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FUTURE RESEARCH TOPIC PROSPECT DEALING WITH THE "FLOOD SEVERITY" TERM: A SYSTEMATIC LITERATURE REVIEW

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Abstract: Most recent flood prediction studies focus on the probability and frequency of a flood at a specific location or flood vulnerability prediction. However, their results often lack flood magnitude or severity information. Therefore, severity levels are highly imperative for further research in floods, such as their mapping and prediction. This study has involved various stages, such as developing the literature selection protocol in obtaining the expected papers, searching the literature by protocol implementations, and results interpretation. The search results were 537 articles; the selected rigorously peer-reviewed articles were then bibliometrically analyzed. The limited flood severity-related research was proven by the "severity" term detected in fewer than five terms. Recommendations of flood severity-related research can be categorized into seven clusters based on the term co-occurrences. Those clusters consist of: 1) urban flood, 2) flood disaster management, 3) adaptability and prediction, 4) land use and urban planning, 5) natech and mitigation, 6) climate change, and 7) ecosystem services and resilience. There is a research gap in geographical terms for several countries classified as the world's top 10 at risk of flood, such as China, India, Bangladesh, Indonesia, Pakistan, and others. The urgent prior research guidelines are to trigger further future research on flood severity levels. Future research recommendations will give better contribution and consideration to flood risk management rather than merely vulnerability zonation as they also imply the possible impacts of predicted floods.

Keywords: flood severity; systematic literature review; bibliometric analysis; clustering

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1. Introduction

The term "flood", in general, is abundantly found in titles, keywords, and abstracts of papers in prominent world reputable research publication database. Science Direct at http://sciencedirect.com publication database Elsevier owns has published rigorous peer-reviewed article research. Such database has shown that the oldest flood research publication was the paper published in 2001. When the years 2015 to 2024 were included in searching criteria, the database of the rigorous web page of Science Direct showed 425,352 publications about floods in general. Historically, flood events tend to increase in frequency and magnitude due to climate change, land use change, rain storms, and urbanization (Kjeldsen, 2010; Tambal et al., 2024; Xu et al., 2024). The best practice of flood handling was implementing the cycle of disaster management; most governments have taken counteractions seriously to flood disasters. Those management actions consisted of prevention, mitigation, response, and recovery (Ngcamu, 2023; Rana et al., 2021). To enhance decision-making and policy-making dealing with a flood, there is a growing number of studies focusing on flood prediction that is based on various approaches, such as the empirical approach (G.-L. Feng et al., 2020; Hu et al., 2017) and the artificial intelligence (AI) approach (Costache, Pal, et al., 2024; Ghosh & Dey, 2021; Zhang et al., 2023). Most such research results are the vulnerable flood mapping, flood vulnerability zonation, or predicting areas of high levels of flood vulnerability (Roldán-Valcarce et al., 2023; Sulistyo & Respati, 2023).

Flood vulnerability was the central topic of flood-related research, and flood severity was just minor or complement topic (Costache, Crăciun, et al., 2024; Roldán-Valcarce et al., 2023; Sami et al., 2020; Tanoue et al., 2016). There were only a few research publications that focused on flood severity (Diakakis et al., 2020; Horton et al., 2021; Murray et al., 2012; Sadler et al., 2018), and the development flood severity index is in the early stage (Scheiber et al., 2023; Schroeder et al., 2016). Even the descriptions of flood severity in the reports, news, and even scientific articles are not comparable. No prevailing global standards in determining the level or index of flood severity can be applied to describe the scale and magnitude of any flood. There is rarely an available proposed index of the severity of flash floods based on the physical damage of natural and anthropogenic features (Diakakis et al., 2020) and the impact of flash floods on coastal roads (Ghosh & Dey, 2021). Recently, it has been difficult to describe the flood intensity proxy for both scientific and news purposes that can be understood by the audiences easily. The flood severity phenomena from different places and times are also difficult to compare, as there is no standard reference of severity level or level of magnitude. The trend of flood research diversity has increased (Wang et al., 2022). Such various flood research, mainly the recent advanced flood research, focuses on flood vulnerability prediction and assessment based on machine learning and Geographic Information Systems (GIS) (Tudunwada & Abbas, 2022; Wang & Sebastian, 2021; Yang et al., 2018).

