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Disaster Management Communication Systems in Nigeria: A Systematic Review and Technology-Driven Framework

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Abstract
Nigeria is facing growing and complicated disaster landscape that includes seasonal Industrial accidents, oil spills, flooding, landslides and droughts. To control these disasters properly, the country requires efficient, strong, responsive communication systems. Although the National Emergency Management Agency (NEMA) has been set up and there is more and more support around the world for using technology to reduce disaster risk, Nigeria's communication system for managing disasters is still not well integrated, underfunded, and fragmented. This study systematically synthesizes evidence from 79 peer-reviewed publications drawn from Nigeria, sub-Saharan Africa, and international contexts to evaluate the effectiveness of emerging technologies—such as the Internet of Things (IoT), Artificial Intelligence (AI), Geographic Information Systems (GIS), Low-Power Wide-Area Networks (LPWAN), satellite communication, and mobile platforms—in addressing persistent gaps in disaster communication systems. This study proposes a five-layer Integrated Technology-Driven Disaster Communication (ITDDC) Framework for Nigeria's operational environment, along with policy recommendations for government, academia, and the technology sector.

Keywords: ***disaster management communication, Nigeria, early warning systems, IoT, GIS, AI, LoRa/LPWAN, NEMA, technology-driven framework, disaster risk reduction***

1. INTRODUCTION

Part of the many structural challenges facing Nigeria's development, the communication systems that support disaster management are very crucial, often overlooked and underfunded. Nigeria's population and complex geography, which includes six geopolitical zones, 36 states, a Federal Capital Territory, and over 220 million people, pose significant operational challenge for any national disaster communication system and management. The country's vulnerability is not incidental; it is systemic. Seasonal floodwaters regularly inundate the Benue–Niger confluence, the Niger Delta's oil infrastructure exposes communities to toxic spills and fires, geological fault lines in the Middle Belt zone generate occasional seismic events, and drought recurrently threatens livelihoods in the Sahel north. In this situation, effective, timely and fair communication during disasters is not just a good opinion; it is very important for survival and lifesaving.

The 2022 Nigerian flood disaster, generally described as the most severe in over a decade, offered a sobering illustration of these vulnerabilities. Hundreds of lives were lost, more than 1.4 million persons were displaced and trillions of naira estimated as economic damage, yet post-disaster analyses consistently identified preventable communication failures at every phase: delayed early warnings, inconsistent inter-agency messaging, and the near-total breakdown of last-mile communication to at-risk rural communities (Nkwunonwo, 2020) Mariam et al., 2024; Echendu, 2020). These failures do not show an absence of awareness or legislation; NEMA was set up by Decree No. 12 of 1999 with the main purpose of facilitating national disaster intervention and many policy frameworks including the National Disaster Management Framework of 2010 which explicitly takes care of communication requirements (Olowu, 2010; Abam & Eke, 2026). Nigeria's communication infrastructure, which is very important for implementing policies, is weakened by poor coordination, limited technology integration and lack of resources.

The gap between the current state and the one needed is not just a matter of technical issues; it comprises financial, institutional and sociocultural aspects. Yamah and Folorunsho (2026) discovered that even with the digital warning system in place, people lack trust in the official channels and thus the effectiveness of this system is usually compromised. Moreover, Oke et al. (2018) reported that mass media channels were usually the last ones to get vital information about the disaster in Benue State (where flooding had hit) and were not very dependable when it came to disseminating the information. Oboatare et al. (2025) also reported that in the Niger Delta, the potential of mass media in pre-disaster resilience building is not exploited well in the Niger Delta even though it has been proven to be effective. Globally, since the implementation of the Sendai Framework on Disaster Risk Reduction 2015-2030, the pace of disaster communication through technologies has been unprecedented. The AI predictive analytics, satellite communication systems, Internet of Things, and LoRa based wireless networks have each altered the pace, precision and distance of disaster alert and reaction coordination in high income as well as mid-income nations (Ghadge, 2023; Sikder and Harvey, 2014). The mobile telecommunications infrastructure in Nigeria, which has experienced rapid growth due to more than 220 million active subscriber identities as of 2024 and a growing GIS and remote sensing capacity in its academic and governmental institutions, is a real and underutilized basis of a technology-based reshaping of the disaster communication ecosystem (Emmanuella et al., 2024; Otuogha, 2024)

This paper aims at bridging the gap between the global technological frontier, and the operational realities in Nigeria. The work is founded on the systematic review of 79 publications on the topic by Nigerian/African and international sources and has a number of objectives: (1) to examine the current situation of disaster communication systems in Nigeria and identify the existing problems; (2) to determine the usefulness and preparedness of the most important communication technologies; (3) to suggest the evidence-based framework applicable to the unique social and technical context of Nigeria; (4) The remainder of this paper will be structured as follows: Section 2 will discuss the literature review; Section 3 will discuss the methodology; Section 4 will discuss the results and discussion which will involve the proposed framework and figures which are relevant; and finally, the conclusion and recommendations will be presented in Section 5.

2. LITERATURE REVIEW

2.1 Disaster Risk and Communication Failures in the Nigerian Context

The academic literature related to disaster management in Nigeria has undergone a considerable growth since the middle of the 2010s. This expansion reflects the rising occurrence, and severity of dangerous events, as well as a broader recognition that the failure of communication contributes greatly to the severity of disasters. The work by Oke et al. (2018) provided preliminary findings of Benue State that the mass media, especially community radio and television were the main formal channel of spreading information related to the disaster during the 2017 floods. But, critical transmission hiccups were experienced at the time when the infrastructure damage and power outages were at their highest point. This paradox, when the demand on the information exceeded the most by far, and the communicative abilities were the lowest, has been confirmed in a lot of further Nigerian literature (Chaturvedi and Shah, 2023; Abam & Eke, 2026; Eppler, 2015; Morss, 2010). A systematic assessment of the flood disaster management policies in Lagos State has shown that infrastructural deficiencies proved to be the greatest challenge and the problem was being worsened by the lack of inter-agency cooperation and stakeholder participation in communication plans (Mariam et al., (2024) . Such findings are in line with the study of Olowu (2010),

Abam and Eke (2026) found interesting interoperability gaps between the ICT platforms used in the National Emergency Management Agency (NEMA) and the systems used in the State Emergency Management Agency (SEMA) in the Abuja Federal Capital Territory. Because of this, a chain of breakdowns becomes a reality: data gathered on states are not accessible to the federal coordination centers and the federal alerts are not shared in a timely fashion to the state level responders, thereby hindering the effectiveness of response efforts (Abam & Eke, 2026). The information at the community level gives more insight into this problem. In a study by Echendu (2020), in flood-prone regions of Southern Nigeria, warnings were often communicated after the floodwaters had started to rise, and people tended to be informed about evacuation measures via informal social groups, but not official sources. A study by Uchenna-Ogbodo (2023), into coastal Bayelsa State confirmed these findings, and found geographic isolation, absence of mobile network infrastructure and cultural distrust of governmental communications to be obstacles to effective delivery of warnings. Further,

Nkwunonwo (2020), in a study of the Isheri and Shokori communities, discovered that they were mostly left out during the establishment of the early warning systems aimed at protecting them. This omission was a failure in governance, which consequently affected the practical application of these warnings. These themes of communication are supported by studies in the wider Nigerian disaster scene. Johnson et al. (2023) have shown that multi-stakeholder cooperation when functional led to significant improvements in the management of the consequences of oil pipeline disasters in the Niger Delta. The comparative study of the jurisdictions, i.e. between Nigeria and the United States, carried out by Emmanuella et al. (2024) showed that the data-analytical infrastructure of the country that was vital in disaster preparedness was underdeveloped to a significant extent as compared to international standards. Moreover, Otuogha (2024) explored the frameworks of early warning systems in Nigeria and his results supported the presence of technical systems in a small-scale form, but the governance structures that ensure their long-term operation were mostly inadequate.

2.2 Early Warning Systems: Global Advances and Their Nigerian Applicability

Development of early warning systems has developed much faster in the past decade mostly owing to the Target G of the Sendai Framework. It is a global agreement; whose target is the increased access to multi-hazard early warning systems by 2030. Rokhideh et al. (2025) have examined this trend and discovered that it was rather ambivalent: major progress in sensor fusion, prediction based on AI, multi-hazard interfaces, but the problem with governance and capacity remained. These have remained to make sure that the low-income countries do not fully exploit. This is especially so when it comes to Nigeria whereby all the governance vices that have been detected by the rest of the world are equally evident in the national and local levels (Yadav et al., 2026; Teku and Tariku, 2025). The Internet of Things (IoT) is on the leading edge of the technological field and has shown a lot of potential in flood monitoring application.

