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BIBLIOMETRIC MAPPING OF PUBLIC KNOWLEDGE ON MEGATHRUST EARTHQUAKE DISASTER MITIGATION

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Abstract

Public knowledge of megathrust earthquake mitigation is essential for strengthening disaster preparedness and supporting disaster risk reduction. Although earthquake mitigation research has continued to expand, bibliometric evidence positioning public knowledge within this body of literature remains limited. This study maps the development and thematic structure of research on public knowledge regarding megathrust earthquake disaster mitigation published between 2016 and 2026. A descriptive quantitative approach employing bibliometric analysis was used. Data were retrieved from Google Scholar through Publish or Perish using the keywords disaster mitigation, earthquake preparedness, megathrust earthquake, disaster risk communication, and public knowledge. A total of 998 documents meeting the inclusion criteria were exported in RIS format and analyzed using VOSviewer 1.6.20 through network, overlay, and density visualizations. The findings reveal that the research landscape is dominated by the keywords earthquake, knowledge, tsunami, hazard, and mitigation, which constitute the central nodes of the bibliometric network. The network analysis identified 181 keywords distributed across nine clusters, with 4,768 links and a total link strength of 13,732. Although knowledge emerged as a major thematic node, density visualization showed that disaster communication, general knowledge, and indigenous knowledge remain less extensively investigated than technical disaster-related themes. These findings

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demonstrate that megathrust earthquake mitigation research continues to prioritize technical and hazard-oriented dimensions, whereas public knowledge and risk communication remain underdeveloped areas of inquiry. This study contributes a systematic overview of the intellectual structure and research gaps within the field and highlights the need for further investigation of public knowledge, indigenous knowledge, and risk communication, particularly in the context of Mentawai–Siberut megathrust earthquake mitigation.

Keywords: Bibliometric Analysis; Disaster Mitigation; Megathrust Earthquake; Public Knowledge; Risk Communication

INTRODUCTION

Public knowledge about disaster risk and mitigation is a key factor in the success of disaster risk reduction efforts, particularly in megathrust earthquake-prone areas like Indonesia. This is because Indonesia is located at the confluence of three active tectonic plates, making it one of the areas with the highest potential for megathrusts in the world. History has recorded several major earthquakes resulting from this subduction zone activity. Study (Ayuningtyas et al., 2021) identified that disaster risk reduction efforts in various regions of Indonesia are still lacking, both in terms of knowledge and the ability to analyze disaster risks. This situation has prompted increased scientific and institutional attention to how knowledge about megathrust risks is formed, disseminated, and understood by the wider public, in line with the increasingly dominant role of mass media and social media in disseminating disaster information to the public.

This increased attention is also reflected in the increasing number of scientific publications discussing earthquake disasters, including megathrust earthquake mitigation, in recent years. Study (Ismail et al., 2024) in their bibliometric analysis of seismic hazard and risk research from 2002–2022 found a significant surge in the number of publications in this field, particularly since 2006, in line with growing global awareness of the importance of earthquake disaster mitigation. However, this rapid growth in publications also has its own consequences, making it increasingly difficult for researchers and policymakers to fully understand the direction of development in this field by simply reading the literature one by one.

The growth in the number of publications in a scientific field needs to be systematically mapped to ensure a comprehensive understanding of its development, rather

than merely reading them piecemeal. This is in line with the increasing use of bibliometric analysis due to the increasing number of publications and the increasing availability of tools (Ellegaard & Wallin, 2015). Bibliometric analysis allows this to be done objectively and measurably, because it is able to identify thematic structures, mature research clusters, and under-explored gaps by mapping the co-occurrence patterns of keywords in the corpus of scientific literature (Donthu et al., 2021).

Several bibliometric studies have mapped research trends on topics related to public knowledge and perception. A study by (Permana & Maani, 2024) mapped the publication trends of public sentiment toward Indonesian government policies on social media and found that this issue has only grown rapidly since 2018, with Twitter being the most widely researched platform. On the other hand, research on public knowledge, attitudes, and preparedness for earthquakes has largely been conducted at the local case study level, such as the study by (Ristiani et al., 2026) that examined public knowledge, attitudes, and preparedness for earthquake mitigation in East Kolaka.