The latest flash flood severity index has been proposed in previous research based on the description of the damaged infrastructure caused by floods. The proposed index has weaknesses, such as being too qualitative and lacking quantitative parameters and it needs to be improved (Diakakis et al., 2020). Meanwhile, quantitative flood severity research for general floods was initiated from 2012 to 2016 (Murray et al., 2012; Schroeder et al., 2016), and so far, recently, there have been only a few new studies that focus on flood severity scope (Y. Feng et al., 2020; Ghosh & Dey, 2021; Gokul Raj et al., 2023; Horton et al., 2021; Hu et al., 2017).

In recent publications, many terms regarding flood scales have been found. The flood scale terms that are used scientifically are "flood magnitudes", "flood vulnerability", "flood susceptibility", and "flood severity". Meanwhile, the frequently used terminology for flood types are "floods", "flash floods", "river floods", "flood tides", "riparian floods", and other terminology (Kobiyama & Goerl, 2007). Such terminologies refer to flow velocity, place of occurrences, etc. The classification of the flood scale and flood type terms also needs more profound research to assess its severity in harming potency. Most research on flood prediction focuses on river floods compared to others (Hakim et al., 2024), and most flood severity research focuses on flash floods (Diakakis et al., 2020; Gaume et al., 2009; Li et al., 2023; Schroeder et al., 2016). Those terminologies are also used frequently in scientific publications. The recently available flood classifications based on hydroclimatic and causative classification are insufficient to cover a wide range of general flood events (Tarasova et al., 2019). The unavailability of inclusive systematic classification of floods and the scale of floods could be avenues for further studies on flood classification and flood scale or magnitude. The parameters for further classification of flood type and scale, such as hydrology, water origin, water velocity, height of inundation, duration of the flood, and its frequency, need further studies. The distinction of each flood terminology is crucial for further research and disaster management (Kobiyama & Goerl, 2007).

The results of coupling analysis for the term "flood vulnerability" are also needed to compare and assess the advancement and maturity of flood severity research during the last decade. This paper aims to find the research and literature gap between the latest research and fill the gap by recommending further demanded research topics dealing with floods, especially in flood severity terminology. The chances of further research are based on the bibliometric analysis and clustering of words contained in titles, keywords, and abstracts of mined data from rigorous peer-reviewed papers related to flood severity terminology. The novelty of this study will be proven by the absence or low density in the co-occurrence of the term "severity" in bibliometric analysis. This study also inspires flood researchers to start flood severity studies to provide basic knowledge and more references for a deeper study about such topics. The future continual research on flood severity will seed a global frame of reference for the flood severity index, like the Mercalli and Richter earthquake scale (Musson et al., 2010). Such a globally accepted frame of reference is imperative for scientific discussion, publication, and general communication.

2. Method

There were nine stages of systematic literature review (SLR) based on rigorous peer-reviewed articles that were used to reach the objectives of this study. The first stage defined research aims and objectives and described the scope of the SLR based on flood research needs and trends. The second stage of the protocol development stage was defining the search keywords as operands string, logical operation ("AND", "OR", or "NOT"), and developing criteria imposed during the studies that will work as a filter in the search processes. The requirements consisted of determining the inclusion and exclusion criteria. The third stage consisted of conducting a comprehensive literature search using database selection and appropriate keywords defined in the previous stage to get a qualified and relevant article. The fourth stage was screening and selecting papers by implementing inclusion and exclusion based on the predefined protocols. The fifth stage was the extraction of metadata from the selected and screen-passed articles, which can be formed as study design, sample size, intervention type, measured outcomes, and key findings. Tools used in data mining or extraction consisted of Mendeley reference manager as a tool to merge Research Information System (RIS) file and article duplication finding tool, VOSviewer version 1.6.20, and R Studio version 4.2.3 with literature review tool plugin (Arsawan et al., 2024; van Eck & Waltman, 2010). The sixth stage synthesized qualitative data by thematic analysis of the key findings, quantitative synthesizing data by the analysis of meta-data, and specific metrics. Specific metrics from clustering words of titles, abstracts, and keywords from meta-data of merged RIS file extraction were further analyzed based on the frequency of the density of co-occurrence to find the research gap. The seventh stage was formulating future research topics based on each cluster’s term and research gap. The eighth stage discussed the main finding of the need for flood research’s implications for urban society, decision-makers, and further study. The ninth stage concluded the SLR study by ensuring comprehensiveness, transparency, and replication. It also must contribute valuable insights into hydrology, especially in flood studies. The protocol was strictly imposed to ensure the data quality and no biased result (Kanwal et al., 2024).

