Journal of Flood Risk Management

WILEY

CIWEM Chartered Institution of Water and Environmental Management | Journal of Flood Risk Management

CRITICAL REVIEW OPEN ACCESS

Assessing Surface Water Flood Mitigation Strategies: A Global Comparative Review

Funmilayo Ebun Rotimi | Roohollah Kalatehjari | Taofeeq Durojaye Moshood | Zina Abu Ali

Built Environment Engineering Department, School of Future Environments Auckland University of Technology, Auckland, New Zealand

Correspondence: Funmilayo Ebun Rotimi (funmi.rotimi@aut.ac.nz)

Received: 17 April 2024 | **Revised:** 22 February 2025 | **Accepted:** 3 March 2025

Funding: This work was supported by Faculty of Design and Creative Technology Contestable Research Fund, Auckland University of Technology.

Keywords: climate change | flood mitigation | impervious surfaces | stormwater management | urban planning

ABSTRACT

The discourse on climate change has brought to the fore the pressing need for improved flood management strategies. Recent trends indicate a surge in flooding incidents in residential areas, which can potentially disrupt socio-economic activities and result in loss of lives. This study conducts a Systematic Literature Review (SLR) to comprehensively assess and compare various flood mitigation strategies employed in residential zoning practices globally. Residential zoning in New Zealand means a designated area of land specifically set aside for housing development, with rules and regulations governing the density and type of dwellings that can be built there to maintain a suitable living environment for residents. Research articles published between 2001 and 2024 focused on flood reduction strategies were collected, synthesised, and analysed. A predefined review protocol guided this approach, involving searches in widely used electronic databases. Ninety-three articles were ultimately included in the review. The findings highlight several key areas, including the impact of strategies on flood susceptibility, the effectiveness of rainwater harvesting systems and green infrastructure in flood management, and the importance of sustainable urban development and ecological preservation. Proposed strategies, such as neighbourhood and site planning, regional planning, stormwater management, green roofs, permeable pavements, and regulatory measures, offer valuable pathways for safeguarding water resources in urban planning efforts. The study advances knowledge in urban planning, environmental sustainability, and residential zoning practices. It also provides an overview of current approaches for mitigating flooding and identifies research gaps for future studies.

1 | Introduction

The rapid pace of urbanisation presents multifaceted challenges to sustainable development, particularly in the context of flooding in residential zones (Rentschler et al. 2022). The transformation of natural landscapes into urban areas is characterised by increased impervious surfaces, such as roads, buildings, and other infrastructure, which significantly alter the natural hydrological cycle. This alteration leads to increased surface runoff, reduced groundwater recharge, and heightened vulnerability to flooding, thereby exacerbating the urban heat island effect and contributing to water pollution (Biratu et al. 2022; Park et al. 2020). As urban areas continue to expand, these challenges underscore the urgent need for effective strategies to mitigate the adverse effects of impervious surfaces on the natural environment and urban water systems (Zhu et al. 2023).

The occurrence of flooding is becoming increasingly severe due to the rapid pace of urbanisation (Dawson et al. 2008). Flood risk analysis in urban areas is more intricate than in rural areas due to the dense clustering of buildings, varied land uses, and interplay of flood control measures and drainage systems. With the continuous expansion of cities, urban flooding and waterlogging problems are expected to worsen unless more effective measures are adopted (Li et al. 2016). According to Recanatesi et al. (2017) and Xu et al. (2020), most of the rainfall that reaches the ground surface in many natural settings, either infiltrates the soil or is evaporated and transpired back into the atmosphere. However, urbanisation has led to the sealing of natural soils through pavements, roofs, and other impervious surfaces, which has constrained natural infiltration and evapotranspiration, converting rainfall into runoff (Zhu et al. 2023). Unsealed soils in urbanised areas have also experienced increases in runoff due to soil compaction resulting from construction activities (Gregory et al. 2006; Sohn et al. 2020; Yang et al. 2020).

To manage runoff, traditional engineered facilities such as gutters, channels, and pipes are constructed to convey runoff quickly from sealed surfaces to centralised detention ponds, retention facilities, and nearby streams (Ferguson 1995; Ramiaramanana and Teller 2021). However, during periods of heavy rainfall, these facilities often fail to handle the superimposed peak flows that discharge from different sealed surfaces, leading to overflow and flooding. Therefore, there is a need for alternative and sustainable strategies to manage runoff in urban areas. Qin (2020) concludes that conventional methods of retaining, storing, and infiltrating rainwater are effective during light rainfall. However, they fail to prevent significant overflows during heavy rain, which can lead to urban flooding. For example, in 2023, Auckland experienced a heavy downpour, the worst in its history, leading to a state of emergency being declared and around 350 people requiring emergency accommodation (Leal Filho et al. 2023). Aside from the need for emergency accommodation, this unprecedented event blocked many stormwater drains and caused damage to schools, residential homes, and motorways (Armstrong 2024).

Urban flooding occurs when the total overflow from multiple catchments exceeds the capacity of local sewer pipes. Therefore, current mainstream techniques are inadequate in mitigating urban flooding during heavy rainfall. To address this issue, it is necessary to significantly reduce the peak flow during heavy rainfall and extend the discharge duration proportionally. In this regard, the effectiveness of flood reduction strategies in residential zones emerges as a critical area of research, aiming to identify scalable and adaptable solutions that can be implemented across diverse geographical and socio-economic contexts. Integrating green infrastructure and sustainable urban drainage systems (SUDS) has been identified as effective measures for impervious surface reduction (Prybutok and Osipova 2021). These approaches not only mitigate surface runoff and improve water quality but also enhance biodiversity and provide recreational spaces for urban residents, thereby contributing to the overall liveability of urban areas.

However, the implementation of flood reduction strategies is not without challenges. Factors such as urban planning policies, socio-economic conditions, and the existing urban fabric play an important role in determining the feasibility and effectiveness of these approaches (Park et al. 2020; Zaeri et al. 2016). Moreover, the performance of urban drainage systems under the impact of urbanisation highlights the need for continuous assessment and adaptation of water management practices to address the dynamic challenges of urban growth (Bibi, Reddythta, et al. 2023; Bibi, Rehman, et al. 2023; Rotimi et al. 2015).

At the nexus of this discussion is the critical examination of how urbanisation and contribute to increased flood risk. Research by Park et al. (2020) sheds light on this phenomenon, illustrating the cascading effects of coastal city expansion on flood vulnerability. Their findings underscore the imperative for sustainable urban planning that harmonises with nature's rhythms rather than disrupting them. Similarly, Prybutok and Osipova (2021) emphasise the importance of integrating costing nature approaches with suitability modelling to enhance flood resilience. This innovative methodology offers a blueprint for balancing economic development with ecological preservation, ensuring that the prosperity of future generations is not built on the fragility of natural ecosystems. The successful implementation of flood mitigation strategies requires a thorough consideration of incorporated factors such as urban planning policies, socio-economic conditions, and the existing urban fabric to ensure these measures are both feasible and effective. Therefore, the current study thoroughly examines and compares various global flood mitigation strategies used in residential zoning practices. It aims to highlight the diverse approaches to managing the risks associated with flooding and categorise these strategies for effective urban planning and environmental management.

2 | Methodology

2.1 | Search String

This section highlights the stages and techniques employed in this comprehensive review, which involved assessing and comparing diverse flood reduction strategies that are implemented in residential zoning practices. To gather relevant literature, the SCOPUS, EBSCO, and IEEE databases were extensively searched, as they are known for providing high-quality peer-reviewed academic research publications. Furthermore, Google Search was utilised to identify grey literature such as magazines, government reports and news items related to the subject area. Google Search is considered a valuable starting point for research, acknowledging that while it may not always provide access to the most reliable or authoritative sources, it allows access to magazines and newspapers relevant to the study.

This initial exploration helped us gather a broad range of perspectives and information on our topic, which we then critically evaluated and supplemented with more authoritative sources as needed. Some of the keywords frequently used included "flooding mitigation" OR "flood adaptation" OR "stormwater management" OR "urban planning" AND "impervious surfaces" OR "imperviable" AND "residential" OR "area" AND "strategies" OR "policy" OR "regulation." These keywords were chosen to pinpoint the intersection between various impervious area reduction strategies employed, flooding effect, and sustainability elements of flooding. Thus, enabling this research to assess and compare the effectiveness of flood mitigation strategies in residential zones worldwide. Other keywords have been excluded to maintain the study's precise and relevant search scope (see Table 1 and Figure 1).

TABLE 1 | Search engines, scholarly databases, phrases used, and keywords.

Search engines and database	Key words
Scopus Database	TITLE-ABS-KEY "flooding mitigation" OR "flood adaptation" OR
EBSCO Database	"stormwater management" OR "urban planning" AND "impervious
IEEE Database	surfaces" OR "imperviable" AND "residential" OR "area" AND "strategies"
Google Search	OR "policy" OR "regulation" AND (LIMIT-TO PUBYEAR, 2001 to 2023).

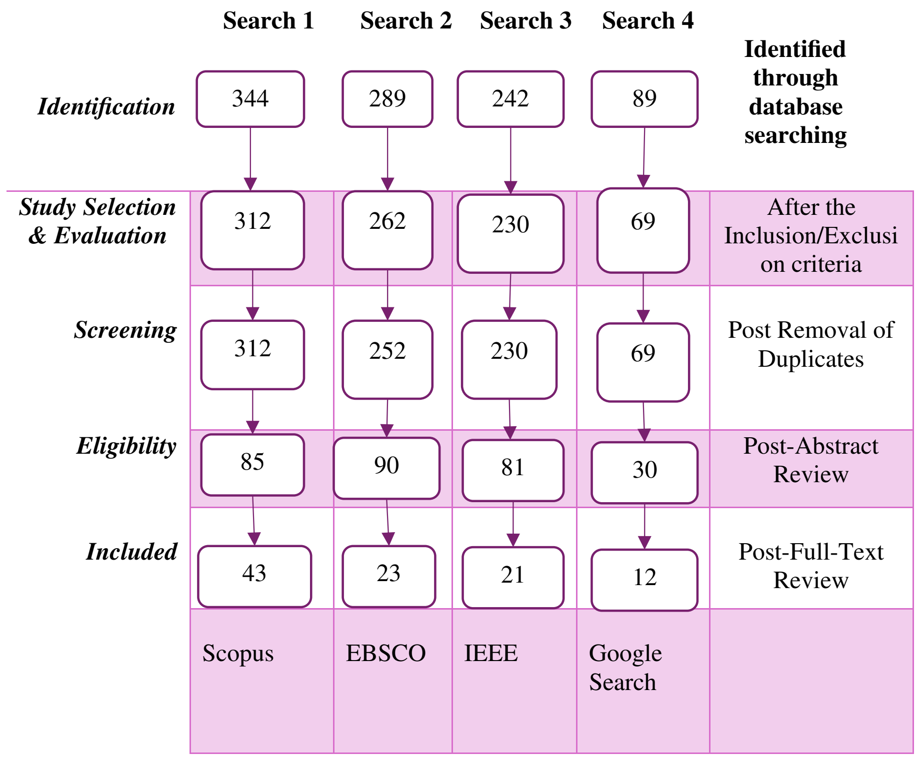

FIGURE 1 | Overview of the process for identifying, selecting, and including papers.

Table 1 shows the keywords used during the search process. The aggregate investigations that were carried out to compile relevant information in the literature were validated by employing this degree of granularity in the database (Bastas and Liyanage 2018). Peer-reviewed journal articles, books, conference proceedings, magazines, news items and government reports were included in the study to ensure that the most reliable sources and publications had examined the issues with exceptional management impact (Rajeev et al. 2017). The study excluded articles not written in English. Additionally, the period from 2001 to 2024 was selected as the target date range to ensure the inclusion of the most recent data available from the sources.

