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Bibliometric Analysis on Farmers' Vulnerability to Climate Change Impacts

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Abstract:

This study aims to conduct a bibliometric analysis of the impact of climate change on farmers. This study uses quantitative methods to analyze and provide a representative picture with the help of VOSViewer. This bibliometric research focuses on observing research activities and trends worldwide using published data from the Scopus database with the keywords vulnerability of farmers and climate change impacts from 2018 to 2022. There are 269 documents analyzed in this research. The study results show that over the last five years, research related to the impact of climate change on farmers has tended to increase, and the phenomenon of climate change has been the most widely discussed. Several other keywords already saturated for research are vulnerability, agriculture, adaptation, adaptive management, and climate effect. This shows that this research is interesting to discuss and explore more broadly

Keywords: Bibliometric Analysis; Climate Change Impacts; Farmer

1. Introduction:

Climate change has recently become an important issue and a significant global challenge (Islam & Wong, 2017; Zwane, 2019; Murniati & Mutolib, 2020; Malhi et al., 2021). Climate change is identified as changes that occur in several climatic factors such as temperature, rainfall, sunlight, humidity, and wind speed over a long period, usually within 30 to 50 years (Hossain et al., 2019). Global average temperatures have increased from 1–1.2 °C since 1850. However, because land temperature changes are much more pronounced, global land temperatures have increased by about twice as much as ocean temperatures (Malhi, Kaur and Kaushik, 2021).

Climate change already has a range of detrimental impacts on human systems, including water security and food production, health and well-being, cities, human settlements, and infrastructure (IPCC, 2022). Prolonged drought, forest fires, floods, and other natural disasters in various regions of the world, especially in food production centres, significantly affect the availability of wheat and other grain crops, which of course, have an impact on the availability of these food products (Gomez-Zavaglia, Mejuto and Simal-Gandara, 2020). Aryal et al (2020) stated that by 2050, food crops may have decreased by 30% due to increased dry season and heat intensity caused by climate change, which could

further reduce per capita water availability by 19%.

Extreme climatic conditions in various parts of the world directly or indirectly affect the planting process and national agricultural products (DP, 2022). Climate change is expected to alter pest and disease outbreaks, increase the frequency and severity of droughts and floods, and increase the likelihood of poor yields, crop failure, and livestock mortality (Harvey et al., 2014; Fahad et al., 2020; Khan et al., 2021). Increased water consumption, accelerated fruit/seed ripening, decreased crop quality, and decreased food crop productivity are some of the impacts caused by climate change (Korres et al., 2016; Mensah, Twene and Adjei, 2022). Baul & McDonald (2015) also stated that lack of water availability, loss of soil fertility, and pest infestation on plants are significant unwanted impacts of climate change. Overall, in the various effects of climate change, the agricultural sector is always considered risky and vulnerable because climate change affects agricultural land, cultivation processes, and food production. (Godfray et al., 2011)

Agricultural production and farming communities in the agricultural sector are greatly affected by climate change (Menike and Arachchi, 2016). Small farmers are one of the social groups most vulnerable to climate change, especially in developing countries (Lindoso et al., 2012). In the western US, China, and southern, western, and central Asia, there may not be enough fresh water for irrigation which could lead to the conversion of 20 - 60 million hectares of irrigated areas to rainfed areas and lead to a loss of 600 - 2900 pcal in food production (Elliott et al., 2014). These challenges are significant for agriculture-dependent economies like Pakistan. The agricultural sector makes up a large share (nearly a quarter) of the national economy and employs more than 45% of the country's workforce. (Khan et al., 2019)

Climate change and its impacts have led to livelihood vulnerabilities for farming households (Kurniawan and Arisurya, 2020). Farmers constantly faced with environmental and social pressures must change their livelihood strategies to prevent damage or loss and take advantage of new opportunities by taking adaptation measures (McDowell and Hess, 2012). However, little research has examined farmers' perceptions of climate change and the risks that come with it (Barnes and Toma, 2012; Arbuckle, Morton and Hobbs, 2015). Therefore, a better understanding of climate change's impacts on agriculture and farmers' adaptation practices to reduce vulnerability and cope with the impacts of climate change is urgently needed.

