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# Information Systems in Disaster Management: A Narrative Review

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**Abstract**

This narrative review explores the critical role of information systems (IS) in enhancing disaster management practices, particularly within the context of preparedness, response, recovery, and mitigation. The study synthesizes findings from scholarly literature to examine how integrated IS platforms—such as early warning systems, geographic information systems (GIS), and communication networks—facilitate real-time decision-making and coordination among stakeholders. Furthermore, it highlights the evolving adoption of cloud computing, mobile applications, and artificial intelligence in predicting disaster risks and managing resource deployment. The review reveals that effective implementation of IS not only improves situational awareness and operational efficiency during crises but also supports community resilience and post-disaster recovery. Challenges such as data interoperability, infrastructure limitations, and cybersecurity risks are also discussed. The study concludes by recommending a multidisciplinary approach to developing adaptive, scalable, and inclusive IS frameworks tailored to disaster-prone regions.
***Keywords:*** *Disaster Management, Information Systems, GIS, Early Warning Systems, Crisis Communication, Disaster Preparedness, Technological Innovation, Resilience, Emergency Response, Cloud Computing*

## Introduction

Disaster management necessitates the prompt coordination of emergency services to protect lives and property, revealing the critical role of information systems in enhancing efficiency and effectiveness in disaster response (Ahmad, 2017). Information systems are essential for optimizing disaster relief efforts, which is especially important considering the increasing frequency and severity of both natural and man-made disasters across the globe (Schempp et al., 2018). The effective application of information systems is critical for coordinating various stakeholders, allocating resources, and making well-informed decisions during crisis situations (Ardiansyah et al., 2024). These systems improve disaster management operations and have become indispensable tools for governments, non-governmental organizations, and other agencies responsible for disaster response. Disaster management involves several stages, which include creating early warning systems, developing response strategies, and providing post-disaster recovery initiatives (Lu et al., 2020). Knowledge-driven systems in emergency management can enhance these stages (Dorasamy et al., 2013). Effective disaster management requires the incorporation of cutting-edge technology to facilitate communication, data analysis, and situational awareness (Thomas et al., 2007).

The role of information systems in disaster management is a complex subject that demands a thorough investigation of the existing literature. The use of information systems to support disaster management requires a comprehensive understanding of the current research trends, difficulties, and potential directions. Analyzing the literature on disaster management systems

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reveals a strong emphasis on responsive strategies, rather than proactive preventative actions (Kondraganti, 2021). Social media analytics play a crucial role in improving disaster response by enabling authorities and communities to make well-informed decisions (Acıkara et al., 2023). The purpose of this review is to critically analyze the literature on the use of information systems in disaster management, with the aim of identifying important research gaps and suggesting areas for further study. Furthermore, disaster response systems are frequently hampered by logistical challenges and information silos, which can result in service interruptions (Liang & Ramírez-Márquez, 2024). The examination of these obstacles is essential to designing more efficient and integrated systems.

Disaster management includes a wide range of tasks that must be completed in order to reduce the effects of disasters, beginning with preparedness and continuing through response, recovery, and mitigation (Njoku et al., 2020). Information systems are essential for the effective implementation of each of these phases, because they provide tools for risk assessment, communication, coordination, and decision-making. In the context of disaster management, coordination and control are vital and require a system to manage complex operations, usually under the responsibility of the government ("6. Coordination and Control," 2014). Disaster informatics methodologies, which include data-driven analytics, can improve situational awareness, decision-making, and operational coordination in disaster management (Yang et al., 2020). Project management concepts such as planning, execution, team collaboration, and governance, when integrated with technologies like the Internet of Things for early warning signs, big data analytics for information gathering, and unmanned aerial vehicles for emergency relief, can significantly enhance disaster management (Njoku et al., 2020).