The evaluation phase was structured with distinct sections focusing on Processes, Findings, and Discussion. This structured approach ensures a systematic assessment, aiding readers in understanding the current paper's concept effectively. This allows readers to gain a deeper understanding of how the data are evaluated and to follow both the implications of the evaluation and the data produced as a result (Moshood et al. 2020). The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) procedures were employed (Moher et al. 2009) to facilitate the analysis and screening of the collected studies. The utilisation of the PRISMA approach in this systematic review amplifies the calibre and dependability of the findings by introducing a uniform methodology for conducting, disclosing, and evaluating the chosen studies. By employing this rigorous approach, the goal is to identify adaptable strategies that can be implemented across diverse geographical and socio-economic contexts to mitigate the adverse effects of urbanisation on the natural environment and provide a solid foundation for evidence-based decision-making. The PRISMA process flow, consisting of four sequential steps, is illustrated in Figure 1.

A total of 1276 papers were initially identified through database searching. After removing duplicates, the screening process was conducted, resulting in 863 remaining papers. Upon completion of an initial review of abstracts, a total of 286 papers met the eligibility criteria for further analysis. Subsequently, a thorough full-text review was conducted, leading to the inclusion of 99 papers.

2.2 | Analysis Process

The method described illustrates one of the many feasible ways qualitative types of research might be applied to text results. To conclude the literature review processing, duplicates were eliminated, eligibility was validated based on the titles, and abstracts, and the entire text was assessed in the context of the research topics. The current study's systematic literature evaluation adhered to a structured approach, wherein all 99 publications were scrutinised and assessed for relevance. These publications were then analysed using the ATLAS.ti 9 software package. The software is an intelligent data analysis tool for extracting valuable insights from qualitative data. It is widely considered a potent software for qualitative analysis, particularly in situations involving substantial amounts of textual and graphical data (Moshood et al. 2022). In the current study, the adoption of a qualitative approach was imperative for the effective analysis of the 99 identified articles. This methodological choice facilitated an in-depth examination of flood mitigation strategies, enabling a comprehensive interpretation of the complex implementation contexts and regional variations involved. The qualitative analysis provided deeper insights into the performance of different strategies across various urban settings, allowing for the identification of nuanced patterns related to implementation challenges and solutions that may have been overlooked through a purely quantitative lens. The results from the ATLAS.ti 9 are presented, accompanied by visualisations to facilitate easy understanding.

3 | Discussion of Findings

This section offers an in-depth analysis, providing valuable insights drawn from extensive research. The objective is to identify scalable and adaptable strategies for mitigating the adverse effects of urbanisation on the natural environment across diverse geographical and socio-economic contexts. The insights stem from content analysis of 99 articles sourced from reputable databases, including Scopus, EBSCO, and IEEE, in addition to an extensive search on Google for relevant magazine and news content. The findings from the literature review in this study are summarised rather than presented as exhaustively to enhance readability.

3.1 | Strategic Approaches for Flood Mitigation

The scope of the research, delineated in Table 2, reveals a diversity of strategies, findings from previous studies, geographic locations, and indicators under scrutiny. The findings extracted from the review of the literature summarise an extensive collection of subjects, spanning from the implications of impervious surfaces on flood susceptibility to the efficacy of rainwater harvesting systems and green infrastructure in flood management. It emphasises the importance of sustainable stormwater management practices as an effective means to mitigate flood risks. By implementing strategies that promote the efficient management of stormwater, communities can reduce the likelihood and severity of flooding events, thereby enhancing overall resilience to water-related hazards.

The review also highlights the critical role of impervious surface data in improving the accuracy of hydraulic modelling. Impervious surfaces, such as pavement and rooftops, significantly influence stormwater flow and can exacerbate flooding in urban areas. Researchers and policymakers can better predict and manage flood events by integrating precise data on impervious surfaces into hydraulic models, leading to more informed decision-making and more effective flood mitigation strategies. The research also suggests the efficacy of low-impact development techniques in mitigating flood volumes. These techniques, which prioritise sustainable land use and green infrastructure, offer promising solutions for reducing the adverse impacts of urbanisation on local hydrology. By incorporating features like green roofs, permeable pavement, and rain gardens into urban design, communities can enhance water infiltration, reduce runoff, and mitigate flooding while promoting environmental sustainability.

Adopting a nonstationary framework for regional flood-frequency analysis is essential for accurately assessing flood risks, particularly in unpredictable weather conditions across different geographical locations. Also, recognising the challenges associated with accurately measuring total rainfall due to varying weather conditions, the research advocates for innovative solutions and methodologies to improve precipitation data collection and analysis. Furthermore, the study emphasises the significance of community involvement and policy interventions in fostering flood resilience. Engaging local communities in flood preparedness and response efforts can enhance disaster resilience and promote sustainable development practices. Therefore, leveraging cutting-edge technologies such as machine learning and remote sensing can provide valuable insights into flood dynamics and improve early warning systems, enabling more effective mitigation strategies.

Flooding mitigation involves various strategic approaches to reduce or prevent the impact of floods on communities and infrastructure. When implemented strategically and collaboratively, these strategies contribute to comprehensive flood risk reduction and increased community resilience.

The research scope, illustrated in Table 2 and Figure 2, encompasses various strategic approaches and indicators for flood mitigation, emphasising a holistic approach to enhancing flood resilience and sustainability in urban environments. Key components include sustainable flood management, impervious surfaces management, traditional ecological knowledge, stormwater management simulation models (SWMM), flood simulation and machine learning approaches, and regulations and policies. The scope of this study encompasses a comprehensive analysis of strategies employed in flood mitigation, with a focus on the complexities of these strategies and their implications.

3.1.1 | Sustainable Flood Management Strategy

One of the primary flood mitigation strategies found in the literature review is sustainable flood management. This Strategy integrates nature-based solutions, community engagement, and innovative technologies to enhance flood resilience, minimise environmental impact, and ensure long-term sustainability. Out of 99 papers reviewed, 12 articles were identified as primary sources informing or recommending Sustainable Flood Management Strategies. These papers contribute to various aspects of flood mitigation. Additionally, numerous concepts related to sustainable flood management are recognised

TABLE 2 | List of strategic approaches and indicators for flood mitigation.

Major strategic groups	Implementation strategies	Area/location	References
Sustainable flood management strategy	Urban green infrastructures, Permeable Pavement, Surface permeability, Sponge city flood mitigation, Sponge watersheds, Green roof implementation, Green space downstream, Sustainable urban drainage systems, Infiltration storage facilities, Porous pavement, Best management practices and Low-impact development.	Netherlands, Cambodia, Iraq, UK, Mexico, China, Korea, USA, Indonesia, New Zealand.	(Heng et al. 2021; Twohig et al. 2022; Al-Khuzaie et al. 2023; Khodadad et al. 2023; Yang and Lee 2021; Liang et al. 2019; Suripin et al. 2018; Tauhid and Zawani 2018; Twohig et al. 2022; Sun 2019; Tansar et al. 2024)
Impervious surfaces strategy	Land-use planning, Site-level planning, Monitoring assessment, Regional-Level Planning, Regional flood protection standards, Peak runoff, Optimising impervious surface layout, Expanding LID measures, improving surface design and Hydrologic Modelling System (HEC-HMS).	Korea, Australia, Brazil, Canada, China, New Zealand, Taiwan, USA, India.	(Park et al. 2020; Feng et al. 2020; Deng et al. 2020; Chang et al. 2021; Li and Burian 2022; Hou, Ding, et al. 2022; Sahu et al. 2021; Meng et al. 2022; Zhang 2018; Southworth 2019; Du et al. 2015; Balaian et al. 2024; Du et al. 2015)
Traditional ecological knowledge	Place-based landscape knowledge, Water use and management and Water values, Rainwater harvesting, Awareness, Rural community consultation, and Community-based organisations (CBOs), Land use decisions, Land cover, Risk-aware approach, Floodwall, Gated spillway, Training and Education, Ocean wave barriers and public awareness programmes.	Bangladesh, India, Uganda, South Africa, Japan and China, Brazil, Korea, Portugal, USA, Iran.	(Asad et al. 2022; Noori and Singh 2023; Bwambale et al. 2018; Dewa et al. 2022; Faruk and Maharjan 2022; Marques et al. 2017; Paule-Mercado et al. 2017; Park and Park 2018; Terêncio et al. 2019; Movahednia et al. 2021; Salehi et al. 2022)
Stormwater management simulation model (SWMM) strategy	Urban drainage systems, Rainfall and Runoff approach, Catchment area, Surface runoff and Storage, Zoning regulations, Water sensitive urban design, Low impact development, Nature reserves, Catchment area, Urban sprawl, Sediment transport, Nonstationary, Treatment train approach, Good urban design approach, Drainage design approach.	Ethiopia, USA, Germany, China, UK, Argentina, Turkey, India, Australia, Poland, Egypt, New Zealand.	(Bibi, Reddythta, et al. 2023; Bibi, Rehman, et al. 2023; Qi et al. 2022; Rosenberger et al. 2021; Wang et al. 2021; Prybutok et al. 2021; Flores et al. 2020; Samouei and Özger 2020; Manchikatla and Umamahesh 2022; Dai et al. 2023; Kong et al. 2017; Johnson and Sample 2017; Stillwell et al. 2018; Cao et al. 2023; Wu et al. 2023; Glas et al. 2023; Li et al. 2021; Hassan et al. 2022; Office of Environment and Heritage 2016)

(Continues)

Major strategic groups	Implementation strategies	Area/location	References
Flood simulation and machine learning approaches	High-risk identification, Quick flood detection, Integrated Big and Crowdsource Data, Flood Monitoring, Prediction, and Rescue (FMPR), Long short-term memory (LSTM), Sectional area width, and Sectional average depth, UNet Combined, Synthetic aperture radar (SAR) satellite, Spatiotemporal filter based on low-rank tensor approximation (STF-LRTA), Word processing approach, Pattern-matching approach, Analytical hierarchy process (AHP), Urban flood hazard (UFH) map, Simulation and assessment of projected climate, Hydrological and Mobility data, Infoworks ICM and Mean-flow, MIKE, Lisflood, and FloodMap.	Pakistan, Serbia, USA, China, Thailand, India, France, Brazil, Japan, Italy, Republic of Korea, Poland, Israel, Germany, Saudi Arabia, UK, Cameroon.	(Ahmad et al. 2023; Gigović et al. 2017; Peter et al. 2020; Xue et al. 2022; Puttinaovarat and Horkaew 2020; Kundu et al. 2022; Akhtar et al. 2019; Prakash et al. 2022; Li et al. 2022; Nguyen et al. 2022; Feng et al. 2022; Zortea et al. 2023; Yokoya et al. 2020; Montello et al. 2022; Ma et al. 2022; Wang et al. 2020; Choi et al. 2009; Berezowski et al. 2020; Ziv and Reuveni 2022; Zhou et al. 2020; Nogueira et al. 2018; Krullikowski et al. 2023; Elsebaie et al. 2023; Chakrabortty et al. 2023; Manchikatla and Umamahesh 2022; Hou, Zhang, et al. 2022; Tomás et al. 2022; Ebodé 2022; Aerts 2018; Du et al. 2020; Mohanty et al. 2020)
Regulations and policies	Resilience-based approaches, Stakeholders' approach, River training, Drainage improvement, Flood control, Water purification, Storm regulation, Flood control, carbon fixation, layout of development, Diversion of water, Manage design, Damming of water, Social engagement, Zoning regulations, Regional policies, Stormwater standard regulatory and Policy implementation, Land use regulation.	Canada, Sweden, Japan, Thailand, China, New Zealand.	(Baird et al. 2016; Satoh 2022; Ly et al. 2022; Sawangnate et al. 2022; Liu et al. 2022; Office of Wastewater Management 2011; Bay of Plenty Regional Council 2021; Waikato District Council 2011; Waterproofing Membrane Association 2020; Guideline Document 2017; Auckland Council Technical Report 2013; Stormwater Policy 2020; Auckland Unitary Plan 2020; Bryan et al. 2018)

globally (Al-Khuzaie et al. 2023; Khodadad et al. 2023; Twohig et al. 2022). These include Urban Green Infrastructures, Permeable Pavement Surface permeability, and Sponge City flood mitigation in China. Sponge City Approach (SCA) offers a comprehensive, nature-based solution to address flooding, waterlogging, and other water-related challenges in urban and rural areas. Sponge watersheds, Green roof implementation in Singapore and China, Green space downstream, Sustainable Urban Drainage Systems (SUDS), Infiltration Storage Facilities, Porous Pavement, Best Management Practices, Low-Impact Development in America, Sustainable Urban Drainage Systems in England, and Water-Sensitive Urban Design in Australia. Khodadad et al. (2023) highlight green infrastructure as an effective method to mitigate urban surface water flooding risk. Numerous studies corroborate the efficacy of these measures in both mitigating and adapting to climate change, underscoring their significance in comprehensive flood management strategies (Liang et al. 2019; Suripin et al. 2018; Tauhid and Zawani 2018; Twohig et al. 2022; Yang and Lee 2021). Figure 3 illustrates the sustainable flood management strategy.