The concept of impact is defined as exposure and sensitivity to environmental stimuli such as fluctuations in temperature and rainfall (Mandal et al., 2018; Sendhil et al., 2018). The agricultural sector is the sector most vulnerable and substantially affected by climate change which threatens the stability of food supplies worldwide (IPCC, 2014; Akhtar et al., 2022). This is because natural factors such as water supply, soil quality, humidity, and so on significantly affect the productivity of this sector. These biological agricultural determinants are very sensitive to changes in climatic elements such as temperature, rainfall, sunshine hours, and so on (Akhtar, Masud and Rahman, 2022). Therefore the agricultural sector is considered a priority for adaptation, given its vulnerability to climate change (Hossain and Paul, 2019).

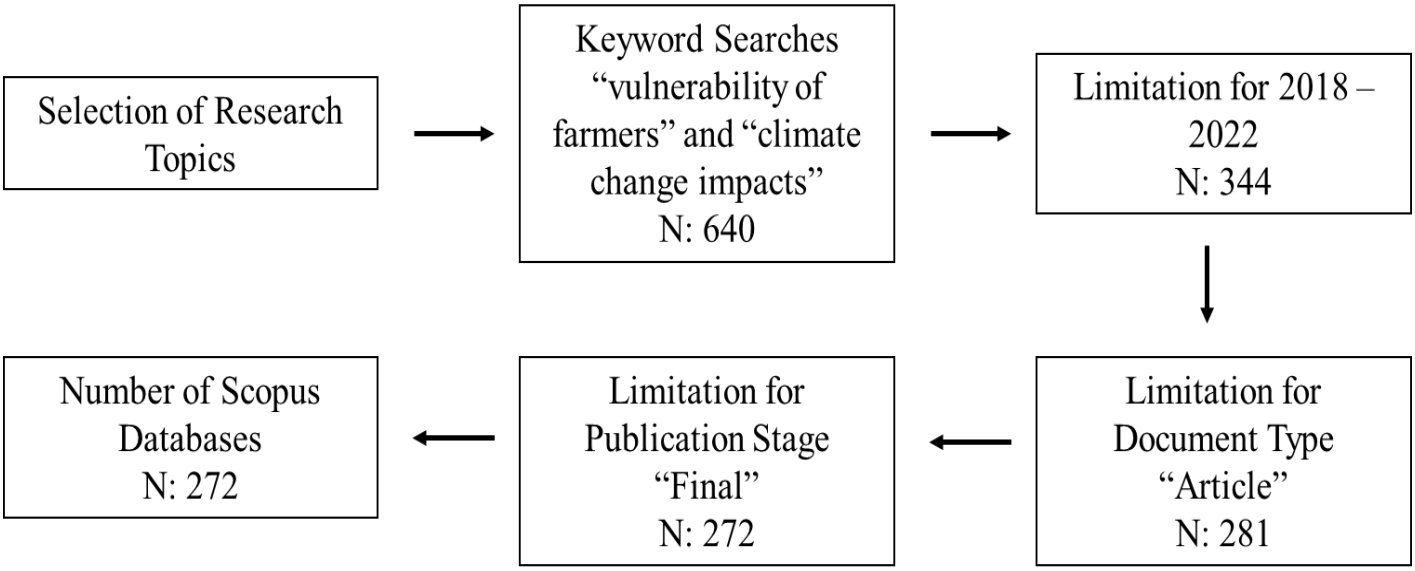
Climate variations for farmers can be a significant future threat to agriculture and negatively impact the agricultural sector, especially for rural farmers (Fahad & Wang, 2018). Several studies have found that farmers are concerned about yield loss and crop stability due to climate change (Khanal et al., 2018). Especially farmers in rural mountain communities generally have high rates of poverty and food insecurity because most of them are highly dependent on the agricultural sector (Wang et al., 2010, 2022). Likewise for farmers in the highlands of Asia, scattered in the northern parts of Myanmar, Thailand, Laos, and Vietnam and the southwestern province of Yunnan in China (Wang, Pandey and Feng, 2020).

This study aims to get an overview of the currently available scientific literature on the theme of "climate change" and "farmers" using bibliometrics. Bibliometrics, or scientometrics, examines the latest trends in the body of literature on a particular subject and offers direction and inspiration for further research (Muhuri, Shukla and Abraham, 2019). The bibliometric analysis aims to identify new patterns in article and journal performance, collaboration patterns, and research constituencies and to investigate domain-specific intellectual frameworks in the existing literature (Verma and Gustafsson, 2020; Donthu et al., 2021). The purpose of selecting bibliometric software is to facilitate selecting, archiving, recording, and presenting research results (Prastya, Misran and Nurmandi, 2021).