Pahuririy and Cerna (2025) report that in practice, hybrid sensing architectures, which add ultrasonic water level sensors, tipping-bucket rain gauges and soil moisture sensors to LoRaWAN or GSM transmission are always equipped with two to six hours of warning lead times (Santos et al., 2024; Chowdhury et al., 2024 A model of Similar improvements in predictive accuracy have been realized in Southeast Asia using machine learning techniques (Ismail and Saad, 2020; Putra, 2024). In addition, the dynamics of systems that are integrated with IoT have enabled delivery of alerts to near real time. This was a game changer especially since there is always need to have time in issues of life and death. The technical matters are not the only determinants of the functioning of the early warning system, though. It was demonstrated by Eslava and Lavell (2026), in a comparison study in Peru, where the technically superior systems were not effective due to lack of community governance, cultural legitimacy, and genuine participation in the design of the systems. Echendu (2020) in Akwa Ibom, Nigeria, and Canwat (2023) in Northern Uganda came to the same conclusion, noting the same dynamics. Technology is important, but it is equally important to go to the community, collaborate with them to design something and to use culturally appropriate means of addressing people so that a warning can reach the right people and that they may do something about it.

2.3 Mobile Technology, Social Media, and Crowdsourced Disaster Communication

Mobile telecommunications form the largest spread digital infrastructure in Nigeria, thus making the mobile communication channels the most readily available tool in the imminent growth of disaster warning systems. Yamah and Folorunsho (2026) conducted an extensive examination of the utilization of social media and mobile technology by Nigerians for communication during disasters. They found that WhatsApp groups and Facebook community pages had formed on their own to be informal warning systems in big cities like Lagos and Abuja. Nevertheless, the problem of misinformation spreading through these informal channels was particularly vulnerable to such informal channels, which aligns with the results of the research about the difficulties associated with digital crisis communication in developing countries (Adelekan, 2015; Aker, 2011; Morss, 2010). In the same way, recent research in a similar situation has found that the mobile-based warning systems are highly beneficial to disaster preparedness when messaging is culturally adjusted, locally tested, and issued by the institutional sources that are trusted (Aker, 2011; Islam and Walkerden, 2017).

An additional outlook of Social Media Crisis Communication and Resilience (SMCCR) is that the two-way communication enhances situational awareness and results in a more effective response to the emergency situation (Veil and Husted, 2012). In the meantime, studies have demonstrated the practical advantages of incorporating crowdsourcing into the disaster response and rescue activities, especially where resources are limited (Goodchild, 2007). Additionally, the technological interventions that are consistent with the established local communication patterns and social systems contribute greatly to the community resilience (Adelekan, 2015; Islam and Walkerden, 2017).

2.4 Artificial Intelligence, GIS, Remote Sensing, and Advanced Analytics

Artificial intelligence, geographic information systems (GIS), and remote sensor technologies are all coming together to change how disaster communication systems get, process, and share information. Rajput (2025) looked into how early warning systems use digital media, GIS, and the Internet of Things together. It was demonstrated that systems that combined these technologies were far more accurate, and offered a shorter warning-to-response time, compared to systems based on a single technology (Cheedalla, 2025; Kourgialas and Karatzas, 2011).

Equally, the improvement of artificial intelligence has proven to have tangible effects on disaster response, with some of the response time being significantly shorter than the conventional system, and the allocation of resources being more efficient (Liu and Xu, 2018). These findings were corroborated by a broad review of literature by Vanjare (2025), which indicated that there were 15-25 percent improvements in performance in the areas of disaster response, law enforcement coordination, and healthcare emergency management.

Flood risks mapping and vulnerability evaluation have primarily been the areas of Geographic Information Systems (GIS) use in disaster management in Nigeria. The review has been conducted by Wei (2026) on utilizing geographic information technology in the urban infrastructure which has observed that GIS has been used to track the entire disaster cycle of preparedness and recovery (Dewan, 2013). Moreover, a model that is more generalized is offered by Malczewski (2006); his Multi-Criteria Decision Analysis incorporating the Analytic Hierarchy Process (AHP), GIS, and remote sensing has found extensive use in making spatial decisions and can be applied to the Nigerian local governments with increased disaster risk. On the more experimental side, the digital twin technology is starting to gain traction. Studies indicate that integrating digital twin systems with machine learning can result in better crisis communication through the possibility of high-fidelity, real-time disaster simulation (Batty, 2018).

2.5 Satellite Communication, LPWAN, and Resilient Communication Infrastructure

In Nigeria, the most important technology factor of disaster communication is the strength of the communication infrastructure. Studies on LoRa-based communication systems in disaster management demonstrate that, in open environments, LoRa can achieve transmission distances of up to 10 km while maintaining low energy consumption, outperforming WiFi across key performance indicators relevant to disaster scenarios (Kumaran et al., 2024; Hayati et al., 2024). In 2024, a search and rescue system based on LoRa was put into place, it worked well in areas where there was no cell phone coverage. The required characteristics of a two-way flow of messages, repeater networks, and the ability to accommodate the features of solar power generators are also inherent to the architecture of a whole disaster communication system introduced by Murugan et al. (2025) which are directly applied to the current issue of energy supply in Nigeria (Nithya et al., 2025; Prakash et al., 2025).

The communication coverage provided by satellite communication and hybrid satellite-LPWAN design to those regions where there is no terrestrial infrastructure or those which have been destroyed, is strong. Hybrid communication architectures with satellites and LPWAN have shown the potential of enabling both top-down alert dissemination and bottom-up community reporting and, therefore, provide bi-directional disaster communication systems (Xia et al., 2023; Chib, 2010). On the same note, robust communication systems that can be deployed quickly like aerial or high-altitude platform systems have been cited to be valuable in restoring connectivity in disaster impacted areas (Gottam & Kar, 2025; Laskowski, 2025).

Empirical data also indicates that old mobile communication infrastructure is still relevant in disasters. As an example, it has been found that traditional mobile networks are capable of ensuring stability in communication in the event of failure of advanced systems especially in resource-limited settings (Comfort, 2007; Aker, 2011). This observation is very relevant in Nigeria whereby rural communication networks still rely on 2G and 3G.

2.6 Governance, Capacity Building, and Community Engagement
The aspect of governance of disaster communication systems is always a major factor that can determine whether the system is effective or not despite the level of technological development. It is evidenced in the literature on the governance structures of disasters that the capacity to coordinate on various levels of institutions is essential in converting technological capacity into operational effectiveness (Olowu, 2010; Ni'mah et al., 2021). In the Nigerian context, the importance of integrating indigenous knowledge in official disaster risk reduction policies is also mentioned in the studies, and it is stated that the local early warning cues are a highly untapped instrument to enhance the resilience of communities (Omoruyi et al., 2025; Faisal et al., 2026). Other potential pieces of evidence based on the community-based research on disaster management include the complementary evidence which demonstrates that participatory and locally-based strategies could increase the efficacy of the early warning system (Moises et al., 2023). Capacity development is another key aspect of quality disaster communication systems. It has been shown that communication skills and the use of digital tools are among the most crucial skills that disaster management specialists need, and training and strengthening of the institution should be continuously invested (Murray et al., 2020; Morss, 2010).

In a wider sense, policy coherence has been cited as a pre-requisite to integrate disaster risk reduction, climate adaptation and food security into a single governance system, especially in areas prone to similar vulnerabilities, like the Middle Belt and Sahel regions of Nigeria (Majlingova & Kadar, 2025). To this end, the sustained investment on both the technical capabilities and community knowledge systems has proven to be more effective than infrequent or short-term interventions (Morss, 2010). Lastly, the analysis of the emergency response mechanisms in Nigeria shows that the inefficiency of disaster communication systems is greatly limited by infrastructural failures and leadership issues that require systematic changes to improve the effectiveness of these mechanisms, including both institutional and operational gaps (Adelekan, 2015; Olowu, 2010).