3.1.2 | Impervious Surfaces Strategies

Another significant finding from the literature review on flooding mitigation is the impervious surfaces strategies, which have been widely employed globally. Impervious surfaces, which impede water infiltration and increase runoff, are a significant

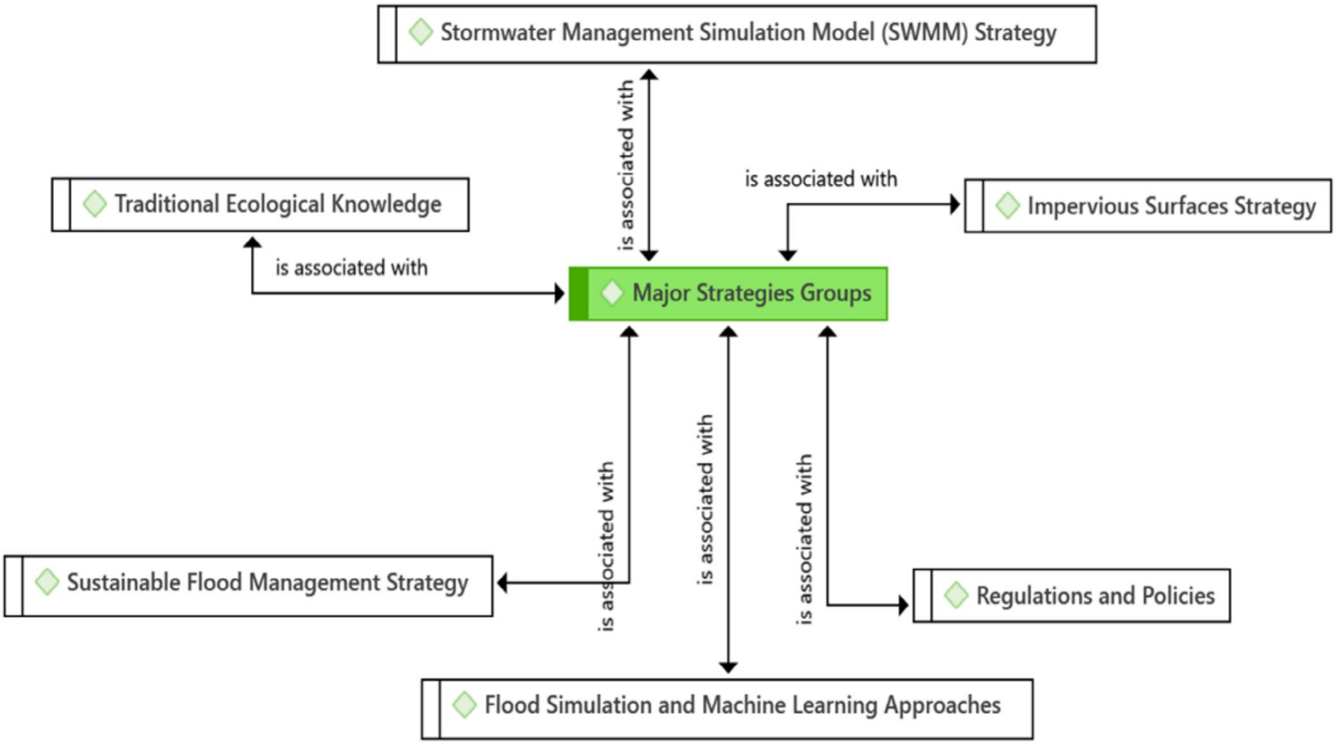

FIGURE 2 | Major strategies identified from the literature review.

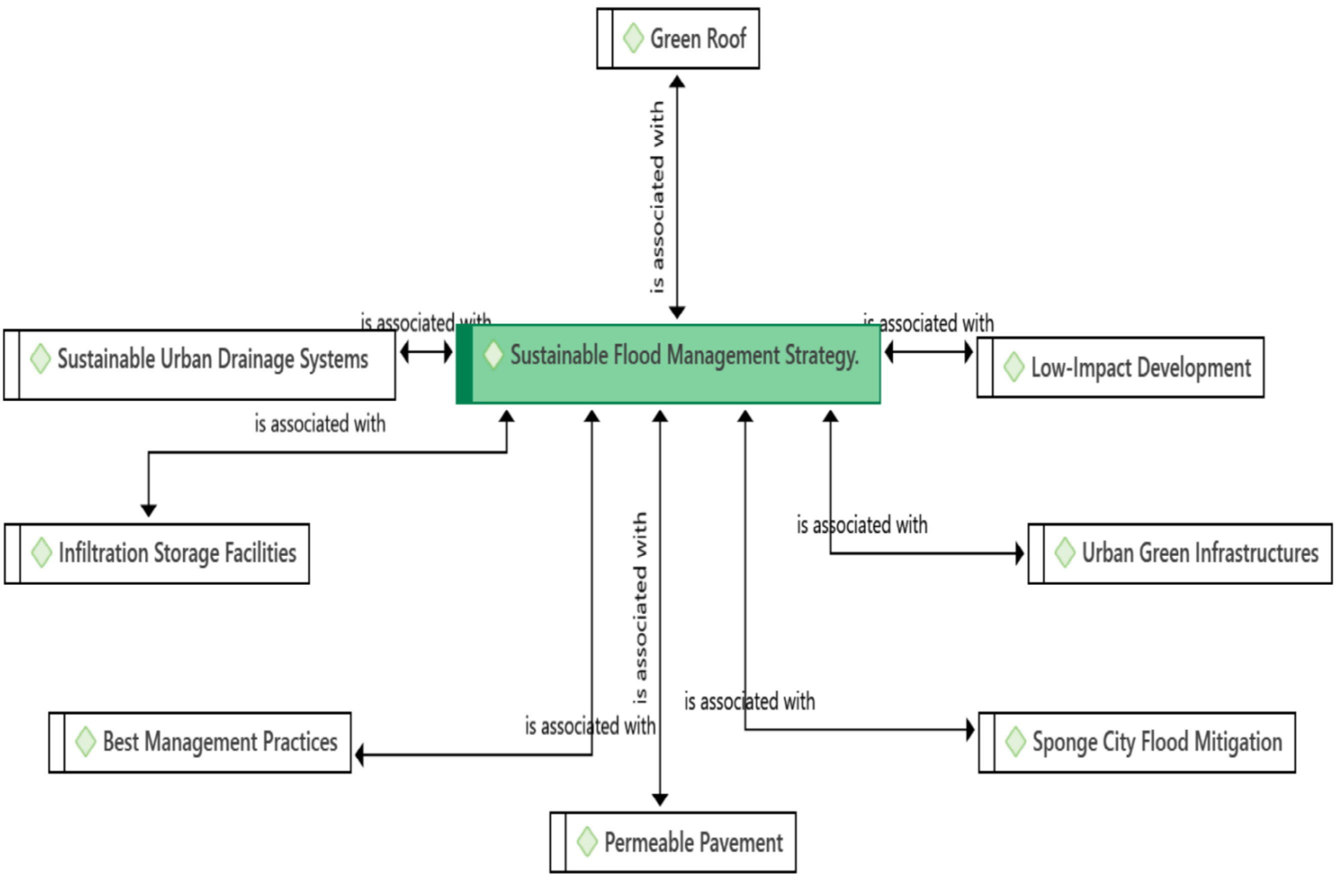

FIGURE 3 | Sustainable flood management strategies identified.

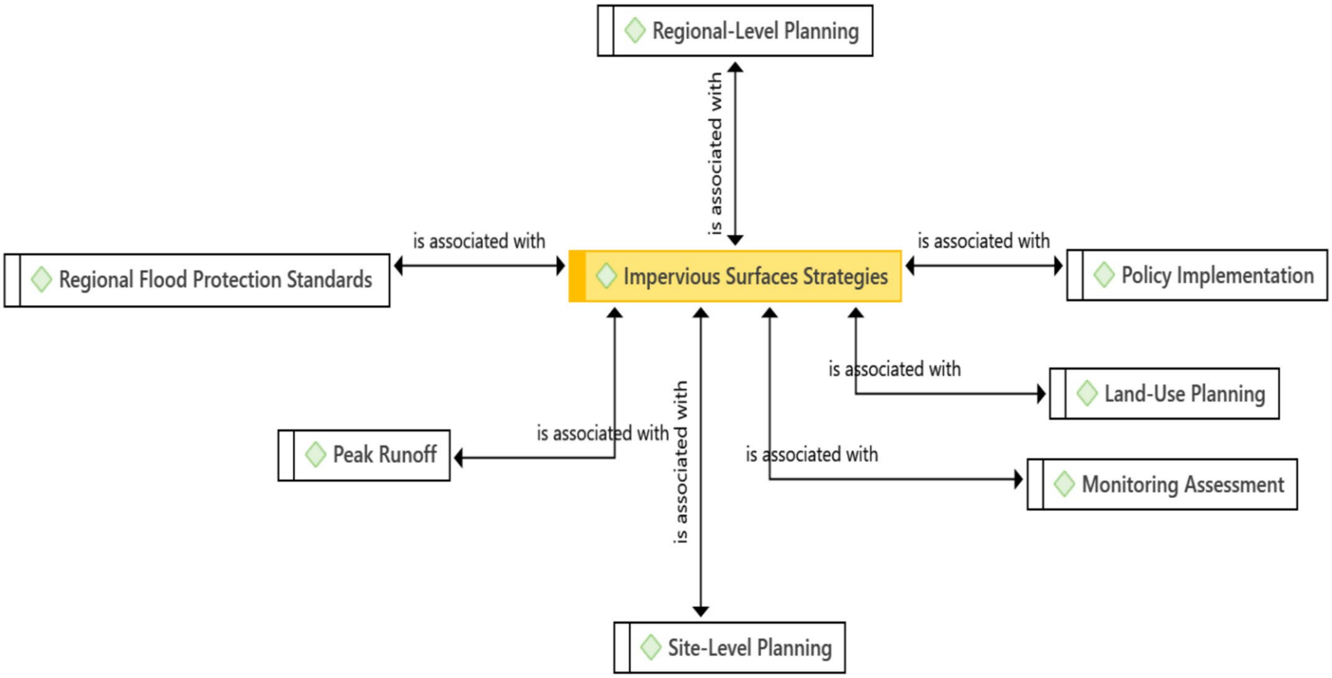

FIGURE 4 | Impervious surfaces strategies.

concern in urban development. Among the 99 papers reviewed, 14 primary articles focused on developing, implementing, or applying strategies to address impervious surfaces. These strategies can be broadly classified into eight groups: Land-use planning, Site-level planning, Policy implementation, Monitoring assessment, Regional-Level Planning, Regional flood protection standards, Floodwall, and Peak runoff, Optimising impervious surface layout, Expanding LID measures, improving surface design and Hydrologic Modelling System (HEC-HMS) (Balaian et al. 2024; Chang et al. 2021; Deng et al. 2020; Du et al. 2015; Feng et al. 2020; Park et al. 2020). Each category presents opportunities to reconsider conventional approaches and prioritise the protection of water resources. The following paragraphs include the outline of general concepts and specific examples within each category that offer promising pathways for implementation. These strategies aim to mitigate increased surface runoff, enhance groundwater recharge, and restore natural hydrological patterns. However, addressing these challenges in community-level planning requires grappling with complex technical considerations, including pollutant loadings, hydrologic modelling, and the effectiveness of various management practices, as noted by Chang et al. (2021), Deng et al. (2020), Feng et al. (2020), and Park et al. (2020).