2. Materials and Methods:

Bibliometric analysis is used to find research boundaries by extracting the most relevant topics and articles from a sizable database, identifying the most critical information contained in those articles, and examining past and present research trends (Zhong et al., 2022). The bibliometric analysis has quantitative and statistical analyzes to review a research area and find increasing trends (Ng and Chai, 2015). The data that are the centre of attention in bibliometric analysis tend to be massive (e.g., hundreds, if not thousands) and objective (e.g., number of citations and publications, the occurrence of keywords and topics) (Donthu et al., 2021).

Data collection using the Scopus database on farmers' vulnerability and climate change impacts. In detail, the number of documents obtained viz



This study uses the VosViewer analysis tool to analyze and visualize research trends on the impact of climate change on farmers. Bibliometric analysis is considered adequate for producing datasets that can be used to improve research quality (Nandiyanto, Biddinika and Triawan, 2020). The bibliometric map displays the distribution of types of publications, the topic areas studied, the country of origin of the researchers, the journal where the publication was published, and the language used (Hamidah, Sriyono and Hudha, 2020)

Data analysis in this study includes trend analysis of journals published in the last five years. These affiliates contribute the most, authors that contribute the most, and countries that contribute the most. Then analysis and mapping of co-occurrence using VosViewer. Co-occurrence refers to the frequency of occurrence of a term in addition to other times (Oladinrin et al., 2022). his research uses keywords to reveal patterns in previous publications and predict future ways, which can help identify topics that have not been researched. Co-occurrence analysis of keywords in the study area can effectively represent research hotspots, providing additional support for scientific research (Li et al., 2016).

3. Results and Discussion

3.1 Result

3.1.1 Document Trends Per Year

Journal development trends related to the vulnerability of farmers and climate change impacts in the last five years tend to increase. The following Figure 1 shows the number of journals published per year from 2018 to 2022

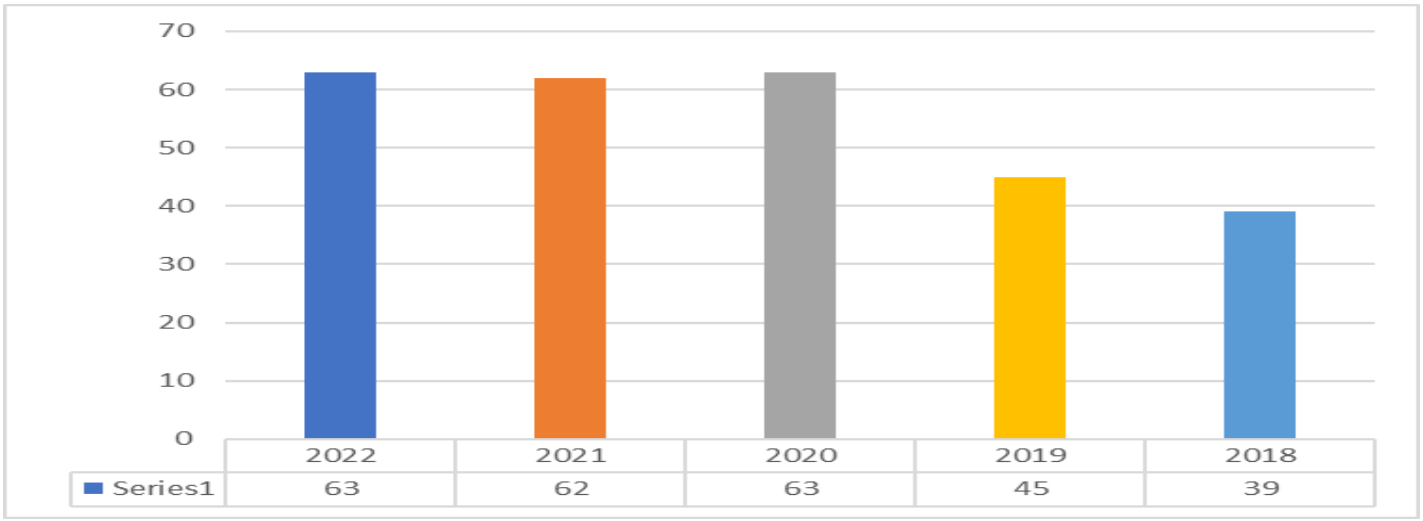


Figure 1. Publications documents

Figure 1 shows the number of journals published in the last five years since 2018. During the previous five years, the number of journals published has increased. Since 39 journals were published in 2018, the number of journals in subsequent years has consistently increased until 2021 and experienced a slight decrease in 2022. The reduction of journals published in 2022 was only one less than the previous year. Whereas from 2018 to 2021, the trend of research interest related to the impact of climate change on farmers has consistently increased successively.

