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REVIEW

Mobile GIS in Disaster Management: A Bibliometric and Systematic Review Across the Disaster Management Cycle

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ABSTRACT: Disasters are occurring much more frequently and their impacts are worsening due to factors such as climate change, rapid urbanization, and environmental degradation. The need for technologies like Mobile Geographic Information Systems (Mobile GIS) in disaster management is increasing every day. This study evaluates mobile GIS applications in disaster management using a hybrid method combining bibliometric analysis with a PRISMA-based systematic review approach. Analyzing 353 publications, the study reveals that mobile GIS research is among the preferred technologies in disaster management. However, a significant structural imbalance is also noticeable in the literature, with a large proportion of studies focusing on the during-disaster phase, while pre-disaster and especially post-disaster applications remain relatively limited. This suggests that Mobile GIS is predominantly positioned in the literature as an operational and reactive decision support tool. In addition to studies demonstrating that Mobile GIS can be used for real-time data collection, enhancing situational awareness, and improving interagency coordination across all phases of the disaster management cycle (preparation, response, and recovery), its integration with new technologies such as artificial intelligence, the Internet of Things (IoT), cloud computing, unmanned aerial vehicles (UAVs), and digital twins will make Mobile GIS a smarter, more flexible, and data-driven decision support system. However, various problems persist, such as low data quality, lack of interoperability, dependence on connectivity, limited user capacity, and organizational obstacles. This means that more robust data infrastructures, standardized and interoperable systems, and user-centric design approaches need to be developed. This study shows that mobile GIS in disaster management should be evaluated not only in terms of individual application areas but also in terms of the relationships between disaster types, management phases, and technological themes. It also reveals the potential for a transition from reactive to proactive and predictive systems.

KEYWORDS: Mobile GIS; mobile data collection; bibliometric analysis; systematic review; real-time geospatial systems; spatial decision support systems; location-based services (LBS); preparedness and risk assessment; emergency response

1 Introduction

Natural and man-made disasters have become one of the most significant problems faced globally today. According to the Emergency Events Database (EM-DAT), natural disasters, in particular, have caused the deaths of millions of people, directly or indirectly affected billions of people, and resulted in trillions of dollars in economic losses in the last century [1].

As a result of studies conducted over many years, disaster management has been developed as a cyclical structure consisting of mitigation, preparedness, response, and recovery phases to reduce disaster risks and impacts. This structure offers a holistic and continuous approach encompassing pre-disaster, during-disaster, and post-disaster processes [2].

Within a framework supporting the disaster cycle, the use of advanced technologies in disaster management has increased significantly in recent years [3]. Remote sensing technologies, supported by different platforms such as satellites, aircraft, and Unmanned aerial vehicles (UAVs), enable continuous and multi-scale monitoring of environmental changes. For example, the integration of high-resolution optical and radar images with machine learning methods significantly accelerates damage assessment processes, especially after disasters [4,5]. UAVs make notable contributions to damage assessment processes by offering the possibility of rapid and real-time data collection in hard-to-reach or hazardous areas [5,6]. In addition, developments in the Internet of Things (IoT), mobile computing, and sensor networks enable real-time data flow and increased situational awareness [7,8]. However, Geographic Information Systems (GIS) [9–13], decision support systems [14], web-based GIS [15,16], and advanced communication infrastructures [17] strengthen inter-agency coordination and support data-driven decision-making processes [13,18,19]. Mobile GIS is among the key technologies supporting real-time data collection, analysis, and sharing processes in disaster management. The integrated and unified use of these technologies supports all phases of the disaster cycle, enabling the development of more proactive, holistic, and data-driven approaches in disaster management.

Mobile GIS brings traditional GIS capabilities to mobile environments via smart devices, reducing the gap between data generation and decision-making processes [20]. One of the most important advantages of Mobile GIS is its ability to provide real-time data synchronization [21–23], offline operation, and location-based services. These features increase the effectiveness of the system, especially in disaster management processes where time and accessibility are critical. Furthermore, Mobile GIS has achieved a more advanced and adaptable structure thanks to integration with IoT, cloud computing, artificial intelligence, and UAV systems. This technological convergence enables Mobile GIS to be used more effectively in all phases of the disaster management cycle.

Despite this, the majority of existing studies consist of research papers focusing on specific technologies or individual phases of the disaster management cycle. This creates a fragmented structure in the literature and makes it difficult to understand the role of Mobile GIS holistically. In particular, the limited number of studies that address the relationships between technologies, application areas, and methodological approaches in an integrated manner points to a notable research gap. Accordingly, this study aims to provide a comprehensive and systematic review of Mobile GIS applications in disaster management. Within the scope of the study, the conceptual and technological infrastructure of Mobile GIS is examined, applications in the disaster management cycle are analyzed, existing limitations are revealed, and future research directions are discussed. This approach aims to contribute to increasing the effectiveness of disaster management systems by evaluating the literature from an integrated perspective.

2 Background of the Disaster and Mobile GIS

2.1 Disaster Management Background

Disasters are generally defined as events that severely disrupt the functioning of a society and cause significant human, economic, and environmental losses that exceed the coping capacity of the affected society. In the literature, disasters are commonly discussed under two main categories: natural and human-induced. Natural disasters are classified as geophysical (earthquakes, volcanic eruptions), hydrological (floods, landslides), meteorological (storms, extreme temperatures), and climatological events (drought, forest fires), while human-induced disasters include technological and industrial accidents, infrastructure failures, and socio-political crises.

Since the 1980s, developments in data collection and recording systems have made it possible to monitor disaster events more systematically; this process has further accelerated with the widespread adoption of digital technologies in the 1990s and the strengthening of data infrastructures in the 2000s. However, the increase in disasters cannot be explained solely by improvements in data recording systems; a significant upward trend is also observed in terms of frequency and severity.

According to the EM-DAT, more than 17,000 disaster events were recorded between 1900 and 2024, with a notable increase particularly after 1980 (Fig. 1). Furthermore, the high coefficient of determination (R^2 = 0.91) supports this upward trend, indicating that the trend is strong and statistically significant.

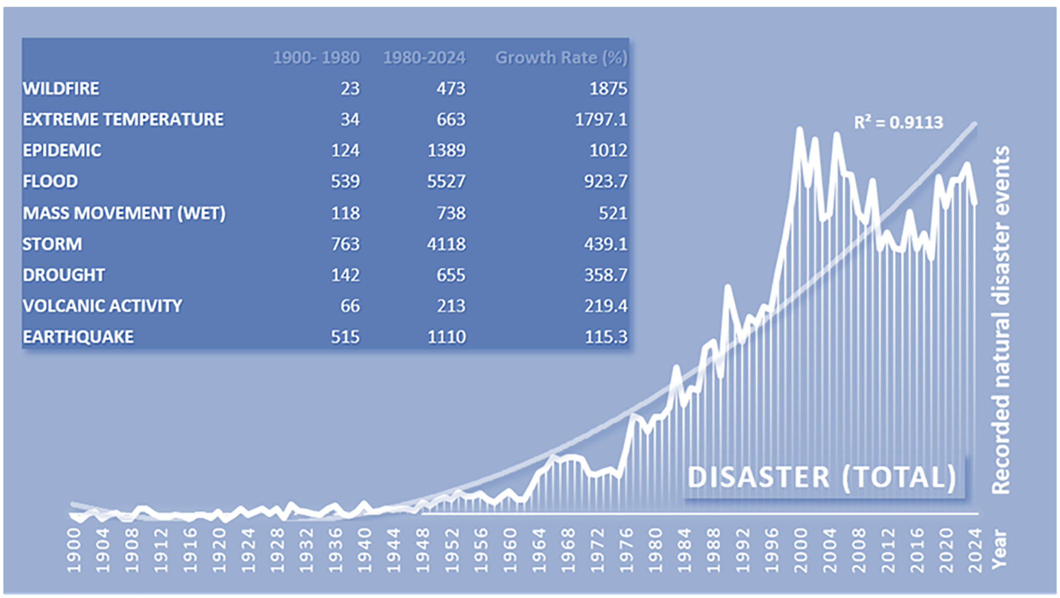

Figure 1: Evolution of recorded natural disasters (1900–2024) with post-1980 growth insights [1].

The increasing risk and complexity of disasters have necessitated a more systematic and integrated approach to disaster management. In this context, disaster management is conceptualized as a cyclical process consisting of mitigation, preparedness, response, and recovery phases. This structure supports continuous learning and improvement mechanisms by addressing pre-disaster, during-disaster, and post-disaster processes with a holistic approach. However, the effectiveness of this cycle largely depends on the availability of timely, accurate, and spatially explicit information.

The increasing complexity of disaster environments is driving the need for more adaptable, real-time, and data-driven approaches. In this context, the integration of geographic information technologies plays a critical role in increasing situational awareness, supporting decision-making processes, and strengthening coordination among stakeholders. In this context, Mobile Geographic Information Systems (Mobile GIS) stand out as a significant technological enabler in all phases of the disaster management cycle by supporting spatial data collection, analysis, and sharing processes in real time (Fig. 2).

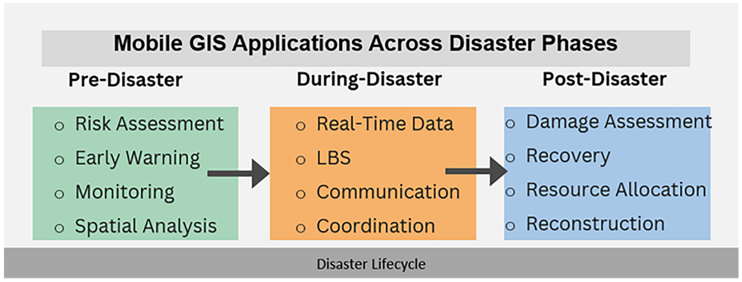

Figure 2: Conceptual framework of Mobile GIS applications across disaster management phases.