The literature on earthquake disaster mitigation in Indonesia is still dominated by technical studies, such as the evaluation of the InaTEWS tsunami early warning system (Lauterjung & Letz, 2017) and the effectiveness of earthquake disaster management policies (Achmad, 2023). However, bibliometric mapping related to the theme of public knowledge within the megathrust earthquake disaster mitigation literature corpus, compared to the dominance of technical earthquake themes, is still rare. This gap is important to fill, because without understanding the position of the theme of public knowledge within the existing research structure, it is difficult to assess whether the scientific literature has sufficiently addressed the public's acceptance and understanding of megathrust risk, or whether it is still biased towards purely technical-earthquake studies.

Public knowledge in this context is understood as society's collective understanding of an issue that is formed through various sources of information and social interactions (Miksa & McLain, 2019), a relevant framework for reading how the megathrust issue is widely understood, not only by scientific circles but also the general public. This research offers novelty in the form of bibliometric mapping which specifically places the theme of public knowledge as an analytical viewpoint to see the position of this theme compared to other technical mitigation themes in the network structure of published scientific literature.Based on the description, this study aims to map the development of research on public knowledge

regarding megathrust earthquake disaster mitigation for the period 2016–2026, and to identify the position of public knowledge themes within the network structure as a basis for assessing the extent to which research gaps in this aspect are still open.

METHODS

This study employed a descriptive quantitative approach using bibliometric analysis to examine the development of scientific knowledge related to public understanding of megathrust earthquake disaster mitigation. Bibliometric analysis was selected because it enables researchers to systematically investigate publication productivity, thematic structures, and research trends within a specific scientific domain through the application of quantitative techniques to bibliographic data (Donthu et al., 2021). In accordance with the objectives of this study, the bibliometric approach was used to map the intellectual landscape of research on megathrust earthquake mitigation, with particular attention to issues of disaster preparedness, disaster risk communication, and public knowledge. The research was conducted from May to June 2026, during which the processes of data collection, screening, analysis, and interpretation were carried out. The research design focused on keyword co-occurrence analysis to identify relationships among concepts and to reveal dominant and emerging themes within the literature. Furthermore, the study adopted a longitudinal perspective by limiting the search period to publications produced between 2016 and 2026, thereby enabling an assessment of research developments over the last decade.

The bibliographic data were retrieved from Google Scholar using Harzing's Publish or Perish software version 8.19.5300.9483. Data collection was conducted using the search keywords "disaster mitigation," "earthquake preparedness," "megathrust earthquake," "disaster risk communication," and "public knowledge." The study population consisted of all scientific documents indexed in Google Scholar that matched the predefined search criteria, including journal articles, conference proceedings, books, book chapters, and other scholarly publications. After applying the inclusion criteria related to publication year and keyword relevance, a total of 998 documents were successfully collected, representing 43,737 citations. The resulting metadata, including titles, abstracts, publication years, author information, and keywords, were exported and compiled into a bibliometric dataset for further analysis.

The analytical process was carried out using VOSviewer version 1.6.20 to visualize the thematic structure and conceptual relationships among the selected publications (Van Eck & Waltman, 2010). The analysis employed keyword co-occurrence techniques to identify the frequency and interconnectedness of keywords within the dataset. The binary counting method was applied to ensure that each keyword was counted only once within each document, regardless of the number of times it appeared. Subsequently, the data underwent cleaning and standardization procedures to eliminate duplicate terms and unify keywords with similar meanings. The results of the analysis were presented in three complementary forms of visualization. First, network visualization was used to identify thematic clusters and conceptual linkages among keywords. Second, overlay visualization was employed to examine the chronological evolution of research themes and identify emerging topics over time. Third, density visualization was utilized to distinguish between highly explored topics and areas that remain underrepresented in the literature. Through these analytical procedures, the study provides a comprehensive bibliometric mapping of public knowledge regarding megathrust earthquake disaster mitigation and identifies potential directions for future research.