Information systems are essential for improving communication and coordination between various agencies involved in disaster response. They are useful for disseminating vital information, such as warnings, evacuation orders, and resource allocation updates, to both first responders and the general public (Acıkara et al., 2023). The integration of multi-disciplinary technologies is critical for addressing emergency management challenges, which include damage assessment, evacuation planning, situation monitoring, information dissemination, and resource and logistics planning (Bhanumurthy et al., 2015). This enables real-time data sharing and situational awareness, which enables more efficient and coordinated response efforts. The real-time information sharing facilitated by these systems is crucial for making well-informed decisions and effectively managing resources during crises (Kabir & Madria, 2019). Modern information and communication technologies play a crucial role in disaster risk reduction and response, emphasizing the importance of information management and communication systems (Kunguma, 2022). Also, governments and relief organizations face the challenge of prioritizing and delivering services to the impacted population following a natural disaster (Demirtas et al., 2014).

Advances in technology have revolutionized disaster management, offering new tools and capabilities for preparedness, response, and recovery. Artificial intelligence is increasingly being used to improve disaster management by providing insights and automation during all phases of the disaster management cycle (Gupta & Roy, 2024). Technologies like remote sensing, geographic information systems, and the Internet of Things provide real-time data and insights that help to improve decision-making and coordination. The application of IoT can provide real-time data for effective disaster management by enhancing decision-making, coordination, and rapid response, and by providing real-time data for damage assessment, resource allocation, and victim support (Sinha et al., 2017). For example, social media platforms play a crucial role in connecting people and disseminating information during and after disasters (Wiederhold, 2013). Mobile technologies enable first responders to access critical data in the field, thereby facilitating more effective and rapid response efforts. These technologies enable the acquisition of images of disaster areas in a short period of time, even though the subsequent image processing may take a while (Lu et al., 2020). The incorporation of technologies like artificial intelligence, machine learning, and real-time data sharing is essential for improving urban disaster resilience (Kangana et al., 2024). The integration of these advanced technologies is essential for building more resilient communities and effectively managing the increasing complexity of modern disasters (Jourabchi et al., 2019; Khan et al., 2020). The use of cutting-edge technology is necessary to improve disaster management and emergency response, guaranteeing that communities are better prepared to handle and recover from calamitous events (McDonald & Sinha, 2008).

The aim of this study is to conduct a comprehensive review of the use of information systems in disaster management, including a discussion of their role in prevention, preparedness, response, and recovery. The review seeks to offer insights into current best practices, pinpoint emerging trends, and evaluate the difficulties and opportunities related to the use of information systems in the management of disasters. This involves examining how these systems are used to improve situational awareness, facilitate decision-making, and enhance coordination among various stakeholders. Also, the research aims to explore the ways in which modern technologies, such as cloud computing, data analytics, and mobile communications, are changing the landscape of disaster management. The scope of this paper will include but is not limited to analyzing the existing literature, case studies, and real-world implementations of information systems in disaster scenarios. The objective of this study is to offer a thorough analysis of the existing knowledge, to find research gaps, and to make suggestions for further investigation in the area of information systems for disaster management. This includes examining the use of artificial intelligence for Geographic Information Systems and exploring the use of social media analytics (Alruqi & Aksoy, 2023) (Karimiziarani, 2023).

## Disaster Management Frameworks

### 1. Phases of Disaster Management

Disaster management is typically divided into distinct phases, each requiring specific strategies and tools. These phases include mitigation, preparedness, response, and recovery, with information systems playing a vital role in each. Mitigation involves actions taken to prevent or reduce the impact of disasters, such as building codes and land-use planning. Preparedness focuses on preparing for a disaster before it occurs by stockpiling supplies and creating evacuation plans. The response phase involves immediate actions taken during and after a disaster to save lives, minimize damage, and meet basic human needs (Ning et al., 2022). Recovery involves the long-term process of restoring affected areas to their pre-disaster conditions (Malla et al., 2020). It is also important to focus on recovery strategies and planning (Soni, 2020). During all these phases, information systems are essential for collecting, processing, and sharing information to support decision-making and coordination (Park et al., 2014).

### 2. Mitigation

The importance of information systems for mitigation efforts cannot be emphasized. These systems enable the evaluation of hazards, mapping of vulnerable areas, and application of preventative actions. Data from remote sensing, GIS, and historical records are used to predict the severity and frequency of various disasters. Information systems facilitate the implementation of building codes, land-use policies, and infrastructure improvements based on this information to lessen the effects of future disasters.