2.2 Conceptual and Technological Background of Mobile GIS

2.2.1 Conceptual Definitions and Evolution of Mobile GIS

Mobile GIS has emerged as a result of the integration and convergence of geographic information technologies, mobile computing, and communication infrastructures. While traditional GIS, developed by Roger Tomlinson in the 1960s, was initially designed for static and desktop-based analyses, technological advancements have transformed it into more dynamic, flexible, and field-oriented systems.

Today, GIS platforms have increased both their analytical capacity and accessibility through cloud computing, artificial intelligence, big data analytics, and real-time processing capabilities. These developments have enabled GIS to assume a central role in areas such as urban planning, environmental monitoring, public health [24], and disaster risk management [16].

The development of Mobile GIS is directly related to advancements in Global Positioning System (GPS), portable devices, and wireless communication technologies [25,26]. The proliferation of smartphones and the development of network technologies such as 4G/5G have significantly increased the accessibility and scalability of Mobile GIS applications [27].

Mobile GIS is defined in different ways in the literature, reflecting its interdisciplinary nature. In general, Mobile GIS is considered a system that integrates location-based services, mobile devices, and communication networks [28].

In recent years, Mobile GIS has transformed from being merely a data collection tool into a real-time decision support system. Cloud computing, IoT, and artificial intelligence technologies play a decisive role in this transformation.

IoT-based sensor networks increase environmental and situational monitoring capacity by providing continuous data flow, while cloud computing supports data storage and synchronization processes, enabling the development of scalable systems. In the context of disaster management, GIS has long been used in hazard mapping and post-disaster assessment processes [14,15,29,30]. However, the transition to Mobile GIS represents a notable paradigm shift in terms of real-time data collection and field-based analysis. Artificial intelligence and machine learning techniques enhance the analytical capacity of Mobile GIS through predictive analysis and automated data interpretation processes. Furthermore, UAVs stand out as complementary technologies that integrate with Mobile GIS, strengthening high-resolution data production and decision support processes.

2.2.2 System Architecture of Mobile GIS

Mobile GIS systems primarily consist of client and server components. The structure of these components varies depending on application requirements and technological infrastructure.

On the client side, Mobile GIS relies on smart devices for data collection, visualization, and analysis. These devices support real-time data generation via GPS and other sensors, and also ensure data continuity thanks to their offline operation capabilities [21,31,32].

In terms of development, native applications provide high performance, while cross-platform solutions offer more flexible development possibilities. Tools such as ArcGIS Runtime, Google Maps SDK [33,34], and Mapbox SDK [35,36] support the implementation of advanced geographic functions in mobile environments.

On the server side, spatial databases and geographic servers provide big data management and distribution. PostGIS [37–40] and similar systems support spatial data management, while platforms such as GeoServer [41] and ArcGIS Server perform map services and data dissemination. Client-server communication is generally provided through Web Map Service (WMS), Web Feature Service (WFS), and Representational State Transfer (REST) services.

In recent years, architectures have become more distributed and flexible with cloud computing, edge computing, and fog computing approaches. These structures reduce latency by bringing data processing processes closer to the data source and improve performance, especially in time-critical applications such as disaster management.

However, many systems still have partially integrated structures. This limits interoperability and can negatively affect real-time decision support processes. Therefore, more integrated and scalable architectures are needed.

2.2.3 Integration and Research Gaps in Mobile GIS

Despite advancements in the field of Mobile GIS, a lack of integration and standardization poses important limitations. Most studies focus on individual technologies, making it difficult to address systems within an integrated structure.

One of the main problems is the insufficient interoperability between the client, server, and external data sources. Data format and platform differences limit real-time data sharing and system integration.

Furthermore, there is a significant imbalance in the literature regarding the disaster management cycle. While most studies focus on response and post-disaster processes, preparedness and early warning phases are less addressed.

In addition, many Mobile GIS applications are developed specifically for certain scenarios, limiting generalizability and standardization. Although new technologies such as Artificial Intelligence (AI), edge computing, and sensor networks offer significant opportunities, how these technologies can be applied within integrated systems has not been sufficiently researched.

This situation indicates that Mobile GIS needs to be addressed with a more holistic and systematic approach. Accordingly, the next section will present the general structure of the field and research trends through bibliometric analysis.

3 Methodology

The methodology of this study is designed to provide a systematic and reproducible synthesis of the Mobile GIS literature in disaster management. For this purpose, a hybrid review method combining bibliometric analysis with systematic and integrative review approaches has been adopted.

A Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)-based search process was applied to ensure the transparent and consistent selection of relevant studies according to predefined inclusion and exclusion criteria [42]. This structured process increases the reproducibility and reliability of the study. The dataset was compiled from the Web of Science and Scopus databases, and keyword-based thematic analysis was performed to identify dominant research trends, thematic structures, and emerging issues in the literature.

The study selection process was conducted by two independent researchers. At each stage, titles, abstracts, and full texts were systematically reviewed, and consistency was ensured through cross-comparison. Any discrepancies were resolved through discussion and consensus; thus, potential selection bias was reduced, and transparency and methodological rigor were increased. Study relevance was assessed based on alignment with the scope of the review, thematic relevance to Mobile GIS and disaster management, and the availability of sufficient bibliographic metadata for systematic analysis.

The bibliometric component allows for a quantitative assessment of the development of the research field, including publication trends and keyword relationships. In parallel, the systematic review approach ensures a structured and consistent evaluation of studies throughout the disaster management cycle. Furthermore, an integrative perspective has been adopted to synthesize results from different studies by combining technological, methodological, and application-based findings. This approach allows for the structured classification of Mobile GIS applications within the pre-disaster (preparation), disaster (response), and post-disaster (recovery) phases, while also facilitating the identification of research gaps, limitations, and future directions.

A formal risk of bias assessment, commonly applied in quantitative systematic reviews and meta-analyses, was not conducted in this study because the research focuses on bibliometric mapping and thematic synthesis rather than quantitative effect size comparison. Instead, methodological rigor and study selection consistency were ensured through the structured PRISMA-based screening process, predefined eligibility criteria, and independent reviewer evaluation. However, because no formal study quality appraisal framework was applied, differences in methodological quality among included studies may not have been fully captured, which represents a limitation of this review.

By combining these complementary approaches, this study adopts a multidimensional and phase-integrated review perspective for analyzing Mobile GIS in disaster management. This approach enhances both analytical depth and conceptual clarity.

3.1 Data Sources and Search Strategy

The literature search was conducted using Web of Science (WOS) and Scopus, two major scientific databases widely recognized for their comprehensive inclusion of high-quality peer-reviewed publications. To ensure both scientific rigor and to cover emerging technological developments, the search process included conference proceedings in addition to peer-reviewed journal articles.

The search was limited to studies published between 2005 and 2025 and in English. This time frame was chosen to capture the development of Mobile GIS technologies in parallel with advancements in mobile computing, wireless communication, and real-time spatial systems.

To provide a comprehensive literature search and overcome database query limitations (e.g., terminology restrictions in Web of Science), the search vocabulary was systematically structured into five thematic clusters representing the core dimensions of Mobile GIS and disaster-related research (Table 1). These clusters are: (i) Mobile GIS core concepts and applications, (ii) data collection and participatory approaches, (iii) system architecture and technologies, (iv) Mobile GIS tools and platforms, and (v) disaster management and hazard context are covered. The final search query is constructed as a combination of these thematic clusters as follows:

Table 1: Literature search databases, terms, strategy, and counts.

Databases ■ Web of Science; ■ Scopus
Set 1 (Mobile GIS Core Concepts and Applications) **Results:** WOS: 8567; Scopus: 15,932 **Year:** 2005–2025 mobile GIS; mobile geographic information system; mobile mapping; mobile spatial data; mobile geoinformatics; mobile geospatial system; mobile geospatial application; mobile field mapping; smartphone GIS; handheld GIS; tablet GIS; field-based GIS; location-based services; location-aware system; mobile GIS application; mobile GIS platform; mobile GIS system; mobile spatial decision support system; mobile SDSS; real-time GIS
Set 2 (Data Collection and Participatory Approaches) **Results:** WOS: 17,807; Scopus: 19,728 **Year:** 2005–2025 mobile data collection; field data collection; mobile spatial data collection; real-time data collection; offline data collection; participatory GIS; crowdsourced mapping; volunteered geographic information; VGI; citizen science; geo-tagged data; geolocation services; GNSS-enabled mobile systems; mobile sens; networks
Set 3 (System Architecture and Technologies) **Results:** WOS: 31,925; Scopus: 48,287 **Year:** 2005–2025 TS = (mobile GIS client; mobile GIS server; mobile web GIS; mobile GIS API; mobile GIS SDK; mobile GIS framework; mobile GIS integration; cross-platform GIS application; open-source mobile GIS; cloud GIS; cloud-based GIS; edge computing GIS; mobile edge computing; IoT-based GIS; sensor-based GIS; real-time spatial systems; spatial analytics; real-time analytics; GeoAI; geospatial artificial intelligence; mobile geospatial analytics; real-time geospatial analytics; digital twin; smart city GIS
Set 4 (Mobile GIS Tools and Platforms) **Results:** WOS: 1818; Scopus: 2108 **Year:** 2005–2025 ArcGIS Field Maps; QField; Survey123; KoboToolbox; Fulcrum; SW Maps
Set 5 (Disaster Management and Hazard Context) **Results:** WOS: 1,151,243; Scopus: 1,767,877 **Year:** 2005–2025 disaster management; emergency management; disaster response; disaster recovery; disaster preparedness; disaster mitigation; disaster risk reduction; risk assessment; hazard assessment; early warning system; evacuation; disaster; natural disaster; earthquake; seismic hazard; flood; wildfire; drought; pandemic; extreme weather; landslide
Search strategy **(Set 1; Set 2; Set 3; Set 4) AND Set 5** **Results:** WOS: 2582; Scopus: 4249

(Set 1 OR Set 2 OR Set 3 OR Set 4) AND Set 5

This structured query design enabled a comprehensive yet focused literature search covering diverse technological and application dimensions. The final literature search was completed on 14 April 2026, yielding a total of 6831 records from the Web of Science (2582) and Scopus (4249) databases.