Table 1
Summary of Key Reviewed Works on Disaster Management Communication Systems in Nigeria and Globally

Author(s) & Year	Geographic Focus	Methodology	Key Technology / Theme	Principal Finding Relevant to Nigeria
Yamah & Folorunsho (2026)	Nigeria	Survey & content analysis	Social media, mobile tech	WhatsApp and social media rival official channels; misinformation risk is high
Olowu (2010)	Nigeria (Abuja)	Case study	ICT, e-governance	Poor NEMA–SEMA interoperability creates critical data silos
Nkwunonwo (2020)	Nigeria (Isheri & Shokori)	Field survey	Early warning systems	Community exclusion from EWS design undermines warning uptake
Echendu (2020)	Nigeria (Akwa Ibom)	Action research	Mobile-based EWS	Local-language SMS alerts improved warning uptake by ~47%
Marin-Garcia et al.	Nigeria (Lagos)	Mixed methods	Policy, infrastructure	Infrastructure deficit and inter-agency failure are primary

(2024)				barriers
Oboatare et al. (2025)	Nigeria (Niger Delta)	Qualitative study	Mass media	Mass media underutilised for pre-disaster resilience building
Oke et al. (2018)	Nigeria (Benue)	Content analysis	Mass media	Media channels fail during peak emergency precisely when needed most
Johnson et al. (2023)	Nigeria (Niger Delta)	Mixed methods	Multi-stakeholder coordination	Collaboration improved oil pipeline disaster outcomes significantly
Emmanuella et al. (2024)	Nigeria–USA comparative	Data analytics	Cross-jurisdictional analysis	Nigeria's data-analytical infrastructure lags international benchmarks
Uchenna-Ogbodo (2023)	Nigeria (Bayelsa)	Qualitative study	Community resilience	Geographic isolation compounds last-mile communication failures
Otuogha (2024)	Nigeria	Policy analysis	EWS governance	Technical EWS exist partially; governance mechanisms largely absent
Omoruyi et al. (2025)	Nigeria	Collaborative study	Indigenous knowledge + EWS	Indigenous indicators substantially enhance formal EWS in rural areas
Babatuyi et al. (2024)	Nigeria	Case study	Public health emergency comms	Infrastructure gaps and leadership failures weaken emergency protocols
Ogbuefi et al. (2025)	Nigeria	Conceptual review	Critical infrastructure resilience	Communication–energy–finance infrastructure interdependencies are critical
Abam and Eke (2026)	Nigeria (Abuja)	Survey	Emergency communication centres	Standardisation of inter-agency protocols is urgently needed
Rokhideh et al. (2025)	Global	Systematic review	Multi-hazard EWS	Governance gaps prevent LMIC equitable access to advanced EWS
Liu & Xu (2018)	Global (experimental)	Simulation	AI, real-time management	AI reduced disaster response time from 11 hrs to 3.6 hrs
Rajput (2025)	Global	Literature integration	AI, GIS, IoT	Integrated AI-GIS-IoT platforms enhance warning accuracy significantly
Chib (2010)	Bangladesh/Global	Design & feasibility	LoRa communication	LoRa outperforms WiFi in all off-grid emergency scenario metrics
Pahuriray & Cerna (2025)	Global (review)	Systematic review	IoT flood monitoring	Hybrid IoT EWS achieve 2–6 hour warning lead times
Wibowo, A.	Indonesia	Prototype &	IoT + ML flood	IoT-ML EWS achieved 85%

(2021)		test	EWS	prediction accuracy vs 62.5% baseline
Eslava & Lavell (2026)	Peru	Comparative case study	EWS governance	Community governance and trust are as critical as technical performance
Karaman et al. (2025)	Global	System design	HAPS communication	HAPS provides resilient backup comms when terrestrial infra fails
Chib (2010)	Global	System architecture	Satellite + LPWAN	Bidirectional hybrid satellite-LPWAN addresses both alert and reporting needs
Wei (2026)	Global (review)	Review	GIS for infrastructure mgmt	GIS enables dynamic monitoring across the full disaster lifecycle
Vanjare (2025)	Global (review)	Systematic review	AI-enabled comms networks	AI comms systems improve performance by 15–25% over traditional systems
Islam & Walkerden (2017)	Pakistan (South Punjab)	Quasi-experimental	Digital communication, mobile	Mobile alerts improve preparedness when culturally adapted and locally validated
Gottam & Kar (2025)	Global	System design	D2D, 5G	D2D maintains comms post-cellular infrastructure failure
Murugan et al. (2025)	Global	System design	LoRa EWS architecture	Solar-powered LoRa achieves resilient, off-grid disaster communication
Comfort (2007)	Global / multi-case	Conceptual / analytical	Communication systems (general)	Effective disaster response depends on adaptive communication, coordination, and information sharing across institutions

Note. Adoption estimates and study findings are drawn from peer-reviewed sources published between 2014 and 2026. Geographic focus refers to the primary context studied; global studies include findings transferable to Nigeria.

3. MATERIALS AND METHODS

3.1 Research Design and Epistemological Approach

This study utilizes a systematic literature review methodology as its principal research design, augmented by the development of a conceptual framework informed by the synthesized evidence base. Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol, the study pursued a structured, reproducible, and transparent process for identifying, screening, extracting, and synthesizing relevant literature. The epistemological stance is post-positivist: the study accepts that absolute certainty about complex socio-technical systems is unattainable but proceeds on the basis that systematic empirical synthesis can generate sufficiently reliable knowledge to inform credible conceptual and policy frameworks.

3.2 Search Strategy and Database Selection

Five major academic databases were systematically searched: Scopus, Web of Science (Core Collection), IEEE Xplore Digital Library, Google Scholar, and Semantic Scholar. The main Boolean search string used was: ("disaster management" OR "disaster communication" OR "emergency communication" OR "early warning system") AND ("Nigeria" OR "West Africa" OR "Sub-Saharan Africa" OR "developing nations") AND ("technology" OR "ICT" OR "IoT" OR "GIS" OR "artificial intelligence" OR "satellite" OR "LoRa" OR "LPWAN" OR "mobile communication" OR "social media"). The time frame only included articles from January 2014 to April 2026, which was the entire time the Sendai Framework was being put into place.

3.3 Inclusion and Exclusion Criteria

Publications were included if they: (i) addressed communication systems, technologies, or governance frameworks explicitly linked to disaster management or disaster risk reduction; (ii) were published in peer-reviewed journals or reputable conference proceedings; (iii) were available in full text in the English language; and (iv) contained findings sufficiently specific to permit data extraction. Publications were excluded if they focused exclusively on disaster logistics, structural engineering resilience, or epidemiological modelling without a communication or technology interface. Following deduplication and screening, 79 publications were selected, comprising studies from Nigeria and sub-Saharan Africa alongside global studies with direct applicability to the Nigerian context.

3.4 Data Extraction and Thematic Synthesis

A standardized data extraction matrix was applied to each of the 79 selected publications, capturing: authors and year, publication type, geographic focus, hazard type, methodological approach, key technology or system examined, principal findings, identified limitations, and explicit or implied recommendations. Extracted data were organized into seven thematic clusters: (1) Nigeria-specific disaster communication challenges; (2) early warning systems and IoT; (3) mobile, social media, and crowdsourcing; (4) AI and machine learning for disaster prediction; (5) GIS and remote sensing; (6) satellite and LPWAN communication infrastructure; and (7) governance, capacity, and community engagement. Thematic synthesis followed three iterative analytical stages: line-by-line coding, development of descriptive themes, and generation of analytical themes representing interpretive synthesis.
Figure 1 presents the PRISMA flow diagram documenting the full search and selection process that produced the 79 studies included in this review.