RESULTS

The results of the study show that the data collection process using the Publish or Perish software version 8.19.5300.9483 with a year range from 2016-2026 related to the search keywords "disaster mitigation", and "earthquake preparedness", and "megathrust earthquake", and "disaster risk communication", and "public knowledge" produced the following results:

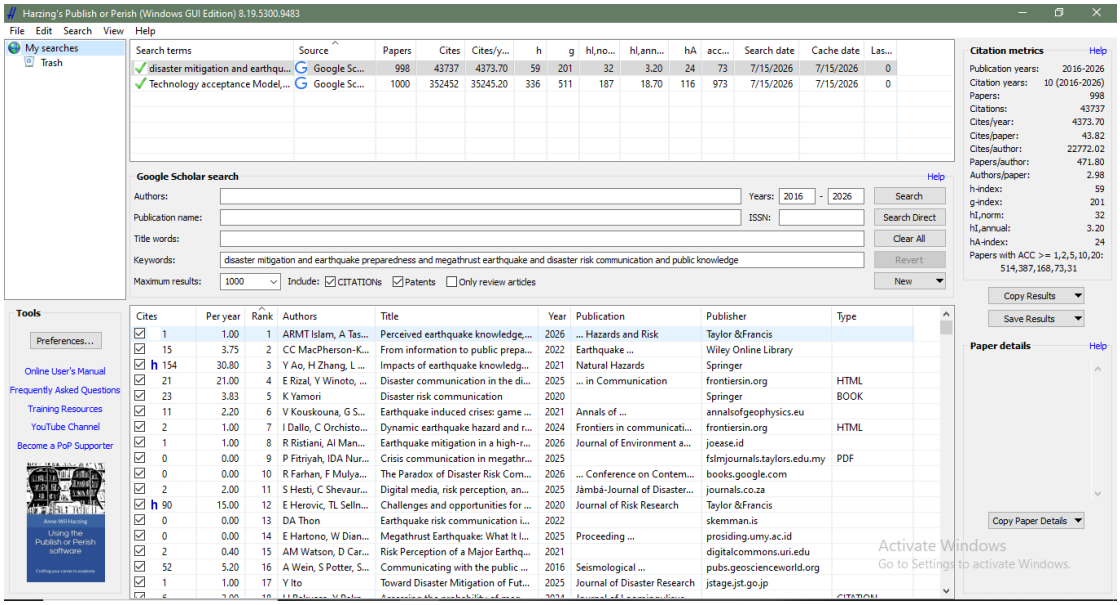

Figure 1: Research Results Using Publish or Perish

Source: Data processed by researcher, 2026

The figure above shows the results of the bibliometric analysis, which shows 998 publications published between 2016 and 2026 with a total of 43,737 citations. The average citation rate reached 4,373.70 per year or 43.82 per article, indicating that the analyzed collection of publications has a high level of scientific influence. In addition, the h-index value of 59 indicates that there are 59 articles each of which has received at least 59 citations, while the g-index of 201 indicates that there are a number of articles with a very high number of citations. The search results were then exported in Research Information Systems (RIS) format for further analysis using VOSviewer software. which has a good level of visibility and influence in the research field.

Based on the results of VOSviewer processing, a keyword co-occurrence map was obtained consisting of 181 items, divided into 9 thematic clusters, with 4,768 links between terms and a total link strength of 13,732. Terms with the highest occurrence and link strength include "knowledge", "earthquake", "tsunami", "mitigation", and "hazard", which indicates that research in this field is still dominated by issues of disaster knowledge and the characteristics of earthquakes themselves. In addition to these core terms, a number of terms with high relevance scores also appeared, such as "emergency response plan", "hazard map", "hazard information", and "early warning system", which indicates that aspects of emergency preparedness and response are also a significant concern in this literature corpus.

Interestingly, the co-occurrence map also displays a number of terms referring to megathrust case studies in various countries, such as "Nankai megathrust earthquake" (Japan), "Chile," and "Cascadia subduction zone" (North America), indicating that the megathrust disaster mitigation literature is global in nature and compares seismic characteristics across regions, rather than focusing on a specific region. On the other hand, terms directly related to public knowledge and disaster communication, such as "disaster communication," "public safety," and "general knowledge," appear with relatively small node sizes and link strengths compared to technical earthquake terms, indicating their position on the periphery of the thematic network structure.

