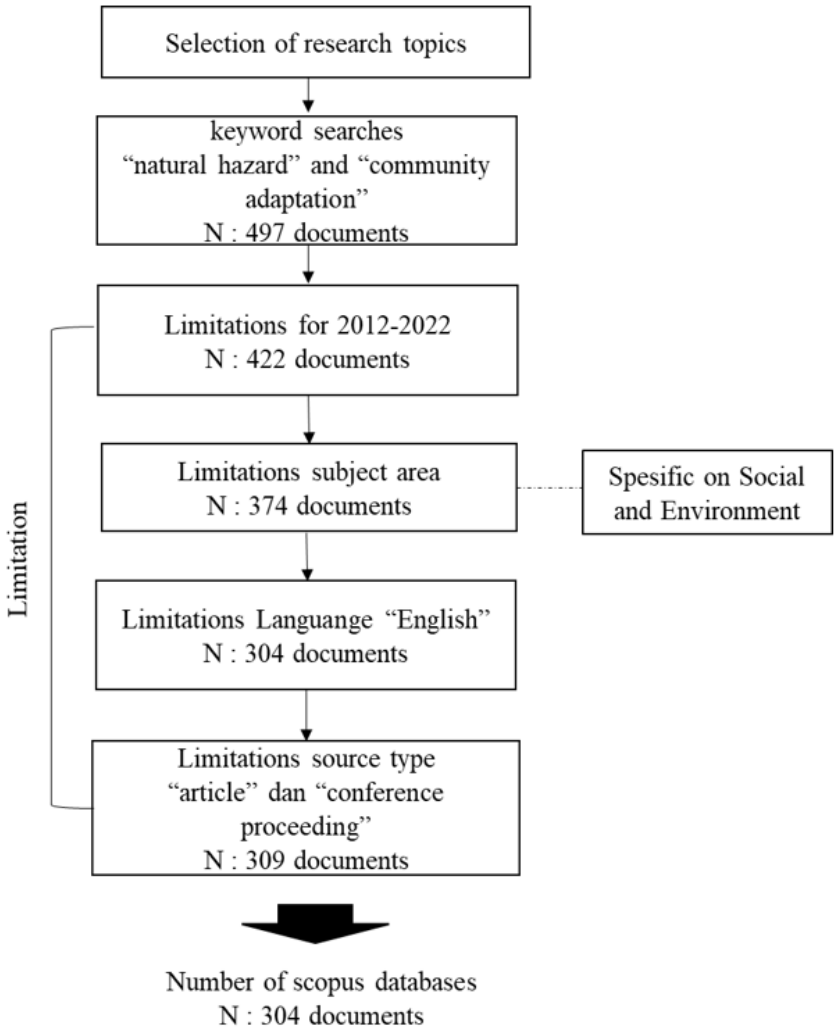
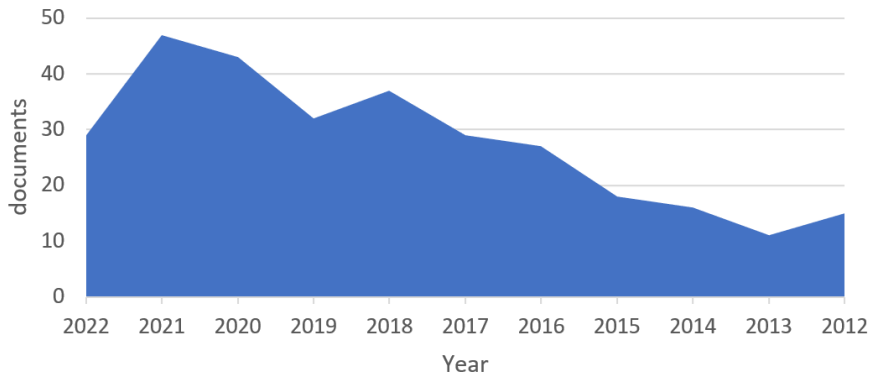