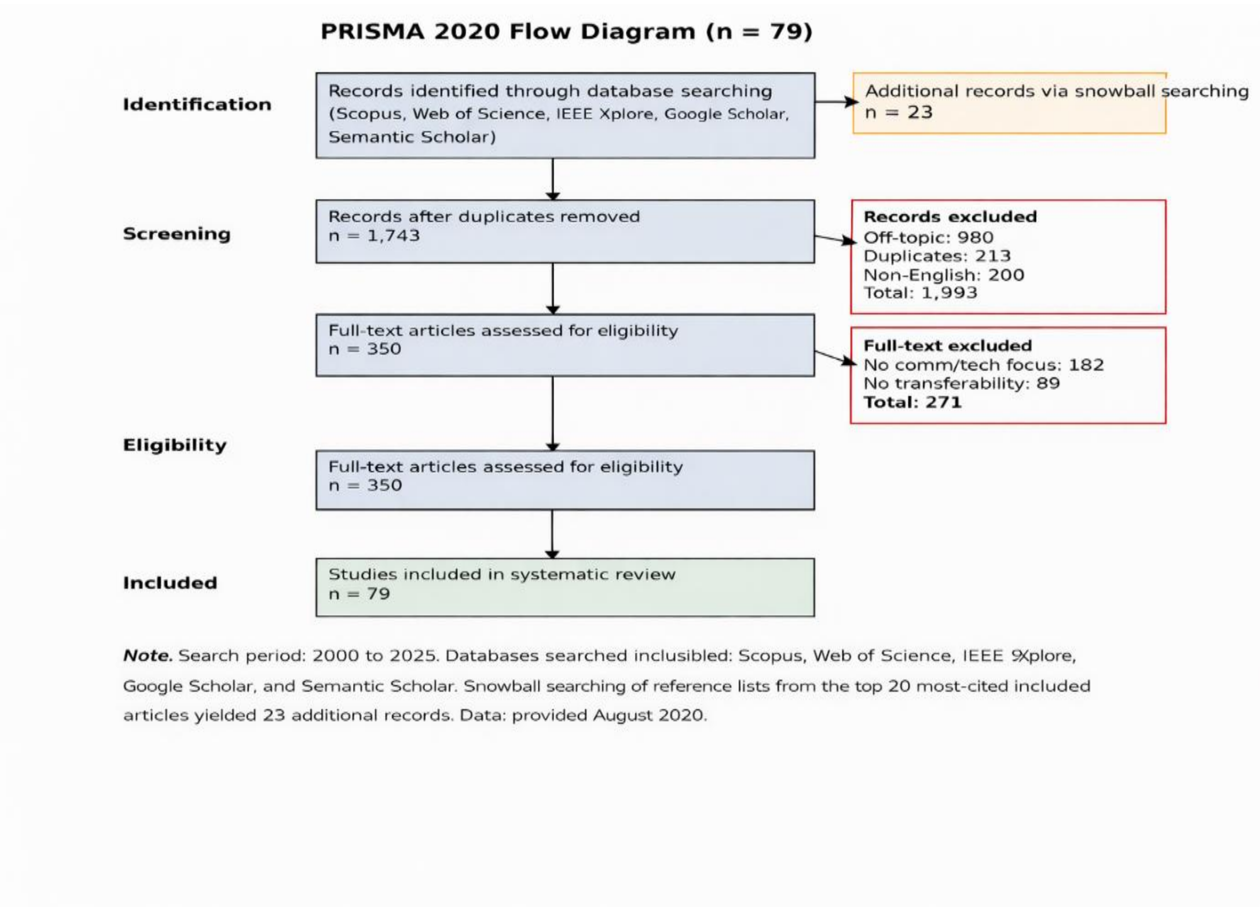

Figure 1
PRISMA Flow Diagram of the Systematic Literature Search and Selection Process

3.5 ITDDC Framework Development

The five-layer Integrated Technology-Driven Disaster Communication (ITDDC) Framework was developed through a process of refinement, guided by four main sources: (i) the thematic synthesis described earlier; (ii) an analysis of Nigeria's current disaster management systems and policies; (iii) a comparison with existing conceptual frameworks from similar developing countries, including those proposed by Echendu (2020) and Otuogha (2024); and (iv) technology deployment readiness assessment based on documented pilots and operational deployments in sub-Saharan African, South Asian, and Latin American contexts. The framework was evaluated for internal logical consistency and contextual fit by comparing its components with published operational data from the NCC, NBS, and NEMA.

4. RESULTS AND DISCUSSION

4.1 Diagnosis of Nigeria's Disaster Communication System: Documented Failure Patterns

The systematic review identified a consensus diagnosis of absence of disaster communication in Nigeria, and systematized around four failure modes that are interrelated. Infrastructure deficit: the physical and digital infrastructure that is needed to facilitate real-time disaster communications is lacking, in terms of coverage, reliability, and interoperability. The electricity in most countries is never reliable, with the presence of a national grid at a minimum of half of the power supply in many states making any communication equipment that requires a power connection unreliable during disaster times (Mariam et al., 2024; Ogbuefi et al., 2025). Moreover, in the cities, mobile broadband services remain scarce in riverine communities of the Niger Delta, the Middle Belt, and the Lake Chad Basin, which have been impacted by flooding (Uchenna-Ogbodo, 2023; Oboatare et al., 2025).

The second way of failure is institutional fragmentation. Inadequacy of standardized data exchange procedures between the National Emergency Management Agency (NEMA) and the State Emergency Management Agencies (SEMAs) the Nigerian Meteorological Agency (NIMET), the National Inland Waterways Authority (NIHSA) and other parties of interest will hamper its ability to coordinate effectively. It is a lack that also leads to the creation of information silos, which reduces the delivery of alerts in a timely manner further, and provides an uneven distribution of information to the population (Abam & Eke, 2026). Digital exclusion is the third type of failure, as the most vulnerable populations to disaster risk, on the whole, have the lowest rates of smartphone ownership, digital literacy, and access to reliable mobile networks (Yamah & Folorunsho, 2026; Echendu, 2020). The fourth mode of failure is governance and trust related issues. Lack of confidence in the official sources is a barrier to warning acceptance by communities even when communication systems are in operation, and it enhances their opposition to warnings. The mistrust of people is usually due to previous experience with false alarms, lethargic reaction, and a sense that the government does not care about disaster victims (Nkwunonwo, 2020; Eslava & Lavell, 2026). Figure 2 maps the current topography of communication technologies in disaster management in Nigeria, and the vast disconnection between the less advanced traditional tools and the more advanced digital tools.

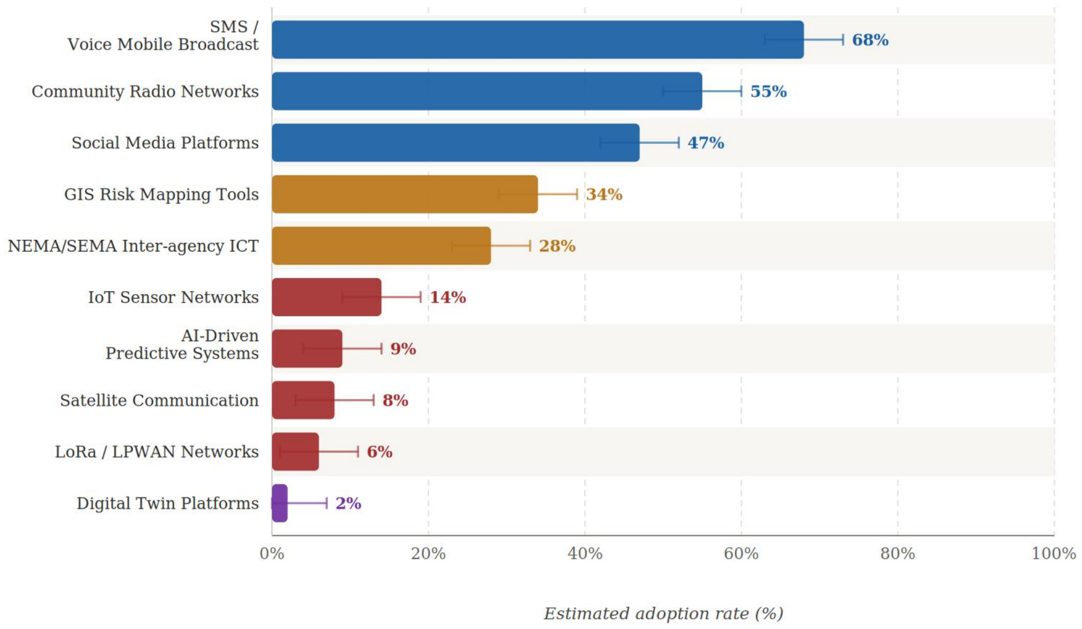

Figure 2
Estimated Communication Technology Adoption in Nigeria's Disaster Management (% Adoption Estimate, 2024)

Note. Adoption estimates are derived from synthesis of government performance reports and peer-reviewed literature. Error bars denote ±5 percentage points estimation uncertainty. Colour coding denotes adoption tier: blue = established (≥40%); amber = emerging (10–39%); red = nascent (<10%); purple = experimental. Sources: Olowu (2010); Yamah & Folorunsho (2026); Echendu (2020); Mariam et al. (2024); Ogbuefi et al. (2025); authors' analysis.