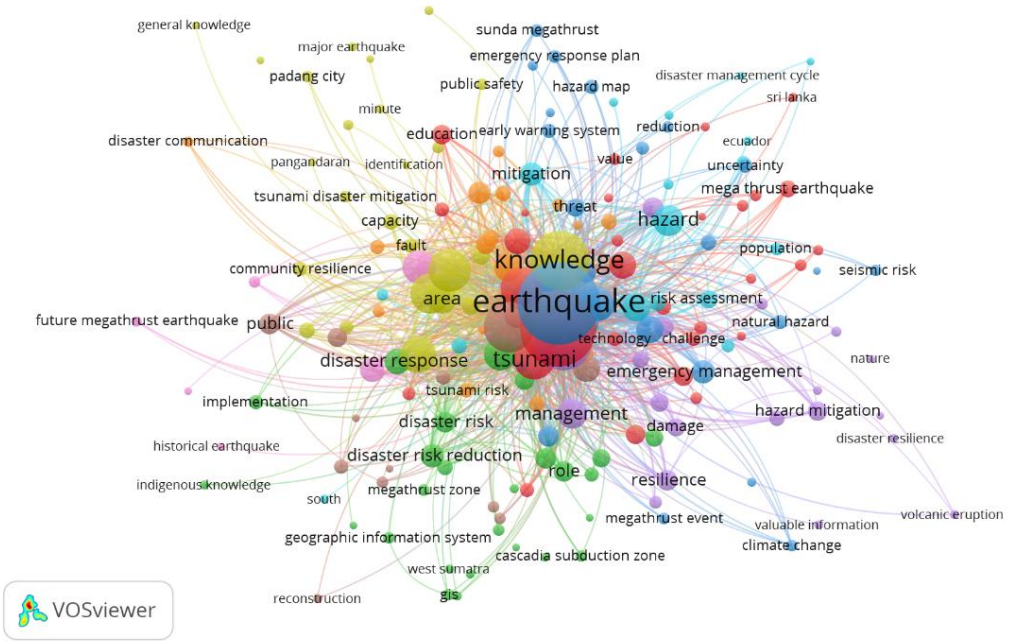

Figure 2. Network Visualization of Keyword Co-occurrence
Source: Research Results, 2026

Figure 2 displays a network visualization of the co-occurrence of keywords in the megathrust earthquake disaster mitigation literature corpus. The terms "knowledge," "earthquake," and "tsunami" occupy a central position as the main link between clusters, with emergency management clusters (management, emergency management, resilience), technical mitigation clusters (hazard reduction, megathrust earthquake), and community-local wisdom clusters (community resilience, indigenous knowledge, disaster risk reduction) scattered around them.

