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Enhancing Disaster Management through Artificial Intelligence: A Systematic Review

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Abstract

The escalating frequency and severity of disasters, intensified by climate change and rapid urbanisation, demand innovative approaches that go beyond traditional disaster management systems. Artificial Intelligence (AI) has increasingly been recognised as a transformative tool with the potential to enhance disaster prediction, preparedness, response, and recovery. However, the integration of AI into disaster risk reduction remains fragmented, with varying applications, methodologies, and policy perspectives across the literature. To address this, the present study conducts a systematic literature review (SLR) using advanced searches across Scopus and Web of Science (WoS) databases with the keywords "inclusive," "disaster," and "AI." The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework guided the screening process, resulting in a final dataset of 50 relevant studies. Analysis of the selected literature revealed three overarching themes: (1) AI Models and Predictive Analytics for Disaster Risk, which highlight advances in machine learning and deep learning for forecasting hazards and improving situational awareness; (2) Emerging Technologies, IoT, and Social Media for Disaster Management, which demonstrate the integration of real-time sensing, edge computing, and crowd-sourced data to enhance response and coordination; and (3) Frameworks, Reviews, and Policy Perspectives on AI in Disaster Risk Reduction, which underscore the importance of governance, ethics, and interoperability for sustainable implementation. The review indicates that while AI offers remarkable potential to strengthen disaster resilience, significant challenges remain concerning data quality, model interpretability, ethical safeguards, and cross-institutional integration. The findings suggest that future research should focus on developing transparent, explainable, and inclusive AI frameworks supported by robust policy and governance mechanisms. By synthesising current evidence and identifying gaps, this study contributes to advancing the role of AI as both a technological enabler and a policy catalyst for enhancing global disaster management.

Keywords: Disaster Management, Artificial Intelligence, SLR, IoT

Introduction

The escalating frequency and severity of natural and human-induced disasters represent one of the most urgent challenges of the twenty-first century. Climate change, urbanisation, population growth, and global interconnectedness have amplified the risks, leaving communities increasingly vulnerable to cascading and compound hazards. Traditional disaster management frameworks, while critical, often struggle to process the vast amounts of heterogeneous data required for rapid and effective decision-making. Within this context, Artificial Intelligence (AI) has emerged as a transformative tool capable of bridging these limitations by providing advanced predictive, analytical, and operational capabilities. By leveraging machine learning (ML), deep learning (DL), natural language processing (NLP), and computer vision, AI enables the identification of complex patterns in extensive datasets, leading to more accurate forecasting, timely early warning systems, and better-informed resource allocation. This growing relevance situates AI not only as a technological innovation but as a strategic necessity for disaster risk reduction, aligning with global frameworks such as the Sendai Framework for Disaster Risk Reduction and the Sustainable Development Goals, both of which highlight the role of technology in building resilience and adaptive capacity.

Building on this recognition of AI's potential, current research demonstrates notable achievements in prediction, monitoring, and response. Studies show that AI models applied to floods, earthquakes, wildfires, and landslides have markedly improved the accuracy of hazard forecasting, especially when integrated with remote sensing (RS), Geographic Information Systems (GIS), and IoT-enabled sensor networks. Convolutional neural networks (CNNs) have been widely used to interpret satellite imagery for rapid damage assessment, while recurrent neural networks (RNNs) and ensemble learning methods enhance the timeliness of flood and landslide predictions. Natural language processing also provides valuable insights during disaster events by extracting situational information from social media, complementing physical data sources with real-time accounts of community needs and responses. Beyond hazard detection and forecasting, AI contributes significantly to logistics, resource distribution, and relief coordination, offering decision-support systems that enable responders to prioritise vulnerable populations and streamline emergency operations. Collectively, these applications illustrate a growing consensus in the literature: AI extends disaster management capabilities beyond traditional approaches by embedding intelligence into the full disaster cycle, from preparedness to response and recovery. However, these same studies also highlight challenges such as data fragmentation, limited scalability, and ethical concerns, which suggest that the integration of AI into disaster governance is still incomplete.