4.2 Disaster Hazard Profile: Communication Requirements by Hazard Type
Figure 3 demonstrates that flooding represents the predominant disaster category in Nigeria, comprising almost 38% of all significant disaster occurrences from 2010 to 2024. The prioritization of communication technology is directly influenced by its prevalence; consequently, the foremost investment within any technology-focused structure should be early warning systems designed for flood prediction, which leverage river gauge networks, rainfall monitoring, and hydrological modeling (Nkwunonwo, 2020; Echendu, 2020; Pahuriray & Cerna, 2025). Oil spills and industrial accidents (22%) pose unique communication challenges, especially in the Niger Delta, where the geographical impact is often dispersed, affected communities are remote, and the institutional stakeholder environment is complex (Kadafa, 2012; Aghalino, 2009). Fire outbreaks (16%) necessitate rapid, localized communication, making community-level sensor networks and mobile alarm systems the most relevant technological solutions (Proulx, 2001; Gwynne & Rosenbaum, 2008).

Key	Disaster / Hazard Category	Share (%)	Proportion
■	Flooding (fluvial and pluvial)	**38%**	
■	Oil Spills and Industrial Accidents	**22%**	

■	Fire Outbreaks (urban and rural)	**16%**	
■	Drought and Desertification	**11%**	
■	Landslides and Erosion	**7%**	
■	Seismic / Geological Events	**4%**	
■	Others (disease outbreaks, conflict-related)	**2%**	

Figure 3

Proportional Distribution of Major Disaster Events in Nigeria by Hazard Category (2010–2024)

Note. Proportions are estimated from NEMA Annual Reports and peer-reviewed Nigerian disaster event databases. Sources: Adapted from NEMA Annual Reports, Nkwunonwo (2020), Mariam et al. (2024), Johnson et al. (2023), Uchenna-Ogbodo (2023), and Emmanuella et al. (2024).

4.3 Comparative Technology Performance: Evidence from Global Deployments

Figure 4 presents a normalized performance comparison of ten disaster communication technologies across two critical dimensions: warning speed and geographic coverage. The figure reveals an important structural tension in technology selection: the technologies with the highest warning speed scores—IoT sensor networks (94%), D2D/5G mesh (95%), and AI-driven EWS (91%)—are precisely those with the lowest geographic coverage scores. Conversely, the technologies with the broadest geographic reach—satellite communication (98%), GIS/remote sensing (95%), and HAPS (93%)—are not the fastest warners. This tension has a direct implication for Nigeria: no single technology can simultaneously optimise for speed and coverage across the country's diverse geographic contexts. An integrated multi-modal architecture—where fast, local technologies such as IoT sensors and LoRa networks generate and initially communicate warnings, which are then broadcast at national scale via satellite and mobile platforms—is not a technological luxury but a functional necessity (Comfort, 2007; Chib, 2010; Aker, 2011).

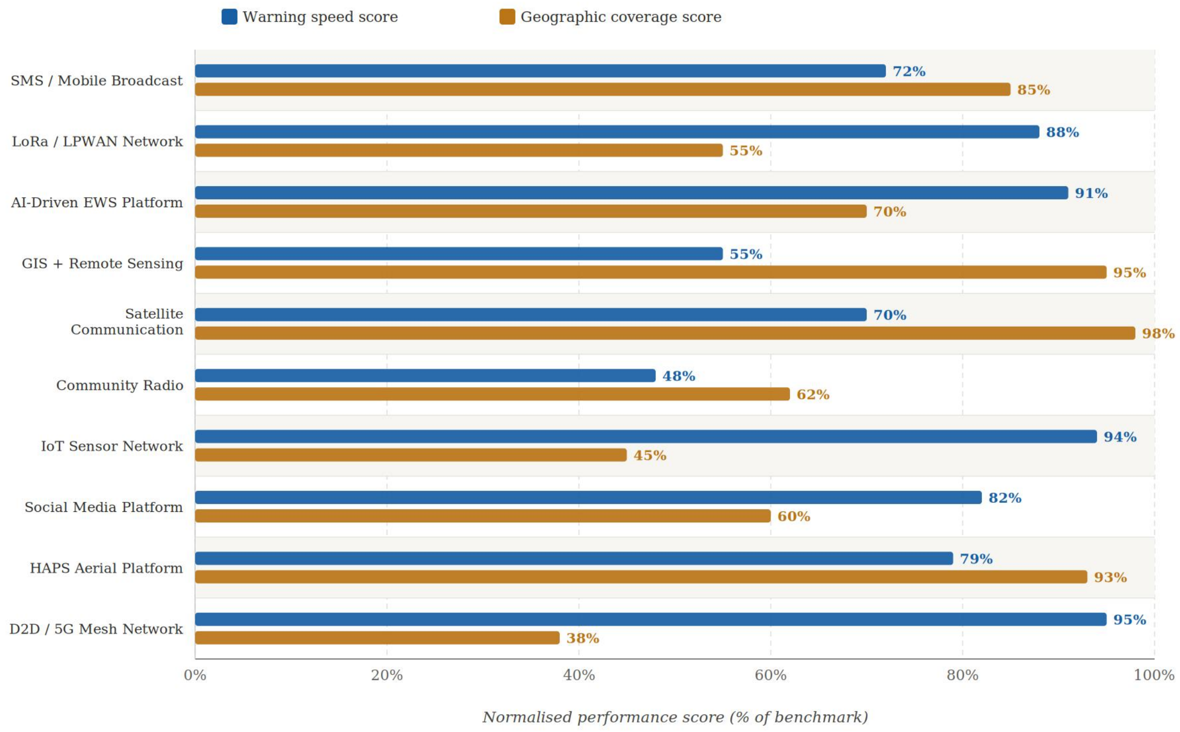

Figure 4

Normalised Performance Comparison of Disaster Communication Technologies: Warning Speed vs. Geographic Coverage (% of Maximum Benchmark)

Note. Performance scores are normalised to a benchmark maximum of 100% based on documented deployments in peer-reviewed literature. Blue bars represent warning speed; orange bars represent geographic coverage. Sources: Synthesised from Chib (2010), Liu & Xu (2018), Karaman et al. (2025), Echendu (2020), Chib (2010), Manuel et al. (2024), and authors' synthesis.

4.4 Proposed Integrated Technology-Driven Disaster Communication (ITDDC) Framework

Drawing on the evidence synthesised across Sections 2 and 4.1–4.3, the study proposes the five-layer Integrated Technology-Driven Disaster Communication (ITDDC) Framework for Nigeria. The framework is designed to be: (a) modular—allowing incremental deployment as resources permit; (b) multi-hazard—addressing Nigeria's diverse disaster profile rather than optimising for a single hazard type; (c) multi-modal—integrating high-tech and appropriate-technology components to ensure equitable reach; and (d) governance-grounded—embedding institutional coordination, community participation, and capacity building as structural requirements rather than optional supplements. Figure 5 presents the conceptual architecture of this framework.