3.1.2 Top 10 journal distribution by Institution

The Institution with the highest number of published journal articles according to the Scopus database is Wageningen University & Research, followed by Addis Ababa University (AAU) and the University of Ghana, and Kwame Nkrumah University of Science and Technology. Most of the most influential institutions are in Europe, East Africa, and West Africa. The following Figure 2 shows the number of journals published by affiliation

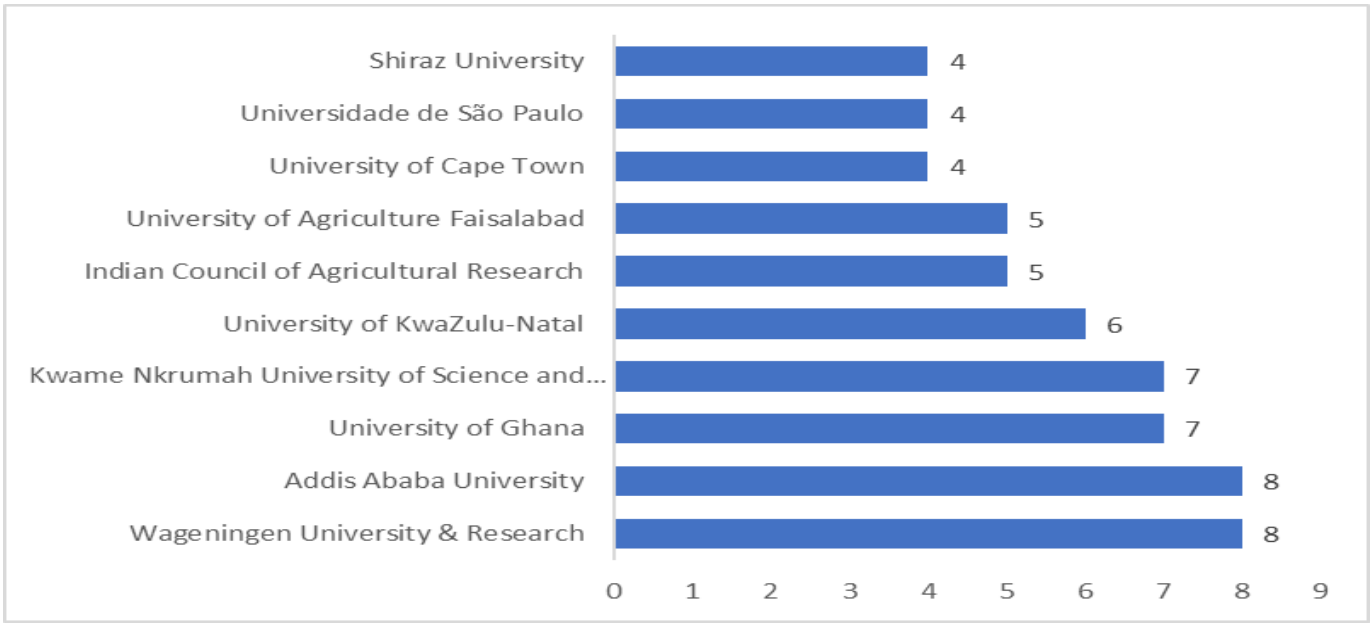


Figure 2. Number of Publications by Institution

Wageningen University & Research is the only university in the Netherlands focusing on themes related to healthy food and the environment. Addis Ababa University (AAU) is Ethiopia's oldest and largest Institution of higher education and research—a leading university inteaching–learning, research, and community service. AAU was founded in 1950 as the University College of Addis Ababa (UCAA), and today is a leading center for teaching-learning, research, and community service. The University of Ghana is the oldest and largest university among the thirty universities in Ghana. The University of Ghana has four research fields: malaria research, cross-disciplinary research on climate change adaptation, increasing food production and processing, and development policy and poverty monitoring and evaluation. And finally, Kwame Nkrumah University of Science and Technology is prominent in Science, Mathematics, and Information Communication Technology (ICT).