These unresolved issues highlight the need for a forward-looking agenda that addresses gaps while capitalising on opportunities. Data quality and accessibility remain critical barriers, as many regions—particularly in the Global South—lack robust datasets necessary for training reliable models, which risks widening the technological divide. Ethical challenges also persist, with algorithmic bias, privacy concerns, and opaque "black box" models raising questions about accountability, fairness, and trust in AI systems. Moreover, despite advances in technical capacity, the incorporation of AI into existing disaster management institutions is often hindered by misalignment between technological innovation and governance frameworks. Over-reliance on AI without adequate human oversight is another pressing concern, especially in high-stakes contexts where errors can have life-threatening consequences. To overcome these barriers, future research must focus on explainable AI, hybrid frameworks that integrate traditional risk management practices with modern analytics, and robust data governance mechanisms. At the same time, interdisciplinary collaboration across computer science, disaster studies, and public policy is essential to ensure that AI systems are socially legitimate as well as technically effective. International cooperation and equitable investment in digital infrastructure are also needed to prevent technological exclusion of vulnerable populations. Taken together, these directions suggest that the future of AI in disaster management lies not merely in refining algorithms but in creating interconnected ecosystems that combine prediction, situational awareness, and governance, ultimately positioning AI as both a catalyst for resilience and a cornerstone of sustainable disaster risk reduction.

Literature Review

Introduction and Predictive Capabilities

Artificial Intelligence (AI) has emerged as a transformative tool in disaster management, offering significant advancements in prediction, preparedness, and response. The increasing frequency and severity of natural disasters, intensified by climate change, necessitate innovative approaches to mitigate their impacts. AI's predictive models analyze extensive datasets to identify patterns and forecast potential disasters, enabling proactive measures such as early warning systems (EWSs), evacuation planning, and resource allocation (Abid et al., 2021; Hamid & Abedlmajid, 2025; Ruiz-Diaz et al., 2025). Techniques such as machine learning (ML) and deep learning (DL) improve both the accuracy and timeliness of predictions by processing vast data streams and identifying complex, non-linear relationships (Chew et al., 2025; Varsha et al., 2024)24). Furthermore, integrating AI with Geographic Information Systems (GIS) and remote sensing (RS) enhances situational awareness and recovery operations, equipping governments with tools to make faster, evidence-based decisions during crises(Ouaissa et al., 2024; Ruiz-Diaz et al., 2025). Despite these advancements, issues related to data quality, model interpretability, and ethical constraints remain, underscoring the importance of continuous research and development to refine predictive capabilities (Hamid & Abedlmajid, 2025; Ruiz-Diaz et al., 2025).

Applications in Disaster Response and Recovery

Building on its predictive functions, AI also plays a vital role in strengthening disaster response and recovery operations. By analyzing heterogeneous datasets, AI systems enhance emergency preparedness through pattern recognition and efficient allocation of scarce resources (Abid et al., 2021; Albahri et al., 2024). For example, Convolutional Neural Networks (CNNs) process satellite imagery to guide responders in identifying affected zones, while AI-driven decision support tools streamline risk communication and optimize logistics during relief distribution (Albahri et al., 2024; Shameem et al., 2025). In post-disaster phases, AI contributes to faster mobilization by assisting government agencies and NGOs in issuing timely warnings, supporting evacuation strategies, and improving coordination across response networks(Shameem et al., 2025). The integration of AI with Internet of Things (IoT) devices further enhances real-time communication and situational awareness by delivering dynamic updates to rescue workers in the field(Astarita et al., 2025). Nevertheless, these benefits are accompanied by significant challenges, including privacy concerns, algorithmic bias, and the need for transparent, equitable AI systems that maintain public trust(Albahri et al., 2024; Gupta & Roy, 2024; Hamid & Abedlmajid, 2025).

Challenges and Future Directions

The evolving role of AI in disaster management underscores the need to address persistent limitations in order to unlock its full potential. Access to high-quality and diverse datasets remains a critical requirement, yet issues of fragmentation, incompleteness, and uneven availability continue to hinder effective deployment (Hamid & Abedlmajid, 2025; Shameem et al., 2025). At the same time, ethical and social challenges—including data privacy breaches, opaque algorithms, and systemic bias—raise important questions about fairness and accountability(Gupta & Roy, 2024; Hamid & Abedlmajid, 2025). Ensuring compatibility and seamless integration with existing disaster management systems and infrastructures is also essential to avoid inefficiencies or redundancies (Hamid & Abedlmajid, 2025). Looking ahead, future research must focus on strengthening data governance, promoting transparent and interpretable modelling approaches, and enhancing computational frameworks to improve resilience and adaptability(Ruiz-Diaz et al., 2025). Interdisciplinary collaboration across data science, policy, and emergency management is equally critical, as innovation in this field requires not only technical progress but also institutional and social alignment. Ultimately, advancing AI-driven solutions for disaster resilience will ensure that these technologies can effectively respond to the complex and interconnected challenges posed by both natural and human-induced disasters(Andrae, 2025; Diehr et al., 2025; Ruiz-Diaz et al., 2025).