All searches were limited to English-language publications to ensure consistency and comparability of interpretations. Peer-reviewed journal articles and conference proceedings were included as appropriate publication types; review articles, grey literature, book chapters, editorials, and other unindexed sources were excluded to maintain data quality and methodological consistency. A limited number of additional publications from other sources were consulted to support the conceptual framework; however, these studies were not included in the main dataset due to a lack of Digital Object Identifier (DOI), insufficient metadata, or standard indexing issues.

Conference proceedings were deliberately included because they reflect current research trends and methodological developments, particularly in rapidly evolving fields such as Mobile GIS and disaster management. Although some papers lacked DOIs or complete metadata, this was considered to stem from publication characteristics rather than data quality. It was noted that excluding such studies could lead to overrepresentation of well-indexed journal articles and the neglect of innovative or early-stage contributions.

Accordingly, the inclusion criteria were designed to balance data quality with representativeness, aiming to ensure comprehensive literature coverage while minimizing potential selection bias through predefined eligibility criteria, independent reviewer screening, and consensus-based study selection.

The study selection process was conducted by two independent researchers according to predetermined inclusion and exclusion criteria. Title, abstract, and full-text reviews were systematically performed; consistency was ensured through cross-checking between evaluators. Differences were resolved through discussion and consensus, enhancing the transparency, reliability, and reproducibility of the process.

3.2 Study Selection and Screening Process (PRISMA)

The study selection process was conducted in accordance with the PRISMA framework to ensure transparency, reproducibility, and methodological rigor. Following a literature review, a total of 6831 records were initially identified, and after removing duplicate records, 4658 unique studies were further evaluated.

The search process was carried out using a Python-based text analysis and data processing pipeline developed by the authors. This pipeline systematically evaluated the studies' relevance to Mobile GIS, disaster context, and conceptual suitability by applying text normalization, keyword matching, and rule-based filtering steps in an integrated manner. The results obtained throughout the process were regularly reviewed by the authors, and manual corrections were applied where necessary. In the initial search phase, 1979 studies not directly related to Mobile GIS were excluded. Thus, 2679 studies were subjected to detailed evaluation in terms of disaster management context and conceptual suitability. In this phase, 359 studies were eliminated because they did not have a disaster context; 1967 studies that were disaster-related but lacked a clear Mobile GIS component, spatial analysis framework, or location-aware decision support structure were also excluded from the evaluation. As a result, 353 studies were included in the review after all screening stages. Furthermore, emerging technologies such as UAVs, AI, IoT, and digital twins were not initially automatically excluded; however, studies focusing solely on these technologies and lacking a clear Mobile GIS component were excluded to maintain conceptual consistency. The PRISMA flowchart (Fig. 3) provides a transparent summary of the identification, screening, eligibility, and inclusion stages.

3.3 Analytical Framework

The final dataset was analyzed using a combined bibliometric and thematic analytical framework designed to support the systematic examination of publication characteristics, thematic structures, hazard categorization, and disaster phase-based comparisons in Mobile GIS disaster research.

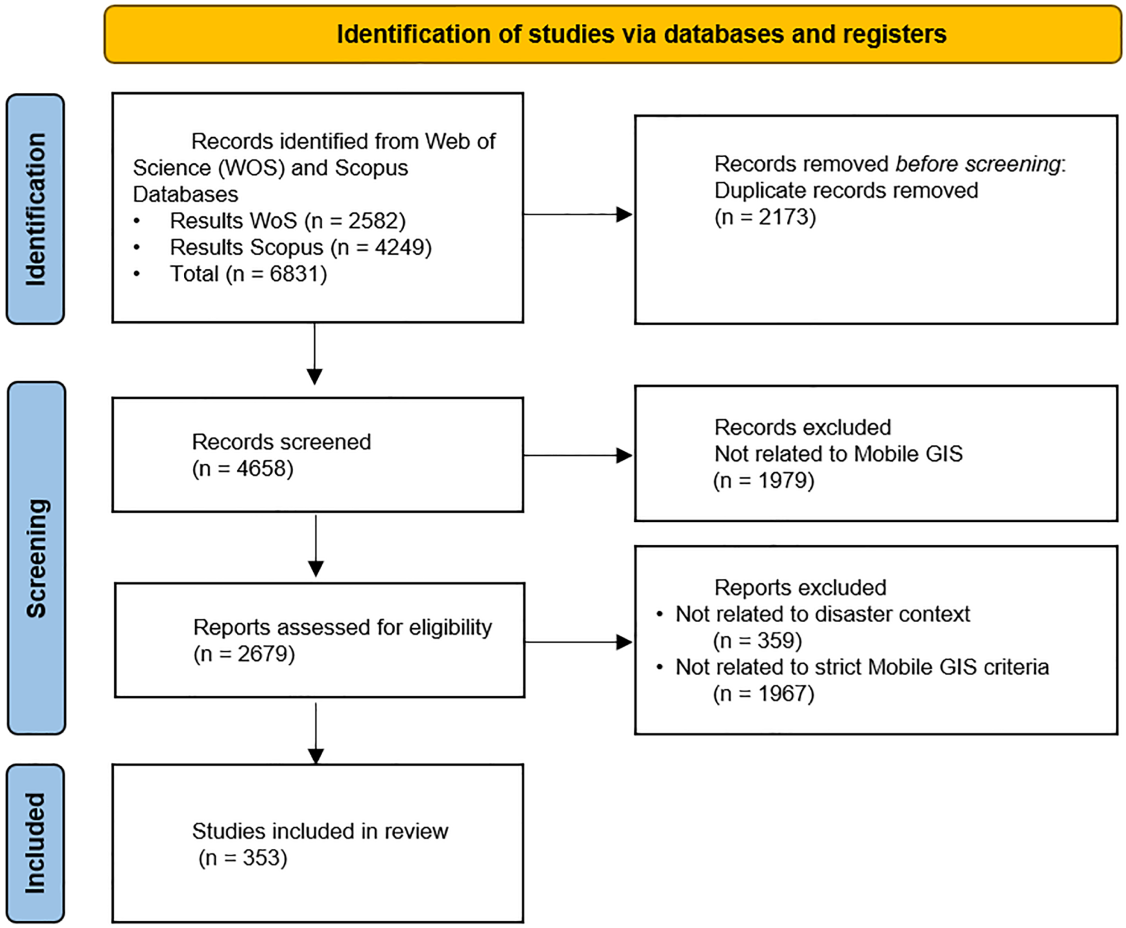

Figure 3: PRISMA-based flow diagram of the study selection process.

3.3.1 Bibliometric Analysis Methods

Bibliometric analysis was conducted to examine the structural characteristics of the selected literature, including annual publication trends, publication type distributions, and keyword frequency patterns. Publication years were used to assess temporal research development, while publication types (e.g., journal articles and conference papers) were compared to evaluate the evolution of publication formats within the field. Keyword frequency analysis was applied to identify thematic concepts and recurring research focuses.

3.3.2 Thematic Classification Framework

A thematic classification framework was developed to organize the reviewed studies according to their primary research focus. Studies were classified according to thematic characteristics such as disaster management functions, communication-related applications, participatory information approaches, and Mobile GIS-related technological components. This classification provided a structured basis for thematic comparison within the literature.

3.3.3 Hazard and Disaster Phase Categorization

To support comparative analysis, the selected studies were categorized according to hazard type and disaster management phase. Hazard classification included categories such as floods, earthquakes, wildfires, landslides, storms, and other identified hazard categories. In addition, studies were assigned to disaster management phases including pre-disaster, during-disaster, post-disaster, or multi-phase applications based on their primary application focus.

3.3.4 Visualization and Comparative Analysis

Comparative visual analyses were used to facilitate the examination of thematic and categorical relationships within the dataset. Frequency-based bar charts, bubble matrix visualizations, and Sankey diagrams were used as comparative visualization techniques to represent relationships between hazard types, disaster phases, and thematic research areas.

4 Bibliometric and Thematic Analysis Results

The bibliometric analysis presented in this section is based solely on 353 studies included in this compilation as a result of a systematic selection process based on PRISMA. Therefore, the findings reflect the characteristics, trends, and thematic structure of the filtered dataset rather than representing the entire Mobile GIS literature. Furthermore, the dataset is predominantly limited to studies obtained from the Web of Science and Scopus databases and narrowed according to specific inclusion criteria focusing on the context of Mobile GIS and disaster management. Studies from different databases or those that do not conform to the defined conceptual framework have been excluded from the analysis. Therefore, the temporal trends and bibliometric findings presented below should be evaluated within this context of limitations.

4.1 Temporal Distribution and Publication Trends

The temporal development of publications related to Mobile GIS in disaster management is presented in Fig. 4. Examining the annual distribution, while a general increasing research trend is observed, it is noteworthy that this increase is not entirely linear and stable, showing significant fluctuations in certain years. In the early years of the study period (2005–2010), the number of publications remained relatively low, reflecting that Mobile GIS was still a developing research field.

From the mid-2010s onwards, a significant upward trend in the number of publications emerged, and studies reached higher values, especially after 2014. However, this growth process was not uninterrupted; relative decreases were observed in some years (e.g., 2012 and 2021). This fluctuating structure indicates that the field follows a dynamic development process depending on technological advancements, data access capabilities, and changes in research trends.

The general trend is supported by linear regression analysis, and there is a positive relationship between the publication year and the number of studies ($R^2 = 0.574$). This value reveals that mobile GIS studies have shown a moderate but steady upward trend over time.

The increase in the number of publications, particularly after 2017, indicates that mobile GIS is gaining more prominence in the disaster management literature and evolving from a developing research field to a more mature and established one.

4.2 Publication Type Analysis

The distribution of publications by type is presented in Fig. 5. The findings show that both journal articles and conference proceedings have made substantial contributions to the development of Mobile GIS research in disaster management. However, when the temporal distribution is examined, a significant structural transformation between these two publication types is noticeable.