3.1.3 Top 10 journal distribution by Author

Table 3 shows the ten authors who have produced the most journals on the topic of climate change impacts and farmers' vulnerabilities over the last five years. So that the findings presented in Table 3 are the ten authors who contributed the most, where these authors collaborated with other authors in preparing journals. In another sense, the journal produced by the Author is written by different authors. Then, the number of journals does not indicate that other authors often cite the journal, and the authors do not mean that they have a close relationship with other authors.

Table 1. Distribution of authors based on the number of journals

No	Author Name	Number of Journals	Citations
1	Simane B.	4	72
2	Ashfaq M.	3	15
3	Cavalcante L.	3	4
4	Crespo O.	3	30
5	Elias E.	3	43
6	Guodaar L	3	15
7	Thornton P.	3	19
8	Tran D. D.	3	24
9	Yazdanpanah M.	3	134
10	Alam G.M.M	2	58

Based on Table 1, on average, the authors produce 3 journals on climate change and farmers' vulnerability. In the last five years, the Author who has written a lot on this topic, namely Simane B, has published four new journal documents in 2022 with the title "Effectiveness of Climate-Smart Agriculture Innovations in Smallholder Agriculture System in Ethiopia" and a widely cited article entitled "Vulnerability of sorghum production to extreme, sub-seasonal weather under climate change" (34 citations) which addresses the sensitivity of plants to sub-seasonal variability of rainfall under climate change in food insecure areas of the Ethiopian highlands.

3.1.4 Journal Distribution by Country

The distribution of journals by country shows that the United States is the most relevant country based on data obtained from the Scopus database, followed by India, Ghana, China, and Australia.

Table 2 Distribution of journals by country

No	Country/Territory	Document
1	United States	51
2	India	26
3	Ghana	24
4	China	23
5	Australia	22
6	United Kingdom	22
7	Germany	21
8	South Africa	20
9	Ethiopia	19
10	Brazil	15

3.2 Bibliometric Analysis

The network or relationship between keywords from 269 Documents obtained from the Scopus database will be analyzed using bibliometric analysis. In this analysis, optical networks and overlays will be made using VOSViewer related to keyword relationships and keyword trends in the last five years, namely from 2018 to 2022, regarding the vulnerability of farmers and climate change impacts. In bibliometric analysis, there are nodes and edges where nodes represent publications, journals, or keywords, which are visualized in circle form. The circle size depends on the number of keywords or issues related to the document. The bigger the circle size, the more relevant documents to these keywords. While the edge shows the relationship of each node. The visualization of the keyword network of the vulnerability of farmers and climate change impacts is shown in Figure 3 below