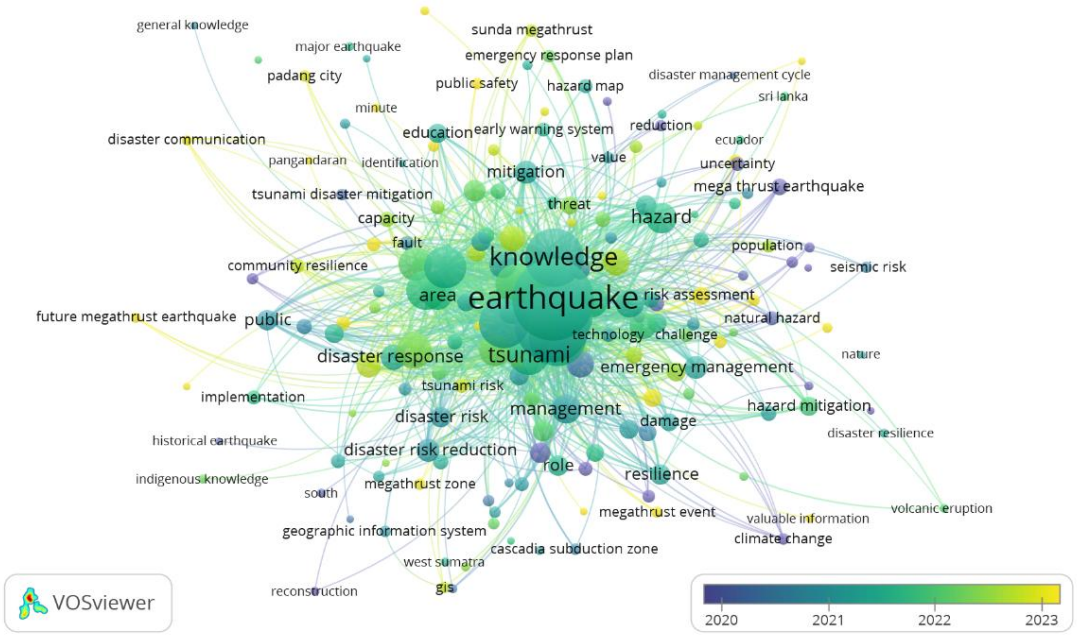

Figure 3. Overlay Visualization Based on Publication Year

Source: Researcher's Processed Results, 2026

Figure 3 displays an overlay visualization based on publication year, with a color scale ranging from dark purple (2020) to yellow (2023). Terms such as "Sunda megathrust," "disaster management cycle," and "Sri Lanka" appear in a lighter yellow/green, indicating themes that have only recently developed in the current period. In contrast, core terms such as "knowledge," "earthquake," and "tsunami" are in a bluish-green, indicating that these themes have been consistently researched from the beginning of the period to the present.

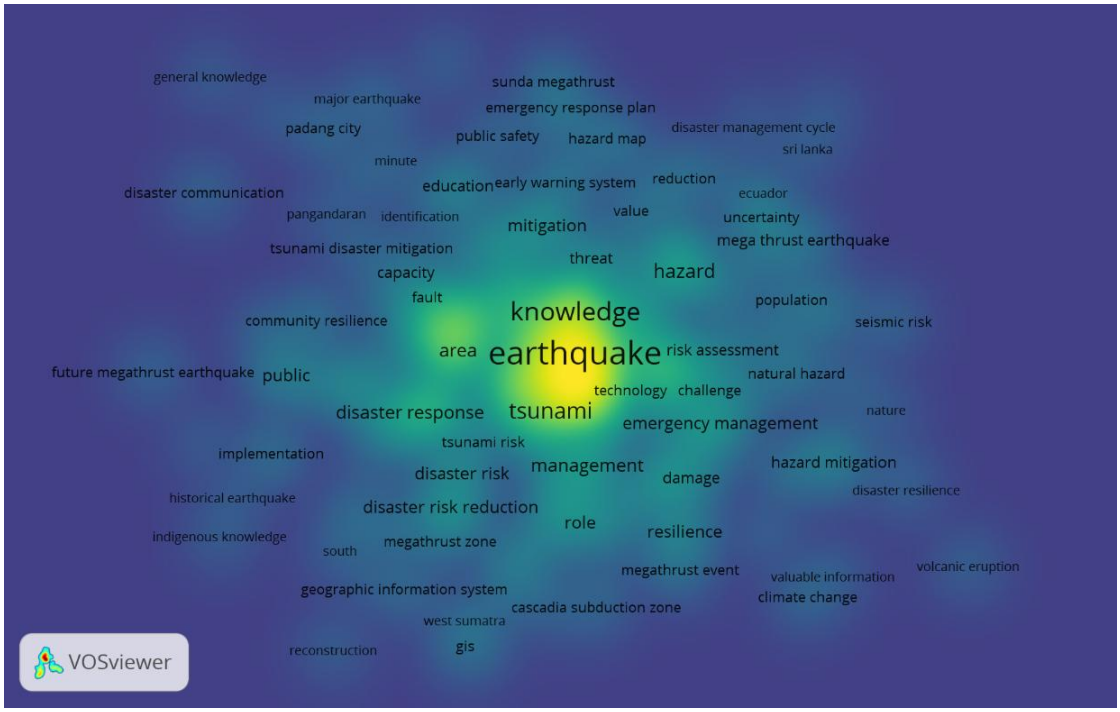

Figure 4. Keyword Density Visualization

Figure 4 displays a density visualization, where bright yellow-green colors indicate the most densely/maturely researched topic areas, while dark blue colors indicate less-studied areas. The bright yellow areas are concentrated around "knowledge," "earthquake," and "tsunami," highlighting that these three themes are the focus of research. Conversely, terms such as "disaster communication," "general knowledge," and "indigenous knowledge" are located in the dark blue areas at the edges of the map, indicating that these themes are less researched than the core earthquake theme.

