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Review Article



A Review of Flood Mitigation Literature: A Case Study of Sidoarjo Regency, Indonesia

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Abstract

Sidoarjo is a buffer city in Surabaya, a comfortable and livable city. To become livable, a city needs several life-supporting infrastructures, including drainage infrastructure. A drainage system that is managed and maintained properly can carry out its functions optimally. But of course, many housing developments do not pay attention to the drainage system, which can cause problems such as flooding. Floods are the most frequent natural disasters in Indonesia. Flooding is a situation where an area is inundated with large amounts of water. The occurrence of floods can be predicted by paying attention to the amount of rainfall and water discharge. However, strong winds or leaking embankments can cause sudden floods, usually called flash floods. The causes of flooding include heavy rain. The earth's surface is lower than sea level. This area is a delta with a low water absorption capacity—construction of buildings along riverbanks. The river flow is uneven because it is blocked by rubbish and lack of land cover in upstream areas. Even if you live in a flood-free area, everyone should be aware of the potential for this natural disaster. Floods are the release of river water that is relatively larger than usual, resulting in overflowing river water that fills and inundates low-lying areas.



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1. Introduction

Sidoarjo is a buffer city for Surabaya City and is a comfortable and livable city. To become a livable city, a city needs several life-supporting infrastructure, including drainage infrastructure. A properly managed and maintained drainage system can perform its functions optimally (Bos et al., 2005; Butler et al., 2018; Rauch et al., 2005). But of course, many housing developments do not pay attention to the drainage system, which can cause problems such as flooding. Floods are the most frequent natural disasters in Indonesia. Flooding is a situation where an area is inundated with large amounts of water (Beden & Ulke Keskin, 2021; Chormanski et al., 2011; Jain et al., 2005). The occurrence of floods can be predicted by paying attention to the amount of rainfall and water discharge (Chormanski et al., 2011; Hapuarachchi et al., 2011). However, strong winds or leaking embankments can cause sudden floods, usually called flash floods. The

causes of flooding include heavy rain. The earth's surface is lower than sea level. This area is a delta with a low water absorption capacity.

Construction of buildings along riverbanks. The river flow is uneven because it is blocked by rubbish and lack of land cover in upstream areas. Even if you live in a flood-free area, everyone should be aware of the potential for this natural disaster. Floods are the release of river water that is relatively larger than usual, resulting in overflowing river water that fills and inundates low-lying areas. Before this decade, the Pucang Indah residential area did not experience flooding problems, but currently, flooding problems often occur in the Pucang Indah Sidoarjo residential area. There are various causes of flooding in the Pucang Indah Sidoarjo housing complex. The construction of a rice field area to the north of the housing complex and the closure of the main channel with the erection of illegal buildings above it so that flooding is inevitable when it rains with high rainfall.

The drainage channel in the Pucang Indah Housing Complex is an open, rectangular channel. It is located at the front extending in front of each house in the Pucang Indah Housing Complex, while the outlet channel that channels the housing drainage water is at the front of the housing complex and behind the housing complex. Specifically, the outlet channel behind the housing complex becomes one with the drainage channel on the Sidoarjo - Surabaya railway line. The losses experienced by residents of the Pucang Indah Sidoarjo housing complex are quite large if flooding occurs in the area, including: (i) The economic value of houses located in areas prone to flooding has dropped drastically. For areas that are not affected by flooding, the selling price of a house is above 1 billion rupiah, while for areas that are prone to flooding it is below 800 million rupiah; (ii) Residents found it difficult to carry out their prayers at the mosque, because the road access to the mosque was blocked by flooding, so residents were worried about falling if they forced themselves to go to the mosque; (iii)

For houses that have not been renovated by raising the floor elevation, and most of the residents are elderly, floods often enter and inundate the house, making electronic and electrical items very dangerous for the residents. Often people's electronic items are damaged due to inundation due to floods. The objectives of this research are as follows: (1) To find out the flood conditions at Pucang Indah Housing Complex; (2) To determine the flood discharge flowing in the research area; (3) To obtain an ideal channel to overcome flooding in the research area; (4) To find out flood control measures.