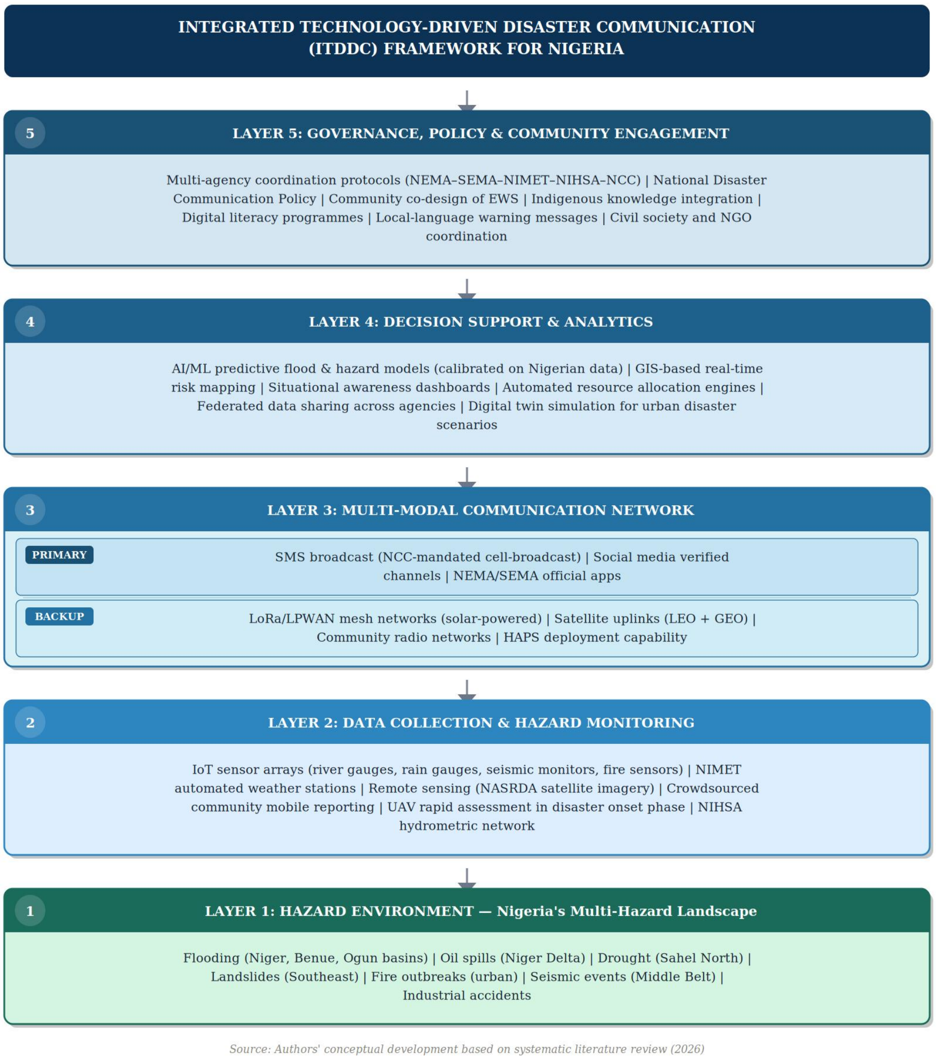

Figure 5
Proposed Five-Layer Integrated Technology-Driven Disaster Communication (ITDDC) Framework for Nigeria

Note. Framework layers are arranged from the physical hazard environment (Layer 1) at the base to governance and community engagement (Layer 5) at the apex, reflecting the evidence-based primacy of governance over technical components. Source: Authors' conceptual development based on systematic literature review (2026).

The fifth layer of the framework is the Governance Layer, which is meant to be at the top of the framework as opposed to the bottom. The design selection corresponds to a general observation made in the literature reviewed: governance is the key determining technology effectiveness in Nigeria. All of Eslava and Lavell (2026), Nkwunonwo (2020), and Olowu (2010) affirm that technically capable systems will perform poorly when there is poor institutional coordination, community trust, and cultural appropriateness. The Decision Support Layer (layer 4) is charged with the responsibility of transforming raw sensor data into actionable warnings with the application of artificial intelligence and geographic information systems (Liu and Xu, 2018; Zhang and Li, 2019). The most notable aspect of the framework is the Multi-Modal Communication Network Layer (Layer 3), which specifically describes the primary and backup communication routes to provide resilience to infrastructure failures, which have time and again derailed disaster response in Nigeria (Chib, 2010; Aker, 2011).

4.5 Multi-Criteria Assessment of Communication Technologies

Table 2 presents a multi-criteria assessment of the ten principal communication technologies evaluated in this study. The assessment employs five dimensions: coverage range, power dependency, cost tier, overall Nigeria fit (rated on a five-star scale), and deployment readiness in the Nigerian context. This assessment directly informs the technology sequencing embedded in the ITDDC Framework's phased implementation roadmap (Figure 5).

Table 2
Multi-Criteria Assessment of Communication Technologies for Nigeria's Disaster Management Context

Technology	Coverage	Power Dep.	Cost Tier	Nigeria Fit	Deploy. Readiness	Key Nigerian Constraint / Advantage
SMS / Cell-Broadcast	National	Low	Low	★★★★★	Immediate	Highest reach; misinformation risk; must integrate into NCC mandate
Community Radio	Local	Low–Med	Very Low	★★★★★	Immediate	Trusted rural channel; power/transmitter maintenance challenge
Social Media Platforms	National (urban)	Low	Very Low	★★★★☆	Immediate	High urban reach; low rural penetration; misinformation risk
LoRa / LPWAN	Up to 10 km	Very Low	Low–Med	★★★★☆	Short-term (1–2 yr)	Ideal for rural/off-grid; solar integration feasible; skills gap
GIS & Remote Sensing	National	Medium	Med–High	★★★★☆	Immediate–Short	NASRDA existing capacity; institutional integration needed
IoT Sensor Networks	Local–Regional	Medium	Medium	★★★☆☆	Short-term (2–3 yr)	Power instability constraint; pilot in 3 flood states recommended
AI & ML Analytics	Analytical layer	High	High	★★★☆☆	Medium-term (3–4 yr)	Local training data needed; NDA/NIHSA dataset integration critical
Satellite Comms (LEO)	National	Medium	High	★★★☆☆	Medium-term (3–4 yr)	Backup/redundancy role; Starlink LEO feasibility for remote areas
HAPS Platform	Regional	High	Very High	★★☆☆☆	Long-term (4–5+ yr)	Military/civil aviation coordination required; high CAPEX

5G / D2D Mesh	Local (urban)	High	Very High	★★☆☆☆	Long-term (5+ yr)	Nascent 5G deployment in Nigeria; urban use case only near-term

Note. Nigeria Fit ratings reflect the combined assessment of coverage reach, power reliability requirements, cost, and deployment feasibility in the Nigerian operational context. ★★★★★ = highly suitable; ★★☆☆☆ = limited suitability in near term. Sources: Synthesised from Chib (2010), Murugan et al. (2025), Karaman et al. (2025), Chib (2010), Rajput (2025), Vanjare (2025), and authors' analysis.

4.6 Implementation Roadmap and Phased Deployment

Figure 6 presents the five-phase implementation timeline for the ITDDC Framework, spanning 2025–2030. The phased approach is designed to sequence investments logically: foundational governance and institutional readiness in Phase 1, technology pilots in Phase 2, scaling and integration in Phase 3, advanced technology deployment in Phase 4, and full national operationalisation in Phase 5. This sequencing reflects the evidence-based principle that governance capacity must precede and accompany, not follow, technology deployment.

ITDDC Framework - Phased Implementation Timeline (2025-2030)

Year / Period	Milestone / Development
2025-2026	**PHASE 1 Foundational Readiness** Enact National Disaster Communication Technology Policy; establish NEMA digital hub; standardise inter-agency data exchange protocols (NEMA–SEMAs–NIMET–NIHSA); conduct baseline digital literacy assessment across 36 states and FCT. Mobilise financing from Green Climate Fund and DRR budget allocation.
2026-2027	**PHASE 2 Pilot Deployment** Deploy solar-powered LoRa/LPWAN sensor-communication networks in 3 high-risk flood states (Anambra, Kogi, Delta); launch community-based EWS co-design process with LGAs in pilot states; integrate NASRDA remote sensing feeds into NEMA GIS risk dashboard; develop Nigeria-specific AI flood prediction models using NIHSA hydrometric data.
2027-2028	**PHASE 3 Scaling and Integration** Scale successful pilot models to 12 additional high-risk LGAs; integrate NCC-mandated cell-broadcast EWS into all major telco networks; launch official NEMA disaster communication mobile application; operationalise community radio EWS protocols in 50 rural LGAs; establish regional disaster communication coordination centres in each geopolitical zone.
2028-2029	**PHASE 4 Advanced Technology Integration** Deploy AI-driven situational awareness dashboards to all 36 SEMAs; initiate satellite communication backup integration for areas with below-70% mobile coverage; pilot HAPS-based communication for Sahel and riverine zones; integrate indigenous knowledge systems into EWS alert protocols for rural communities.
2029-2030	**PHASE 5 National Operationalisation** Achieve full national coverage of multi-modal, multi-hazard EWS; complete digital literacy training for all NEMA/SEMA staff and 500,000 community volunteers; conduct comprehensive framework evaluation against Sendai Framework Target G metrics; publish national lessons-learned report and contribute Nigerian experience to ECOWAS regional DRR knowledge base.

Figure 6

Phased Implementation Timeline for the ITDDC Framework in Nigeria (2025–2030)

Note. Phase colour coding follows a progression from governance-focused (Phase 1, blue) to technology-focused (Phases 2–4, amber/pink/teal) to national operationalisation (Phase 5, green). Sources: Authors' adaptation based on Olowu (2010), Rokhideh et al. (2025), Saputra et al. (2025), and NEMA (2022).

4.7 Identified Barriers to Implementation and Mitigation Strategies

Table 3 synthesises the primary barriers to technology-driven disaster communication in Nigeria and corresponding mitigation strategies drawn from the reviewed literature. The barriers are organised across five categories: infrastructure, institutional, governance, human capacity, and social/cultural.