Table 1. Keywords with (Occurrence), links, and link strength

term	Occurrences	links	link strength
earthquake	468	179	2347
knowledge	238	159	1254
tsunami	114	141	620
communication	127	144	659
megathrust	109	120	564
public	29	58	163

Table 1 shows the results of the keyword co-occurrence analysis obtained from VOSviewer on the analyzed disaster mitigation literature. The keyword "earthquake" emerged as the most dominant term with the highest occurrence (468) and the highest total link strength (2,347), indicating that earthquakes are a central and frequently discussed topic in the studied publication corpus. The keyword "knowledge" came in second with 238 occurrences and a link strength of 1,254, indicating that public knowledge and awareness are important dimensions that accompany discussions of disaster mitigation. Furthermore, "communication" and "tsunami" had relatively close occurrences (127 and 114), but "communication" showed a slightly higher number of links (144 compared to 141), indicating that this term plays a role as a connector between various subtopics within the network, although its frequency of occurrence is not as high as other keywords.

The keyword "megathrust" appears with 109 occurrences and a link strength of 564, indicating that this topic is discussed quite frequently but tends to be concentrated in a specific cluster rather than spread across various subthemes. Meanwhile, "public" has the lowest occurrence and link strength (29 and 163), indicating that this keyword is peripheral and only appears in a small portion of documents in the dataset. Overall, this pattern indicates that the megathrust mitigation literature is dominated by discussions of disaster

aspects (earthquakes, tsunamis) and public knowledge, with communication acting as a connecting element between themes in the publication network.

DISCUSSION

Bibliometric analysis results indicate that research on megathrust earthquake disaster mitigation in the 2016–2026 period developed with a complex network structure consisting of several interconnected thematic clusters. Based on network visualization results, the keywords earthquake, knowledge, tsunami, hazard, and mitigation were the most dominant themes, indicated by high occurrence, link, and total link strength values. According to (Donthu et al., 2021), in bibliometric analysis, keywords with high frequency of occurrence and strong interconnections can be considered core themes that shape the intellectual structure of a scientific field. Thus, the dominance of these five keywords indicates that the development of megathrust earthquake mitigation research remains focused on the characteristics of earthquake hazards and tsunamis, as well as disaster risk reduction and mitigation efforts.

The dominance of the keyword "earthquake" as the primary hub indicates that nearly all research topics are directly related to earthquake issues. Meanwhile, "knowledge" emerged as the second most important hub, connecting various themes, such as mitigation, tsunamis, disaster management, community preparedness, and disaster risk reduction. This indicates that public knowledge is beginning to receive attention in disaster mitigation research, although its proportion remains smaller than technical studies on earthquake characteristics and mitigation systems.

These findings align with research by (Agyepong & Liang, 2023), which mapped the development of public risk communication in disaster management. They explained that global disaster research is still dominated by topics such as disaster risk reduction, risk assessment, and emergency management, while research specifically addressing risk communication to the public has developed more slowly. A similar pattern is also evident in the results of this study, where the keywords communication, public safety, and general knowledge are located on the periphery of the network with relatively small node sizes. This indicates that the aspect of public knowledge formation has not yet become a primary focus in megathrust earthquake disaster mitigation research.

However, the analysis also shows that the keyword "communication" has a relatively high number of links compared to its frequency of occurrence. According to (Donthu et al., 2021), the high level of connectivity of a keyword indicates that the theme plays a role in connecting various research groups, even though its frequency of occurrence is not dominant. Thus, risk communication can be understood as a cross-disciplinary theme that connects research on mitigation, preparedness, risk management, and emergency response. This finding supports the research findings of (Tan & Hao, 2022), which show that research on information seeking, information sharing, and disaster communication has increased significantly in recent years with the development of digital media. This research confirms that the effectiveness of disaster mitigation is influenced not only by the availability of information but also by the community's ability to obtain, understand, and disseminate disaster information.