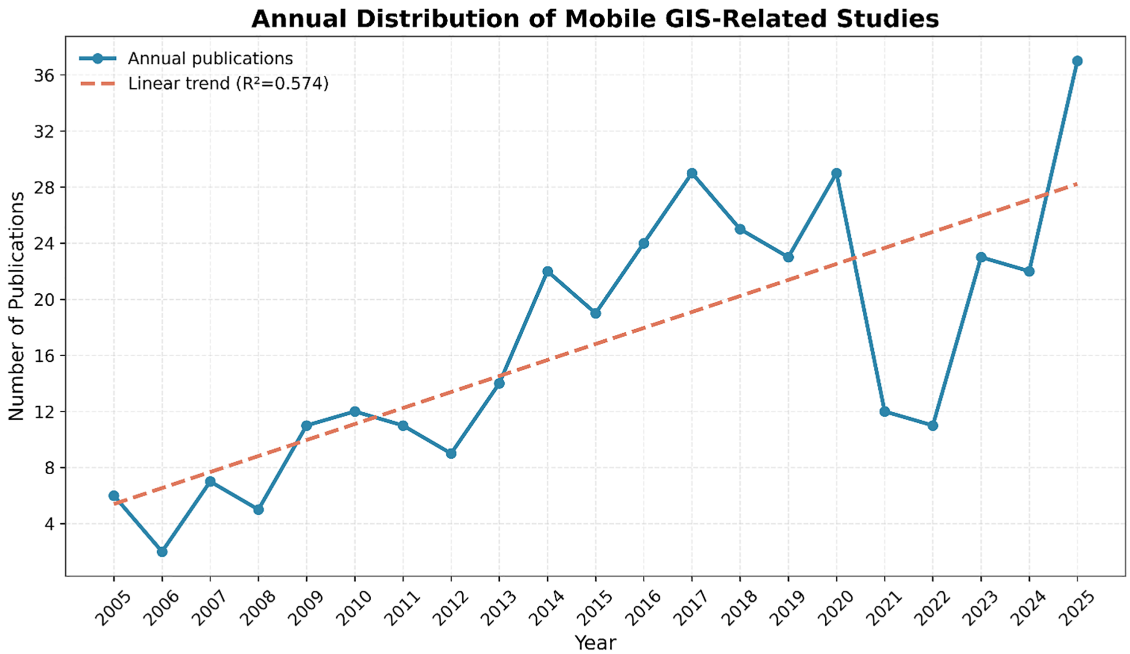

Figure 4: Annual distribution of Mobile GIS-related studies.

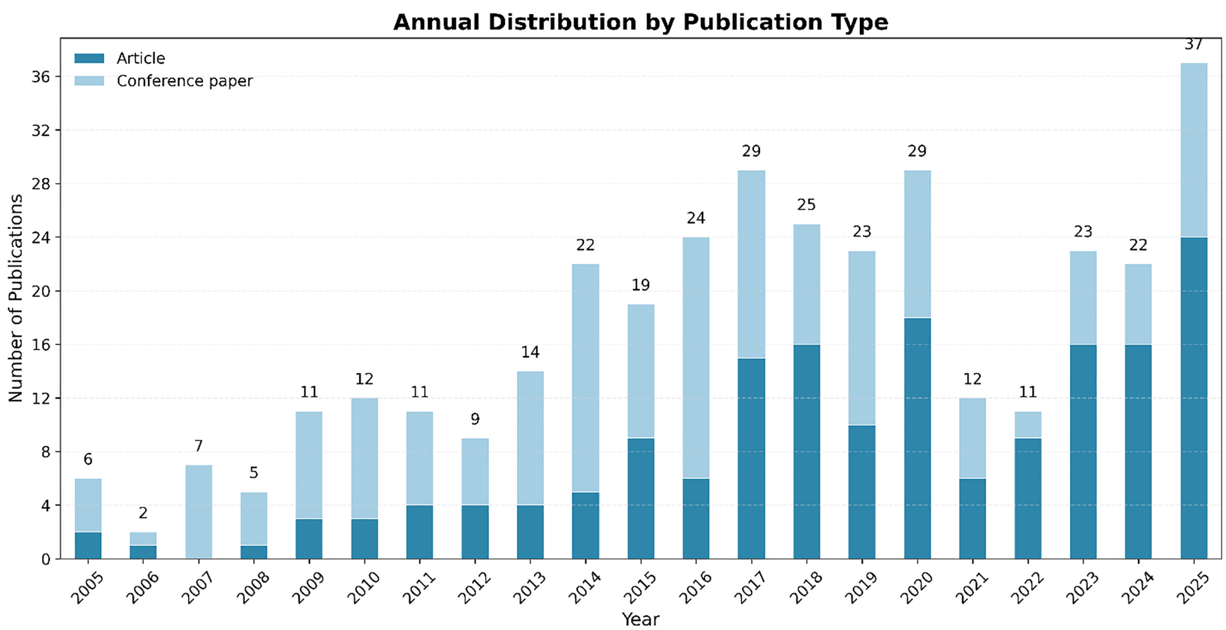

Figure 5: Annual distribution of journal articles and conference papers.

In the early years of the study period (2005–2012), the proportion of conference proceedings within the total publications was higher. This indicates that the field initially had a more technology-oriented and application-based character, and that conferences played an important role in the rapid sharing of new methods and systems.

While a notable increase in the total number of publications is observed, especially in the 2014–2017 period, it is noteworthy that a significant portion of this increase originated from conference proceedings. This period shows that the field entered a rapid development and dissemination process.

In contrast, a stronger and more stable upward trend in journal articles emerges after 2017. From this period onwards, it is observed that journal articles have approached or even surpassed conference proceedings in many years. Particularly in recent years (2023–2025), the significant increase in journal articles indicates that Mobile GIS studies are evolving into a more systematic, verifiable, and academically mature structure. While the increase in journal publications points to a strengthening of methodological depth and the level of scientific contribution, the continued significant share of conference papers shows that the field maintains its dynamic and innovation-oriented character. It is understood that rapidly developing topics, especially mobile technologies, real-time data processing, and integrated spatial systems, are addressed more quickly in conference settings. Overall, the findings reveal that Mobile GIS research follows a two-way development process: conferences play a critical role in disseminating innovative and early-stage ideas, while journal articles stand out as a fundamental mechanism for validating, deepening, and theoretically framing this information.

4.3 Keyword-Based Thematic Analysis

The thematic structure of the literature was examined using keyword frequency analysis, as presented in Fig. 6, which displays the top 10 most frequent keywords identified in the reviewed studies. The findings indicate that Mobile GIS research in disaster management is organized around several prominent thematic areas.

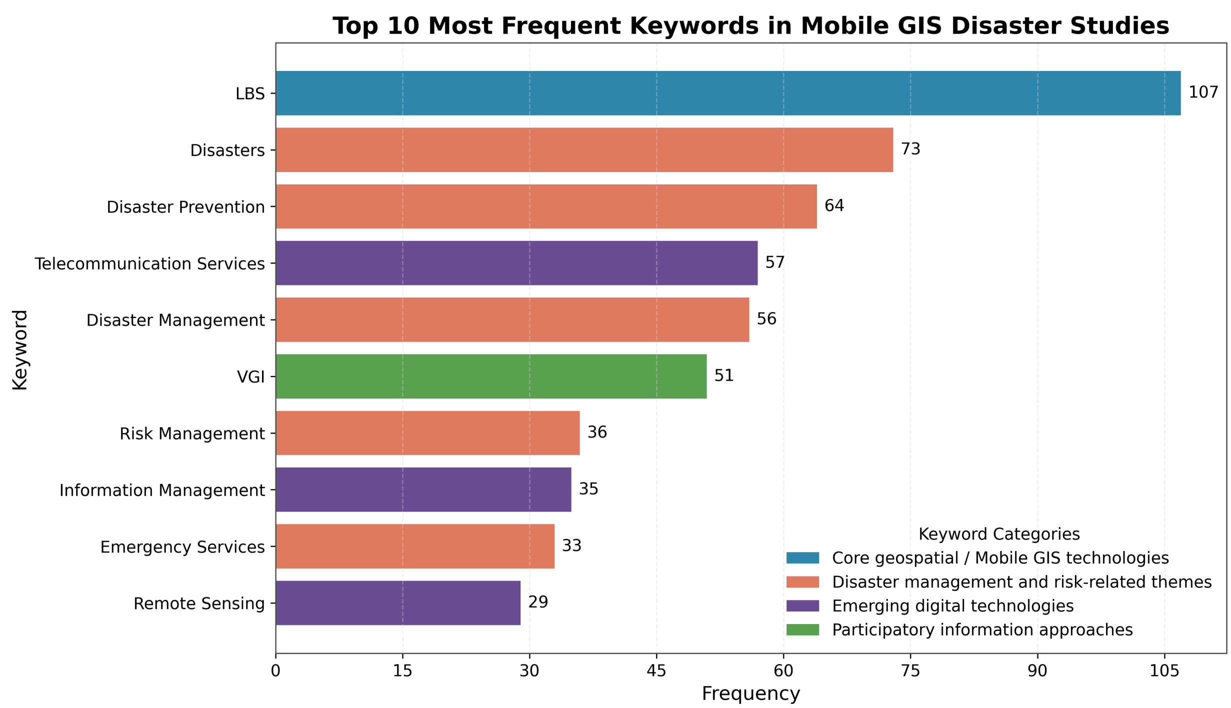

Figure 6: Top 10 most frequent keywords in Mobile GIS disaster studies.

The most frequent keyword was "Location-Based Services (LBS)" (107), followed by "Disasters" (73), "Disaster Prevention" (64), and "Disaster Management" (56). This distribution suggests that Mobile GIS research is strongly associated with location-based technologies while maintaining a clear focus on disaster-related applications.

Keywords such as "Telecommunication Services" (57) and "Information Management" (35) reflect the integration of Mobile GIS with communication infrastructure and data management processes, particularly in contexts requiring real-time information exchange and coordination.

Participatory approaches also appear to have an important presence in the literature. The frequency of "VGI" (51) suggests increasing attention to voluntary geographic information and user-contributed data in disaster management contexts. In addition, terms such as "Risk Management" (36), "Emergency Services" (33), and "Risk Assessment" (29) indicate that Mobile GIS is used not only for data collection, but also in risk analysis, decision support, and operational response processes.