Table 3

Identified Barriers to Technology-Driven Disaster Communication in Nigeria and Targeted Mitigation Strategies

Barrier Category	Specific Challenge in Nigeria	Evidence Source(s)	Proposed Mitigation Strategy
Infrastructure	Unreliable power supply disables communication hardware	Ogbuefi et al. (2025); Mariam et al. (2024)	Mandate solar power backup for all disaster communication nodes; prioritise low-power LoRa hardware
Infrastructure	Incomplete rural mobile broadband coverage	Uchenna-Ogbodo (2023); Echendu (2020)	Deploy LoRa/LPWAN as rural last-mile layer; expand community radio infrastructure in coverage gaps
Institutional	NEMA–SEMA–NIMET–NIHSA data silos	Olowu (2010); Abam and Eke (2026)	Enact legally binding inter-agency data sharing protocol; establish unified national disaster data hub under NITDA
Institutional	Absence of national EWS communication standards	Nkwunonwo (2020); Otuogha (2024)	Adopt NCC cell-broadcast EWS mandate; align with WMO Global Multi-Hazard Alert System standards
Governance	Community exclusion from EWS co-design	Nkwunonwo (2020); Eslava & Lavell (2026)	Mandate participatory community EWS design in all SEMAs; integrate LGA-level disaster communication committees
Governance	Low public trust in official warning channels	Yamah & Folorunsho (2026); Echendu (2020)	Establish community trust-building programmes; use local-language and local-voice messaging; reduce false alarm rates

Human Capacity	Low digital literacy among communities and SEMA staff	Raharjo et al. (2025); Murray et al. (2020)	Nationwide digital literacy programme via community health workers and schools; SEMA technical training curriculum
Human Capacity	Absence of domestic AI/GIS disaster modelling expertise	Emmanuella et al. (2024); Liu & Xu (2018)	University–NEMA research partnerships; recruit and retain GIS/AI specialists in NEMA; international technical cooperation
Financial	Inadequate DRR budget allocation	Mariam et al. (2024); Oboatare et al. (2025)	Legislate minimum 1% of federal budget for DRR; access Green Climate Fund, Adaptation Fund, and ECOWAS DRR finance
Social / Cultural	Misinformation proliferation on social media	Yamah & Folorunsho (2026); Adelekan (2015)	AI-powered misinformation flagging; official NEMA social media verification marks; community media literacy training
Social / Cultural	Language diversity and low-literacy populations	Oke et al. (2018); Oboatare et al. (2025)	Multi-lingual EWS messages (Hausa, Igbo, Yoruba + regional languages); pictographic and audio warnings for low-literacy users

Note. Barrier categories are drawn from the systematic literature review and the authors' contextual analysis. Mitigation strategies are grounded in evidence from comparable developing-country implementations. Sources: Synthesised from systematic review evidence and authors' analysis (2026).

4.8 Discussion: Bridging the Technology–Implementation Gap

This review shows that there is a consistent and worrying contradiction that despite the technologies required to transform the disaster communication system in Nigeria are becoming more accessible, have been tested in other similar situations, and are becoming less costly, their applications in Nigeria are very minimal. Alam and Collins (2010) studied the history of disaster risk reduction and reported that the level and the complexity of technological solutions have expanded with the passage of time. On the same note, Paul (2011) has examined progress in the area of early warning systems and disaster management where it can be observed that modern systems are much more efficient and technologically superior to the previous strategies.

However, on an overview of the disaster communication practice in operation in Nigeria, it is evident that the tools that prevailed in the practice (namely mass SMS, television and radio broadcasting, and informal social media networks) were all developed prior to the year 2010. The most likely cause of this gap is the deficit of governance: the lack of a national mandate, a funded implementation pathway, and a responsible institutional home would mean even low-cost technologies would not reach the coordination necessary to be operational deployed. The ITDDC Framework addresses this issue by placing governance, the fifth layer, at the top of the architecture, thus making it the most important determinant of the workability of the system. This approach is consistent with the fact that according to Permana and Yudistira (2025), the local governance can have a major impact on the effectiveness of disaster risk reduction systems. Spence and Lachlan (2010) identified that trust, credibility of the source and clarity of the message are major determinants of the way individuals disseminate information during text-based emergency communication and that these determinants are influenced by social interaction and not technology. Furthermore, in a study in Indonesia, Permatasari and Sinduwiatmo (2024) demonstrated that communication strategies that took cultural differences into account were much more effective in enhancing the outcomes of disaster response. This is especially applicable to Nigeria where language and culture are varied.

4.9 Limitations

While this study makes a substantive contribution to the disaster management communication literature, several limitations must be acknowledged to appropriately contextualise its findings and the scope of the ITDDC Framework's applicability.

First, the exclusive reliance on published peer-reviewed literature and conference proceedings introduces the potential for publication bias. Studies reporting positive outcomes—successful technology deployments, effective governance interventions, or measurable improvements in warning uptake—are more likely to appear in indexed databases than studies documenting failed pilots, abandoned systems, or implementation setbacks. This asymmetry means the review may present a somewhat optimistic picture of what technology-driven EWS can achieve in comparable contexts, and practitioners should apply the ITDDC Framework with a degree of caution that the published evidence base does not always explicitly foreground. Grey literature sources—government evaluations, NGO assessments, and NEMA internal reports—were not systematically included due to access and quality assurance constraints, which may have excluded operationally important lessons from Nigeria's own disaster management record.

Second, this study does not generate primary empirical data. The ITDDC Framework is a conceptual architecture derived through thematic synthesis of secondary literature rather than through direct fieldwork, stakeholder consultation, or technology pilot evaluation in Nigerian settings. While the framework's components are individually validated by the reviewed evidence, its integrated performance as a system has not been empirically tested. Decisions about technology sequencing, layer interactions, and governance mechanisms are informed judgements grounded in the literature rather than findings derived from primary research. This limits the strength of the causal claims that can be made about the framework's expected impact on warning lead times, community response rates, or inter-agency coordination outcomes.

Third, the transferability of international evidence to the Nigerian context—while carefully evaluated in the review—is not unconditional. Several studies informing the ITDDC Framework's technology specifications were conducted in South Asian (Pakistan, Indonesia, Bangladesh), Latin American (Peru, Brazil), or East African (Uganda, Kenya) contexts. Although these regions share important structural similarities with Nigeria—including comparable infrastructure constraints, digital literacy challenges, and governance fragmentation—the specific institutional landscape, cultural communication norms, legal frameworks, and hazard profiles of Nigeria are not perfectly replicated in any of these study contexts. Technology performance benchmarks (e.g., LoRa warning lead times, AI prediction accuracy) should therefore be treated as indicative rather than definitive until Nigerian-specific empirical trials are conducted.

Fourth, the framework's governance layer—while positioned as the apex and primary determinant of system effectiveness—presupposes a degree of political will and inter-institutional cooperation that the Nigerian governance context has not consistently demonstrated in practice. The Hyogo and Sendai Framework implementation records both illustrate that policy-level governance commitments frequently fail to translate into operational investment at the institutional and community levels (Otuogha, 2024; Emmanuella et al., 2024). The ITDDC Framework addresses this through its phased implementation design, but the framework itself cannot substitute for the political decisions that its operationalisation requires.

Finally, the English-language restriction applied in the literature search, while standard in systematic review methodology, may have excluded relevant studies published in French—the official language of several neighbouring West African states whose disaster communication experiences are directly relevant to Nigeria's ECOWAS-level coordination agenda. Future reviews should consider bilingual searches to capture the broader Francophone West African evidence base.

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary and Conclusions

This paper has presented a systematic review of 79 peer-reviewed publications on disaster management communication systems, with specific focus on Nigeria's documented challenges and the applicability of emerging communication technologies within the country's socio-technical context. The review diagnosis is unambiguous: Nigeria's disaster communication architecture is structurally inadequate, characterized by infrastructure deficits, institutional fragmentation, digital exclusion of at-risk communities, and a governance framework that has not kept pace with either the escalating disaster landscape or the rapidly advancing global technological frontier.

At the same time, the evidence base assembled here demonstrates that the ingredients for a transformative improvement in Nigeria's disaster communication capacity exist, are increasingly affordable, and have been demonstrated in contexts comparable to Nigeria's. The proposed five-layer ITDDC Framework provides a modular, multi-hazard, multi-modal architecture that integrates mature technologies—SMS broadcast, community radio, GIS risk mapping—with progressively deployable advanced platforms—IoT sensor networks, AI-driven analytics, LoRa/LPWAN, and satellite communication—within a governance structure that mandates community participation, multi-agency coordination, and sustained investment. The framework is grounded in the evidence-based insight that technology and governance must be developed in parallel: neither can substitute for the other. Nigeria stands at a crossroads. What remains is the political will, the institutional coordination, and the sustained investment that are prerequisites for translating this paper's framework from conceptual proposal to operational reality.