2. Literature Review

Drainage is a term used to describe systems related to managing excess water, both above, below and underground. Drainage is a water channel, whether naturally or artificially, above or below the ground. Urban drainage is a drainage system in urban and administrative areas that controls or disposes of excess surface water in residential areas originating from local rainfall without causing public disturbance. It can also provide benefits for human life. In Indonesia, drainage refers to ditches above ground or underground sewers, and drainage plays an important role in regulating water sources to prevent flooding. The definition of urban drainage is not only limited to techniques for draining excess water but is also more broadly related to aspects of life in urban areas.

A drainage system is generally defined as a series of hydraulic structures that reduce and/or dispose of excess water in an area of land so that the land can be utilised optimally. Drainage is also defined as an effort to control groundwater quality regarding salinity. Anything that involves excess water in urban areas can certainly cause some pretty complicated drainage problems. With the increasing complexity of drainage problems in urban

areas, the success of planning and developing clean water supply and urban drainage works depends on the capacity of each planner. Therefore, the work process requires the collaboration of several experts in other related fields.

A study by Xu et al. (2023) investigated flood risk management, utilising real options analysis in urban environments facing environmental change. By integrating financial principles with flood mitigation strategies, the study offers a novel framework for decision-making under uncertainty, particularly in the face of evolving environmental conditions such as climate change and land use dynamics. The study navigates through various aspects of real options analysis, flood risk management, and environmental adaptation, providing valuable insights into applying financial techniques to enhance the resilience of urban areas against flooding.

This study demonstrates how real options analysis can account for uncertainties, irreversible decisions, and dynamic changes in flood risk and environmental conditions. By quantifying the value of flexibility and adaptation in flood risk management, the study offers a robust approach for policymakers and stakeholders to optimise investment decisions and prioritise actions to mitigate flood risks effectively.

Moreover, the study illustrates the application of real options analysis in urban flood mitigation. The inclusion of case studies or simulation results demonstrating the effectiveness of real options analysis in informing decision-making and enhancing flood resilience would further enrich the study, providing concrete illustrations and empirical evidence to support its findings. Additionally, discussing the broader implications of the research findings for urban planning, climate adaptation, and risk governance could enhance the study's impact and relevance.

Hammond et al. (2015) assessed the impacts of urban flooding. Urban flooding poses significant threats to infrastructure, public safety, and the environment, necessitating effective assessment techniques to understand its multifaceted impacts. This review critically examines existing literature on urban flood impact assessment, synthesising insights from various disciplines such as hydrology, engineering, urban planning, and social sciences. Their study navigates through a wide range of assessment techniques, including hydrodynamic modeling, GIS-based mapping, vulnerability assessment, economic valuation, and social impact analysis. By providing a detailed overview of these methods, the study offers valuable guidance for researchers, practitioners, and policymakers in assessing and managing urban flood risks.

Moreover, their study illustrates the application of different assessment methodologies in real-world contexts. The inclusion of case studies from various geographic locations and flood events would further enrich the study, providing concrete illustrations and

insights into the applicability and limitations of different assessment approaches. Additionally, discussing the emerging trends, challenges, and opportunities in urban flood impact assessment, such as the integration of remote sensing data, citizen science, and participatory approaches, could enhance the study's relevance and currency.

Doeffinger & Rubinyi (2023) explored broader socio-economic and environmental advantages associated with urban flood protection measures. While the primary goal of flood protection is to mitigate flood risks and safeguard lives and property, this review highlights the additional positive outcomes such interventions can yield for communities, ecosystems, and economies. Through an extensive analysis of existing literature, the study elucidates various secondary benefits of urban flood protection, shedding light on their importance in enhancing resilience and promoting sustainable development. The study navigates through a wide range of socio-economic and environmental co-benefits, including improved public health, enhanced quality of life, increased property values, reduced insurance premiums, preserved ecosystems, and enhanced biodiversity. By synthesising insights from diverse disciplines such as public health, economics, ecology, and urban planning, the study offers a holistic understanding of the multifaceted advantages of flood protection beyond risk reduction.

Moreover, the study showcases a commendable integration of theoretical frameworks, empirical research, and practical examples to illustrate the secondary benefits of urban flood protection. The inclusion of case studies or empirical evidence demonstrating the quantifiable impacts of flood protection measures on various socio-economic and environmental indicators would further enrich the study, providing concrete illustrations and supporting evidence for its arguments. Additionally, discussing the potential trade-offs and synergies between primary flood protection goals and secondary benefits could enhance the study's depth and nuance.