Figure 3. Scopus database search



Source : Scopus Database, (2022)

Figure 4. Annual scientific production

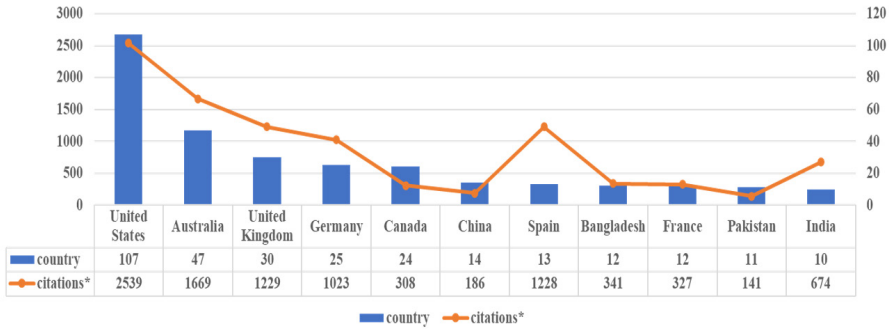
Table 1 lists papers by affiliation (institutions/organizations/universities). The Australian University of Wollongong has the most papers. The University of Washington, CU Boulder, Nature Conservancy, and Oregon State University produced the most articles in the U.S. The University of Waterloo is Canada's fifth-most prolific author. Despite Vietnam not being in the top 10 for scientific productivity, Vietnam National University Hanoi is in the top 10.

Interestingly, the author who authored the most publications on natural risks and community adaptation was Austrian, specifically Mr Thaler t (Figure 2). Meanwhile, the author who has the most citations is Syphard a. d. (from the United States), although the number of articles he wrote was small, only 0.65% of the 304 documents.

3.2 Analysis of Co-occurrence of Keywords

Statistically, 10.58% of the total keywords appear twice, 9.58% appear three times, 9.14% of keywords appear four times in the document, 8.49% appear five times, and so on, with a minimum of three keywords out of 2990 keywords with a minimum appearance threshold of 201.

The study looked at network visualization in the early stages of co-occurrence analysis. In Figure 6, the size of the circles (nodes) shows how often a keyword is used (Maier *et al.,* 2020), and the line (edge) shows how the two nodes are connected. The closer the distance between two nodes, the closer the connection between them (Donthu *et al.,* 2021). The keywords "climate change," "natural hazard," "vulnerability," "floods,"



Note : *citations has been cited at least five times
Source : Scopus Database, 2022

Figure 5. Top 10 countries of scientific production

Table 1. 10 Top Affiliation Scientific Production

No	Country	Affiliation	Total Documents
1	Australia	University Of Wollongong	7
2	United States	University Of Washington	7
3	Austria	Universitat Fur Bodenkultur Wien	7
4	United States	University Of Colorado Boulder	6
5	United States	Nature Conservancy	6
6	United States	Oregon State University	5
7	Canada	University Of Waterloo	5
8	China	Chinese Academy Of Sciences	5
9	Vietnam	Vietnam National University Hanoi	5
10	Australia	The Australian National University	4

Source: Scopus Database, 2022

"natural disaster," and "adaptation" were the strongest of all. With a co-occurrence rate of three and 304 publication documents, 9 groups were made: "climate change" (dark blue circle), "natural hazard" (red circle), "vulnerability" (light blue circle), "adaptive capacity" (brown circle), "perception" (yellow circle), "extreme event" (orange circle), "urban area" (purple circle), and "heat wave" (pink-colored circle).

Figure 7 shows the papers' average citation score and co-keyword link weights, from lowest (dark-purple) to highest (light-purple) (in yellow). Since 2019, "heat wave", "flash flood", "typhoon", and "coastal flooding" are popular natural disaster keywords. Recent adaptation keywords include "awareness," "indigenous knowledge," "preparedness," and "migration." food security", "coastal communities", "agriculture", "government ", and "urban area" are some relevant terms. Figure 8 shows the topic density. The redder the colour, the more topics studied; the bluer, the less. "Climate change," "vulnerability," and "natural hazard" depict density well. Several keywords have been studied for decades. Awareness, agriculture, exposure, developing nations, social vulnerability, local adaptation, indigenous knowledge, disaster preparedness, fishing community, and migration are low density.