Material and Methods

Identification

In conducting this study, a systematic and rigorous approach was employed to identify and gather a substantial body of relevant literature. The review process commenced with the meticulous selection of key terms central to the research topic. To ensure comprehensiveness, related terms were systematically explored using dictionaries, thesauri, encyclopedias, and prior scholarly works. All pertinent terms were compiled to construct robust search strings tailored for querying the Web of Science and Scopus databases (as outlined in Table 1). This exhaustive search strategy resulted in the identification of 478 publications deemed relevant to the study's objectives, serving as the foundation for subsequent analysis.

Table 1
The search string

Scopus	**TITLE-ABS-KEY (("disaster management" OR "emergency response" OR "crisis management" OR "disaster recovery") AND ("artificial intelligence" OR "ai" OR (("machine" OR "deep") AND learning) OR "predictive analytics") AND ("risk assessment" OR "preparedness" OR "mitigation" OR "response") AND ("data analysis" OR "big data" OR "modeling" OR "simulation") AND ("decision support" OR "resource allocation" OR "planning" OR "coordination")) AND (LIMIT-TO (PUBYEAR , 2023) OR LIMIT-TO (PUBYEAR , 2024) OR LIMIT-TO (PUBYEAR , 2025)) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English"))** **Date of Access: Ogos 2025**
WoS	**("disaster management" OR "emergency response" OR "crisis management" OR "disaster recovery") AND ("artificial intelligence" OR "ai" OR (("machine" OR "deep") AND learning) OR "predictive analytics") AND ("risk assessment" OR "preparedness" OR "mitigation" OR "response") AND ("data analysis" OR "big data" OR "modeling" OR "simulation") AND ("decision support" OR "resource allocation" OR "planning" OR "coordination") and 2025 or 2024 or 2023 (Publication Years) and Article (Document Types) and English (Languages)** Date of Access: Ogos 2025

Screening
During the screening phase, potentially relevant research items were meticulously evaluated to ensure alignment with the predefined research question(s). This critical step involved assessing studies related to counseling, families at risk, and intervention processes. A primary objective of this phase was to remove duplicate records and focus on studies meeting the established inclusion and exclusion criteria.

Initially, a total of 182 publications were excluded after a preliminary review, leaving 182 studies for further examination. These remaining publications were screened using specific criteria designed to identify the most relevant and high-quality research. The first criterion prioritized literature that served as a source of practical and theoretical recommendations, encompassing reviews, meta-syntheses, meta-analyses, books, book series, book chapters, and conference proceedings not included in prior studies.

To ensure the review's relevance and rigor, only English-language publications published between 2023 and 2025 were included. Additionally, nine publications were excluded during this phase due to duplication, ensuring the dataset remained focused and free from redundancy. This rigorous screening process ensured that the final selection of studies provided a robust foundation for subsequent analysis and synthesis.

Table 2
The Selection Criterion Is Searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Time line	2023-2025	< 2023
Literature type	Journal (Article)	Conference, Book, Review
Publication Stage	Final	In Press

Eligibility
In the third step, known as the eligibility phase, 181 articles were prepared for review. During this stage, the titles and key content of all articles were carefully examined to ensure they met the inclusion criteria and aligned with the current research objectives. Consequently, 131 data/paper/article were excluded as they did not qualify as due to the out of field, title not significantly, abstract not related on the objective of the study and no full text access founded on empirical evidence. As a result, a total of 50 articles remain for the upcoming review.

Data Abstraction and Analysis
An integrative analysis was used as one of the assessment strategies in this study to examine and synthesize a variety of research designs (quantitative methods). The goal of the competent study was to identify relevant topics and subtopics. The stage of data collection was the first step in the development of the theme. Figure 2 shows how the authors meticulously analysed a compilation of 50 publications for assertions or material relevant to the topics of the current study. The authors then evaluated the current significant studies related to counseling, digital counseling and family. The methodology used in all studies, as well as the research results, are being investigated. Next, the author collaborated with other co-authors to develop themes based on the evidence in this study's context. A log was kept throughout the data analysis process to record any analyses, viewpoints, riddles, or other thoughts relevant to the data interpretation. Finally, the authors compared the results to see if there were any inconsistencies in the theme design process. It is worth noting that, if there are any disagreements between the concepts, the authors discuss them amongst themselves.