Yan et al. (2023) studied the use of advanced technologies in developing urban flood models. Flood modeling plays a crucial role in understanding and mitigating flood risks in urban areas, and the integration of advanced technologies has the potential to enhance the accuracy, efficiency, and reliability of these models. Through an in-depth literature analysis, this study examines the various advanced technologies utilised in urban flood modeling, highlighting their applications, advantages, and limitations.

They used various methodologies, including remote sensing, Geographic Information Systems (GIS), Artificial Intelligence (AI), Machine Learning (ML), and high-resolution modeling techniques. By providing detailed insights into the capabilities and applications of these technologies, the study offers valuable guidance for

researchers, practitioners, and policymakers involved in urban flood risk assessment and management.

Moreover, the study showcases a commendable integration of theoretical frameworks, case studies, and practical examples to illustrate the application of advanced technologies in urban flood modeling. The inclusion of case studies demonstrating successful implementations of these technologies in real-world flood scenarios would further enrich the study, providing concrete illustrations and insights into their effectiveness and applicability. Additionally, discussing the challenges and opportunities associated with adopting and integrating advanced technologies in urban flood modeling could enhance the study's relevance and depth.

Zhang et al. (2023) studied urban flood resilience assessment methodologies, presenting a systematic framework for evaluating the resilience of urban areas to flooding events. Flood resilience is increasingly recognised as a critical aspect of urban planning and disaster management, particularly in the face of escalating flood risks due to climate change and urbanisation. Through a rigorous analysis of existing literature, this study provides valuable insights into the key components, indicators, and approaches for assessing urban flood resilience. They used various methodologies and frameworks for resilience assessment, offering a comprehensive overview of their strengths, limitations, and applications. By proposing a systematic framework, the study provides a structured approach for researchers, practitioners, and policymakers to evaluate and enhance the resilience of urban areas to flooding events.

Also, their study demonstrates the implementation of resilience assessment methodologies in different urban settings would further enrich the study, providing concrete illustrations and insights into their effectiveness and applicability. Additionally, discussing the potential implications of resilience assessment findings for urban planning, policy formulation, and disaster risk reduction strategies could enhance the study's relevance and impact.

Abdrabo et al. (2023) assessed urban flood vulnerability and constructing a vulnerability index tailored to the context of Alexandria, Egypt. Urban areas, particularly coastal cities like Alexandria, face increasing risks from flooding due to various factors, including climate change, rapid urbanisation, and inadequate infrastructure. This study addresses the critical need for robust tools to assess and manage urban flood vulnerability, especially in vulnerable regions like Alexandria. Their study combines indicator-based analysis, Principal Component Analysis (PCA), and Analytical Hierarchy Process (AHP) techniques to develop a comprehensive assessment framework. By incorporating a diverse set of indicators representing physical, socio-economic, and institutional dimensions of vulnerability, the study offers a holistic understanding of

the factors contributing to flood vulnerability in urban areas.

Besides that, the study showcases a commendable integration of theoretical concepts, methodological frameworks, and empirical analysis, providing a detailed explanation of the methodology and its application in the Alexandria, Egypt case study. The inclusion of case study results, including vulnerability index scores and spatial mapping of vulnerability hotspots, further enhances the study's credibility and relevance. Additionally, the study discusses the implications of vulnerability assessment findings for urban planning, policy formulation, and disaster risk reduction strategies, demonstrating its potential as a decision-making tool for stakeholders.

Rendana et al. (2023) examined flood risk assessment and shelter suitability mapping as essential components of sustainable urban flood management strategies. Palembang City, located in South Sumatra, Indonesia, faces significant flood risks due to its geographical location and rapid urbanisation. This study addresses the urgent need for effective flood management measures by utilising geospatial techniques to assess flood risk and identify suitable shelters for affected populations. Their study combines spatial data analysis, hydrological modeling, and multi-criteria decision analysis to identify flood-prone areas and prioritise suitable shelter locations. By integrating physical, socio-economic, and environmental factors, the study offers a comprehensive understanding of flood risk dynamics and shelter needs in Palembang City.