These patterns suggest that Mobile GIS research in disaster management spans disaster-focused applications, mobile and location-based technologies, and data-driven or participatory information approaches. This indicates that Mobile GIS is evolving beyond a purely technological tool toward a broader application-oriented and data-centered research domain.

To examine the temporal dynamics of the research area in more detail, the change in core research themes over the years is presented in Fig. 7. The findings show that some themes have maintained their continuity over time, while thematic concentrations and increases have emerged in certain periods. The disaster-focused keywords "Disasters", "Disaster Prevention", and "Disaster Management" are observed regularly throughout the analyzed period. This indicates that Mobile GIS research has strongly focused on the disaster context from the beginning, and this thematic core has been maintained steadily over time.

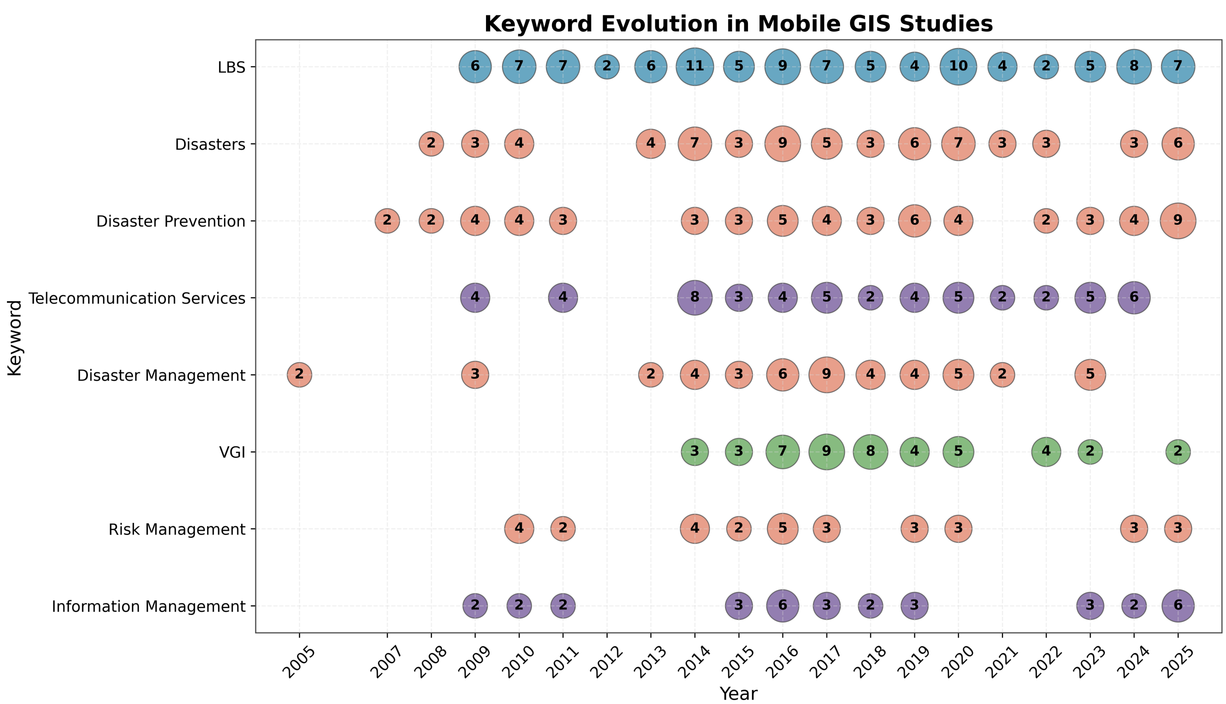

Figure 7: Temporal distribution of major keywords in Mobile GIS disaster studies.

In contrast, the temporal distribution of the keyword "LBS" is one of the most prominent indicators reflecting the technological transformation in the literature. Regularly observed after 2009, LBS reached high frequencies, especially in the 2014–2020 period, becoming a central concept forming the technological basis of Mobile GIS studies. In recent years, it is noteworthy that this keyword exhibits a more balanced but continuous distribution; this indicates that LBS has now become an established component in the literature.

Another noteworthy aspect of the temporal shift is the emergence of the keyword "VGI", particularly after 2014, peaking in the 2016–2018 period. This trend demonstrates the increasing importance of user-generated data production, voluntary participation, and real-time data sharing approaches in the disaster management literature. Similarly, the increased use of keywords such as "Telecommunication Services" and "Information Management," especially in the mid-to-late period, reveals that Mobile GIS applications are not limited to data collection but are more strongly integrated with communication infrastructure, data management, and coordination processes. Furthermore, the continuity of concepts such as "Risk Management" over time shows that the role of Mobile GIS in risk assessment and decision support processes remains stable.

Overall, these findings indicate that the Mobile GIS literature has experienced a development process where existing core themes are preserved while new approaches are gradually added, rather than a sudden and radical thematic shift. This indicates that the field has matured over time and evolved into a more integrated, multidimensional, and application-oriented research structure.

4.4 Hazard and Phase-Based Analysis

The distribution of hazard types in the included studies is presented in Fig. 8. The findings clearly reveal a thematically unbalanced research structure in the literature, concentrating around specific hazard types.

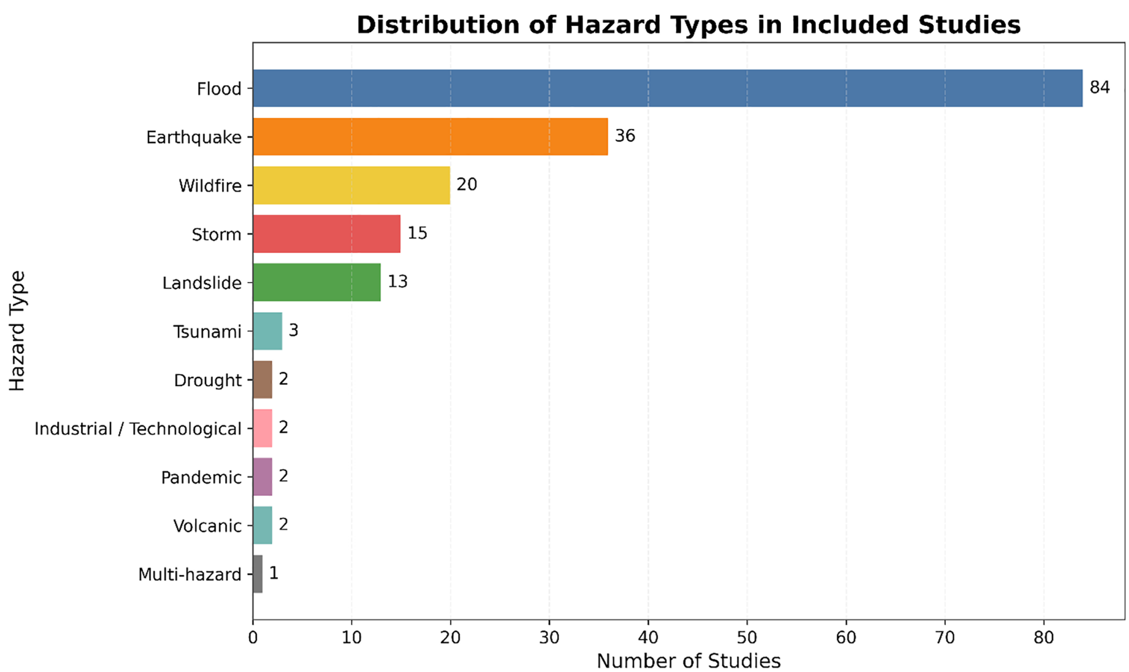

Figure 8: Distribution of hazard types in the included studies.

The most frequently studied hazard type is flood (n = 84), which is by far the most dominant compared to all other hazard types. Flood is followed by earthquake (n = 36) and forest fire (n = 20). These three hazard types constitute a significant portion of the analyzed studies.

Hazard types that are moderately represented include storm (n = 15) and landslide (n = 13), which can be attributed to the fact that hydro-meteorological and geomorphological processes can be analyzed more easily with Mobile GIS applications, the relatively higher accessibility to spatial data, and the widespread socio-economic impacts of these hazards. In contrast, hazard types such as tsunamis (n = 3), droughts (n = 2), volcanic events (n = 2), pandemics (n = 2), and industrial/technological hazards (n = 2) are represented at a very limited level in the literature. Furthermore, multi-hazard studies (n = 1) have an extremely low proportion.

Overall, these findings reveal that mobile GIS research focuses more on rapidly evolving, spatially distinct, and real-time monitorable hazards. In contrast, complex, rare events or events involving multi-hazard interactions appear to be relatively neglected in the literature. This situation presents significant opportunities for future research, particularly in terms of multi-hazard approaches and less-studied hazard types.

The distribution of studies according to disaster types across disaster management stages is presented in Fig. 9. The findings clearly show that Mobile GIS applications are concentrated in specific stages of the disaster management process and that there is a significant imbalance between the stages.