3.3 Co-Authorship

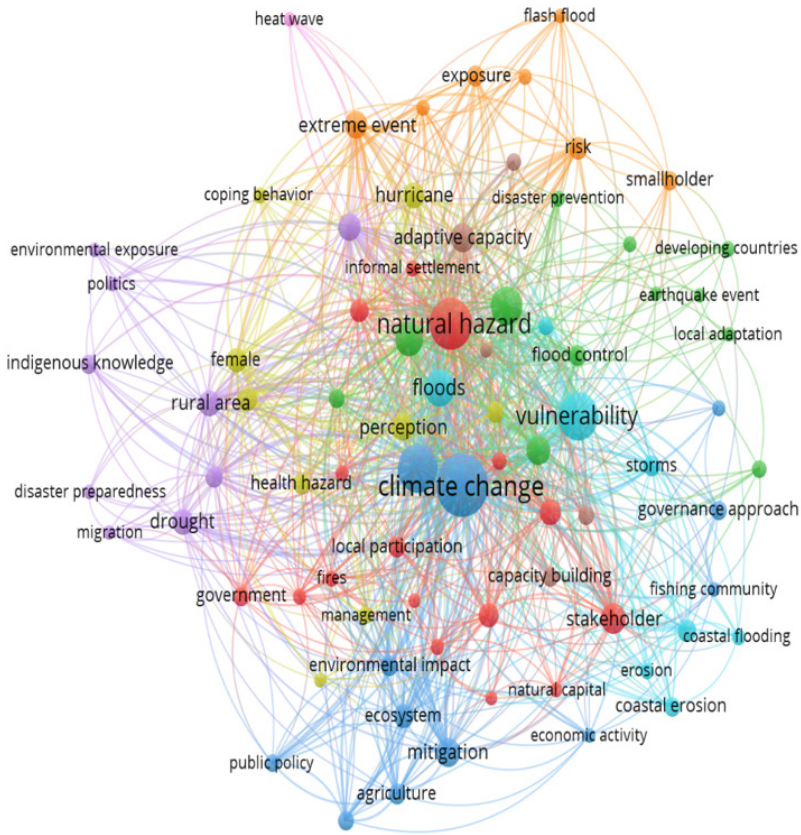
Co-authorship relates to the interaction of authors, contributing countries, or affiliations to develop a field or field of research. In the article's discussion, an analysis will be carried out on contributing countries' interactions. Article documents total 304 article documents; a minimum number of a country's documents was five as a threshold, qualifying 26 countries to meet the threshold. Statistically, 30.95% of the countries (n = 84) were credited to meet the threshold. Other countries had less than five documents published, and thus 26 countries were analyzed for country collaboration network analysis

In Figure 9, the colour balls indicate 6 clusters, and 44 linkages reflect a 206-cluster collaboration. This cluster shows the nation of writers based on the document's weight and average year of publication. As demonstrated in Figure 9, nations with solid relationships include The United States," "Australia," "The United Kingdom", "Germany", and "Canada". Those countries interact directly except "Canada". Other contributors are China, Spain, France, Bangladesh, and Pakistan. In Figure 10, the circle size shows the contribution of documents from nations as document weights, and the blue-to-yellow gradient denotes the average year of issue from 2017 to 2020 (Guleria & Kaur, 2021).