The following detailed procedure explains the fourth and fifth stages, which are crucial in this research. The method for handling the results of searching the relevant articles based on the imposed protocol was downloaded as the RIS file with a maximum number of items of 100 per file. Those separated files, then the RIS files, were imported into Mendeley. The file duplication could be detected using Mendeley features. If the duplicated items were detected, the duplicate file was deleted. From 537 selected references, it showed no duplication. Then, the merged and clean RIS file was downloaded for descriptive analysis using library *revtools* and the *read_bibliography()* function in R Studio (Govindasamy et al., 2020; Westgate, 2019). The imported data table of RIS in R studio was analyzed for its growth during the determined period, as well as the reputable and relevant journal sources that published the articles and the subject area. The merged RIS file was also bibliometrically analyzed using VOSviewer. VOSviewer is computer software available for free download; this software helps create and view maps of bibliometrics networks (van Eck & Waltman, 2010).

3. Results

3.1. Descriptive analysis of the selected papers

The result of the implementation of the protocol is depicted in Figure 1. The protocol in this SLR is as follows: the search keywords are based on two proposed operand strings, “flood severity” OR “severity of flood.” The logical operator “OR” was chosen to obtain a paper containing one of the provided operand strings. Searching was conducted using the Scopus-Science Direct database due to rigorous peer-review processes (Koval et al., 2023). The search was conducted on Sunday, June 1, 2024. The selected papers were published by Elsevier in the Science Direct database from 2015 until 2024, and the literature review papers were excluded during the search processes.

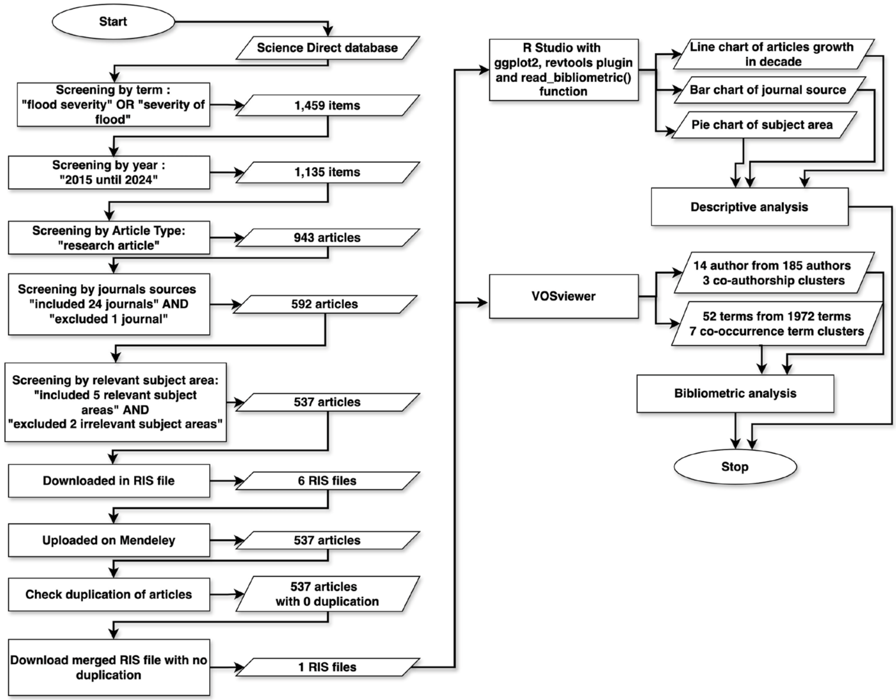

Figure 1. Protocol implementation.

Meanwhile, one of the available journal sources, named *International Journal of Hydrogen Energy*, was excluded as its scope was not suitable enough. Then, two subject areas, "Social Science" and "Economics, Econometrics, and Finance," were excluded from the seven available criteria for the subject area. The screening subject area also automatically excluded four other journal sources. The initial results were 537 articles published in 20 journals. The results of searching by imposing protocol show that the number of articles dealing with flood severity increased significantly during the last decade from 2015 to 2024, as illustrated in Figure 2.