Network visualization also shows that research on megathrust earthquake disaster mitigation is developing in a multidisciplinary manner. In addition to keyword groups related to earthquake characteristics, clusters also emerged related to emergency management, community resilience, disaster risk reduction, hazard maps, and early warning systems. This indicates that disaster mitigation is no longer understood solely as a technical effort to reduce the impact of earthquakes, but also encompasses strengthening institutional capacity, increasing community resilience, and developing an integrated disaster information system. This finding is consistent with research findings (Putera et al., 2026), which indicate that the direction of disaster mitigation research is increasingly shifting toward integrating aspects of governance, public policy, inter-institutional coordination, and comprehensive disaster risk reduction.

However, the density visualization results show that disaster communication, general knowledge, and indigenous knowledge remain in low-density areas. This suggests that research on public knowledge formation and risk communication has not progressed as rapidly as research on earthquake hazard characteristics and technical mitigation systems. In other words, the existing literature focuses more on how earthquake risks are analyzed than on how the public understands and internalizes that risk information. This finding reinforces the findings of research (Marcillo-Delgado et al., 2023), which states that research on risk communication and crisis communication is still dominated by discussions on information delivery mechanisms, while studies on public information reception and public knowledge formation are relatively limited (Xu et al., 2024).

Another interesting finding is the emergence of keywords such as Sunda Megathrust, Nankai Megathrust Earthquake, Cascadia Subduction Zone, and Chile in the bibliometric network. This indicates that research on megathrusts is developing in a global context and utilizes comparative studies across subduction regions. However, keywords specifically describing public knowledge regarding the mitigation of the Mentawai–Siberut Megathrust have not yet emerged as a dominant theme. This condition indicates that research on the Indonesian region, particularly West Sumatra and Mentawai, still has ample room for development, particularly in the aspects of public knowledge formation, risk communication, and community preparedness.

Overall, the results of this study indicate that the development of megathrust earthquake disaster mitigation research has moved toward a multidisciplinary approach that integrates geology, risk management, community resilience, and disaster governance. However, the dimensions of public knowledge and risk communication remain relatively less dominant than technical earthquake studies. Therefore, further research is needed to examine more deeply how disaster information is produced, disseminated, understood, and utilized by the public, particularly through digital and social media, to support increased public preparedness for the threat of megathrust earthquakes.

CONCLUSION

This bibliometric study of megathrust earthquake mitigation research published between 2016 and 2026 identified 998 publications with a total of 43,737 citations and revealed a complex intellectual structure consisting of 181 keywords grouped into nine thematic clusters. The analysis shows that the literature is dominated by technical and hazard-oriented topics, such as earthquakes, tsunamis, hazards, and mitigation systems, whereas themes related to public knowledge, disaster communication, and local wisdom remain relatively underrepresented. These findings indicate that the existing body of knowledge on megathrust earthquake mitigation has primarily focused on geological and engineering perspectives, while the social dimensions of disaster preparedness have received comparatively less attention. Consequently, there is still considerable room for expanding research on community awareness, risk perception, and public preparedness in areas vulnerable to megathrust earthquakes.

This study contributes theoretically by positioning public knowledge as an important yet insufficiently explored theme within the broader literature on megathrust earthquake mitigation. Methodologically, it demonstrates the usefulness of integrating Publish or Perish and VOSviewer in identifying publication trends, thematic structures, and conceptual relationships within disaster studies. In practical terms, the findings provide valuable insights for researchers, policymakers, and disaster management institutions by highlighting the need to strengthen risk communication strategies and public education programs. Furthermore, the study enriches the interdisciplinary dialogue between disaster management, public policy, and social sciences by emphasizing the importance of balancing technical mitigation efforts with community-based approaches.

Future studies are recommended to expand the scope of bibliometric analysis by incorporating additional databases, such as Scopus and Web of Science, to obtain a more comprehensive representation of the scientific literature. Researchers are also encouraged to employ complementary bibliometric techniques, including co-citation, bibliographic coupling, and citation network analysis, to gain deeper insights into the evolution of research themes. In addition, future investigations should place greater emphasis on public knowledge, disaster communication, local wisdom, and community resilience, particularly in regions with high megathrust risks, such as the Mentawai–Siberut area. Adopting interdisciplinary approaches that integrate geological, social, cultural, and governance perspectives will also be essential for developing more effective and inclusive disaster mitigation strategies.

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