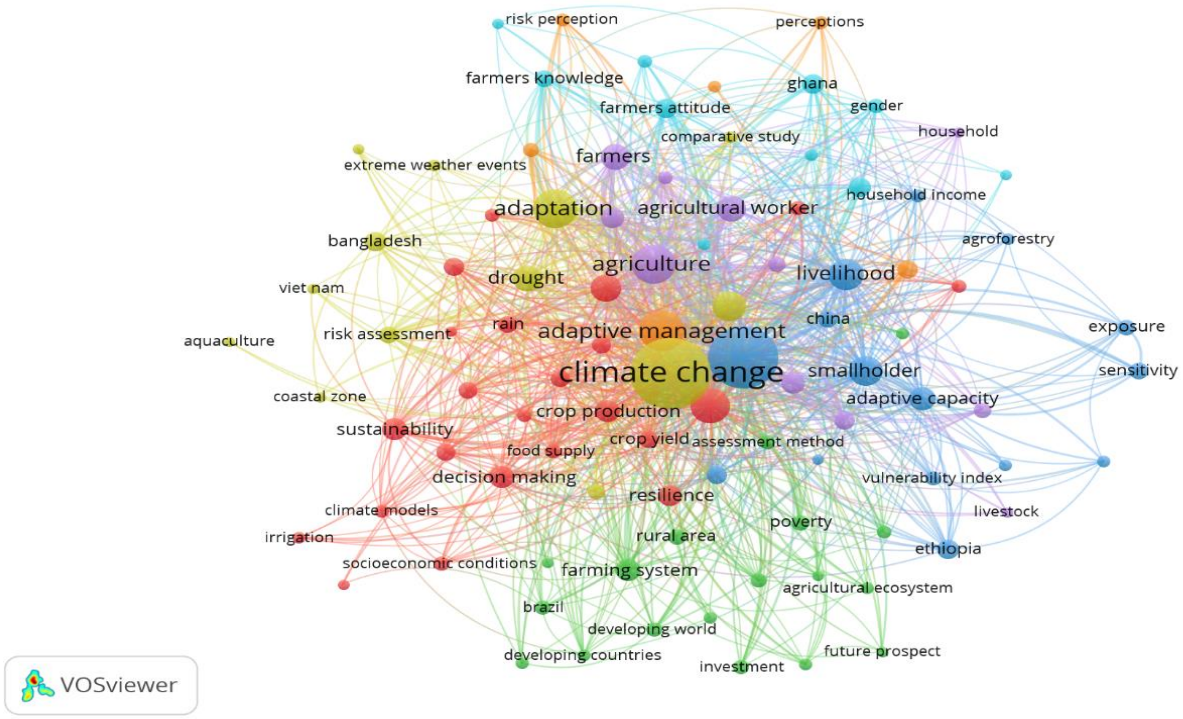


Figure 3. Network visualization

Figure 3 shows that the most discussed keyword is climate change. In addition, keywords relevant to climate change are vulnerability, agriculture, adaptation, adaptive management, climate effect, farmers, etc. In addition to network visuals, overlay visualizations can also be displayed. The colour of the nodes on the overlay visualization shows the year the article that shows these keywords was published. The overlay visualization can be seen in Figure 4 below

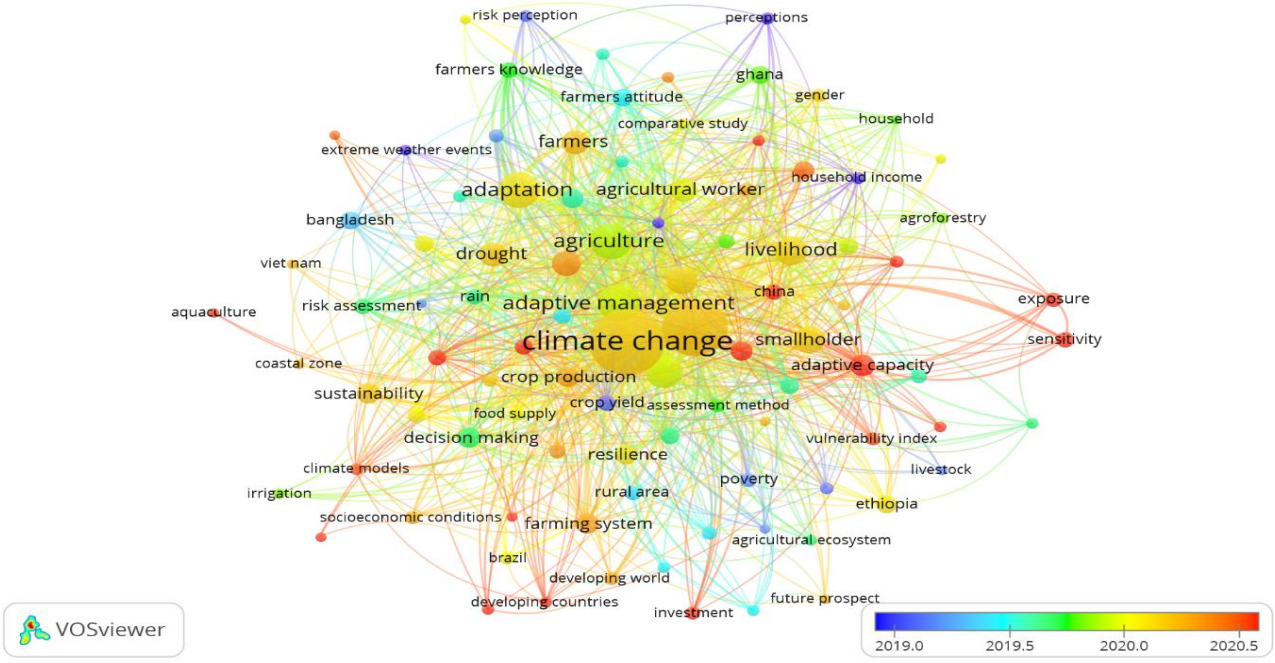


Figure 4. Overlay visualization

The colour scale of the nodes in Figure 4 shows the most recently researched keywords, from blue representing keywords from 2019 to red representing journal keywords published in 2020. Topics related to climate change, vulnerability, farmers' perceptions of adaptation, and livelihoods developed significantly in 2020. At the beginning of the period, many issues related to weather changes were developed, as evidenced by the keyword extreme weather event, which was also supported by agrometeorology. Then at the end of the period, many journals developed with the topic of adaptation as evidenced by the keywords adaptive capacity associated with other keywords, namely adaptation strategies, exposure, sensitivity, vulnerability, index of sustainable development, and agriculture.