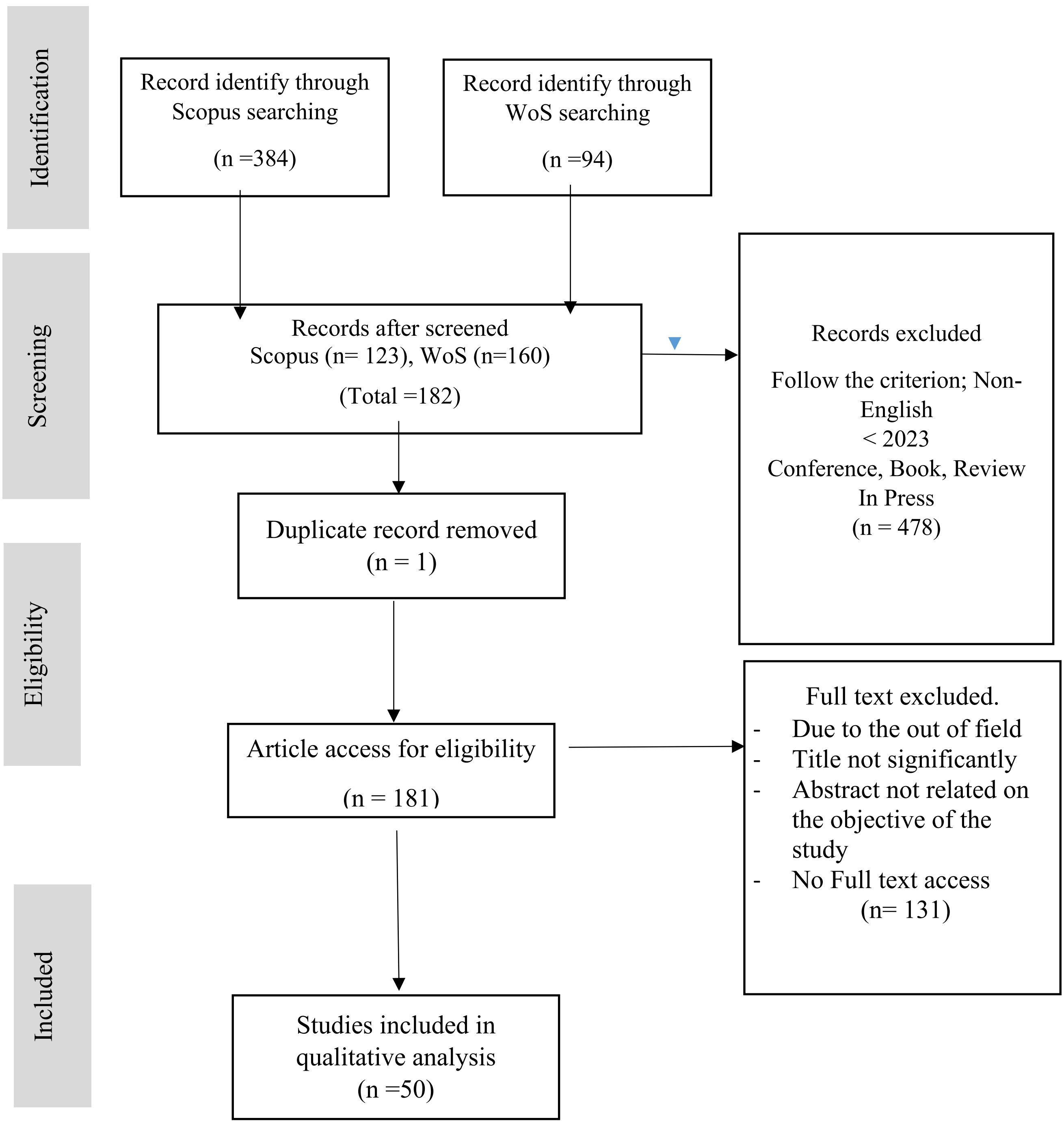

Figure 2. Flow diagram of the proposed searching study

The produced themes were eventually tweaked to ensure consistency. The analysis selection was carried out by two experts, one in Disaster and one in Technology. To ensure the validity of the problems, the examinations were performed by two experts. The expert review phase helped ensure each sub-theme's clarity, importance, and adequacy by establishing domain validity. Adjustments based on the discretion of the author, based on feedback and comments by experts, have been made.