According to Meng et al. (2022), impervious coverage emerges as a practical and cost-effective solution for planners seeking to protect water resources. Its integrative nature enables the estimation of cumulative water resource impacts, simplifying the complexities associated with nonpoint source pollution. While Meng et al. (2022) emphasised that impervious surfaces themselves do not generate pollution, they do exert significant influence on hydrologic changes. They intensify land uses that generate pollution, impede natural pollutant processing in the soil, and efficiently transport pollutants into waterways. Research consistently demonstrates a strong correlation between the imperviousness of a drainage basin and the health of its receiving stream. Studies, including those by Li and Burian (2022) and Hou, Ding, et al. (2022) emphasise that even relatively low levels of imperviousness (10%–20%) can lead to stream degradation and impair freshwater wetland habitat quality. Impervious coverage emerges as a reliable and integrative indicator of the developmental impact on water resources. Its measurable nature enhances its utility in planning and regulatory applications, providing a range of techniques for impervious coverage measurement adaptable to various scales and applications. Figure 4 depicts the impervious surfaces strategies extracted from the literature.

3.1.3 | Traditional Ecological Knowledge

Based on the literature review, Traditional Ecological Knowledge (TEK) encompasses the wisdom, practices, and knowledge passed down through generations by indigenous and local communities (Bwambale et al. 2018). As the importance of resilience to natural hazards grows, along with a renewed emphasis on culture in disaster risk management, approaches tied to traditional ecological knowledge become increasingly pertinent. Out of 99 papers, 11 primarily centre on traditional environmental knowledge in mitigating residential flooding risk. Strategies related to traditional ecological knowledge include place-based landscape knowledge, water use and management, water values, rainwater harvesting, awareness, rural community consultation, and community-based organisations (CBOs), Land use decisions, Land cover, Risk-aware approach, Floodwall, Gated spillway, Training and Education, Ocean wave barriers and public awareness programmes (Balaian et al. 2024; Du et al. 2015; Southworth 2019). Bwambale et al. (2018) underscore that the Traditional Ecological Knowledge strategy encompasses indigenous wisdom derived from interactions between indigenous communities and their ecosystems. This knowledge transcends specific ecosystems, offering a broader understanding of the environment, hence also referred to as 'traditional environmental knowledge'. Asad et al. (2022) highlight that

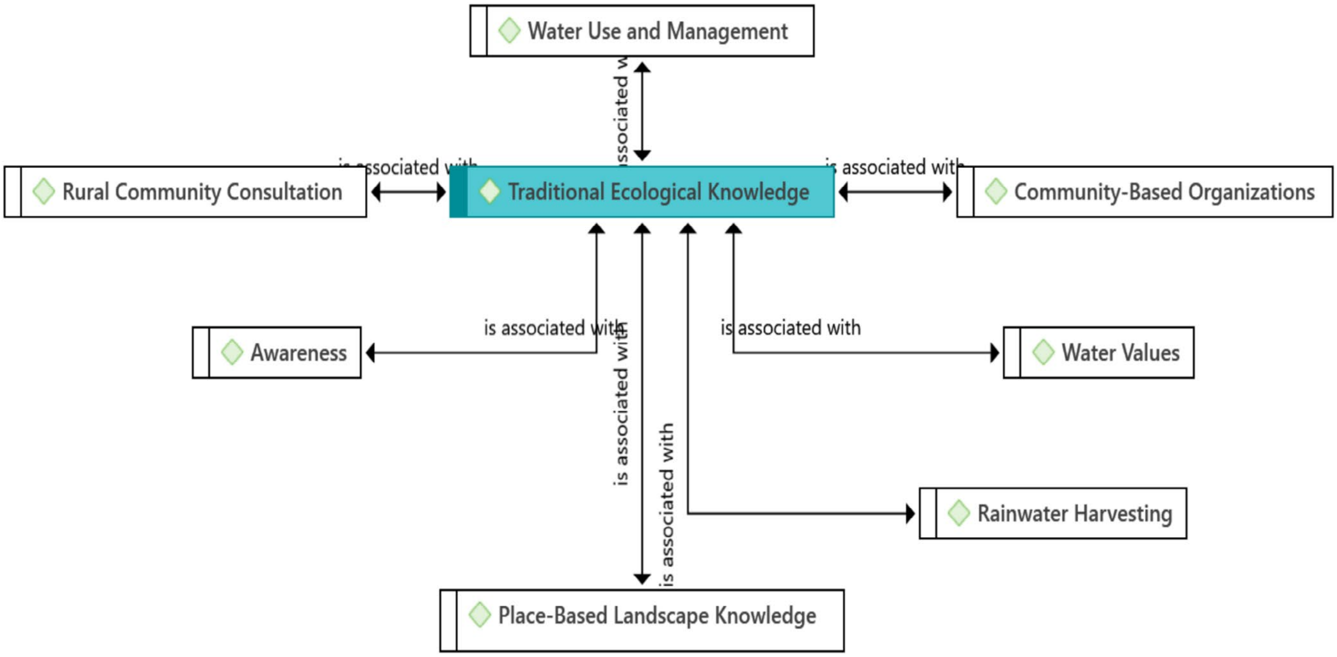

FIGURE 5 | Traditional ecological knowledge.

riverine communities, in particular, have extensive interactions with flood events and hydrological systems, particularly during rainy seasons. Over time, these communities accumulate intimate perceptions and experiences through observation, sharing, monitoring, and evaluating flood hazards, thereby contributing to their resilience and adaptive strategies. Figure 5 depicts the traditional ecological knowledge strategy.

3.1.4 | Stormwater Management Simulation Model (SWMM) Strategy

Stormwater management is also one of the primary strategic findings for flooding mitigation. It encompasses the planning and implementing strategies to effectively control and mitigate the impact of stormwater, addressing both its quality and quantity. The Stormwater Management Practices Strategy is a comprehensive plan designed to effectively and sustainably manage stormwater within a specific area or community. Out of 99 papers reviewed, 18 papers focused on various aspects of this strategy. These papers discussed topics such as urban drainage systems, rainfall–runoff, catchment areas, surface runoff and storage, zoning regulations, water-sensitive urban design, low-impact development, nature reserves, urban sprawl, sediment transport, and approaches like the treatment train approach, good urban design approach, drainage design approach, and rainfall and runoff approach to mitigate residential flooding. According to Li et al. (2021), this strategy seamlessly integrates an array of practices, policies, and initiatives, all directed towards alleviating the adverse impacts of stormwater runoff on the environment, water quality, and local infrastructure. The effective execution of this strategy hinges on implementing sustainable stormwater management practices. Seminally, Stillwell et al. (2018) show that concrete examples of these practices include establishing rain gardens and bio-retention basins specifically designed to capture and treat runoff. Furthermore, constructing detention basins and retention ponds is pivotal, providing a means to store excess stormwater and prevent temporary downstream flooding. By embracing these practices, the strategy aspires to achieve a harmonious balance between stormwater management, environmental conservation, and infrastructure resilience.

According to Manchikatla and Umamahesh (2022), as a fundamental component of this strategy, stormwater management works towards reducing the risk of flooding by thoroughly managing both the volume and rate of runoff from urban areas. Implementation measures span across detention basins, infiltration trenches, and green roofs. Wang et al. (2021) emphasised that stormwater management goes beyond flood risk mitigation, playing a crucial role in improving waterway quality and preventing erosion.

It also can potentially create green spaces and habitats for urban wildlife, enhancing environmental quality. Moreover, the study by Cao et al. (2023) confirms that stormwater management practices contribute to economic benefits by reducing flood damage costs, enhancing water quality, and increasing property values. According to Prybutok et al. (2021), Stormwater management simulation model practices strategy is essential for safeguarding water quality, fostering urban environmental health, and generating diverse economic and social advantages. Figure 6 illustrates the strategy for stormwater management simulation model strategy.

3.1.5 | Flood Simulation and Machine Learning Approaches

Out of 99 papers reviewed, 31 delved into Flood Simulation and Machine Learning Approaches. These encompass various applications such as identifying high-risk areas, rapidly detecting

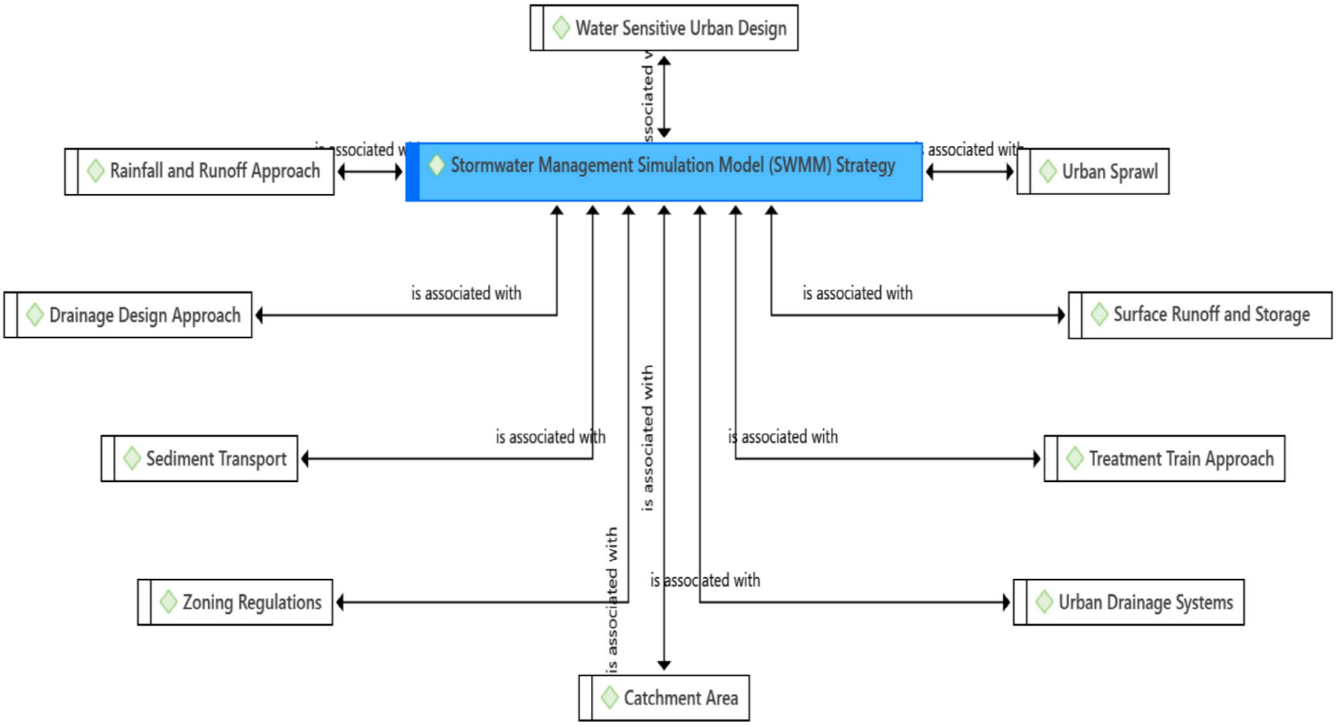

FIGURE 6 | Stormwater management simulation model practices strategy.

floods, and monitoring flood occurrences. Additionally, they include the integration of large datasets and crowdsource information for improved flood prediction and rescue efforts. Long short-term memory (LSTM) networks are also employed as part of these techniques to enhance predictive capabilities, Sectional area width, and Sectional average depth, UNet Combined, Synthetic Aperture Radar (SAR) satellite, Spatio-Temporal Filter based on Low-Rank Tensor Approximation (STF-LRTA), Word processing approach, Pattern-matching approach, Analytical Hierarchy Process (AHP), Urban Flood Hazard (UFH) map, The simulation and evaluation of projected climate, hydrological, and mobility data, Infoworks ICM and Mean-flow, MIKE, Lisflood, and FloodMap are crucial for mitigating flooding (Aerts 2018; Ahmad et al. 2023; Du et al. 2020; Gigović et al. 2017; Mohanty et al. 2020; Peter et al. 2020; Puttinaovarat and Horkaew 2020). Floods, a longstanding natural disaster, have intensified in recent years due to climate change. Therefore, Ahmad et al. (2023) assert that the development of precise numerical tools for simulating these events is imperative. These tools must strike a balance between accuracy and computational efficiency to provide timely and reliable results. The insights derived from these numerical models enable decision-makers to design resilient infrastructure and anticipate the severity of impending extreme events. Consequently, appropriate measures can be implemented to minimise economic and human losses associated with flooding. Figure 7 depicts the flood simulation and machine learning approaches.