3.3 Discussion

Scientific interest in the causes and effects of climate change has grown in recent years (Klingelhöfer et al., 2020) and other branches of research, as shown in Figure 3. Research related to climate change has strong relevance to climate effect, vulnerability, agriculture, adaptation, adaptation capacity, farmers, and so on. Climate change has a considerable emergence, which shows that this keyword can establish a strong relationship with other keywords, including agriculture and farmers. According to research by Dahal et al (2023), agriculture is the most affected by climate change. The vulnerability of the agricultural sector is a globally concerning scenario, as adequate production and food supplies are threatened by irreversible weather fluctuations (Abbass et al., 2022).

Bibliometric analysis conducted between 2018 and 2022 shows that research trends related to climate change for farmers tend to increase. Climate change studies on a global or regional scale provide a more comprehensive picture of climate change (Dahal et al., 2023), so research related to climate change is increasingly expanding at the world level. As shown in Figure 4, the linkage network between keywords in the last five years linked the impact of the agricultural sector, where the agricultural sector is one of the

most affected sectors because it will affect crop production (Siddiqui et al., 2012; Abid et al., 2016; Fahad & Wang, 2018). According to Khan et al (2019), the agricultural sector contributes to the national economy and provides employment. Figure 4 also shows that climate change has relevance to climate change, namely climate effect, vulnerability, agriculture, adaptation, adaptation capacity, farmers, etc.

The findings show that recent trends regarding the impact of climate change on farmers are a consequence and the need for adaptive capacity to mitigate these impacts (Kabobah, Nukpezah and Ntiamoa-Baidu, 2018; Karimi, Karami and Keshavarz, 2018; Aryal et al., 2020; Dahal et al., 2023). It is critical to consider how farmers are the key decision-makers in understanding climate risk and uncertainty. This can impact farm-level short- and long-term management practices and adaptation choices Lebel et al. (2015).

Adaptation practices within farming communities vary according to household economic status and depend on access to education, information, and resources within the community (Gentle et al., 2018). Farmers with accurate perceptions base their decisions on what crops to plant when to plant them, and with what inputs (Ma et al., 2022). Previous studies (Zizinga et al., 2017; Assan et al., 2018) linked successful adaptation to factors of farmer knowledge base, farmer support, social support systems, access to capital, technology, and the physical environment that enables these changes.

Smallholder identification of various risks demonstrates the importance of climate-related conditions for farm-level operations (Abid et al., 2016). This is because agriculture is very dependent on the climate in any location, so climate change that occurs greatly affects crop productivity and can severely impact agricultural production (Alam et al., 2016; Dahal et al., 2023). Schilling et al (2012) revealed that to increase resilience to climate change, and agricultural policies must shift from maximizing agricultural output to stabilizing it. In addition, farmers also need to understand actual changes and trends in climatic conditions, risks, and steps to adapt to the impacts that may occur and focus on food crops that are resistant to high temperatures (Esham and Garforth, 2013; Gul et al., 2022)

4. Conclusion

In this study, research trends related to climate change and its impact on farmers over the last five years have continued to increase. Based on the research results using bibliometric analysis obtained from the Scopus database, it can be concluded that with specific keywords, the final sample is 269. The keywords used are the vulnerability of farmers and climate change impacts. The results show that the keywords that have been discussed the most in the last five years, namely climate change, have relevance to other keywords, namely vulnerability, agriculture, adaptation, adaptive management, climate effect, farmers, and so on.

From 2018 to 2022, this related research trend continues to increase. The countries that discussed this topic the most based on the Scopus database were the United States, India, Ghana, China, and Australia. At the same time, the distribution is based on the Institution that has published the most articles based on the Scopus database, namely Wageningen University & Research, followed by Addis Ababa University and the University of Ghana and Kwame Nkrumah University of Science and Technology.

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