The questions are as follows:

i. *How can explainable and hybrid artificial intelligence models improve the accuracy, interpretability, and cross-hazard generalisability of predictive analytics in disaster risk assessment?*
ii. *In what ways can the integration of IoT-enabled sensing, edge computing, and social media analytics be optimised to enhance real-time situational awareness and decision-making during disasters?*
iii. *What governance frameworks, ethical safeguards, and interoperability standards are required to ensure that AI-driven disaster management systems are transparent, accountable, and adaptable across diverse institutional and regional contexts?*

Result and Finding

AI Models and Predictive Analytics for Disaster Risk

Recent studies consistently demonstrate that artificial intelligence techniques substantially improve the predictive accuracy and operational efficiency of disaster risk assessment. Flood detection is one of the most prominent applications, where enhanced deep learning architectures such as improved U-net models and interpretable multi-stage frameworks have provided higher resolution flood mapping and more reliable change detection. These approaches exploit attention mechanisms and sequential multispectral analysis to reduce classification errors and deliver interpretable outcomes that can inform on-the-ground decision-making. Reviews of flood depth estimation reinforce this evidence, highlighting that accuracy gains are most significant when models are trained on large annotated datasets and paired with systematic validation procedure (Wang & Feng, 2025; Zhang et al., 2025; Liu et al., 2025).

The pursuit of interpretability connects closely with the demand for trustworthy applications of AI in disaster contexts. Research on explainable artificial intelligence shows that transparent attribution of risk drivers—such as rainfall intensity, soil conditions, and urban morphology—enhances the legitimacy of model outputs in governance contexts. Geographic explainable AI demonstrates that flood risk factors are spatially heterogeneous and nonlinear, which underscores the importance of location-specific calibration. Moreover, investigations comparing traditional methods with machine learning approaches argue that the most effective frameworks blend established models with advanced learning techniques to ensure continuity with existing analytical practices while extending predictive capability. This indicates a convergence between technical innovation and governance requirements, ensuring that AI systems are not only accurate but also usable in formal disaster planning workflows (Nam et al., 2025; Ke et al., 2025; Thekdi et al., 2025).

The integration of predictive analytics across hazards further strengthens this interconnected perspective. Ensemble models developed for landslides induced by combined rainfall and seismic triggers show that multi-model approaches capture different causal mechanisms and improve reliability across diverse geographic terrains. Similarly, multimodal frameworks for earthquake-induced building damage incorporate both imagery and metadata to expand coverage and improve classification accuracy, thereby complementing flood-related findings. Broader disaster classification systems reinforce this pattern by using supervised learning over multiple data types to provide rapid, scalable insights. Together, these efforts illustrate that predictive analytics can be generalised across hazard types, with a common emphasis on fusion of heterogeneous inputs and interpretable outputs (Dutta et al., 2025; Kuo & Lin, 2025; Rathna et al., 2025).

Operational frameworks close the loop between model innovation and practical deployment. Studies on cloud-based disaster classification highlight that elastic computing resources allow for rapid model scaling during emergencies, while end-to-end systems integrating sensing, deep learning, and remote visualisation enable smoother transitions from data ingestion to actionable products. Investigations into humanitarian supply chains demonstrate how predictive models support resilience planning by anticipating disruption patterns, thereby linking technical advances directly to policy-relevant outcomes. Collectively, these abstracts show that effective operationalisation depends on embedding AI models into larger infrastructures that connect real-time monitoring, predictive modelling, and organisational decision-making (Ali, 2025; Roohi et al., 2025; Rawat & Yadav, 2025).

Despite these gains, interconnected challenges remain. Data scarcity and heterogeneity limit generalisability across contexts, with several studies cautioning that model performance is sensitive to local geomorphology and urban features. Reviews highlight that uneven maturity across hazards risks over-reliance on a small set of benchmark datasets, which may embed bias into applied systems. At the same time, governance perspectives underline that adoption is constrained unless models provide transparency and align with existing risk analysis protocols. Taken together, the findings indicate that predictive accuracy, interpretability, multi-hazard generalisation, and operational scalability are deeply intertwined elements. Future work must therefore advance in parallel across these dimensions, ensuring that innovations in modelling translate into reliable and accountable disaster management practices (Nam et al., 2025; Ke et al., 2025; Rawat & Yadav, 2025).

Emerging Technologies, IoT & Social Media for Disaster Management

The findings collectively illustrate that IoT-enabled sensing infrastructures form the foundation for enhancing disaster risk management. Flood management studies describe how sensor-rich systems and intelligent telemetry improve early alerts by capturing real-time hydrological dynamics, while AI-enabled IoT frameworks are reported to strengthen anomaly detection in industrial transport and structural monitoring. Building-focused applications extend this logic by demonstrating predictive maintenance and enhanced safety functions that directly contribute to disaster resilience. These findings indicate that embedding IoT sensors across diverse infrastructures creates a more complete risk picture, thereby strengthening adaptive capacity during emergencies (Yang et al., 2025; Nagaiah et al., 2024; Nanthini et al., 2024).