3.1.6 | Regulations and Policies: A Comprehensive Approach

Regulations and Policies also emerged as one of the strategies identified from the literature review. Regulations and policies related to flood mitigation encompass a wide array of laws, rules, and guidelines established by governments and regulatory bodies to manage and reduce the risks associated with flooding. Out of 99 reviewed papers, 14 articles focused on regulations and policies. These papers primarily addressed resilience-based approaches, stakeholder engagement, river training, drainage improvement, flood control, water purification, storm regulation, carbon fixation, development layout, water diversion, design management, dam construction, social engagement, regional policies, stormwater standard regulations worldwide, and land use regulation (Auckland Council Technical Report 2013; Auckland Unitary Plan 2020; Bryan et al. 2018; Stormwater Policy 2020).

Ly et al. (2022) emphasised that implementing regulations and policies necessitates a comprehensive and cohesive strategy to address the complex challenges posed by impermeable materials in urban and environmental settings. Similarly, Satoh (2022) highlighted that this approach aims to establish effective regulations, guidelines, and practices to mitigate the impact of impervious surfaces on stormwater runoff, water quality, and overall environmental health. Furthermore, Sawangnate et al. (2022) stated that by embracing this holistic perspective, the regulatory framework seeks to balance the imperatives of urban development with the need to preserve ecological integrity.

According to Bay of Plenty Regional Council (2021), enhancing planning strategies at community and site levels can involve integrating specific applications to align planning objectives with regulatory measures. One crucial aspect involves reevaluating existing zoning and subdivision requirements by considering imperviousness. For instance, current lot coverage limits, especially in residential zones, may only address rooftops while disregarding impervious surfaces such as parking areas, sidewalks, and driveways. Based on the Auckland Council Technical

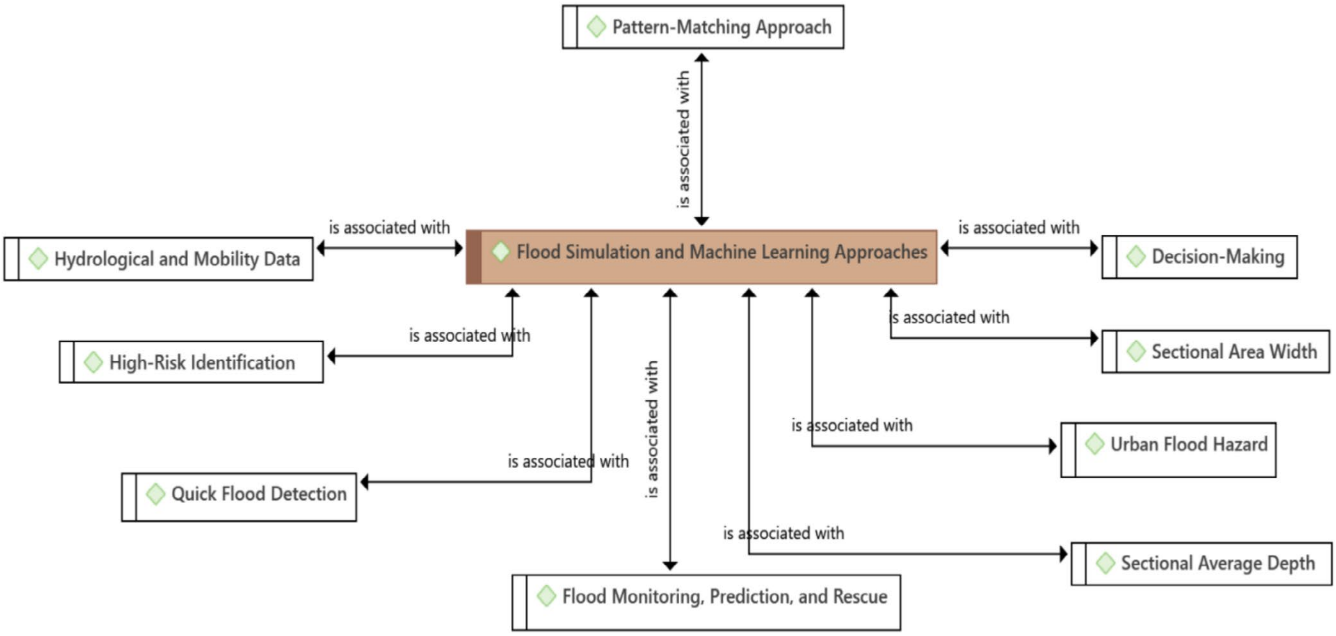

FIGURE 7 | Flood simulation and machine learning approaches.

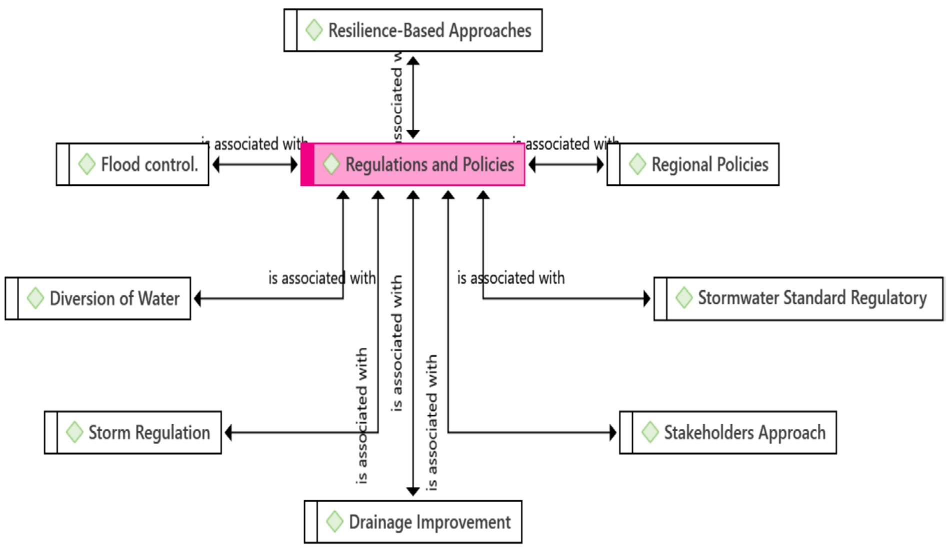

FIGURE 8 | Regulations and policies.

Report (2013), employing impervious cover as a benchmark is conducive to performance-based zoning, promoting mixed-use development that inherently lowers impervious coverage and associated pollution by reducing road infrastructure and vehicular traffic. In community-wide applications covering various land uses, the regulatory strategy involves sliding scales of impervious coverage limits. These limits adjust dynamically based on location, size, and type of use.

Furthermore, based on the suggestion of Sawangnate et al. (2022), incentivising sustainable design becomes a pivotal component of the regulatory framework. These incentives, whether tax breaks or development bonuses, encourage projects incorporating sustainable design practices, reducing impervious cover and promoting environmentally conscious development. Figure 8 depicts the regulations and policies.

3.2 | Coverage Area and Diverse Strategies Employed

These analyses offer valuable insights into a wide array of strategies and their geographic applications geared towards mitigating flooding and bolstering resilience in diverse regions worldwide based on the 99 papers reviewed. One such strategy, Sustainable Flood Management, prioritises the adoption of sustainable practices such as urban green infrastructures, permeable pavement, green roofs, and low-impact development techniques. This approach has been successfully implemented in countries including the Netherlands, Cambodia, Iraq, Mexico, Korea, the USA, UK, New Zealand, and Indonesia.

The Impervious Surfaces Strategy is a comprehensive urban planning and environmental management approach that deals

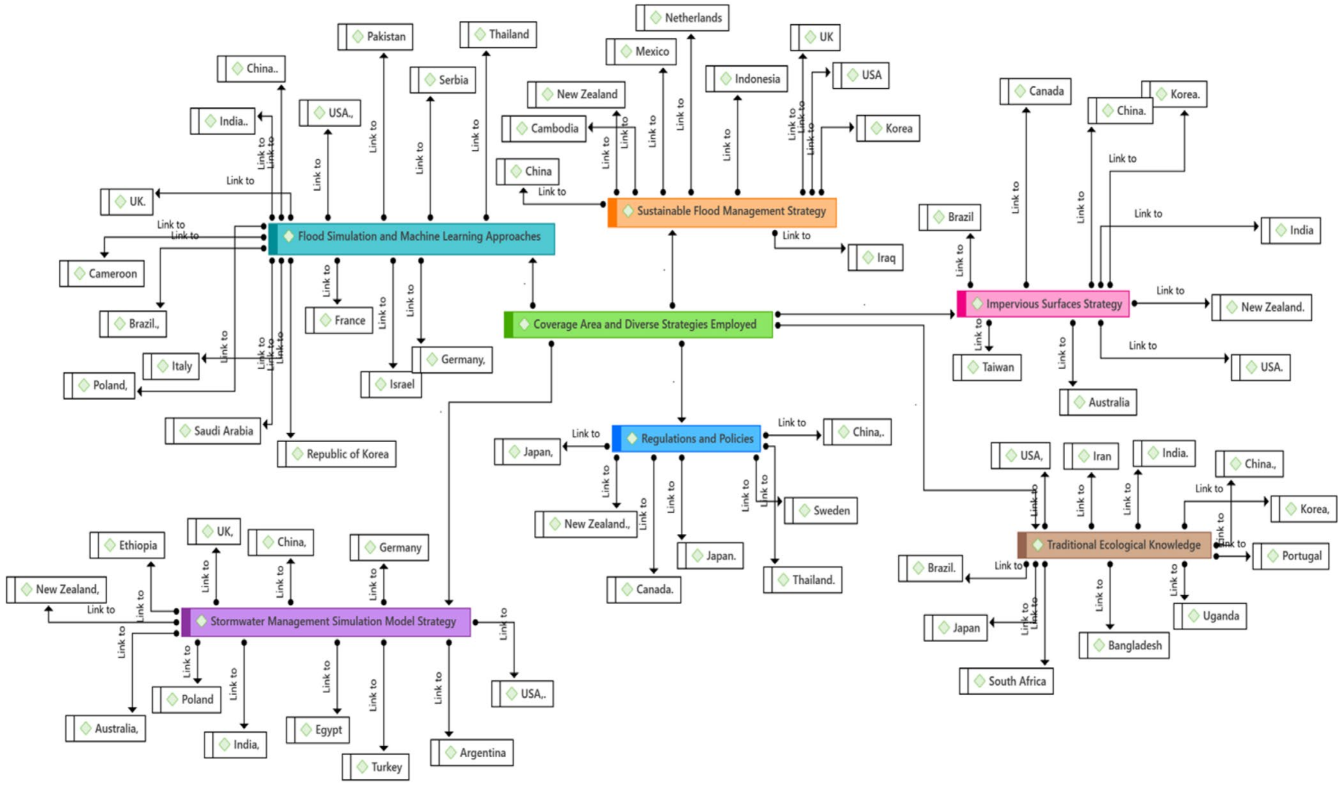

FIGURE 9 | Coverage area and strategies employed.

with surfaces that do not allow water to penetrate the ground. Implemented in countries such as Korea, Brazil, New Zealand, Canada, China, Taiwan, the USA, and India, this strategy underscores a global commitment to proactive measures for flood prevention and resilience building.