Table 2. 10 Top Author Scientific Production

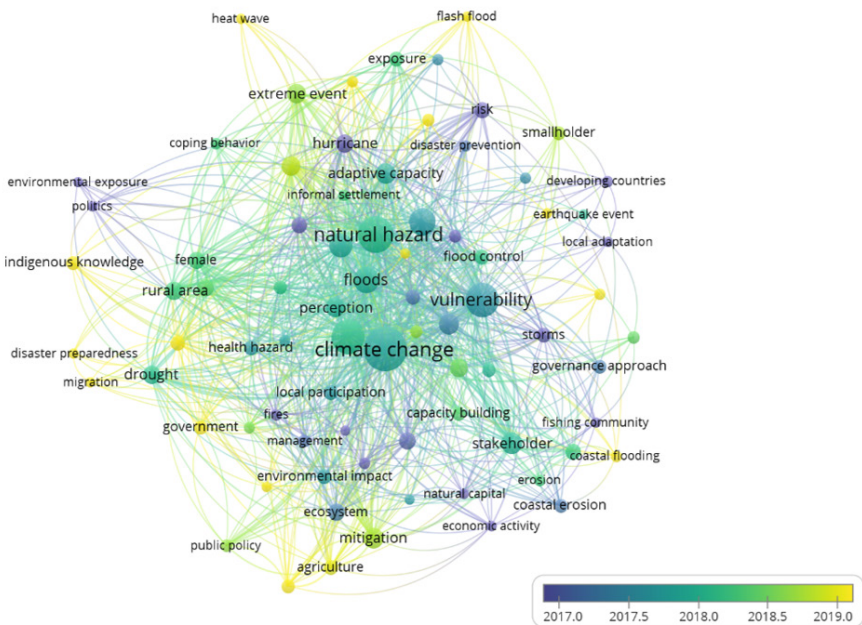
No	Author	Country	Documents	Citations*
1	Thaler T	Austria	5	149
2	Djalante R.	Germany	4	136
3	Keiler M.	Switzerland	3	519
4	Birkmann J.	Germany	3	521
5	Fuchs S.	Australia	3	120
6	Gilmer B.	United States	3	192
7	Paton D.	Australia	3	45
8	Doberstein B.	Canada	3	45
9	Becker A.	United States	3	163
10	Syphard A. D.	United States	2	551

Note: *Citations has been cited at least five times
Sources: Scopus Database, 2022