Also, the study showcases a commendable integration of theoretical frameworks, methodological approaches, and empirical findings, providing a detailed explanation of the methodology and its application in the context of the case study. The inclusion of spatial maps depicting flood risk zones and shelter suitability scores enhances the study's clarity and visual appeal, facilitating better interpretation of the results. Additionally, the study discusses the implications of the findings for urban planning, emergency response planning, and community resilience-building efforts, highlighting its relevance for policymakers and practitioners involved in flood management.

Chitwatkulsiri & Miyamoto (2023) analysed real-time urban flood forecasting systems in the context of Southeast Asia. With the region facing increasing challenges from urbanisation, climate change, and flood risk, the development of effective forecasting systems is crucial for mitigating the impacts of flooding on communities, infrastructure, and the environment. This review critically examines existing literature on urban flood forecasting models, assesses their capabilities and limitations, and explores prospects for enhancing forecasting accuracy and reliability in Southeast Asia. Their study applies various modelling techniques, including hydrodynamic models, rainfall-runoff models, data-driven models, and ensemble forecasting methods, providing insights into their strengths, weaknesses, and

applications in Southeast Asian urban contexts. By synthesising findings from diverse studies, the study offers valuable guidance for researchers, practitioners, and policymakers involved in urban flood management and disaster risk reduction efforts.

Also, the study showcases a commendable integration of theoretical frameworks, methodological approaches, and empirical findings, providing a detailed overview of the state-of-the-art in urban flood forecasting systems. The inclusion of case studies or examples demonstrating the implementation and performance of forecasting models in Southeast Asian cities would further enrich the study, offering concrete illustrations and insights into their effectiveness in real-world applications. Additionally, the study discusses the future prospects and challenges for improving forecasting accuracy and reliability, highlighting the importance of incorporating climate change projections, improving data availability, and enhancing stakeholder engagement in the development of forecasting systems.

Dadrasajirlou et al. (2023) examined the pressing problem of urban flooding and emphasises the importance of implementing low-impact development (LID) strategies. By framing the issue within the context of sustainable urban planning, the authors effectively convey the urgency and relevance of their research. The integration of AHP and PROMETHEE methodologies offers a promising avenue for systematic decision-making in selecting optimal LID designs. This study found that the selection of LID designs for urban flood mitigation. Through the application of AHP-PROMETHEE, the authors effectively prioritise alternatives based on multiple criteria, offering valuable insights for decision-makers.

3. Materials and Methods

The bibliometric analysis was conducted systematically to gather relevant scholarly publications. The primary data source utilised was academic databases such as PubMed, Scopus, and Web of Science. Keywords pertinent to the research topic were employed to retrieve articles published within a specified timeframe. The search strategy encompassed variations of terms related to the subject matter to ensure comprehensive coverage. Additionally, inclusion and exclusion criteria were established to filter out irrelevant literature and maintain the focus on the research objectives. Duplicate records were identified and removed to ensure data integrity.

A rigorous analysis was performed to extract meaningful insights upon collecting the pertinent literature. The bibliographic data, including publication year, authorship, journal title, citation count, and keywords, were systematically organised and synthesised using bibliometric software such as VOSviewer or CitNetExplorer. Co-authorship networks were constructed to visualise collaborations among

researchers, while citation networks provided a glimpse into the dissemination and impact of the publications within the academic community. Furthermore, bibliometric indicators such as citation rates, h-index, and journal impact factor were calculated to assess the significance and influence of individual publications and authors.

The findings obtained from the bibliometric analysis were interpreted in the context of the research objectives and existing literature. Patterns, trends, and relationships identified within the scholarly landscape were critically evaluated to draw meaningful conclusions. The interpretation phase involved identifying seminal works, emerging research themes, and gaps in the literature. Comparative analyses were conducted to benchmark the research output against relevant benchmarks or similar studies in the field. Finally, the synthesised results were used to inform discussions, draw implications for future research directions, and contribute to advancing knowledge in the subject area.

Besides that, a systematic literature review was conducted to explore existing research relevant to the chosen topic comprehensively. The search strategy was meticulously designed to ensure inclusivity and rigor. An electronic database named Scopus was systematically searched using keywords and controlled vocabulary terms. The search was limited to peer-reviewed journal articles published within a predefined timeframe, typically spanning the last decade to capture the most recent developments in the field. In addition to electronic databases, manual searches of reference lists from identified articles and relevant journals were performed to supplement the electronic search and ensure thoroughness.