The utilisation of Traditional Ecological Knowledge (TEK) represents a holistic approach to flood mitigation that combines centuries-old environmental wisdom with modern practice. This approach has been effectively applied in countries such as Bangladesh, India, Uganda, South Africa, and Japan, where local knowledge and community engagement play pivotal roles in sustainable flood management practices.

Flood Simulation and Machine Learning Approaches employ a sophisticated array of tools including high-risk identification, flood monitoring systems, machine learning methodologies, and simulation models to accurately predict and effectively manage floods. Successful implementation has been recorded in countries like Pakistan, Serbia, the USA, China, Thailand, India, France, Brazil, Japan, Italy, the Republic of Korea, Poland, Israel, Germany, Saudi Arabia, and Cameroon. This widespread adoption underscores the global recognition of the importance of leveraging technology and data-driven solutions to address the challenges posed by flooding and enhance resilience against its impacts.

The Stormwater Management Simulation Model (SWMM) Strategy integrates urban drainage systems, rainfall and runoff methodologies, zoning regulations, low-impact development practices, and advanced simulation models to enhance flood management effectiveness. In various countries around the world, including Ethiopia, the USA, Germany, China, Argentina, Turkey, India, Australia, New Zealand, Poland, and Egypt, innovative strategies have been successfully implemented to tackle stormwater issues and improve resilience against flooding. This approach demonstrates a global commitment to finding effective solutions to these challenges.

Lastly, Regulations and Policies leverage resilience-based approaches, stakeholder engagement strategies, and regulatory frameworks to facilitate effective flood control and management. This comprehensive approach has been successfully implemented in countries such as Canada, Sweden, Japan, Thailand, China, and New Zealand. By emphasising collaboration among stakeholders and implementing robust regulatory measures, these nations demonstrate a commitment to enhancing flood resilience and ensuring the sustainable management of water resources. Figure 9 illustrates the coverage area and employed strategies.

3.3 | Practical Implications

From the foregoing discussions, this study offers practical guidance for flood management practitioners, by indicating that effective flood mitigation necessitates an integrated approach that could encompass six key strategies: Sustainable Flood Management Strategies (SFMS), Impervious Surfaces Strategies (ISS), Traditional Ecological Knowledge, Flood Simulation and Machine Learning Approaches, Stormwater Management Simulation Model (SWMM) Strategy, and the establishment of supporting Regulations and Policies. It may be argued that the strategy covering Imperious Surfaces solutions includes both technical (e.g., reducing peak runoff) and policy (e.g., regional-level planning) aspects. However, the models are typically used to inform different strategy developments. Some practical applications include implementing green infrastructure solutions, such as rain gardens and bioswales, at the property level, alongside developing supportive policy frameworks at the municipal level. These nature-based solutions not only aid in flood control but also provide multiple additional benefits, including the enhancement of biodiversity, improvement in air and water quality, and increased carbon sequestration.

The success of these strategies is contingent upon robust collaboration among property owners, local authorities, and urban planners, particularly in adapting approaches to specific geographical contexts. As urban areas increasingly confront climate-related challenges, this research underscores the necessity of adopting innovative and multifaceted flood management strategies that harmonise technological solutions with community engagement and policy reform.

4 | Conclusion

The aim of this study is to highlight the diverse approaches to managing the risks associated with flooding and categorise these global strategies for effective urban planning and environmental management. The study synthesised research spanning over two decades (2001–2024), focusing on the pivotal realm of flood reduction strategies. This exhaustive analysis not only highlights the multifaceted approaches to mitigating flooding risk but has also categorised the strategies into coherent subcategories, which offer a comprehensive roadmap for urban planning and environmental management. Furthermore, the categorisation underscores the nuanced application and implementation of the strategies tailored to meet the diverse needs of geographical locations with varying characteristics and vulnerabilities. The dynamic nature of urban environments and the evolving threat of climate change necessitate ongoing inquiry and adaptation of extant strategies.

Central to the findings of the study is the realisation that six flood mitigation strategies could address the escalating challenges posed by urban flooding. These include Sustainable Flood Management Strategies (SFMS), Impervious Surfaces Strategies (ISS), Traditional Ecological Knowledge, Flood Simulation and Machine Learning Approaches, Stormwater Management Simulation Model (SWMM) Strategy, and Regulations and Policies. The integration of these strategies showcases a paradigm shift towards embracing more holistic and sustainable urban planning methodologies. These findings can be invaluable to policymakers, urban planners, and environmentalists working towards creating more resilient communities. Particularly notable is Figure 9, which shows the various strategies and the countries where they have been widely implemented. This information could assist in selecting strategies appropriate for similar geographical locations.

The presented systematic literature review condenses recent years of academic research into practical recommendations, enabling decision-makers to prioritise the resilience, sustainability, and welfare of their respective urban communities. Communities have the potential to utilise these findings to take measures to reduce the flood risk in their area. For instance, property owners can create green infrastructure, such as rain gardens and bioswales, which can help minimise runoff and reduce flooding. Communities can also collaborate with local authorities to support policies and regulations that promote the application of green infrastructure and other flood mitigation techniques. Implementing measures to reduce the flood risk, communities can safeguard their homes and businesses from potential damage and enhance the safety of their residents.

Exploring ways to increase resilience, incorporating green infrastructure and nature-based solutions has emerged as a promising area of study. These approaches have the potential to boost urban biodiversity, enhance air and water quality, and support carbon sequestration, while simultaneously reducing the risk of floods. Thus, a comprehensive approach to sustainable urban development. The findings of this study further underline the importance of adopting multifaceted approaches to flood risk management, especially those that integrate technological innovations, community engagement, and policy reforms. The challenge ahead is formidable, yet with concerted effort and ongoing research, we can realise a new era of urban development where flood risks are mitigated, and communities thrive in harmony with their natural environments.

This study has some limitations that suggest directions for future research. First, given the focus on flood mitigation strategies, future research could expand the review by investigating specific zoning requirements concerning flood risk exposure. In addition, future research could explore the interaction between these strategies and emerging technologies, such as smart urban planning tools and advanced materials and methods for reducing impervious surfaces. Also, future research could build upon these findings by incorporating quantitative metrics such as bibliometric analysis, strategy effectiveness measurements, and temporal trend analysis to provide additional empirical evidence for decision-making in flood risk management. Moreover, the role of community involvement and social equity in the successful implementation of these strategies deserves deeper investigation to ensure that flood management solutions are inclusive and accessible to all segments of society.

Acknowledgements

The research work is supported by a contestable research fund granted by the Faculty of Design and Creative Technology, Auckland University of Technology, New Zealand, and is gratefully acknowledged. Open access publishing facilitated by Auckland University of Technology, as part of the Wiley - Auckland University of Technology agreement via the Council of Australian University Librarians.

Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

References

Aerts, J. 2018. "A Review of Cost Estimates for Flood Adaptation." *Water* 10, no. 11: 1646.

Ahmad, M. N., Z. Shao, and A. Javed. 2023. "Mapping Impervious Surface Area Increase and Urban Pluvial Flooding Using Sentinel Application Platform (SNAP) and Remote Sensing Data." *Environmental Science and Pollution Research* 30, no. 60: 125741–125758.

Akhtar, N., A. Rehman, M. Hussnain, et al. 2019. "Hierarchical Coloured Petri-Net Based Multi-Agent System for Flood Monitoring, Prediction, and Rescue (FMPR)." *IEEE Access* 7: 180544–180557.

Al-Khuzaie, A. H., I. J. Alyaseri, and B. K. Nile. 2023. "Flood Reduction Using Green Infrastructure in Stormwater Sewer Systems: A Case Study in Al-Samawa City." *AIP Conference Proceedings* 2631, no. 1.

Armstrong, K. 2024. "New Zealand Flooding: Fears of Further Damage as New Alerts Issued."

Asad, R., I. Ahmed, J. Vaughan, and J. von Meding. 2022. "Traditional Water Knowledge: Challenges and Opportunities to Build Resilience to Urban Floods." *International Journal of Disaster Resilience in the Built Environment* 13, no. 1: 1–13.

Auckland Council Technical Report. 2013. *Auckland Unitary Plan Stormwater Management Provisions: Technical Basis of Contaminant and Volume Management Requirements*. Auckland Council Technical Report.

Auckland Unitary Plan. 2020. "Proposed Plan Change 78 (PC78) to the Auckland Unitary Plan (Operative in Part)." file:///C:/Users/taofe/OneDrive-MasseyUniversity/Newz(1)/FloodingDoc/1significant-natural-hazards-flooding.pdf.

Baird, J., A. Dzyundzyak, R. Plummer, et al. 2016. "Ecosystem Perceptions in Flood Prone Areas: A Typology and Its Relationship to Preferences for Governance." *Water* 8, no. 5: 191.

Balaian, S. K., B. F. Sanders, and M. J. Abdolhosseini Qomi. 2024. "How Urban Form Impacts Flooding." *Nature Communications* 15, no. 1: 6911.

Bastas, A., and K. Liyanage. 2018. "Sustainable Supply Chain Quality Management: A Systematic Review." *Journal of Cleaner Production* 181: 726–744.

Bay of Plenty Regional Council. 2021. "Stormwater Management Guidelines for the Bay of Plenty Region." file:///C:/Users/taofe/OneDrive-MasseyUniversity/Newz(1)/FloodingDoc/10guidelines-2012-01-stormwater-management-guidelines-for-the-bay-of-plenty-region2.pdf.

Berezowski, T., T. Bieliński, and J. Osowicki. 2020. "Flooding Extent Mapping for Synthetic Aperture Radar Time Series Using River Gauge Observations." *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing* 13: 2626–2638.

Bibi, T. S., D. Reddythta, and A. S. Kebebew. 2023. "Assessment of the Drainage Systems Performance in Response to Future Scenarios and Flood Mitigation Measures Using Stormwater Management Model." *City and Environment Interactions* 19: 100111. https://doi.org/10.1016/j.cacint.2023.100111.

Bibi, T. S., S. Rehman, and I. Rehman. 2023. "Urbanization and Water Management: Challenges and Opportunities." In *Advances in Water Resources Management*, edited by S. Rehman and I. Rehman. Springer.

Biratu, A. A., B. Bedadi, S. G. Gebrehiwot, et al. 2022. "Impact of Landscape Management Scenarios on Ecosystem Service Values in Central Ethiopia." *Land* 11, no. 8: 1266.

Bryan, B. A., L. Gao, Y. Ye, et al. 2018. "China's Response to a National Land-System Sustainability Emergency." *Nature* 559, no. 7713: 193–204.

Bwambale, B., M. Muhumuza, and M. Nyeko. 2018. "Traditional Ecological Knowledge and Flood Risk Management: A Preliminary Case Study of the Rwenzori." *Jàmbá: Journal of Disaster Risk Studies* 10, no. 1: 1–10.

Cao, R., P. Feng, Y. Han, Z. Liu, X. Huang, and F. Li. 2023. "A Flood-Attenuating Impervious Surface Layout Planning Framework: Integrated Storm Water Management Model With Harmony Search." *Journal of Water Resources Planning and Management* 149, no. 7: 4023025.

Chakrabortty, R., S. C. Pal, D. Ruidas, P. Roy, A. Saha, and I. Chowdhuri. 2023. "Living With Floods Using State-of-the-Art and Geospatial Techniques: Flood Mitigation Alternatives, Management Measures, and Policy Recommendations." *Water* 15, no. 3: 558.