With IoT providing a baseline, edge computing emerges as a critical complement that enables rapid inference directly at the data source. Studies on intelligent transport systems show that IoT-assisted fire segmentation achieves reliable detection with reduced latency, while forest fire pipelines employing Bi-GRU architectures enhance sensitivity under noisy conditions. Structural health monitoring and AI-assisted building applications reinforce this pattern, where lightweight models, efficient feature extraction, and embedded analytics ensure continuous operation under resource-constrained environments. The convergence of IoT and edge frameworks demonstrates that disaster analytics increasingly relies on compact, energyefficient models capable of sustaining performance where bandwidth and computational resources are limited (Muhammad et al., 2023; Moeed et al., 2024; Shibu et al., 2023).

Social media integration further expands the scope of disaster awareness by capturing signals beyond sensor coverage. Research on wildfire incidents shows that AI-enhanced natural language processing can extract spatio-temporal cues from Twitter, while multimodal GeoAI fuses text with geospatial data to reveal evolving hazards. Bias in user-generated content is addressed through bilevel learning frameworks that stabilise damage estimation, reducing inequities in representation. Collectively, these approaches indicate that social data streams function as complementary sensors, providing early situational awareness and guiding verification and resource allocation when physical sensing alone is insufficient (Karimiziarani et al., 2025; Hanny & Resch, 2025; Bai et al., 2025).

The integration of IoT, edge, and social signals converges within advanced platforms such as UAV-assisted networks and extended reality systems. UAV deployments optimised with intelligent path planning ensure coverage in sensor-sparse zones, while XR overlays of flood extents improve shared situational awareness among field operators and decision-makers. Edge technologies serve as the connective tissue, ensuring that both UAV and XR outputs can be processed locally and transmitted efficiently to command structures. These interconnected tools reinforce the principle that time-critical disaster response benefits when sensing, analytics, and visualisation are embedded directly into operational environments (Li et al., 2024; Symeonidis et al., 2023; Aboualola et al., 2023).

Generative AI and advanced computer vision represent the next stage of this progression, enabling enhanced decision support under challenging conditions. Research in Malaysia demonstrates that YOLO-based object detection, strengthened by generative augmentation, improves recognition of flood-related obstacles, while conceptual studies highlight the potential of large language models to streamline reporting and operator assistance. These methods are positioned as accelerators within the broader IoT–edge–social ecosystem, reinforcing earlier findings by providing higher detection rates, enriched information synthesis, and operator-friendly outputs. Importantly, human oversight remains emphasised across abstracts, highlighting the need for validation and contextualisation before operational deployment (Teoh et al., 2024; Abid & Sulaiman, 2024; Hanny & Resch, 2025).

The portability of these technologies across hazards further strengthens the argument for integrated approaches. Early-warning studies reveal that earthquake hypocenter estimation and landslide prediction benefit from the same design principles demonstrated in flood management: redundant sensors, lightweight inference, and transparent trigger mechanisms. This consistency underscores that once an interoperable IoT–AI–edge–social framework is in place, it can be adapted to multiple hazard types with appropriate calibration. The evidence suggests that disaster management is shifting toward multi-hazard platforms, where lessons learned from one context reinforce performance in others (Yang et al., 2024; Li et al., 2024; Jin et al., 2024).

Despite the documented benefits, the abstracts converge on persistent limitations that must be addressed to achieve reliable and equitable deployment. Interoperability remains uneven, with studies emphasising the risk of fragmented systems if common standards are not adopted. Social-media-based analytics continue to face challenges from bias and misinformation, necessitating robust debiasing frameworks. Generative AI introduces risks of over-reliance on synthetic outputs unless paired with strong human-in-the-loop governance. These concerns highlight that technical innovation cannot be decoupled from issues of governance, validation, and inclusivity.

Frameworks, Reviews and Policy Perspectives on AI in Disaster Risk Reduction

Artificial intelligence is framed as an enhancer of existing disaster-risk doctrines rather than a wholesale replacement. Reviews emphasise hybrid frameworks that keep the transparency of physical and statistical models while adding learning-based components for complex, context-dependent patterns. This positioning aims to protect methodological continuity in agencies, reduce adoption barriers, and keep auditability for high-stakes decisions. Evidence from comparative pieces argues that evaluation protocols and risk communication improve when model assumptions and contributions are explicitly articulated in the workflow, linking predictive gains to governance needs (Thekdi et al., 2025; Chen et al., 2025; Rawat & Yadav, 2025).