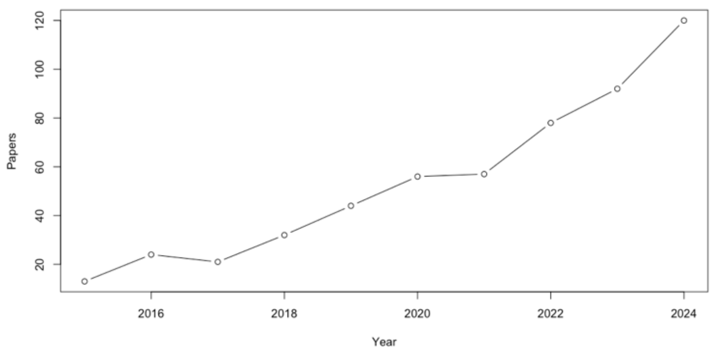

Figure 2. The growth of peer-reviewed articles relating to flood severity in Science Direct.

The articles that resulted from the inclusion and exclusion of journal sources and the subject area published in 20 journals are listed in Table 1. The order is based on the number of published articles.

The subject areas included consist of: 1) Earth and planetary sciences (407 articles), 2) environmental science (355 articles), 3) agricultural and biological sciences (292 articles), 4) energy (17 articles), and 5) computer science (8 articles). The selected articles were downloaded as a RIS file, which consisted of six RIS files that would be merged and extracted for further analysis and synthesis.

Table 1. List of journal and number of papers screening results

No.	Journal source	Papers
1	*Advances in Water Resources*	6
2	*Reliability Engineering & System Safety*	6
3	*Transportation Research*	6
4	*Remote Sensing of Environment*	7
5	*Atmospheric Research*	9
6	*Progress in Disaster Science*	9
7	*Water Research*	9
8	*Weather and Climate Extremes*	9
9	*Ecological Economics*	11
10	*Climate Risk Management*	12
11	*Environmental Science & Policy*	12
12	*Land Use Policy*	13
13	*Environmental Modelling & Software*	14
14	*Journal of Cleaner Production*	16
15	*Ecological Indicators*	21
16	*Journal of Hydrology: Regional Studies*	26
17	*Journal of Environmental Management*	32
18	*Science of The Total Environment*	58
19	*International Journal of Disaster Risk Reduction*	127
20	*Journal of Hydrology*	134
	Total number of papers	537

3.2. Bibliometric analysis

Duplicate items were not detected after merging six RIS files by importing them in the Mendeley library, and the total reference items in those files were 537 articles. Then, they were downloaded. The data table of RIS was analyzed for paper growth during the determined period, as well as the reputable and relevant journal sources that published the articles and the subject area. The merged RIS files were extracted for paper authors, co-authors, citations, titles, keywords, abstracts, year of publication, and journal sources using VOSviewer software for further bibliometric analysis.

The merging of six RIS files was conducted by importing all the RIS files in the online Mendeley library; the duplication of references was not detected in the Mendeley duplication detection menu. This merged RIS file was inputted into VOSviewer software for bibliometric analysis. Through map-based bibliographic data, such bibliometric analysis consisted of co-authorship, citation, keywords co-occurrences, co-citation, or bibliographic coupling. The bibliographic analysis of 537 papers involved 2,272 authors. The analysis of co-authorship was set using complete calculation, where the minimum number of authors per document was set to two. The results were that 185 authors met the threshold, and only 14 authors connected to other authors. Then, the 14 connected authors were clustered into three clusters of co-authorship. The first cluster consisted of six authors, the second cluster consisted of five authors, and the third cluster consisted of three authors. The clusters of their network are illustrated in Figure 3. Figure 3 represents only the period from 2021 to 2023 because the co-authorship occurrences in periods 2015–2021 and 2023–2024 were zero.

Figure 3. Co-authorship clusters of articles relating to flood severity.

The bibliometric analysis was also imposed on the RIS file's extracted title and abstract field using the complete counting method, where all the word occurrences in the documents were counted. The minimum number of occurrences of a term was set to five of the recorded 1,972 terms; the result was that 52 terms met the threshold. Then, a relevance score was calculated for each of the 52 terms. From the 52 selected terms clustered by the VOSviewer seven clusters were formed as follows:

- Cluster 1: Urban flood and flood hazard (fifteen terms);
- Cluster 2: Flood disaster management (eight terms);
- Cluster 3: Adaptability, mapping, and prediction (six terms);
- Cluster 4: Land use, urban planning, and prevailing parameters (six terms);
- Cluster 5: Natech and mitigation (six terms);
- Cluster 6: Climate change and its impact (six terms); and
- Cluster 7: Ecosystem services and resilience (five terms).