Chang, H.-S., Q. Su, and T. Katayama. 2021. "Research on Establishment of the Region Flood Protection Standard—A Case of Watershed of Dajiaxi, Taiwan." *Urban Water Journal* 18, no. 3: 173–182.

Choi, Y., C.-T. Huang, and M. G. Gouda. 2009. "Stabilization of Flood Sequencing Protocols in Sensor Networks." *IEEE Transactions on Parallel and Distributed Systems* 21, no. 7: 1042–1055.

Dai, K., S. Shen, C. Cheng, and Y. Song. 2023. "Integrated Evaluation and Attribution of Urban Flood Risk Mitigation Capacity: A Case of Zhengzhou, China." *Journal of Hydrology: Regional Studies* 50: 101567.

Dawson, R. J., L. Speight, J. W. Hall, S. Djordjevic, D. Savic, and J. Leandro. 2008. "Attribution of Flood Risk in Urban Areas." *Journal of Hydroinformatics* 10, no. 4: 275–288.

Deng, J., H. Yin, F. Kong, J. Chen, I. Dronova, and Y. Pu. 2020. "Determination of Runoff Response to Variation in Overland Flow Area by Flow Routes Using UAV Imagery." *Journal of Environmental Management* 265: 109868.

Dewa, O., D. Makoka, and O. Ayo-Yusuf. 2022. "A Deliberative Rural Community Consultation to Assess Support for Flood Risk Management Policies to Strengthen Resilience in Malawi." *Water* 14, no. 6: 874.

Du, S., P. Scussolini, P. J. Ward, et al. 2020. "Hard or Soft Flood Adaptation? Advantages of a Hybrid Strategy for Shanghai." *Global Environmental Change* 61: 102037.

Du, S., P. Shi, A. Van Rompaey, and J. Wen. 2015. "Quantifying the Impact of Impervious Surface Location on Flood Peak Discharge in Urban Areas." *Natural Hazards* 76: 1457–1471.

Ebodé, V. B. 2022. "Hydrological Variability and Flood Risk in a Forest Watershed Undergoing Accelerated Urbanization: The Case of Mefou (South Cameroon)." *Water Supply* 22, no. 12: 8778–8794.

Elsebaie, I. H., A. Q. Kawara, and A. O. Alnahit. 2023. "Mapping and Assessment of Flood Risk in the Wadi Al-Lith Basin, Saudi Arabia." *Water* 15, no. 5: 902.

Faruk, M. O., and K. L. Maharjan. 2022. "Impact of Farmers' Participation in Community-Based Organizations on Adoption of Flood Adaptation Strategies: A Case Study in a Char-Land Area of Sirajganj District Bangladesh." *Sustainability* 14, no. 14: 8959.

Feng, B., J. Wang, Y. Zhang, B. Hall, and C. Zeng. 2020. "Urban Flood Hazard Mapping Using a Hydraulic–GIS Combined Model." *Natural Hazards* 100: 1089–1104.

Feng, H., L. Zhang, J. Dong, et al. 2022. "Mapping the 2021 October Flood Event in the Subsiding Taiyuan Basin by Multitemporal SAR Data." *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing* 15: 7515–7524.

Ferguson, B. K. 1995. "Storm-Water Infiltration for Peak-Flow Control." *Journal of Irrigation and Drainage Engineering* 121, no. 6: 463–466.

Flores, A. P., L. Giordano, and C. A. Ruggerio. 2020. "A Basin-Level Analysis of Flood Risk in Urban and Periurban Areas: A Case Study in the Metropolitan Region of Buenos Aires, Argentina." *Heliyon* 6, no. 8: e04517. https://doi.org/10.1016/j.heliyon.2020.e04517.

Gigović, L., D. Pamučar, Z. Bajić, and S. Drobnjak. 2017. "Application of GIS-Interval Rough AHP Methodology for Flood Hazard Mapping in Urban Areas." *Water* 9, no. 6: 360.

Glas, R., J. Hecht, A. Simonson, C. Gazoorian, and C. Schubert. 2023. "Adjusting Design Floods for Urbanization Across Groundwater-Dominated Watersheds of Long Island, NY." *Journal of Hydrology* 618: 129194.

Gregory, J. H., M. D. Dukes, P. H. Jones, and G. L. Miller. 2006. "Effect of Urban Soil Compaction on Infiltration Rate." *Journal of Soil and Water Conservation* 61, no. 3: 117–124.

Guideline Document. 2017. "Stormwater Management Devices in the Auckland Region." file:///C:/Users/taofe/OneDrive-MasseyUniversity/Newz(1)/FloodingDoc/6GD01SWMD(Amendment2).pdf.

Hassan, B. T., M. Yassine, and D. Amin. 2022. "Comparison of Urbanization, Climate Change, and Drainage Design Impacts on Urban Flashfloods in an Arid Region: Case Study, New Cairo, Egypt." *Water* 14, no. 15: 2430.

Heng, S., S. Ly, S. Chhem, and P. Kruy. 2021. "Analysis of Public Perceptions on Urban Flood in Phnom Penh, Cambodia." In *Water Security in Asia: Opportunities and Challenges in the Context of Climate Change*, 687–701. Springer.

Hou, J., Y. Zhang, J. Xia, et al. 2022. "Simulation and Assessment of Projected Climate Change Impacts on Urban Flood Events: Insights From Flooding Characteristic Metrics." *Journal of Geophysical Research: Atmospheres* 127, no. 3: e2021JD035360.

Hou, Y., W. Ding, C. Liu, et al. 2022. "Influences of Impervious Surfaces on Ecological Risks and Controlling Strategies in Rapidly Urbanizing Regions." *Science of the Total Environment* 825: 153823.

Johnson, R. D., and D. J. Sample. 2017. "A Semi-Distributed Model for Locating Stormwater Best Management Practices in Coastal Environments." *Environmental Modelling & Software* 91: 70–86.

Khodadad, M., I. Aguilar-Barajas, and A. Z. Khan. 2023. "Green Infrastructure for Urban Flood Resilience: A Review of Recent Literature on Bibliometrics, Methodologies, and Typologies." *Water* 15, no. 3: 523.

Kong, F., Y. Ban, H. Yin, P. James, and I. Dronova. 2017. "Modeling Stormwater Management at the City District Level in Response to Changes in Land Use and Low Impact Development." *Environmental Modelling & Software* 95: 132–142.

Krullikowski, C., C. Chow, M. Wieland, et al. 2023. "Estimating Ensemble Likelihoods for the Sentinel-1 Based Global Flood Monitoring Product of the Copernicus Emergency Management Service." ArXiv Preprint, ArXiv:2304.12488.

Kundu, S., V. Lakshmi, and R. Torres. 2022. "Estimation of Flood Inundation and Depth During Hurricane Florence Using Sentinel-1 and UAVSAR Data." *IEEE Geoscience and Remote Sensing Letters* 19: 1–5.

Leal Filho, W., M. Krishnapillai, A. Minhas, et al. 2023. "Climate Change, Extreme Events and Mental Health in the Pacific Region." *International Journal of Climate Change Strategies and Management* 15, no. 1: 20–40.

Li, C., X. Cheng, N. Li, X. Du, Q. Yu, and G. Kan. 2016. "A Framework for Flood Risk Analysis and Benefit Assessment of Flood Control Measures in Urban Areas." *International Journal of Environmental Research and Public Health* 13, no. 8: 787.

Li, C., R. Widlak, and M. Zalewski. 2021. "Stormwater Gravel-Peat Infiltration Filter—An Ecohydrological Technology With Good Urban Design." *Ecohydrology & Hydrobiology* 21, no. 3: 555–563.

Li, J., and S. J. Burian. 2022. "Effects of Nonstationarity in Urban Land Cover and Rainfall on Historical Flooding Intensity in a Semiarid Catchment." *Journal of Sustainable Water in the Built Environment* 8, no. 2: 4022002.

Li, W., J. Wu, H. Chen, Y. Wang, Y. Jia, and G. Gui. 2022. "Unet Combined With Attention Mechanism Method for Extracting Flood Submerged Range." *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing* 15: 6588–6597.

Liang, Z., R. R. Hewitt, and Y. Du. 2019. "Research on Design Method for the Blue-Green Ecological Network System to Deal With Urban Flooding: A Case Study of Charleston Peninsula." *International Journal of Design & Nature and Ecodynamics* 14, no. 4: 275–286.

Liu, J., Z. Cao, X. Li, et al. 2022. "Modelling Urban Flooding Integrated With Flow and Sediment Transport in Drainage Networks." *Science of the Total Environment* 850: 158027.

Ly, S., S. Uk, N. B. Pham, and C. Yoshimura. 2022. "Ecosystem Service of Tropical Flooded Forests and Its Relation to Characteristics of Local Communities." *Wetlands* 42, no. 8: 116.

Ma, F., D. Xiang, K. Yang, Q. Yin, and F. Zhang. 2022. "Weakly Supervised Deep Soft Clustering for Flood Identification in SAR Images." *IEEE Geoscience and Remote Sensing Letters* 19: 1–5.

Manchikatla, S. K., and N. V. Umamahesh. 2022. "Simulation of Flood Hazard, Prioritization of Critical Sub-Catchments, and Resilience Study in an Urban Setting Using PCSWMM: A Case Study." *Water Policy* 24, no. 8: 1247–1268.

Marques, G. F., V. B. F. S. de Souza, and N. V. Moraes. 2017. "The Economic Value of the Flow Regulation Environmental Service in a Brazilian Urban Watershed." *Journal of Hydrology* 554: 406–419.

Meng, B., M. Li, X. Du, and X. Ye. 2022. "Flood Control and Aquifer Recharge Effects of Sponge City: A Case Study in North China." *Water* 14, no. 1: 92.

Mohanty, M. P., S. Nithya, A. S. Nair, et al. 2020. "Sensitivity of Various Topographic Data in Flood Management: Implications on Inundation Mapping Over Large Data-Scarce Regions." *Journal of Hydrology* 590: 125523.

Moher, D., A. Liberati, J. Tetzlaff, D. G. Altman, and Group P. 2009. "Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement." *Annals of Internal Medicine* 151, no. 4: 264–269.

Montello, F., E. Arnaudo, and C. Rossi. 2022. "Mmflood: A Multimodal Dataset for Flood Delineation From Satellite Imagery." *IEEE Access* 10: 96774–96787.

Moshood, T. D., A. Q. Adeleke, G. Nawanir, and F. Mahmud. 2020. "Ranking of Human Factors Affecting Contractors' Risk Attitudes in the Malaysian Construction Industry." *Social Sciences & Humanities Open* 2, no. 1: 100064.

Moshood, T. D., G. Nawanir, and F. Mahmud. 2022. "Sustainability of Biodegradable Plastics: A Review on Social, Economic, and Environmental Factors." *Critical Reviews in Biotechnology* 42, no. 6: 892–912.

Movahednia, M., A. Kargarian, C. E. Ozdemir, and S. C. Hagen. 2021. "Power Grid Resilience Enhancement via Protecting Electrical Substations Against Flood Hazards: A Stochastic Framework." *IEEE Transactions on Industrial Informatics* 18, no. 3: 2132–2143.

Nguyen, T. H., S. Ricci, C. Fatras, et al. 2022. "Improvement of Flood Extent Representation With Remote Sensing Data and Data Assimilation." *IEEE Transactions on Geoscience and Remote Sensing* 60: 1–22.

Nogueira, K., S. G. Fadel, Í. C. Dourado, et al. 2018. "Exploiting ConvNet Diversity for Flooding Identification." *IEEE Geoscience and Remote Sensing Letters* 15, no. 9: 1446–1450.

Noori, A. R., and S. K. Singh. 2023. "Rainfall Assessment and Water Harvesting Potential in an Urban Area for Artificial Groundwater Recharge With Land Use and Land Cover Approach." *Water Resources Management* 37, no. 13: 5215–5234.