Source: Scopus Database, 2022

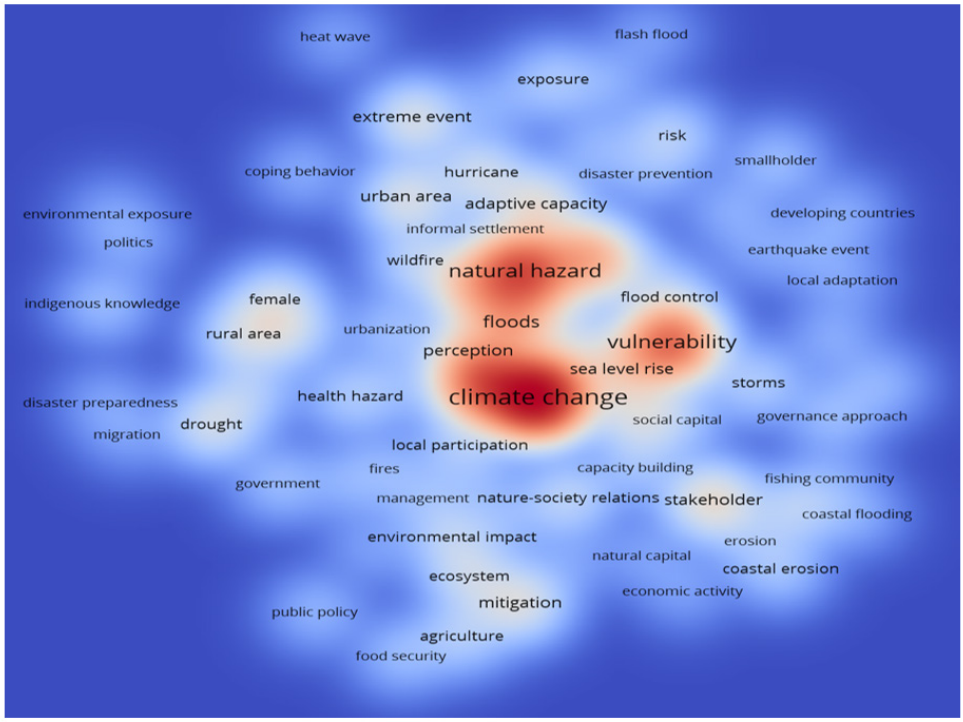
Figure 6. Keyword network visualization



Source: Scopus Database, 2022

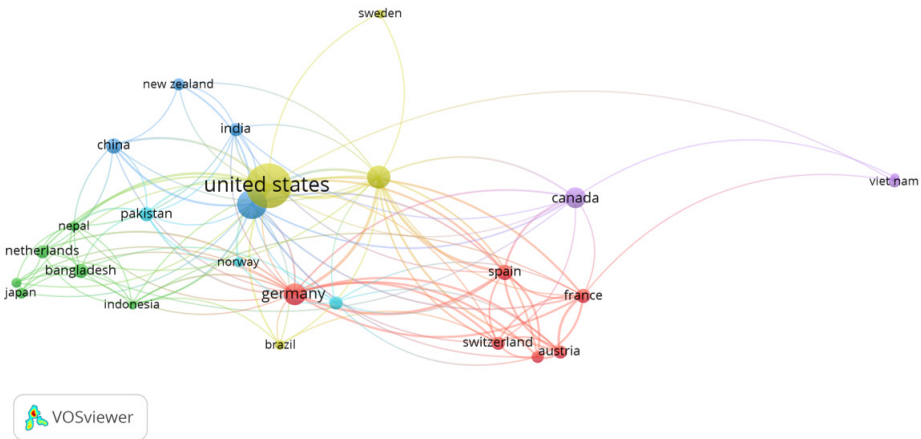
Figure 7. Overlay visualization keywords

Figure 10 shows that older papers had significant state affiliations, such as "Japan", "Switzerland", "Italy", and "Canada." In Figure 11, the density of red circles shows the most tightly related country groupings (Guleria & Kaur, 2021). The visualizations demonstrate strong country collaboration in earlier years, notably "The United States" and "Australia." With more inter-country contributions, links and cooperation have improved, such as in "Indonesia", "New Zealand", "Sweden", and "Brazil".