### 3. Preparedness

Effective preparedness relies heavily on information systems to improve communication, coordination, and resource management. Early warning systems that utilize real-time data from weather sensors, seismographs, and other monitoring devices can alert communities to impending threats. These systems depend on quick data processing and dissemination through

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different communication channels, including social media, mobile apps, and public alert systems. To ensure that people are ready for impending events, preparedness also entails public education and training initiatives, which are greatly aided by information systems.

During a crisis, geographic information systems become a vital component in evaluating the magnitude and extent of damage, facilitating reconstruction efforts, and raising public awareness (Brumarová et al., 2021). Also, geographic information systems and global positioning systems can help utilities during both scheduled and unscheduled events, including anticipating, planning, and preparing for emergencies (Kahn, 2014). The incorporation of geo-informatics, with its strong data management capabilities, is perfectly suited for disaster management, providing substantial support from raising awareness to sharing information during mitigation, preparedness, and response activities (Upadhyay et al., 2020). Crisis management encompasses measures taken before, during, and after a crisis to control its impact. Emergency management, a subset of crisis management, employs geo-information technologies, with Geographical Information Systems having a history of over two decades in this field (El-Hamied et al., 2012). Maps, in general, have played a crucial role in emergency and crisis management long before the development of GIS.

## 4. Response

The response phase requires the quick deployment of resources and well-coordinated operations, both of which are greatly aided by information systems. GIS technology is essential for evaluating damage, mapping affected areas, and coordinating relief efforts (Brumarová et al., 2021). Real-time data streams from drones, satellites, and ground sensors give responders an understanding of the current circumstances. Communication systems are essential for enabling responders to communicate with one another and with the public, and they must be interoperable and resilient. Even when the emergency operations center's capabilities are overburdened or when outdated computer systems cause frustration, information systems help to maintain situational awareness and aid decision-making (El-Hamied et al., 2012).

Information systems have revolutionized disaster response by providing tools for real-time situational awareness, resource allocation, and communication. GIS platforms are used to map affected areas, assess damage, and identify the most efficient routes for emergency vehicles. Connectivity analysis, such as navigation services, is essential to help emergency rescue units reach disaster areas promptly, and real-time data from emergency response units can improve service quality (Baharin et al., 2009). Furthermore, the integration of social media and citizen reporting into information systems provides valuable real-time insights into the evolving situation on the ground, which can inform response strategies and resource deployment (Earth, 2007).

## 5. Recovery

Information systems support the long-term recovery process by facilitating data collection, analysis, and sharing among stakeholders. Damage assessments, infrastructure restoration, and community rebuilding all depend on thorough data on the effects of the disaster. GIS and remote sensing data are used to track the progress of reconstruction projects and spot locations that require more help. Information systems also make it easier to coordinate between government agencies, non-profits, and community organizations, ensuring that resources are used effectively and that recovery efforts are in line with community needs. The integration of spatial planning with disaster risk management is crucial for the successful implementation of recovery strategies (Nur et al., 2018).

## 6. Information Needs in Each Phase

During disaster response, social networks are increasingly used for emergency communications and help related requests (Ragini et al., 2018). The information that stakeholders need differs based on the specifics of the disaster and the duties and responsibilities that each stakeholder is responsible for. Government agencies are the most dependable disaster relief forces in developing nations, where a sizable portion of the world's impacted population resides (Ma et al., 2022). However, social networks and informal relationships play a key role in helping people return to normal life after disasters because disasters can cause formal systems to fail (Li et al., 2015). The use of social media data is very helpful in identifying the state of afflicted areas, calculating damages, tracking rescue requests, and enhancing emergency management (Wang et al., 2023). Social media images can be utilized to get information about flooding in places where sensor coverage is inadequate, to make up for measurement failures, or to supplement other data because the majority of modern consumer devices have GPS and save the geographic location where an image was taken in its metadata (Barz et al., 2019). The public, formal response agencies, and local, national, and international aid organizations are increasingly acknowledging that social media communications are a valuable and helpful source of information in the immediate aftermath of a disaster (Imran et al., 2014).