Institutional readiness is repeatedly connected to digital infrastructure, interoperability, and operating rules. Survey-style studies describe architectures that combine edge processing, cloud back-ends, and standards for data exchange to keep latency low while preserving traceability. Policy-oriented analyses also connect AI capability to supply-chain resilience and continuity targets, indicating that analytics must be embedded in end-to-end processes (from sensing to logistics) to matter operationally. Case material on national or city deployments further notes that governance principles—roles, escalation thresholds, and shared telemetry—are as critical as models, because fragmented interfaces weaken response speed (Aboualola et al., 2023; Ali, 2025; Yang et al., 2025).

Ethical and legal perspectives prioritise bias control, accountability, and data protection. Social-media pipelines are valuable for rapid situational awareness, but uneven representation can distort estimates unless explicitly mitigated; bilevel learning and multimodal GeoAI are presented as governance-compatible remedies that document uncertainty and reduce demographic skew. Forward-looking commentary on generative systems positions large language models as drafting and triage assistants, but stresses the need for human oversight, provenance tracking, and safeguards against hallucination and misinformation to keep public trust (Bai et al., 2025; Hanny & Resch, 2025; Abid & Sulaiman, 2024).

Decision-support frameworks increasingly include visual analytics and simulation to align experts and field teams. Extended-reality interfaces are reported to shorten sense-making cycles by overlaying flood extent and operational media, while spatio-temporal simulation provides scenario views that link model outputs to planning actions. Early-warning studies on landslides demonstrate how statistical thresholds grounded in monitoring data can be formalised as trigger logic, offering a policy-friendly bridge between continuous sensing and rule-based activation. Together these contributions show how interfaces, simulation, and codified thresholds translate analytics into coordinated action (Symeonidis et al., 2023; Jin et al., 2024; Li et al., 2024).

A cross-paper synthesis points to a pragmatic roadmap. First, adopt hybrid, auditable analytics that integrate with recognised risk methods to maintain legitimacy. Second, invest in interoperable edge-to-cloud infrastructure and standard operating procedures so that outputs travel reliably from sensors to logistics. Third, regulate bias and privacy with documented debiasing, uncertainty reporting, and human-in-the-loop checks, especially when using social or generative data sources. Finally, broaden empirical bases beyond a narrow set of hazards and geographies, as mapped by recent intellectual-landscape analyses, to avoid transfer failures when models move across contexts. In this view, accuracy, governance, and capacity building are interdependent rather than separate tracks (Rawat & Yadav, 2025; Chen et al., 2025; Thekdi et al., 2025).

Discussion and Conclusion

The collective body of abstracts illustrates that the deployment of artificial intelligence in disaster management is undergoing a shift from isolated predictive models toward integrated, multi-layered systems that combine sensing, analytics, and governance. Each theme, predictive analytics, emerging IoT, social platforms, and broader frameworks, contributes distinct but interconnected perspectives. When considered together, these perspectives outline a comprehensive trajectory in which disaster management is not merely about improving model accuracy, but about embedding intelligence into end-to-end infrastructures that are transparent, scalable, and policy ready.

The first theme, AI models and predictive analytics, shows that the technical capability of machine learning is advancing rapidly in detecting, forecasting, and classifying disaster events. Deep learning networks, particularly improved U-net architectures, interpretable multi-stage approaches, and ensemble models, demonstrate significant gains in mapping flood extents, predicting landslides, and classifying earthquake-induced damage. These advances are important because they establish the foundation for automation in disaster monitoring, enabling high-resolution analysis that would otherwise demand extensive human and material resources. However, the discussion across multiple studies makes it clear that prediction alone is insufficient. Accuracy without interpretability risks limiting adoption, particularly among agencies that require transparency for governance and accountability. Hence, the consistent emphasis on explainability through SHAP values, geographic explainable AI, and hybrid approaches, shows a recognition that predictive systems must align with institutional decision-making practices. The underlying message is that technical progress in predictive accuracy must go hand in hand with interpretability and governance-oriented outputs to achieve operational legitimacy.