The screening process involved multiple stages to identify articles that met the predefined inclusion criteria. Initially, titles and abstracts of retrieved records were screened to exclude irrelevant studies. Subsequently, full-text articles were assessed against the inclusion criteria, which typically included relevance to the research question, publication in peer-reviewed journals, and availability of full text in English. Any discrepancies or uncertainties in article eligibility were resolved through consensus among the review team. The selected articles underwent data extraction, where pertinent information such as study design, sample characteristics, key findings, and implications were systematically recorded.

The synthesised findings from the selected studies were analysed to identify common themes, patterns, and gaps in the existing literature. Data extraction tables or matrices were employed to organise and summarise relevant information from each included study. Narrative synthesis techniques were utilised to qualitatively summarise and interpret the findings across studies. Additionally, quantitative synthesis methods such as meta-analysis were considered to pool and analyse numerical data from comparable studies where appropriate. The synthesised results were critically

evaluated in light of the research objectives to draw conclusions, identify implications for practice and policy, and suggest avenues for future research.

4. Results and Discussions

Trend of flood research in Sidoarjo, Indonesia on the basis of Scopus database (2007-2023). Analyse search results in Scopus as seen below:

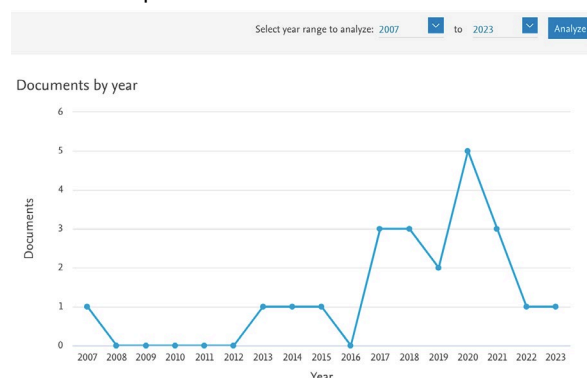


Figure 1. Trend of flood research in Sidoarjo, Indonesia (2007-2023)

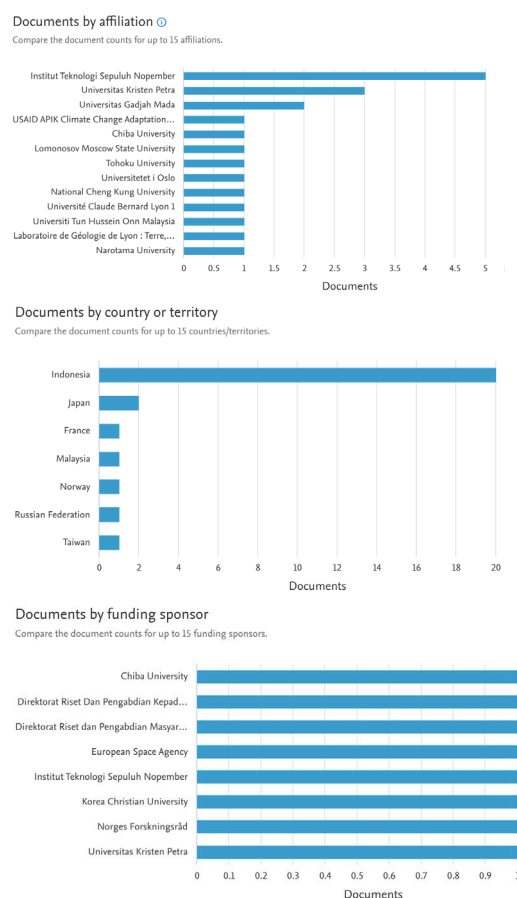


Figure 2. Trend of flood research in Sidoarjo, Indonesia (2007-2023) on the basis of articles by affiliations, countries and funding sponsors

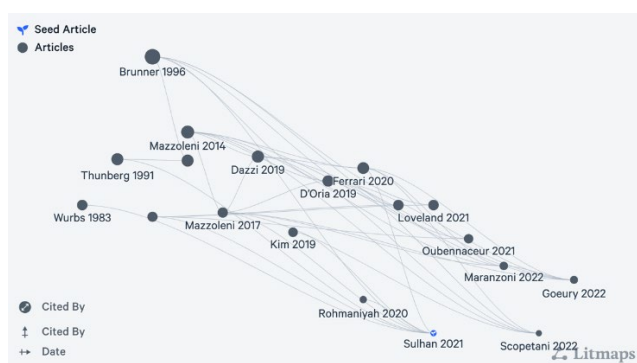


Figure 3. Literature Analysis of flood research in Sidoarjo, Indonesia by Sulhan 2001