The use of information systems in disaster management has some drawbacks, including the possibility of data overload, technological dependence, and unequal access to technology. During a disaster, the amount of data produced by sensors, social media, and other sources can be overwhelming, making it difficult for decision-makers to extract useful information. Social media has become a primary channel for the public, news media, and relief agencies to understand the status of a disaster-stricken community (Maldeniya et al., 2023). Furthermore, disaster response and recovery may be hampered by an overreliance on technology, especially if systems fail or are hacked (Mehta et al., 2016). It is important to acknowledge that not everyone has equal access to technology, which may widen existing disparities during and after disasters. It is imperative to understand the geographic and political context of a disaster (Hasfi et al., 2021).

## Information Systems in Disaster Management

### 1. Early Warning Systems

Early warning systems are paramount in disaster management, leveraging information systems to detect, forecast, and disseminate alerts regarding impending hazards (Nguyen et al., 2016). These systems integrate data from various sources, including weather stations, seismographs, and satellite imagery, to model potential disaster scenarios and predict their impact (Fohringer et al., 2015). Advanced algorithms and machine learning techniques enhance the accuracy and timeliness of warnings, enabling timely evacuation and preparedness measures (Said et al., 2019). Effective communication channels, such as mobile alerts, sirens, and public broadcasts, ensure that warnings reach vulnerable populations in a timely manner. Information systems are used by researchers and disaster relief organizations to gather information from satellite imagery and social media during large-scale disaster incidents (Ahuja et al., 2022). Building resilience to disasters, however, necessitates an all-encompassing approach that tackles pressing social and economic issues, strengthens governance frameworks, and fosters community involvement, in addition to technological advancements.

### 2. Communication Networks

Effective communication networks are the backbone of disaster response, facilitating coordination among emergency responders, government agencies, and affected communities. Redundant communication infrastructure, including satellite phones, radio systems, and internet connectivity, ensures reliable communication even when traditional networks are disrupted. Interoperable communication platforms enable seamless information exchange between different agencies and organizations, improving situational awareness and response

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coordination. Moreover, social media platforms serve as valuable channels for disseminating information, gathering citizen reports, and coordinating relief efforts. When traditional communication channels are disrupted, community and social networks become crucial for disaster response (Romo-Murphy et al., 2011). Information systems support community resilience by providing platforms for sharing local knowledge, coordinating mutual aid, and building social capital (Mow et al., 2021).

The effectiveness of early warning systems hinges not only on scientific and technical foundations but also on a people-centered approach that considers social vulnerabilities and long-term processes (Basher, 2006). Early warning systems should provide people with user-defined warning messages (Ou et al., 2025). Integrating community knowledge and feedback mechanisms into the design and implementation of early warning systems enhances their relevance and effectiveness (Glago et al., 2019).

Comprehensive early warning systems include hazard monitoring, risk knowledge, communication, and community response preparedness (Perera et al., 2020). Effective programs for early response and early warning of conflict have relied on accurate, consistent, and timely information obtained from various sources ("Conflict Early Warning and Early Response," 2018). Dissemination channels are crucial for ensuring that early warnings reach vulnerable communities in a timely and accessible manner. The use of new technology enables affected populations to actively participate in data gathering and conflict prevention ("Conflict Early Warning and Early Response," 2018). The biggest challenge for conflict early warning systems is that they have not yet been effectively translated into a preventive response ("Conflict Early Warning and Early Response," 2018). The most effective warning systems integrate the subsystems of detection of extreme events, hazard information management, and public response and also maintain relationships between them through preparedness (Kelman & Glantz, 2014). Longer-term peacebuilding initiatives are crucial for maintaining peace, not just averting violence, and early warning and response should be a part of a larger peace infrastructure ("Conflict Early Warning and Early Response," 2018).