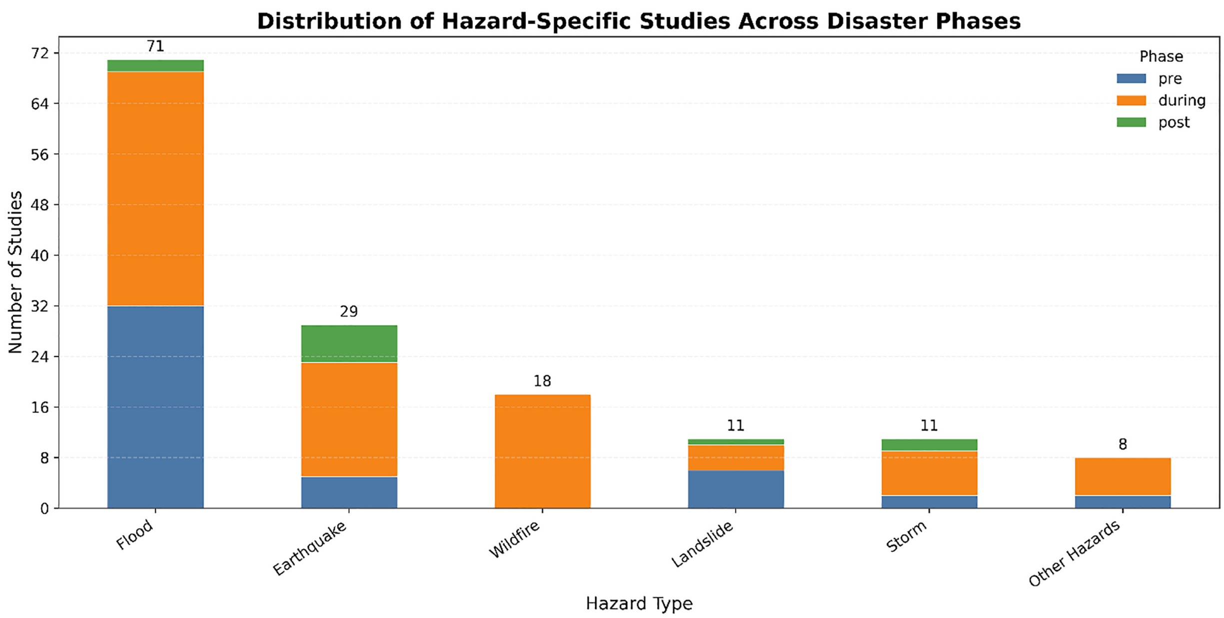

Figure 9: Distribution of hazard-specific studies across phases of the disaster management cycle.

When the general distribution is examined, it is seen that during-disaster studies are dominant in all hazard types. It is noteworthy that the during stage is clearly prominent in hazards such as floods (n = 39), earthquakes (n = 17), and forest fires (n = 18). This situation shows that Mobile GIS technologies are used intensively, especially in real-time data collection, field coordination, and instant decision support processes.

Pre-disaster studies are in second place, showing a more prominent representation, especially in hazards such as floods (n = 32) and landslides (n = 7). This finding reveals that Mobile GIS also plays an important role in risk analysis, preparedness, and planning processes, but this use remains more limited compared to during-disaster applications. In contrast, post-disaster studies appear to be at a very low level across all hazard types. For example, even in basic hazards such as floods (n = 2), earthquakes (n = 6), and landslides (n = 1), the limited representation of this phase indicates that Mobile GIS is primarily used in the literature for immediate response and short-term processes. When evaluated on a hazard type basis, some striking patterns emerge. For instance, the concentration of all forest fire studies in the immediate disaster phase is directly related to the rapidly evolving nature of such hazards and the need for real-time intervention.

Similarly, the strong presence of both pre-disaster and during-disaster phases in flood studies reflects that this hazard is both predictable and dynamic.

Overall, these findings reveal that Mobile GIS is predominantly positioned in reactive (during-disaster) processes in disaster management, while it is used relatively less in proactive (pre-disaster) and especially recovery/long-term assessment (post-disaster) phases. This situation demonstrates the need for further investigation of post-disaster processes and long-term recovery efforts within the context of Mobile GIS, and points to a significant gap for future research.

The relationships between disaster types and the basic disaster management phases are presented in Fig. 10. The findings show that while mobile GIS applications can differ in specific phases depending on the type of hazard, the overall trend indicates a strong concentration during-disaster phase.

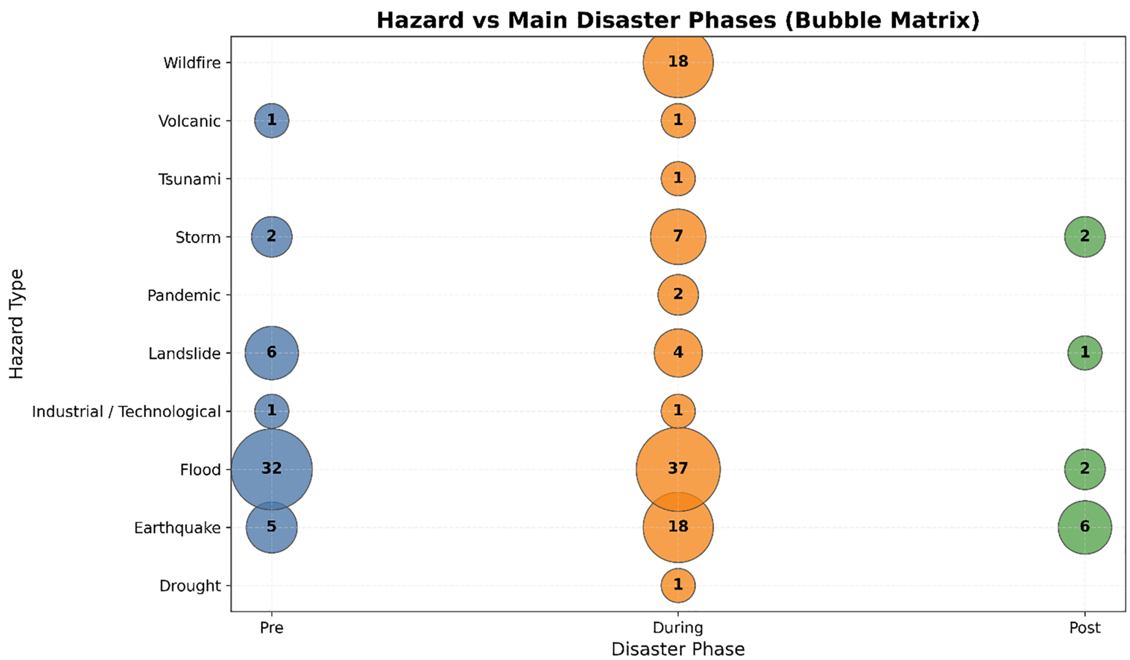

Figure 10: Bubble matrix of hazard-specific studies across disaster phases.

Examining the general distribution, the during-disaster phase appears to be the most represented across major hazard types. In particular, the concentration of studies on floods (n = 37), earthquakes (n = 18), and forest fires (n = 18) largely in the during-disaster phase demonstrates that mobile GIS is primarily used in the literature for real-time response, field coordination, and operational response activities.

However, more distinct phase-specific patterns also emerge in some hazard types. For example, the strong representation of the pre-disaster phase in flood (n = 32) and landslide (n = 6) studies is related to the relatively predictable and modelable nature of these hazards. This situation demonstrates that Mobile GIS can also be effectively used in risk assessment, early warning, and planning processes.

In contrast, the fact that forest fire studies are almost entirely concentrated in the during-disaster phase (n = 18) suggests that real-time data collection and immediate response are particularly important due to the rapidly evolving nature of such hazards. Similarly, the during-disaster phase is also clearly prominent in sudden-onset hazards such as storms and earthquakes. The post-disaster phase, however, is represented at a very limited level across all hazard types, and is only represented in a small number of studies (e.g., earthquake n = 6, flood n = 2). This indicates that Mobile GIS is more focused on short-term and operational processes in the literature, and is relatively less used in long-term recovery and reconstruction processes.

Overall, these findings reveal that Mobile GIS applications in disaster management have a usage structure that varies depending on the type of hazard, but is generally concentrated in the during-disaster phase. This suggests that Mobile GIS is predominantly positioned as a reactive operational support tool in the literature, but it has notable development potential in terms of proactive (pre-disaster) and especially long-term (post-disaster) applications.

The relationships between hazard types, disaster stages, and research themes are illustrated in Fig. 11 using a Sankey diagram, providing an integrated view of the thematic distribution of Mobile GIS research across the disaster management cycle. The diagram suggests that Mobile GIS research exhibits a multi-layered structure, with thematic flows distributed across different disaster phases.

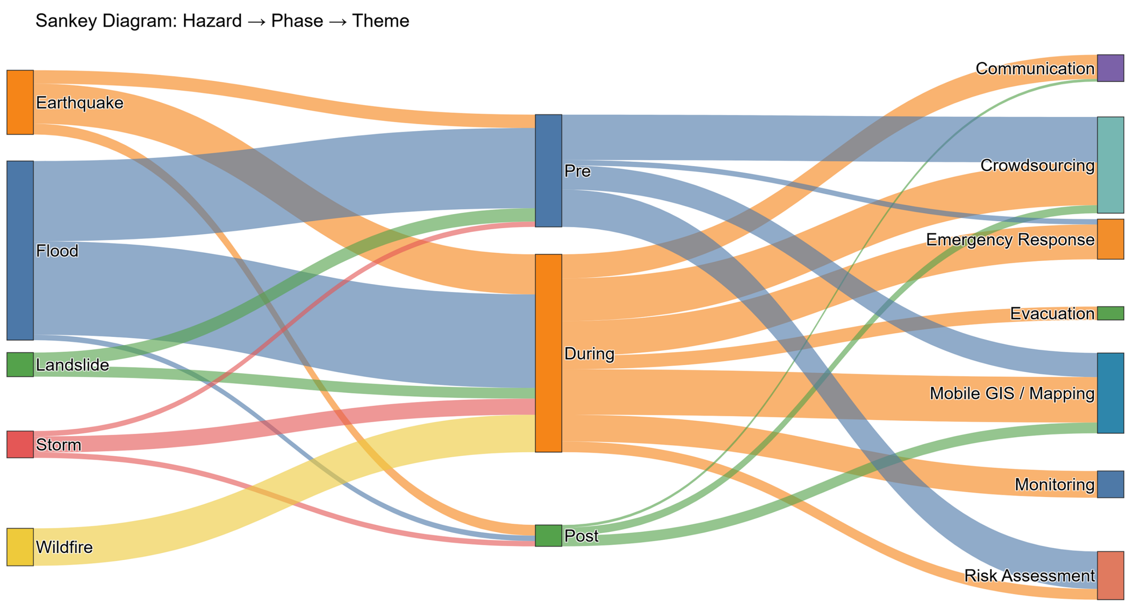

Figure 11: Sankey diagram showing relationships among hazard types, disaster phases, and key research themes.