The second theme, emerging technologies, IoT, and social media, extends the scope of disaster intelligence beyond predictive modelling into distributed sensing and human-centered data sources. IoT-based flood sensors, structural health monitors, and industrial safety systems underline the importance of continuous data streams that anchor predictive algorithms in real-time observations. Edge computing further complements these efforts by bringing processing closer to the data source, thereby reducing latency and enabling reliable inference in bandwidth-constrained settings. Importantly, the abstracts also highlight social media as an increasingly vital layer in disaster intelligence. Natural language processing on Twitter and multimodal GeoAI techniques demonstrate how crowd-sourced data can augment sensor networks by providing early indicators of disaster impact and public needs.

At the same time, the abstracts also caution that social data is subject to bias and misinformation, requiring debiasing frameworks and robust validation. This theme therefore situates AI not only as a tool for prediction but also as a mediator of diverse data ecosystems, combining physical and social signals to create a richer, more adaptive picture of disaster dynamics.

The third theme, frameworks, reviews, and policy perspectives, situates these technological developments within institutional, legal, and governance contexts. Comprehensive reviews highlight that despite advances in predictive analytics and IoT integration, adoption across regions and hazards remains uneven. Framework-focused abstracts consistently argue for hybrid systems that maintain the strengths of established statistical and physical models while integrating AI for added sensitivity and complexity capture. Legal and ethical perspectives are also prominent, particularly around issues of accountability, privacy, and bias. Generative AI and large language models are discussed as potentially transformative for drafting, reporting, and information synthesis, but the necessity of human oversight and regulation is strongly emphasised. This demonstrates that while technology provides powerful capabilities, its integration into disaster risk reduction requires adaptive policy frameworks that ensure trust, inclusivity, and transparency. Reviews and scientometric analyses also underscore that future research must broaden its empirical base to avoid geographic and hazard-specific biases that may limit generalisability.

Taken together, the three themes reveal a converging trajectory where disaster management increasingly depends on integration rather than isolated innovation. Predictive analytics provides accuracy, IoT and social media expand situational awareness, and frameworks ground these advances in governance. This interdependence suggests that the real innovation lies not in each theme individually but in their convergence. For instance, predictive models gain practical relevance when their outputs are fed into IoT-enabled monitoring systems and communicated through policy-ready frameworks. Similarly, IoT sensing and social media monitoring achieve credibility when embedded within governance structures that regulate bias and enforce interoperability. Thus, the conversation across abstracts collectively signals a paradigm shift: disaster management is no longer about standalone technologies but about building resilient, interoperable ecosystems where AI, sensing, and governance reinforce each other.

The conclusion that emerges from this synthesis is that artificial intelligence in disaster management holds transformative potential but only when approached as part of a holistic system. Predictive models continue to push the boundaries of accuracy and resolution, but their value is maximised when coupled with IoT infrastructures that provide continuous data and with social platforms that capture human dimensions of disaster impact. At the same time, legal and ethical frameworks must evolve to safeguard against misuse, bias, and inequity, ensuring that AI-enabled systems strengthen rather than undermine public trust. The integration of these elements points toward a future of multi-hazard, multi-source platforms that are adaptive, transparent, and globally relevant. Achieving this vision will require not only technical innovation but also deliberate investment in interoperability standards, governance frameworks, and equitable access to digital infrastructure. Ultimately, the evidence across the three themes suggests that the future of AI in disaster risk reduction rests on the principle of mutual reinforcement between technology, data, and governance, creating systems that are not only intelligent but also resilient, inclusive, and accountable.

This research makes two interlinked contributions. Theoretically, it integrates three previously siloed streams, predictive AI modelling, real-time data infrastructures, and governance and ethics, into a single, interoperable architecture that treats accuracy, explainability, and multi-hazard generalisability as co-dependent design constraints. This reframes “trustworthy AI” from a property of individual algorithms to an emergent systems characteristic arising from alignment between models, data pipelines, and activation protocols. Contextually, the review distils a policy-ready roadmap for data-scarce, institutionally fragmented settings typical of the Global South by specifying phased steps: building edge-to-cloud telemetry that pairs sensors with crowd signals, operationalising auditable standards to translate analytics into clear decision rules, and embedding human-in-the-loop oversight for legitimacy in high-stakes use. In doing so, the study advances existing knowledge by moving the discourse beyond tool adoption toward capability building within Sendai-aligned, multi-agency arrangements; it supplies researchers with a comparative scaffold for evaluating AI across hazards and offers practitioners an implementation pathway that reduces failure modes (bias, opacity, interoperability gaps) while improving situational awareness, coordination, and equity of response.

Conflicts of Interest

The authors declare that they have no conflicts of interest to report regarding the present study

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