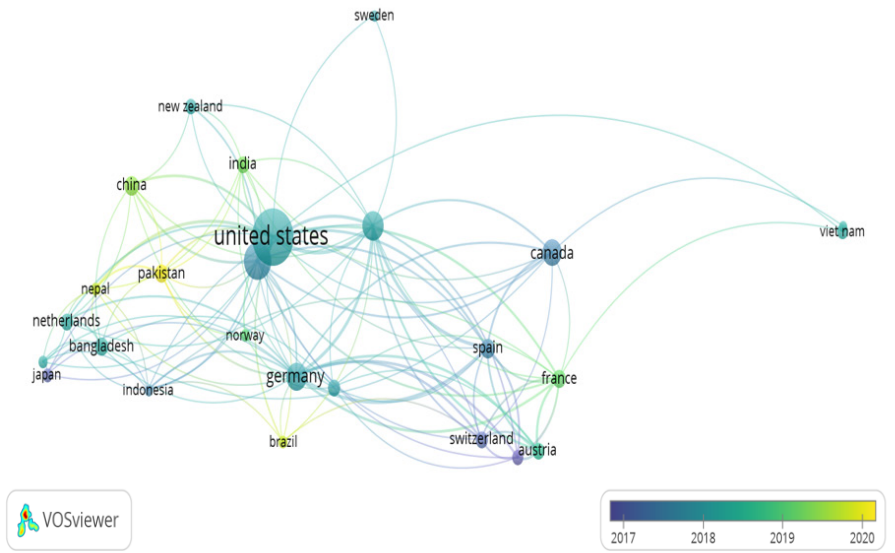
Source: Scopus database, 2022

Figure 8. Keyword network density



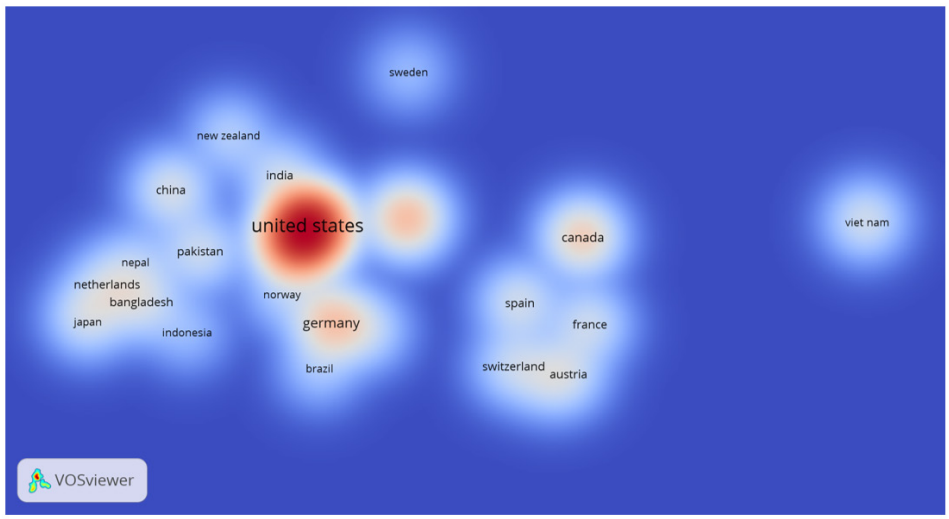
Source: Scopus Database, 2022

Figure 9. Network visualization



Source: Scopus Database, 2022

Figure 10. Overlay visualization keywords



Source: Scopus Database, 2022

Figure 11. Keyword network density

3.4 Discussion

The VOS viewer output results show that the discussion of adaptation, natural hazards, vulnerability and climate change is reasonably close to each other. It means that the majority of previous studies discussed these topics interestingly in their research, such as research conducted by Huang et al. (2020), Kerle *et al.* (2019), Tiller *et al.* (2022) and others.

Based on the display of VOS viewer output, there is still a space for ideas or topics, types of natural hazards and countries that have not / rarely contributed to the written contributions from the Scopus database. **First,** migration, indigenous knowledge, mitigation, gender, disaster preparedness, exposure, ecosystem-based adaptation and coping strategies are some of the topics that are rarely discussed, together with the topic

of adaptation; climate change; natural hazard, and or vulnerability. Second, based on the current topic, some recently studied topics are migration and indigenous knowledge. Third, based on its density, some rarely studied topics are migration, indigenous knowledge, coping behaviour, exposure, and ecosystem-based adaptation. Recommendations for the following research topic are based on output network visualization, overlay and density visualization, migration and indigenous knowledge.

Furthermore, migration and indigenous knowledge can be grouped into community adaptation to face natural hazards. Previous research has indeed associated more adaptation with awareness and perception (Fuchs *et al.,* 2017; Peñalba *et al.,* 2021), adaptation strategies (Nichols *et al.,* 2019; Suadi *et al.,* 2021), adaptability (Buch-Hansen *et al.,* 2015; Dilling *et al.,* 2017), mitigation efforts (Fischer *et al.,* 2020; Thaler *et al.,* 2018), resilience (Baig *et al.,* 2021; Lama *et al.,* 2017). In contrast to the research conducted by Rankoana (2016), which examines the mechanism of culture-based adaptation by rural communities to maintain their livelihoods from the impact of drought, and scarcity of rain.