## 3. Data Management and Analysis

Information systems play a pivotal role in collecting, processing, and analyzing vast amounts of data generated during disasters, providing valuable insights for decision-making and resource allocation. Geographic Information Systems integrate spatial data with other relevant information, such as population density, infrastructure networks, and hazard zones, to create comprehensive maps and visualizations. Data analytics techniques are applied to identify patterns, trends, and correlations, enabling evidence-based decision-making and resource optimization. Data-driven insights inform the development of targeted interventions, such as evacuation plans, shelter locations, and resource distribution strategies. Data analysis and management has become important in the wake of disasters.

## 4. Decision Support Systems

Decision support systems leverage information systems to aid decision-makers in evaluating alternative courses of action and selecting the most effective response strategies. These systems integrate real-time data, predictive models, and expert knowledge to simulate disaster scenarios and assess the potential impact of different interventions. Decision support tools assist in resource allocation, logistics planning, and evacuation management, optimizing the use of available resources and minimizing the impact of disasters (Jung et al., 2020). In chaotic and fast-changing emergency situations, scientific data such as monitoring systems, real-time sensor observations, predictive models, and early warnings have the potential to fill an information vacuum and allow emergency responders to make more informed decisions (Groeve, 2020). The complexity of modern disaster response necessitates the development of sophisticated decision support systems.

The role of information systems extends beyond immediate disaster response to encompass long-term recovery and resilience-building efforts. Damage assessment tools utilize remote sensing data, field reports, and citizen observations to evaluate the extent of damage to infrastructure, buildings, and critical facilities (Ortiz et al., 2020). Recovery planning platforms facilitate the coordination of reconstruction efforts, track progress, and ensure accountability. Integrating disaster risk reduction into development planning is crucial for building resilience to future events.

Geodesign frameworks utilize spatial analysis and collaborative decision-making to support resilient urban planning and design (Ye et al., 2021). Information systems can contribute to community resilience by providing access to information, facilitating communication, and empowering citizens to participate in disaster preparedness and response (Pastor-Escuredo et al., 2020). These systems provide the public, media, and other responders with a continuously updated stream of official, verified information, including the location of shelters, evacuation routes, and areas impacted by disaster (Yuan et al., 2023). Integrating GIS spatial analysis with disaster management principles can be visualized in web-mapping browsers for planning and development purposes (Armenakis et al., 2017). Geospatial information based systems have improved the workflow during all phases of emergency response by integrating GIS technology, geospatial data, and emergency equipment (Zheng, 2020). Visualization systems integrate various domains of knowledge that require specific skills to determine incongruence and heterogeneity of information from various sources, specifically for disaster management (Abdalla, 2018). Effective application of big data technology in surveying and mapping geographic information provides technical support for the effective use of data information, which positively impacts the development of the industry and social progress (Liu et al., 2021).

Information systems play a crucial role in improving emergency management service practice by leveraging social media and crowdsourcing analysis (Havas et al., 2017). For example, a national remote sensing center initiated a crowdsourcing campaign that enabled residents to upload photos of damages from their smartphones (Ajmar et al., 2015). The application of Geographic Information Systems and Global Positioning Systems in humanitarian emergencies provides maps for decision-making and advocacy, which allow overlaying of information (Kaiser et al., 2003).

## 5. GIS and Mapping Technologies

GIS and mapping technologies are integral components of information systems for disaster management, offering capabilities for spatial data management, analysis, and visualization (Abdalla, 2018). These technologies stand on the cutting edge of modern geosciences, finding direct implementation in analysis and modeling of natural phenomena and research in key sectors like hydrology (Chalkias et al., 2016). GIS enables the creation of digital maps depicting hazard zones, critical infrastructure, and population distribution, providing a visual representation of the spatial context of disasters (Nugraha, 2018). Remote sensing technologies allow for the observation of Earth's features from space, employing techniques to differentiate information collected on land, vegetation, and water (Reddy, 2018). Spatial analysis techniques, such as overlay analysis, network analysis, and spatial statistics, can identify areas at high risk, optimize evacuation routes, and allocate resources effectively (Abdalla, 2016). Thematic layers for GIS can be built using digital elevation models and satellite images (Ostanin et al., 2021). GIS is ideally suited for the storage, display, output, analysis, and modeling of geographic data (Wyngaarden & VanderWal, 2006). GIS tools can be used to integrate existing data such as soil survey maps and aerial photos with project specific data, identify potential geological hazards, plan and track field work, catalog and review sampling and laboratory testing results, create maps and figures for reports, and develop three-

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dimensional models. Remote sensing can be coupled with GIS, offering robust tools for modeling what occurred in the past and what may occur in the future (Wang & Xie, 2018).