Many of the flows are associated with the during-disaster phase, particularly for hazard types such as floods, earthquakes, and wildfires. Connections from this phase are mainly directed toward themes such as Mobile GIS/Mapping, Emergency Response, Monitoring, and Communication, reflecting the frequent use of Mobile GIS in real-time field coordination, situational awareness, and response-oriented activities.

The pre-disaster phase also represents a notable area of activity. Flows associated with this phase are particularly linked to Risk Assessment, Mobile GIS/Mapping, and Crowdsourcing. Connections from hazards such as floods and landslides suggest that Mobile GIS is also used in preparedness, planning, and risk analysis applications.

Compared with the pre- and during-disaster phases, the post-disaster phase appears to be less represented. The limited flows observed in this phase are mainly associated with Crowdsourcing and Mobile GIS/Mapping, suggesting comparatively fewer studies focused on long-term recovery and post-event evaluation processes.

The diagram also indicates that certain themes extend across multiple disaster stages. In particular, Mobile GIS/Mapping and Crowdsourcing appear across more than one phase, highlighting their integrative role within the broader Mobile GIS research landscape.

Overall, the distribution suggests that Mobile GIS research is more frequently oriented toward disaster response applications, while also showing meaningful contributions to preparedness-related activities. In contrast, post-disaster applications remain comparatively limited, indicating opportunities for further development in recovery-focused research.

Overall, the findings indicate that Mobile GIS in disaster management exhibits a usage pattern that is distributed across different disaster phases, but particularly concentrated during-disaster phase, rather than being focused on a single phase.

When the graphs are considered together, it is seen that a significant portion of the studies are clustered in the disaster phase, especially for major hazard types such as floods, earthquakes, and wildfires; conversely, pre-disaster studies are more limited but focused on specific hazard types (especially floods and landslides).

However, the relatively low number of multi-phase studies shows that Mobile GIS applications are mostly addressed in the literature by focusing on a single disaster phase. The Sankey diagram and bubble matrix results also support this interpretation; they reveal that the disaster phase, in particular, establishes strong connections with both different hazard types and operational themes such as "mapping," "emergency response," and "communication."

These findings show that Mobile GIS has developed primarily in the literature within the framework of real-time data collection, field coordination, and operational response and coordination processes. However, studies covering multi-stage, integrated, and especially post-disaster recovery processes remain limited. Therefore, while the current usage trend of Mobile GIS exhibits a strong operational focus, there is still notable development potential in terms of applications covering the holistic disaster management cycle.

This study synthesizes the existing literature and examines structural relationships between hazard types, disaster stages, and technological themes, evaluating the position of Mobile GIS in disaster management within a more holistic framework. Overall, this analysis indicates where Mobile GIS applications are most frequently concentrated across disaster types and stages, and provides a useful analytical basis for future research.

Based on this structural evaluation, the next section will discuss in more detail how Mobile GIS applications are implemented in different stages of the disaster management cycle.

5 Applications of Mobile GIS across the Disaster Management Cycle

This section presents a structured synthesis of Mobile GIS applications across the disaster management cycle, organized according to the pre-disaster, during-disaster, post-disaster, and multi-phase contexts. Rather than providing an exhaustive list of all reviewed studies, the analysis focuses on identifying dominant application categories, technological patterns, and functional roles of Mobile GIS within each phase. The tables included in this section summarize these patterns by presenting representative studies for each application category, ensuring clarity and readability. Additional studies that support and extend these findings are further discussed within the text to provide a more comprehensive and evidence-based interpretation.

5.1 Applications in the Pre-Disaster Phase

Consistent with the bibliometric findings presented in Chapter 3, it appears that Mobile GIS applications are not entirely limited to the pre-disaster phase, but are addressed with a relatively lower intensity compared to disaster response applications. In this phase, studies primarily focus on risk assessment, vulnerability modeling, and preparedness processes; however, Mobile GIS is positioned as a crucial tool supporting proactive decision-making processes through data collection, spatial analysis, and early warning systems. In the pre-disaster phase, Mobile GIS applications are mainly associated with hazard and risk mapping, susceptibility assessment, mobile data collection, early warning, and preparedness-oriented decision support. The reviewed studies show that these applications are particularly used for floods, landslides, earthquakes, and other hazard contexts where spatial information is critical for preparedness and risk reduction.

Hazard and risk mapping studies generally rely on remote sensing data, GIS datasets, and spatial analysis methods to identify risk-prone areas and support preparedness planning. In this context, Mobile GIS contributes to the spatial representation of flood risk, vulnerability, and potential disaster impacts [43,44]. Similarly, susceptibility and predictive modeling studies use environmental, historical, and spatial datasets together with modeling or AI-supported approaches to improve risk reduction and preparedness strategies [45,46].

Mobile GIS also plays an important role in field-based data production and participatory mapping. Early studies emphasized mobile data collection through tablets, smartphones, PDAs, and GPS-enabled devices, showing the importance of field-oriented systems in disaster preparedness [43,47]. Participatory and VGI-based approaches further support local knowledge production and community-based data contribution, making preparedness processes more inclusive and dynamic [30].

In addition, some studies focus on early warning, real-time monitoring, and preparedness support systems. These applications use mobile systems, IoT-based infrastructures, and real-time data flows to strengthen situational awareness before disasters and support more adaptive preparedness strategies [41,46]. Location-based and mobile application-supported systems are also used for evacuation and shelter planning, indicating that Mobile GIS can support practical preparedness activities at the community level [48].

Finally, integrated Mobile GIS platforms combine multiple data sources such as GIS layers, mobile data, sensor information, and cloud-based architectures. These systems contribute to decision support by improving data integration, accessibility, and operational readiness in disaster risk management [41,49]. Overall, the pre-disaster literature indicates that Mobile GIS is positioned as a data-driven and multi-source decision support tool, with applications evolving from device-based field data collection toward integrated, real-time, and intelligent preparedness systems.

5.2 Applications During-Disaster Events

Consistent with the findings presented in Chapter 3, the disaster response phase appears to be the phase where Mobile GIS applications are most intensively addressed. It is noteworthy that studies in this phase primarily focus on real-time data collection, monitoring, and supporting operational processes. Mobile GIS enhances situational awareness through sensor data, mobile devices, and location-based services, thereby strengthening decision-making and coordination processes.

In the during-disaster phase, Mobile GIS applications are predominantly focused on real-time monitoring, communication, and operational decision-support processes. The reviewed studies clearly indicate that Mobile GIS plays a critical role in dynamic and time-sensitive disaster environments, where rapid data acquisition, processing, and dissemination are essential. A significant portion of the literature emphasizes real-time monitoring and situational awareness systems, which integrate sensor data, environmental observations, and mobile data streams to support immediate response activities [50,51].

Communication and coordination systems also represent a major application category in this phase. Mobile GIS enables efficient information exchange between field teams, emergency responders, and decision-makers through mobile devices and web-based infrastructures, thereby improving coordination and response efficiency [52]. In parallel, emergency response and decision-support systems integrate multiple data sources, including GIS data, real-time inputs, and mobile technologies, to facilitate rapid and informed decision-making during-disaster events [53,54].

Another important application area is evacuation and navigation systems, which utilize location-based services and mobile platforms to guide individuals toward safe zones and optimize evacuation routes in real time [55–57]. In addition, mobile application-based solutions are widely used to support disaster response processes by providing user-friendly interfaces for communication, information dissemination, and situational awareness [58–60].

The integration of emerging technologies further enhances the capabilities of Mobile GIS during-disaster events. IoT-based and sensor-integrated systems enable continuous data flow and real-time monitoring, improving both early response and adaptive management processes [61]. Moreover, hazard-specific applications such as wildfires, demonstrate the effectiveness of Mobile GIS in supporting real-time response and warning systems tailored to specific disaster contexts [39].

Overall, the findings reveal that Mobile GIS in the during-disaster phase is strongly oriented toward real-time, operational, and adaptive applications [62]. Unlike pre-disaster studies, which are primarily focused on planning and risk assessment, during-disaster applications position Mobile GIS as an active and indispensable decision-support tool, facilitating rapid response, coordination, and situational awareness in complex disaster environments.

5.3 Applications in the Post-Disaster Phase

In the post-disaster phase, mobile GIS applications are seen to focus on damage assessment, impact analysis, and data updating processes. In this phase, mobile GIS brings together different sources such as field data, remote sensing, and crowdsourced data generation to enable the evaluation of the spatial impacts of the disaster and to support recovery processes. However, decision support systems and planning-oriented approaches also play an important role in post-disaster processes.

In the post-disaster phase, Mobile GIS applications are primarily focused on damage assessment, field data collection, and data updating processes. Compared to pre-disaster and during-disaster phases, the reviewed studies indicate a shift from real-time operational support toward evaluation, documentation, and recovery-oriented functions. In this phase, Mobile GIS plays a critical role in capturing, analyzing, and updating spatial information related to disaster impacts.

A significant portion of the studies emphasizes damage assessment and spatial analysis. Mobile GIS-based approaches, supported by spatial analysis techniques such as interpolation and geostatistical methods, are used to estimate damage levels and assess the spatial distribution of impacts in disaster-affected areas [63]. These approaches provide essential inputs for post-disaster evaluation and recovery planning processes.

Field-based data collection and mapping also constitute a core application area in this phase. Mobile GIS tools, particularly those implemented on tablets, smartphones, and other portable devices, enable efficient collection of field observations and hazard-related data. This is especially evident in earthquake and landslide studies, where detailed field mapping and data acquisition are essential for understanding disaster impacts [64].

Another important application area is post-disaster data updating and inventory development. Mobile GIS supports the updating and validation of environmental and geomorphological datasets, ensuring that post-event conditions are accurately represented and integrated into spatial databases [65].

In addition, integrated post-disaster management systems utilize Mobile GIS within open-source and multi-source system architectures to support recovery and management processes. These systems enhance data accessibility, coordination, and decision-making in the aftermath of disasters [66].