Indigenous knowledge research is based on community participation (rural and urban communities) to share, plan, and assess their knowledge and daily living conditions (Ali *et al.,* 2018; Hambati & Yengoh, 2018; Shahzad *et al.,* 2019). To determine the adaptive capacity locally or culturally based is needed to deal with climate change and natural hazards disturbances. Furthermore, the migration topic is rarely discussed because there is a tendency for people to face environmental degradation and natural hazards by doing nothing and accepting a low quality of life (Reuveny, 2007). Migration becomes a household decision due to the gradual effects of climate change or extreme weather events (Chen *et al.,* 2022; Prior & Eriksen, 2013). In addition, migration decisions are also influenced by complex factors that may be influenced by various non-climate-related factors (Buchori *et al.,* 2021). **Second,** several types of natural hazards have been saturated discussed in the Scopus database collected, including hurricanes (Binder *et al.,* 2015; Dunning, 2020; Thiele, 2017), storms (Geirsdóttir *et al.,* 2014; Logan *et al.,* 2018; Nguyen *et al.,* 2017; Vasseur *et al.,* 2015), drought (Balch *et al.,* 2020; Lwasa, 2018; MacDonald *et al.,* 2020; Sherman *et al.,* 2015), and flood (Bott *et al.,* 2020; Victoria & Alexander, 2018; Wilby & Keenan, 2012). Furthermore, heat waves, flash floods, coastal flooding, wildfires, earthquake events, and typhoons are rarely the type of natural hazards in the discussion of adaptation, climate change, natural hazards, and vulnerability. Based on the current topic, several types of natural hazards have rarely been discussed: heatwaves, flash floods, coastal flooding, and typhoon. Based on its density, some rarely studied topics are heat waves, flash floods, coastal flooding, typhoons and earthquakes. Recommendations for the type of natural hazard subsequent study are based on output network visualization, overlay visualization and density visualization: heat waves, flash floods, coastal flooding, and typhoons.

Third, the country that publishes the most articles with the theme of "natural hazard" and "community adaptation" is the United States, followed by Germany, Australia, Canada, united kingdom. It can be observed that high-income countries consistently dominate the top rankings and are more likely to produce and publish more articles; of course, the main factor is to have sufficient funds, human resources, equipment and equipment. Developing countries rarely research the topic of natural hazards and community adaptation. Even though developing countries also experience various kinds of natural hazards, such as Indonesia, Brazil, Pakistan and others. Limited experience in academic collaboration, power play among researchers, a lack of research capacity, weak English academic writing skills, and limited higher education provisions are why developed countries rarely research hazards, disasters, risk reduction, and climate (Djalante, 2018).

4. Conclusion

This bibliometric study presents the results using VOS viewer visualization to find gaps in research ideas and help in understanding previous studies and the relationship of the theory with the research topic explored. In addition, this study examines the thematic trend of community adaptation to the occurrence of natural hazards.

Based on the results of VOS viewer visualization, the natural hazard is widely discussed using the keywords climate change and flood. Meanwhile, community adaptation is widely discussed using vulnerability, adaptation and resilience. The gap in research ideas on the topic of natural hazards and community adaptation is based on the results of VOS viewers, which can be recommendations for future research, namely migration and indigenous knowledge. The importance of community adaptation studies on the occurrence of natural hazards can be an addition to scientific characteristics regarding multidisciplinary, interdisciplinary, and economic development. In addition, it is interesting for further research to examine the community's adaptation to the occurrence of heat waves, flash floods, coastal flooding, and typhoons. Developing countries have the potential to contribute to producing articles on natural hazards and the adaptation of communities such as Vietnam, Brazil, Indonesia, Bangladesh, Nepal, Pakistan, China, and India. This research is helpful for researchers, particularly academics, who are looking for new ideas to apply to the subject of natural disasters and community adaptation. In addition, the findings of this study contribute to the explanation of various theories concerning natural and social interactions. More specifically, these findings shed light on how the influence of natural hazards on people's attitudes and behaviour choices can help them achieve prosperity while simultaneously reducing the risk of adverse outcomes.

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