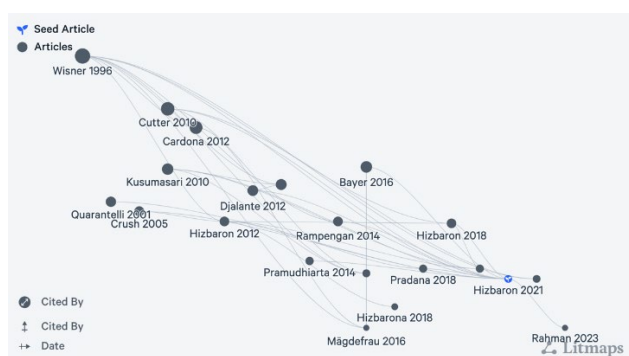


Figure 4. Literature Analysis of flood research in Sidoarjo, Indonesia by Hizbaron (2021)

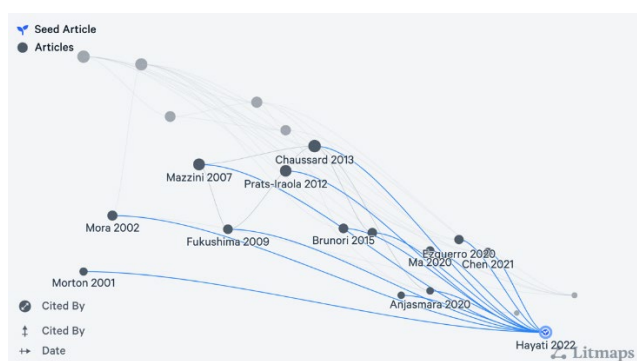


Figure 5. Literature Analysis of flood research in Sidoarjo, Indonesia by Hayati (2022)

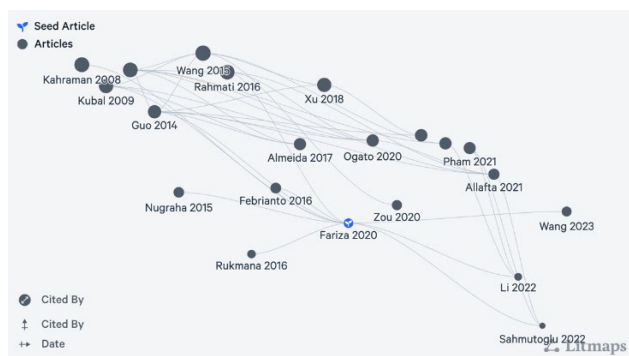


Figure 6. Literature Analysis of flood research in Sidoarjo, Indonesia by Fariza (2020)

5. Conclusions

Conducting a flood literature review analysis entails a rigorous and systematic examination of the extensive body of scholarly literature pertaining to floods. This meticulous process comprehensively reviews and synthesises existing knowledge, offering insights into various aspects of flood-related research. By methodically scrutinising a wide array of academic publications, the review aims to offer a panoramic view of the current state of understanding regarding floods, encompassing their causes, impacts, mitigation strategies, and socio-economic implications.

Furthermore, the primary objective of a flood literature review analysis is to pinpoint gaps in the existing research landscape. Through this critical evaluation, researchers can identify areas where further investigation is warranted, thereby contributing to advancing knowledge in flood-related disciplines. These identified gaps serve as crucial signposts for future research endeavors, guiding scholars towards avenues that hold promise for addressing unanswered questions and expanding the breadth and depth of understanding in flood studies.

Moreover, synthesising key findings and trends from the literature review provides valuable insights for policymakers, practitioners, and stakeholders involved in flood risk management and disaster resilience. By distilling and presenting the collective wisdom accumulated in scholarly literature, the review facilitates evidence-based decision-making and formulation of effective strategies to mitigate floods' impacts. Ultimately, a flood literature review analysis serves as a cornerstone for fostering interdisciplinary collaboration, promoting informed discourse, and catalysing progress towards building more resilient communities in the face of this pervasive natural hazard.

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