Clusters of the selected 52 terms in the title and keywords of 537 articles are illustrated in Figure 4 and Figure 5. Figure 4 shows the cluster in the link of the networks. Each cluster was differentiated by color; meanwhile, Figure 5 shows the density of words, where the view density uses Red, Green, and Blue (RGB) color (van Eck & Waltman, 2010) and where the high-density terms use red, indicating that the most dominant articles use the highlighted term in their title or abstract. At the same time, the blue color shows just a few articles that use the term in their titles and abstracts. So, less frequent term usage can indicate avenues for future research topics. The legend of Figure 4 only captures the years from 2020 to 2023, which means the co-occurrences of the terms in 2015 to 2019 and 2024 were below the threshold; the threshold for co-occurrences was 5 terms.

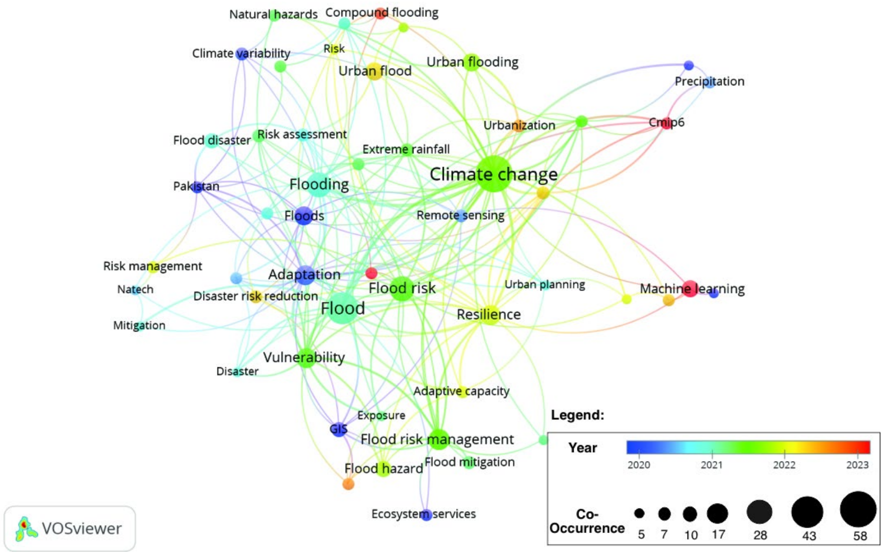

Figure 4. Co-occurrence terms cluster map.

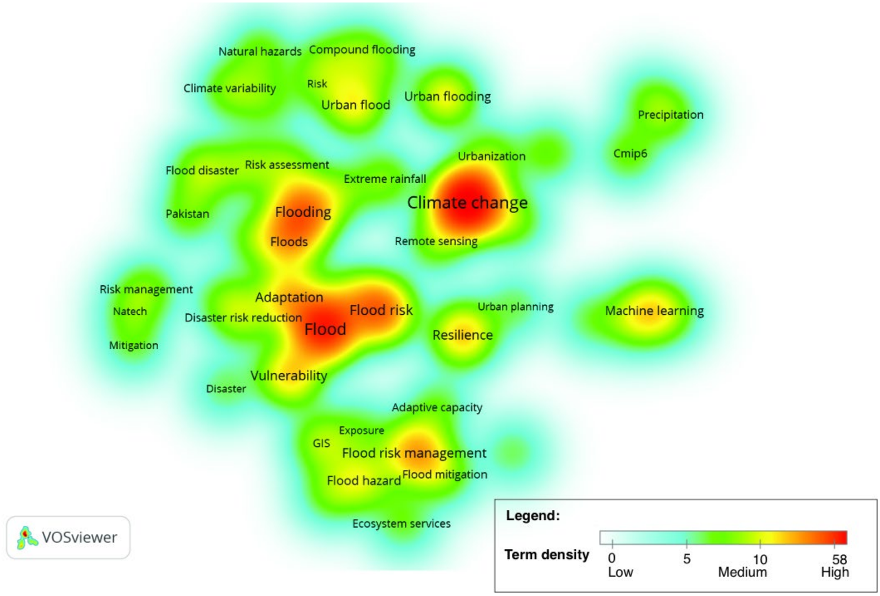

Figure 5. Co-occurrence terms density visualization map.