Office of Environment and Heritage. 2016. "Report on Sensitivity to ARR 2016 Approaches." file:///C:/Users/taofe/OneDrive-MasseyUniversity/Newz(1)/FloodingDoc/13australian-rainfall-runoff-2016-case-study-urban.pdf.

Office of Wastewater Management. 2011. "Summary of State Stormwater Standards." file:///C:/Users/taofe/OneDrive-MasseyUniversity/Newz(1)/FloodingDoc/12sw_state_summary_standards.pdf.

Park, G., and H. Park. 2018. "Influence Analysis of Land Use by Population Growth on Urban Flood Risk Using System Dynamics." *WIT Transactions on Ecology and the Environment* 215: 195–205.

Park, H., R. Paterson, S. Zigmund, H. Shin, Y. Jang, and J. Jung. 2020. "The Effect of Coastal City Development on Flood Damage in South Korea." *Sustainability* 12, no. 5: 1854.

Paule-Mercado, M. A., B. Y. Lee, S. A. Memon, S. R. Umer, I. Salim, and C.-H. Lee. 2017. "Influence of Land Development on Stormwater Runoff From a Mixed Land Use and Land Cover Catchment." *Science of the Total Environment* 599: 2142–2155.

Peter, B. G., S. Cohen, R. Lucey, D. Munasinghe, A. Raney, and G. R. Brakenridge. 2020. "Google Earth Engine Implementation of the Floodwater Depth Estimation Tool (FwDET-GEE) for Rapid and Large Scale Flood Analysis." *IEEE Geoscience and Remote Sensing Letters* 19: 1–5.

Prakash, C., A. Barthwal, and D. Acharya. 2022. "FLOODWALL: A Real-Time Flash Flood Monitoring and Forecasting System Using IoT." *IEEE Sensors Journal* 23, no. 1: 787–799.

Prybutok, S., G. Newman, K. Atoba, G. Sansom, and Z. Tao. 2021. "Combining Co $ Ting Nature and Suitability Modeling to Identify High Flood Risk Areas in Need of Nature-Based Services." *Land* 10, no. 8: 853.

Prybutok, V., and E. Osipova. 2021. "Transforming Urban Landscapes Towards Sustainability: Green Infrastructure and Flood Control in the USA." *Environmental Science and Pollution Research* 28, no. 10: 3579.

Puttinaovarat, S., and P. Horkaew. 2020. "Flood Forecasting System Based on Integrated Big and Crowdsource Data by Using Machine Learning Techniques." *IEEE Access* 8: 5885–5905.

Qi, M., H. Huang, L. Liu, and X. Chen. 2022. "An Integrated Approach for Urban Pluvial Flood Risk Assessment at Catchment Level." *Water* 14, no. 13: 2000.

Qin, Y. 2020. "Urban Flooding Mitigation Techniques: A Systematic Review and Future Studies." *Water* 12, no. 12: 3579.

Rajeev, A., R. K. Pati, S. S. Padhi, and K. Govindan. 2017. "Evolution of Sustainability in Supply Chain Management: A Literature Review." *Journal of Cleaner Production* 162: 299–314.

Ramiaramanana, F. N., and J. Teller. 2021. "Urbanization and Floods in Sub-Saharan Africa: Spatiotemporal Study and Analysis of Vulnerability Factors—Case of Antananarivo Agglomeration (Madagascar)." *Water* 13, no. 2: 149.

Recanatesi, F., A. Petroselli, M. N. Ripa, and A. Leone. 2017. "Assessment of Stormwater Runoff Management Practices and BMPs Under Soil Sealing: A Study Case in a Peri-Urban Watershed of the Metropolitan Area of Rome (Italy)." *Journal of Environmental Management* 201: 6–18.

Rentschler, J., P. Avner, M. Marconcini, R. Su, E. Strano, and S. Hallegatte. 2022. "Rapid Urban Growth in Flood Zones."

Rosenberger, L., J. Leandro, S. Pauleit, and S. Erlwein. 2021. "Sustainable Stormwater Management Under the Impact of Climate Change and Urban Densification." *Journal of Hydrology* 596: 126137.

Rotimi, F. E., J. Tookey, and J. O. Rotimi. 2015. "Evaluating Defect Reporting in New Residential Buildings in New Zealand." *Buildings* 5, no. 1: 39–55.

Sahu, A., T. Bose, and D. R. Samal. 2021. "Urban Flood Risk Assessment and Development of Urban Flood Resilient Spatial Plan for Bhubaneswar." *Environment and Urbanization ASIA* 12, no. 2: 269–291.

Salehi, F., M. Najarchi, M. M. Najafizadeh, and M. M. Hezaveh. 2022. "Multistage Models for Flood Control by Gated Spillway: Application to Karkheh Dam." *Water* 14, no. 5: 709.

Samouei, S., and M. Özger. 2020. "A Rainfall-Runoff Model for Highly Urbanized Areas: A Case Study at Istanbul Technical University Main Campus." *IOP Conference Series: Materials Science and Engineering* 737, no. 1: 12163.

Satoh, M. 2022. "Position and Role of Agricultural Land in the New Policy of Integrated Watershed Flood Management of Japan."

Sawangnate, C., B. Chaisri, and S. Kittipongvises. 2022. "Flood Hazard Mapping and Flood Preparedness Literacy of the Elderly Population Residing in Bangkok, Thailand." *Water* 14, no. 8: 1268.

Sohn, W., J.-H. Kim, M.-H. Li, R. D. Brown, and F. H. Jaber. 2020. "How Does Increasing Impervious Surfaces Affect Urban Flooding in Response to Climate Variability?" *Ecological Indicators* 118: 106774.

Southworth, V. 2019. "Increasing the Uptake of Building-Scale Water Sensitive Urban Design Stormwater Management Options in Christchurch, New Zealand."

Stillwell, C. C., W. F. Hunt III, J. L. Page, J. B. Baird, and S. G. Kennedy. 2018. "Stormwater Management in Nutrient-Sensitive Watersheds: A Case Study Investigating Impervious Cover Limits and Pollutant-Load Regulations." *Water Science and Technology* 78, no. 3: 664–675.

Stormwater Policy. 2020. "Stormwater Policy and Plan Provisions Stocktake and Assessment." file:///C:/Users/taofe/OneDrive-MasseyUniversity/Newz(1)/FloodingDoc/3storm-water-policy-and-plan-provisions.pdf.

Sun, T. 2019. "The Sponge City in New Zealand."

Suripin, S., S. S. Sangkawati, S. A. Pranoto, E. Sutarto, B. Hary, and K. Dwi. 2018. "Reducing Stormwater Runoff From Parking Lot With Permeable Pavement." *E3S Web of Conferences* 73: 5016.

Tansar, H., F. Li, F. Zheng, and H.-F. Duan. 2024. "A Critical Review on Optimization and Implementation of Green-Grey Infrastructures for Sustainable Urban Stormwater Management." *AQUA – Water Infrastructure, Ecosystems and Society* 73, no. 6: 1135–1150.

Tauhid, F. A., and H. Zawani. 2018. "Mitigating Climate Change Related Floods in Urban Poor Areas: Green Infrastructure Approach." *Journal of Regional and City Planning* 29: 98.

Terêncio, D. P. S., L. F. S. Fernandes, R. M. V. Cortes, J. P. Moura, and F. A. L. Pacheco. 2019. "Can Land Cover Changes Mitigate Large Floods? A Reflection Based on Partial Least Squares-Path Modeling." *Water* 11, no. 4: 684.

Tomás, L. R., G. G. Soares, A. A. S. Jorge, J. F. Mendes, V. L. S. Freitas, and L. B. L. Santos. 2022. "Flood Risk Map From Hydrological and Mobility Data: A Case Study in São Paulo (Brazil)." *Transactions in GIS* 26, no. 5: 2341–2365.

Twohig, C., Y. Casali, and N. Y. Aydin. 2022. "Can Green Roofs Help With Stormwater Floods? A Geospatial Planning Approach." *Urban Forestry & Urban Greening* 76: 127724.

Waikato District Council. 2011. "Report for Tamahere Catchment Stormwater Catchment Management Plan." file:///C:/Users/taofe/OneDrive-MasseyUniversity/Newz(1)/FloodingDoc/9tamahere---stormwater-catchment-management-report.pdf.

Wang, R.-Q., Y. Hu, Z. Zhou, and K. Yang. 2020. "Tracking Flooding Phase Transitions and Establishing a Passive Hotline With AI-Enabled Social Media Data." *IEEE Access* 8: 103395–103404.

Wang, Y., X. Zhang, J. Xu, C. Liang, D. She, and Y. Xiao. 2021. "Evaluating Effects of Urban Imperviousness Connectivity on Runoff With Consideration of Receiving Pervious Area Properties." *Urban Water Journal* 18, no. 8: 598–607.

Waterproofing Membrane Association. 2020. "Code of Practice for Internal Wet-Area Membrane Systems." file:///C:/Users/taofe/OneDrive-MasseyUniversity/Newz(1)/FloodingDoc/8code-of-practice-for-internal-wet-area-membrane-systems.pdf.

Wu, W., B. Jamali, K. Zhang, L. Marshall, and A. Deletic. 2023. "Water Sensitive Urban Design (WSUD) Spatial Prioritisation Through Global Sensitivity Analysis for Effective Urban Pluvial Flood Mitigation." *Water Research* 235: 119888.

Xu, D., Z. Ouyang, T. Wu, and B. Han. 2020. "Dynamic Trends of Urban Flooding Mitigation Services in Shenzhen, China." *Sustainability* 12, no. 11: 4799.

Xue, F., W. Gao, C. Yin, et al. 2022. "Flood Monitoring by Integrating Normalized Difference Flood Index and Probability Distribution of Water Bodies." *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing* 15: 4170–4179.

Yang, B., and D. Lee. 2021. "Urban Green Space Arrangement for an Optimal Landscape Planning Strategy for Runoff Reduction." *Land* 10, no. 9: 897.

Yang, Q., S. Zhang, Q. Dai, and R. Yao. 2020. "Assessment of Community Vulnerability to Different Types of Urban Floods: A Case for Lishui City, China." *Sustainability* 12, no. 19: 7865.

Yokoya, N., K. Yamanoi, W. He, et al. 2020. "Breaking Limits of Remote Sensing by Deep Learning From Simulated Data for Flood and Debris-Flow Mapping." *IEEE Transactions on Geoscience and Remote Sensing* 60: 1–15.

Zaeri, F., F. E. Rotimi, and J. D. Owolabi. 2016. "The Effectiveness of the Last Planner System in New Zealand Construction Industry: Towards an Empirical Justification." In *Creating Built Environments of New Opportunities*, vol. 1, 528. University of Technology.

Zhang, Y. 2018. *Urban Ecology and the Design of a Green Infrastructure Network Based on Catchments for Urban Auckland*. Oakley Creek Catchment Case Study.

Zhou, B., W. Hu, K. Brown, and T. Chen. 2020. "Generalized Pattern Matching of Industrial Alarm Flood Sequences via Word Processing and Sequence Alignment." *IEEE Transactions on Industrial Electronics* 68, no. 10: 10171–10179.

Zhu, C., J. Susskind, M. Giampieri, H. B. O'Neil, and A. M. Berger. 2023. "Optimizing Sustainable Suburban Expansion With Autonomous Mobility Through a Parametric Design Framework." *Land* 12, no. 9: 1786.

Ziv, S. Z., and Y. Reuveni. 2022. "Flash Floods Prediction Using Precipitable Water Vapor Derived From GPS Tropospheric Path Delays Over the Eastern Mediterranean." *IEEE Transactions on Geoscience and Remote Sensing* 60: 1–17.

Zortea, M., M. Muszynski, P. Fraccaro, and J. Weiss. 2023. "Flood Mapping Using Sentinel-1 Images and Light-Weight U-Nets Trained on Synthesized Events." *IEEE Geoscience and Remote Sensing Letters* 20: 1–5.