AI is also leveraged with GIS by utilizing geographical visualization and spatial analytic skills to further process and mine data in response to AI recognition discoveries (Alruqi & Aksoy, 2023). In recent years, Geographical Information System technology has been largely used for landslide susceptibility assessing and mapping, frequently combined with data detected by innovative techniques, such as satellite remote sensing and light detection and ranging images (Roccati et al., 2021).

## 6. Challenges and Opportunities

Despite the significant advancements in information systems for disaster management, several challenges remain to be addressed. Data quality and interoperability are critical concerns, as disparate data sources may have inconsistent formats, accuracy levels, and metadata, which limits their usability. The integration of socio-economic and geographical information assists in decision-making across subject-matter fields affecting education, health, environmental protection, municipal services, economic development and location of essential infrastructure (Meliskova, 2000). The development of GIS methods requires further research to overcome the substantial initial investment in equipment and capacity building, particularly in humanitarian emergencies where equipment and methodologies must be practical and appropriate for field use (Kaiser et al., 2003).

However, challenges to more widespread use of GIS technology, such as limited access to GIS infrastructure, inadequate technical and analytical skills, and uneven data availability still remain (Fletcher & Caprarelli, 2016). Addressing these limitations requires investments in data infrastructure, capacity building, and standardization efforts to ensure that information systems are reliable, accurate, and accessible to all stakeholders (Moore et al., 1995; Player, 2004). Furthermore, the adoption of emerging technologies, such as cloud computing, artificial intelligence, and blockchain, offers new opportunities to enhance the capabilities of information systems for disaster management (Yordanov et al., 2021). These technologies can enable real-time data processing, predictive analytics, and secure information sharing, improving decision-making and coordination during disasters (Alruqi & Aksoy, 2023; Bajwa, 2025).

The integration of geographic information with other data sources and analytical models can provide valuable insights into disaster risk and vulnerability (Zhang, 2019). Additionally, the establishment of data sharing agreements and protocols can facilitate the seamless exchange of information between different organizations and agencies, improving situational awareness and response coordination.

## 7. Future Directions

The future of information systems in disaster management involves several promising directions. One key area is the development of more sophisticated predictive models that can forecast the likelihood and impact of disasters with greater accuracy. This requires the integration of diverse data sources, including weather data, seismic data, and social media data, along with advanced machine learning algorithms. Another direction is the use of virtual reality and augmented reality technologies to create immersive simulations of disaster scenarios for training and education purposes.

## Conclusion

This review has explored the multifaceted role of information systems in disaster management, highlighting their contributions to risk assessment, early warning, response coordination, and recovery efforts. The findings of this review have several important implications for practitioners and policymakers involved in disaster management.

First, it underscores the importance of investing in robust data infrastructure and information systems to support evidence-based decision-making. Second, it highlights the need for greater collaboration and coordination among different organizations and agencies to ensure the effective sharing of information and resources (Khan et al., 2023). Finally, it emphasizes the importance of adopting a holistic and integrated approach to disaster management that considers the social, economic, and environmental dimensions of disasters.

To enhance disaster prevention, response, and post-disaster reconstruction, integrated BIM-GIS technologies are essential, aiding urban managers in making well-informed decisions and mitigating disaster-related losses (Cao et al., 2023). Effective coordination is underpinned by common principles, while community participation is crucial throughout all phases of disaster management (Moore et al., 2009).

Finally, it is important to acknowledge the limitations of this review. Further, in most of the existent research on long-term recovery, housing and infrastructure reconstruction are emphasized to the exclusion of other aspects of disaster recovery (Ogie et al., 2022). In addition, some relevant publications may have been missed due to language restrictions or publication bias. Future research should address these limitations by expanding the scope of the review to include a wider range of sources and perspectives.

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