The result of screening the most relevant terms shows that the lowest co-occurrence terms (five occurrences) are "urban planning", "uncertainty", "risk", "natech", "mitigation", "land use change", "insurance", "flash flood", "exposure", and "disaster". Meanwhile, the 10 trending words or 10 highest co-occurrence terms are "climate change" (58 co-occurrences), "flood" (43 co-occurrences), "flood risk" (28 occurrences), "flooding" (26 occurrences), "flood risk management" (20 occurrences), "resilience" (18 occurrences), "vulnerability" (17 occurrences), "adaptation" (17 occurrences), "floods" (16 occurrences), and "urban flooding" (14 occurrences).

The term "Australia" as a continent was absent or had no occurrence term. Still, the term "New Zealand" as the country had low occurrences as it appeared only once and was not detected in the cluster. However, for the term "America" it was not determined whether it referred to a country or continent so that it can be interpreted as both the country and the continent. The country terms of "India" and "China" showed the relation of occurrences, whereas the most extensive territories and citizens in Asia, and other countries such as Ghana, Thailand, Bangladesh, Pakistan, Vietnam, Germany, and Brazil were much more determined by the frequency and severity of flood events, academic attention, and government support to the research on the subject area. The trending country terms are illustrated in Figure 6.

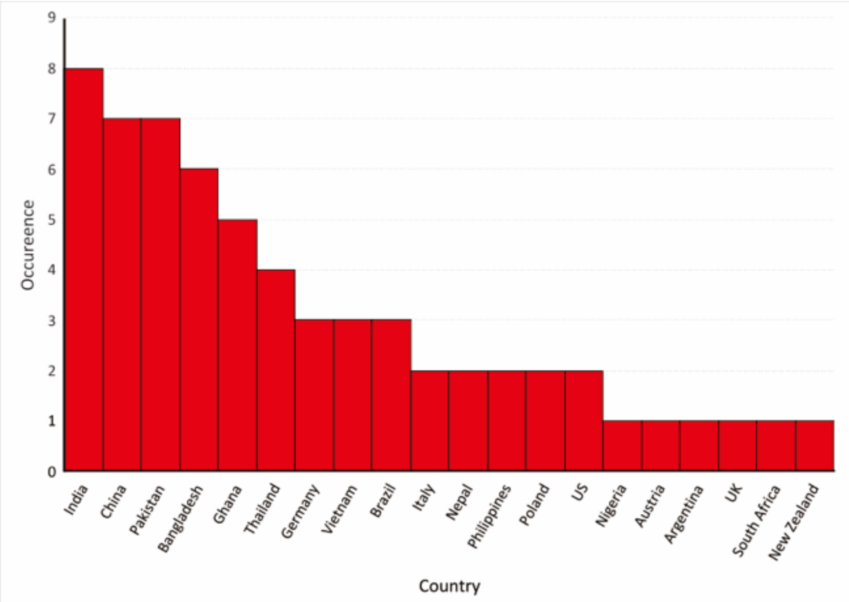

Figure 6. The country-term occurrence.

Based on the article search result profile and the bibliometric analysis of the co-occurrence term cluster, the trending term, the density of the selected term, the research networks, and the flood severity topic, future research topics related to flood severity recommendations can be formulated. The results of the recommendation formulation of flood severity topic for future research are listed in Table 2.

Table 2. Recommendations for future topics of research in each cluster

No.	Clusters	Topics recommendation for future research
1	Urban flood and flood hazard	Urban drainage system, damage quantification of natural and artificial environment, flood impact on environment, flood magnitude and severity, scale of flood, index of flood
2	Flood disaster management	Prioritizing flood disaster mitigation based on flood severity scale, mitigation planning, flood disaster reduction, flood disaster in developing and underdeveloped country (Asia Pacific and Africa), flood in archipelagos country
3	Adaptability, mapping, prediction, and direction for future research	Tool development for automatic measurement, Internet of Thing (IoT), Smart Lamp post, crowd sourcing, social media platform, flood database, machine learning, GIS, research gap in flood, flood severity index
4	Land use, urban planning, and prevailing parameters	Land conversion, buffer area and forest conservation, retention pound development, the anthropogenic factors in flood, flood administration
5	Natech and mitigation	Identification of industrial potency of natech in certain flood level, mitigation scenario for natech, geo-medic, diseases spreading
6	Climate change and its impact	Extreme weather, sea level rise and coast flood, forest degradation
7	Ecosystem services and resilience	Role of earth and atmosphere, soil, hydrology, geohydrology, geology, morphology, climate change, empowerment of local wisdom and indigenous people, dam, retention pond, early warning system