Overall, the findings reveal that Mobile GIS in the post-disaster phase is predominantly oriented toward data collection, impact evaluation, and recovery support. Unlike the real-time and operational focus observed in the during-disaster phase, post-disaster applications emphasize the systematic documentation and analysis of disaster impacts, positioning Mobile GIS as a critical tool for recovery planning and long-term data management.

5.4 Applications across Multiple Disaster Phases

Mobile GIS applications, encompassing multiple disaster phases, stand out as integrated systems that provide integration between different phases of the disaster management process. These applications support data continuity, ensuring uninterrupted information flow between pre-disaster, during-disaster, and post-disaster phases. Real-time systems, communication platforms, and decision support mechanisms are key components of this multi-stage structure. In studies covering multiple disaster phases, Mobile GIS applications are designed as integrated systems that support data continuity and functional interoperability across pre-disaster, during-disaster, and post-disaster processes. Unlike single-phase applications, these systems aim to provide a seamless flow of information and support decision-making throughout the entire disaster management cycle.

A key component of multi-phase applications is real-time integrated monitoring systems. These systems combine sensor data, environmental observations, and mobile technologies to enable continuous monitoring and adaptive response across different stages of disasters [49,67]. By supporting both early warning and real-time situational awareness, such systems enhance the overall responsiveness and resilience of disaster management processes.

Communication and coordination platforms also play an important role in multi-phase applications. Mobile GIS facilitates information exchange between stakeholders, field teams, and decision-makers, ensuring effective coordination not only during-disaster response but also in preparedness and recovery phases [38,68]. Similarly, evacuation and navigation systems provide location-based guidance and routing capabilities that can be utilized across multiple stages, particularly in preparedness planning and real-time response scenarios [40].

Participatory approaches further strengthen multi-phase Mobile GIS applications. Systems based on Volunteered Geographic Information (VGI) and mobile applications enable user-generated data collection and community participation, contributing to more inclusive and dynamic disaster management processes [69]. In addition, awareness and early warning systems supported by WebGIS and mobile platforms play an important role in enhancing public awareness and risk communication [11,70].

Finally, integrated Mobile GIS platforms and system architectures support risk management, data integration, and decision-making by combining multiple data sources and technologies [71,72]. These systems enable the development of flexible and scalable solutions that can be adapted to different disaster contexts and phases [67,73].

Overall, the findings indicate that multi-phase Mobile GIS applications are characterized by integration, continuity, and adaptability. Rather than focusing on a single function or phase, these systems provide a comprehensive framework that connects monitoring, communication, data collection, and decision support processes across the entire disaster management cycle.

5.5 Synthesis across Disaster Phases

A holistic evaluation of the studies examined shows that Mobile GIS is positioned as an integrated technology that provides continuity between different stages of the disaster management cycle, while undertaking different functional roles in these stages. The findings reveal that Mobile GIS applications focus primarily on risk assessment and preparedness processes in the pre-disaster phase, real-time data management and operational response during the disaster, and damage assessment and recovery processes after the disaster.

This distribution shows that Mobile GIS is not merely a tool serving a single stage in disaster management, but rather offers a dynamic information infrastructure that connects analysis, operation, and evaluation processes. Multi-phase applications, in particular, support this continuity, strengthening data flow and decision support mechanisms.

However, the literature also reveals that Mobile GIS is undergoing a transformation in line with its integration with evolving technologies. Convergence with IoT, artificial intelligence, cloud computing, and real-time data systems increases both analytical capacity and operational efficiency, making Mobile GIS a smarter and more adaptable decision support tool.

Furthermore, the increasing prevalence of participatory data generation and voluntary geographic information approaches indicates the development of a more inclusive and multi-actor structure in disaster management. This situation increases the importance of local knowledge, especially in data generation and updating processes.

When all these findings are evaluated together, it is understood that Mobile GIS stands out as a data-driven and dynamic system that provides inter-stage integration in modern disaster management.

6 Limitations and Challenges in Mobile GIS Applications

Although Mobile Geographic Information Systems (Mobile GIS) offer significant advantages such as flexibility, portability, and real-time data generation, their effective use in disaster management is limited by various technical, data-driven, user-based, and organizational challenges. These challenges directly impact system performance, particularly in disaster environments where time is critical and uncertainty is high.

Technically, the limited processing capacity, battery life, and connectivity dependency of mobile devices pose notable limitations. Damage to communication infrastructure during-disaster makes access to cloud-based systems difficult and disrupts real-time data flow. In addition, factors such as positional accuracy issues and device compatibility can affect the reliability of field applications.

Data-related challenges are one of the most critical limitations of Mobile GIS applications. The integration of heterogeneous data from different sources (remote sensing, IoT, user-generated data) creates significant problems in terms of data consistency and synchronization. Furthermore, data quality and timeliness issues limit accuracy, especially in pre-disaster risk assessment and post-disaster analysis processes.

User and usability-related challenges are also noteworthy. The technical knowledge level of field personnel, complex interfaces, and insufficient training opportunities hinder the effective use of Mobile GIS systems. In addition, data security and privacy issues in real-time data collection processes are a significant concern.

At the enterprise level, financial constraints, lack of standardization, and interoperability issues limit the widespread use of Mobile GIS. The lack of integration between enterprise systems and mobile platforms leads to fragmented data flow and reduced effectiveness of decision support processes.

These challenges affect all phases of the disaster management cycle. In the pre-disaster phase, data quality problems limit risk analysis, while during a disaster, connectivity problems hinder real-time coordination, and after a disaster, data synchronization and accuracy problems slow down recovery processes.

Both short-term and long-term approaches are needed to overcome these limitations. Offline capabilities, data caching, and portable energy solutions can increase operational continuity in the short term. In the long term, the development of standard data models, the establishment of interoperable systems, and the adoption of user-centered design approaches are critically important.

Overall, the full realization of Mobile GIS's potential in disaster management depends on addressing these multifaceted challenges with a holistic approach.

7 Future Directions and Emerging Trends

The development of Mobile GIS in disaster management signals a shift from reactive applications to smarter, predictive, and integrated systems. This transformation is accelerating, particularly through the integration of emerging technologies with Mobile GIS infrastructures.

In this context, artificial intelligence and machine learning-based approaches play a significant role in improving automated damage detection, predictive risk modeling, and decision support processes. Similarly, IoT-based systems enhance real-time situational awareness by enabling the continuous collection of environmental data. Cloud computing and big data technologies expand the analytical capacity of Mobile GIS by offering scalable solutions in data storage, processing, and analysis processes.

In addition, 5G communication infrastructures support rapid information flow during-disasters thanks to low-latency data transmission, while technologies such as augmented reality (AR), virtual reality (VR), and UAVs significantly improve field-based data collection and visualization processes. UAV-supported applications, in particular, increase the effectiveness of Mobile GIS by providing high-resolution spatial data in hard-to-reach areas.

Participatory data generation and VGI approaches also hold a significant place in the future of Mobile GIS. User-friendly mobile applications and crowdsourcing platforms accelerate data production and enable broader participation in disaster management processes. This offers notable advantages, especially in regions with data deficiencies.

However, some important research needs for the future of Mobile GIS continue. Developing offline working capabilities, multi-source data integration, interoperability, and data security are among the key research priorities in this field. In addition, developing user-centered design and ethical data management approaches is critical for the sustainable and reliable use of systems.

Overall, the future of Mobile GIS is shaped by the development of intelligent, connected, and participatory systems, and effectively managing this transformation requires interdisciplinary collaboration, robust infrastructure, and sustainable technological investments.

8 Conclusion

This study provides a comprehensive and structured review of Mobile Geographic Information Systems (Mobile GIS) in the context of disaster management, conducting a holistic assessment of applications and technological developments through bibliometric analysis. The findings show that Mobile GIS has evolved from traditional GIS environments to dynamic, real-time, and field-oriented systems, playing an important role in decision support processes at all stages of the disaster management cycle. The bibliometric analysis results point to a rapidly growing and application-oriented research area, revealing that studies are particularly concentrated in disaster-during processes. In contrast, pre-disaster and post-disaster applications remain relatively limited, indicating that Mobile GIS is still largely used as an operational and response-oriented tool. This finding suggests that the potential of Mobile GIS as a predictive and preventive decision support system has not yet been fully evaluated. The evaluations of applications show that Mobile GIS significantly improves disaster management processes through real-time data collection, increased situational awareness, and strengthened coordination. Integration with emerging technologies such as artificial intelligence, IoT, cloud computing, UAVs, and digital twins is transforming Mobile GIS into a smarter, more adaptable, and data-driven platform. Furthermore, the increasing role of participatory approaches and voluntary geographic information reveals a shift towards more inclusive and multi-actor disaster management models.

However, multi-dimensional challenges such as data quality, interoperability, connectivity dependency, and user capacity continue to limit the effective use of Mobile GIS. This necessitates the development of more robust data infrastructures, standardized systems, and user-centric design approaches.

From a future perspective, Mobile GIS is expected to evolve towards intelligent, integrated, and resilient systems. This transformation can be achieved sustainably not only through technological innovations but also through robust infrastructures, data governance, and interdisciplinary collaboration.

In conclusion, Mobile GIS stands out as a critical technology in disaster management, bridging the gap between field-based data generation and decision-making processes, and connecting all phases of a disaster. This study contributes to the literature by examining the role of Mobile GIS in disaster management from a holistic, inter-stage perspective, and provides a guiding framework for future research.

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Availability of Data and Materials: The disaster information datasets used in this study are openly accessible via EM-DAT—The international disaster database at https://www.emdat.be.

Ethics Approval: Not applicable.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

AI	Artificial Intelligence
AR	Augmented Reality
DOI	Digital Object Identifier
EM-DAT	Emergency Events Database

GPS	Global Positioning System
IoT	Internet of Things
LBS	Location-Based Services
OSM	OpenStreetMap
PGIS	Participatory Geographic Information Systems
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
REST	Representational State Transfer
UAV	Unmanned Aerial Vehicle
VGI	Volunteered Geographic Information
VR	Virtual Reality
WebGIS	Web Geographic Information Systems
WFS	Web Feature Service
WMS	Web Map Service
WoS	Web of Science

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