4. Discussion

In the search protocol, the keywords were "flood severity" OR "severity of flood," with only the research article included and a few exclusions of journal source and subject area. The reason for the logical operation "OR" means that the papers that contain one of the two strings ("flood severity" and "severity of flood") will pass that logical filter, as the two phrases of keywords have the same meaning. The phrase was used as a search keyword because using a single word, "severity", would give more results from another field, such as the medical field. The result of the research article screening from the Science Direct database was bibliometrically analyzed in coupling clustering with a minimum occurrence of five terms. The term "severity" cannot be found in the cluster of terms, which means the occurrence of "severity" in 537 selected articles was very low. Its occurrence was below the applied threshold of five terms. Therefore, by default, it did not appear in Figure 4 and Figure 5, as the minimum counting had been set to five terms. When further imposing a scrutiny search to phrases containing the term "severity", it appears in five related terms: "severity scale", "flood severity", "safety and severity factors", "flood severity detection", and "duration and severity". For instance, if "severity" is compared to "vulnerability," it had a medium occurrence and was found in Cluster 3. By imposing a scrutiny search, it reached 18 related terms; it has a higher density than "severity", as denoted by the yellow color in Figure 5. That indicates that "flood severity" has been a less trending research topic than "flood vulnerability" in recent years. Similarly, this kind of trending topic is also in other prominent research publication databases such as Francis & Taylor, Springer Link Sage Publication, and JSTOR (Chan et al., 2022). Based on the above bibliometric analysis, the term "severity" has lower density in co-occurrence, which indicates study gap in relation to this term and therefore shows opportunity for future research. It has a low density in co-occurrence analysis and it needs further identification and prioritizing in mitigation planning and decision-making rather than just identifying flood-vulnerable zones to enhance flood disaster resilience and mitigation planning (Muthu & Ramamoorthy, 2025). A quantitative severity index is needed for flood studies from a global perspective. When such a flood index is available, further research in quantitative flood models based on recent technological advancements will be triggered.

Geographically, the location represented as continents—Asia, Europe, America, and Africa—were mentioned in the number of occurrences; while the term "Australia" as the continent was absent, although a country was present as a term, such as "New Zealand". However, some prominent Asian and African countries, such as Indonesia, Malaysia, Taiwan, Japan, Maldives, UEA, Kenya, and Tanzania, were absent in the selected terms. Meanwhile, according to the previous research publication, the list of top 10 countries at flood risk by the number of people is shown in Table 3. Those countries are mostly located in Asia—China, India, Bangladesh, Indonesia, Pakistan, Vietnam, the United States, Nigeria, Egypt, and Japan (Conte, 2022; Rentschler et al., 2022). Those countries on the list of top 10 countries at the risk of floods do not fully correspond to the country term-occurrence in Figure 6. Such a mismatched comparison between the top 10 countries at flood risk and the geographic or country term occurrence (Figure 6 and Table 3) indicates a gap in the flood severity research in certain geographic locations.

Table 3. Top 10 countries by the number of people at the risk of floods (Conte, 2022; Rentschler et al., 2022)

Rank	Country	Number of people safe (million people)	Number of people at risk (million people)
1	China	1,400	395
2	India	1,400	390
3	Bangladesh	164	94
4	Indonesia	280	76
5	Pakistan	231	72
6	Vietnam	54	46
7	United States	298	43
8	Nigeria	178	39
9	Egypt	57	39
10	Japan	90	36

Note. Data in the table were obtained from "Flood exposure and poverty in 188 countries" by J. Rentschler, M. Salhab, and B. A. Jafino, 2022, *Nature Communications*, *13*, p. 5 (https://doi.org/10.1038/s41467-022-30727-4). Creative Commons Attribution 4.0 International License (CC BY 4.0).

Further gap analysis can be done by implementing the results mentioned in the previous paragraph. There are some countries in Table 3 that correspond to the country term occurrence in Figure 6, where China has seven occurrences, India – eight, Pakistan – seven, Bangladesh – six, Vietnam – three, the United States – two, and Nigeria – one. In Table 3, Indonesia has the fourth position on the list, Egypt is the ninth, and Japan is the tenth of the top 10 countries at flood risk, but in the bibliographic analysis, those countries have no occurrence (Figure 6). Therefore, the flood severity study in Indonesia, Egypt, and Japan is needed. Such study can be carried out in specific geographic locations such as region, city, island of the top 10 countries at flood risk.

The seven clusters of research topics, as a result of terms occurrences clustering from the titles and abstracts of the selected articles as listed in Table 2, can give direction on further research topics dealing with floods. That direction is based on the current trending term occurrences in research publications, in order to have more impact in future research. The topics can be combined with the terms gap such as geographic term, flood scale term, or flood type term with the lowest density in occurrences, for instance, the combination of the term "floods" and country terms, such as "urban floods in Indonesia", "urban floods in Egypt", and "urban floods in Japan." The scale terms, such as "severity" or "magnitude", can also be augmented to the recommended topics, such as "Flood severity in Asian countries." The intersection of the lowest density term occurrence and the clusters of recommendation can be the gate to future flood research topics. Such topics can also be covered using the latest technological advancements like AI. Recommended topics can be combined with AI, such as implementing machine learning in the mapping and predicting flood severity of urban floods, especially in the top 10 countries at the risk of floods, to obtain a greater impact (Mosavi et al., 2018; Pandey, 2024).

However, the result of the bibliographic analysis of this study has weaknesses. The imposed protocol determined that papers came from only one publisher database of Science Direct that Elsevier owns. The protocol consideration is that journals under Science Direct are well known and conditioned by rigorous peer review and high standard of paper publication (Koval et al., 2023; O'Doherty et al., 2018). Therefore, it is the initial screening to get high-quality papers with novelties from the tremendous number of papers, including the ones from mildly reviewed publications, local journals, repetitive publication, and unreviewed papers that are available in the cloud database. Although the publication database is owned by a reputable world publisher with editors, reviewers, and authors who represent globally acknowledged scientists and researchers in publishing processes, the selected articles possibly do not represent other research publication databases. Therefore, further SLR on a similar scope with extended databases such as Scopus, Web of Science, and Google Scholar may give additional insight into finding research gaps in the papers related to flood severity. Meanwhile, the challenge in following up the recommended topics to fill the research gap in the scope of flood severity in this paper is the uniformity of available flood data, the availability of quantitative flood parameters data such as height, duration, and velocity, especially in the flood-prone locations in the underdeveloped and developing countries (Notti et al., 2018; René et al., 2014). The effort in collecting data based on citizen science using cutting-edge technology can be applied to overcome such challenges (Sulistyo et al., 2025). The commitment of authorities to measuring and recording flood events and publishing flood data is also another challenge.

5. Conclusion

Based on the bibliometric analysis of rigorous peer-reviewed articles of Science Direct as a reputable research publication database during the decade of 2015–2024, 1,135 research papers related to the search keyword "flood severity" OR "severity of flood" have passed the high standards of peer-review and publishing processes during the decade. A deeper bibliometric analysis of titles and abstracts of the final 537 selected papers has shown that only a few papers contain the term "severity", and it did not appear in the visualization density of co-occurrence terms as it was found to be with fewer than five occurrences. Such data were analyzed for future research recommendations based on term density, cluster, and geographical terms. The topics related to flood severity have been formulated for future recommendation based on seven clusters of term co-occurrences. Those recommended topics can be implemented in the countries with flood risks that have the lowest term occurrence or even have no occurrence in bibliometric analysis. Such research results will trigger new avenues for future flood severity topics. There are also geographical term gaps as a result of comparison of the term occurrence and the world's top 10 countries with flood risks. The geographical term gaps refer to Indonesia, Egypt, and Japan. The geographical research gap in flood severity can be a new avenue for future research to fill the gap.

The weakness of this study is that it is just based on one reputable publication research database, where the result can be different if involving all kinds of publication research databases that are available in the cloud. Further literature review can be done by extending the research publication database to obtain other possible gaps on the similar scope. The other weaknesses and challenges to follow up the recommendation are the availability of global flood data, especially in underdeveloped and developing countries, the uniformity of flood data, and the commitment of all the countries to the recording and publishing every flood event in its authorities.

The implication of the follow-up recommendation to fill the research gap will give novel and beneficial results in the scope of flood scale that will contribute to both water science and humanity, especially in flood disaster management. It will also inspire and trigger new breakthroughs in solving problems related to flood severity.

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