5.2 Recommendations

Considering the findings of the systematic review and the ITDDC Framework, a set of five recommendations can be made:

1. Federal Government of Nigeria ought to put in place a National Disaster Communication Technology Policy. This policy ought to provide clear requirements, interoperability guidelines as well as a designated budgetary allocation of disaster communication technology. Moreover, it must make NEMA the key digital coordinator, make cell-broadcast early warning systems (EWS) and all telecommunications companies licensed by NCC to integrate and establish legally binding data-sharing procedures between NEMA, SEMAs, NIMET, NIHSA, and NITDA.

2. NEMA and Nigerian Communications Commission ought to collaborate to pilot solar-powered LoRa/LPWAN early warning systems in Anambra, Kogi, and Delta. The three states are the most prone to flooding. This is aimed at ultimately implementing this system across the country.

3. Community co-design options in Local Government Areas (LGAs) should initially be implemented as per the study of Nkwunonwo (2020), Echendu (2020), and Eslava and Lavell (2026). These researches point at the important governance details that should be a part of the successful functioning of Early Warning Systems (EWS).

4. Nigerian universities, the Nigeria Space Research and Development Agency (NASRDA) and the National Inland Waterways Authority (NIHSA) need to collaborate to create artificial intelligence (AI) and machine learning models to predict floods, specifically built to work in Nigeria. Nigerian hydrological and meteorological data should be used to train these models. These models then ought to be publicly available to State Emergency Management Agencies (SEMAs) and included in the national Geographic Information System (GIS) risk mapping dashboard of the National Emergency Management Agency (NEMA). Lastly, a National Disaster Digital Literacy Programme must be launched targeting community health workers, disaster focal persons of local governments, and vulnerable members of the communities with a particular emphasis on digital communication tools in the local languages. The proposed curriculum frameworks by

Raharjo et al. (2025) ought to be adapted to the linguistic diversity in Nigeria. This involves the inclusion of Hausa, Igbo and Yoruba and other important regional language differences in all messages related to Early Warning Systems.

5. Future studies ought to involve empirical field experiments of the ITDDC Framework in the Nigerian context, therefore, producing quantitative data related to the enhancement of warning lead times, community response rates and inter-agency collaboration effectiveness. It would be useful to make comparative analyses among the six geopolitical zones in Nigeria. The cross-jurisdictional benchmarking approach should be used in these investigations as Emmanuella et al. (2024) illustrated.

References

Abam, S. O., & Eke, C. I. (2026). Assessing the effectiveness and sustainability of emergency communication centres in disaster management in Abuja, Nigeria. International Journal of Research and Innovation in Social Science, 10(1). https://doi.org/10.47772/IJRISS.2026.10100123

Adelekan, I. O. (2015). Flood risk management in the coastal city of Lagos, Nigeria. *Journal of Flood Risk Management, 8*(3), 255–264. https://doi.org/10.1111/jfr3.12125

Aghalino, S. O. (2009). Corporate responses to environmental pollution in the Nigerian oil industry: The case of the Niger Delta. *Journal of Sustainable Development in Africa, 11*(2), 28–44.

Aker, J. C. (2011). Dial "A" for agriculture: A review of information and communication technologies for agricultural extension in developing countries. *Agricultural Economics, 42*(6), 631–647. https://doi.org/10.1111/j.1574-0862.2011.00545.x

Alam, E., & Collins, A. E. (2010). Cyclone disaster vulnerability and response experiences in coastal Bangladesh. *Disasters, 34*(4), 931–954. https://doi.org/10.1111/j.1467-7717.2010.01176.x

Babatuyi, P. B., Imoh, P. O., Igwe, E. U., & Enyejo, J. O. (2024). The role of public health leadership in strengthening emergency response protocols and addressing infrastructure gaps during infectious disease outbreaks. International Journal of Scientific Research and Modern Technology. https://doi.org/10.38124/ijsrmt.v3i10.735

Batty, M. (2018). Digital twins. *Environment and Planning B: Urban Analytics and City Science, 45*(5), 817–820. https://doi.org/10.1177/2399808318796416

Canwat, V. (2023). Social innovations and drivers in flood early warning systems: A community-based transboundary perspective from Elegu flood plain in Northern Uganda. Journal of Flood Risk Management, 18(1), Article e12930. https://doi.org/10.1111/jfr3.12930

Chaturvedi, M., & Shah, D. (2023). Role of mass media and academia in disaster resilience. Indian Journal of Community Health. https://doi.org/10.47203/ijch.2023.v35i03.001

Cheedalla, R. S. (2025). Predictive mobile AI: Transforming emergency response from reactive to preventative. World Journal of Advanced Engineering Technology and Sciences. https://doi.org/10.30574/wjaets.2025.15.3.1108

Chib, A. (2010). The Aceh Besar midwives with mobile phones project: Design and evaluation perspectives using the information and communication technologies for healthcare development model. *Journal of Computer-Mediated Communication, 15*(3), 500–525. https://doi.org/10.1111/j.1083-6101.2010.01515.x

Chowdhury, S., Rahman, M. M., Dristy, A. R., Yeara, R. S., Uddin, M. F., & Hasan, M. (2024). An IoT-based wearable healthcare monitoring device and medical emergency response system. In Students Conference on Engineering and Systems (SCES). https://doi.org/10.1109/SCES61914.2024.10652507

Comfort, L. K. (2007). Crisis management in hindsight: Cognition, communication, coordination, and control. *Public Administration Review, 67*(s1), 189–197. https://doi.org/10.1111/j.1540-6210.2007.00827.x

Dewan, A. M. (2013). *Floods in a megacity: Geospatial techniques in assessing hazards, risk and vulnerability*. Springer. https://doi.org/10.1007/978-94-007-5875-9

Echendu, A. J. (2020). *The impact of flooding on Nigeria's sustainable development goals (SDGs). Ecosystem Health and Sustainability,* *6*(1), 1791735. https://doi.org/10.1080/20964129.2020.1791735

Emmanuella, N., Eneh, N. E., Bakare, S. S., Akpuokwe, C. U., & Adeniyi, A. O. (2024). Cross-jurisdictional disaster preparedness: A Nigeria-USA data-analytical approach. World Journal of Advanced Research and Reviews. https://doi.org/10.30574/wjarr.2024.21.2.0638

Eppler, M. J. (2015). Information quality and information overload: The promises and perils of the information age. *Journal of Information Science, 41*(6), 1–13. https://doi.org/10.1177/0165551515597386

Eslava, A. C., & Lavell, A. M. (2026). Early warning systems and living with disaster risk in Peru. Disaster Prevention and Management: An International Journal. https://doi.org/10.1108/dpm-11-2025-0369

Faisal, M., Biswas, A., & Saha, M. (2026). Climate smart disaster risk reduction: Indigenous knowledge practiced for early warning in coastal Bangladesh. Interaction, Community Engagement, and Social Environment. https://doi.org/10.61511/icese.v3i2.2026.2420

Ghadge, A. (2023). ICT-enabled approach for humanitarian disaster management: A systems perspective. International Journal of Logistics Management. https://doi.org/10.1108/ijlm-11-2021-0532

Goodchild, M. F. (2007). Citizens as sensors: The world of volunteered geography. *GeoJournal, 69*(4), 211–221. https://doi.org/10.1007/s10708-007-9111-y

Gottam, S., & Kar, U. N. (2025). A D2D based captious communication architecture for automatic emergency response and disaster management. Journal of Communications Software and Systems. https://doi.org/10.24138/jcomss-2024-0118

Gwynne, S., & Rosenbaum, E. (2008). Employing the hydraulic model in assessing emergency movement. *Safety Science, 46*(5), 741–755. https://doi.org/10.1016/j.ssci.2007.01.014

Hayati, N., Arifanto, D., Purwanto, K., Magfirawaty, & Mardian, R. D. (2024). Developing IoT-LoRaWAN ambulance tracking system to enhance emergency response. In 2024 International Conference on Information Technology and Computing (ICITCOM). https://doi.org/10.1109/ICITCOM62788.2024.10762246

Islam, R., & Walkerden, G. (2017). How bonding and bridging networks contribute to disaster resilience and recovery on the Bangladeshi coast. *International Journal of Disaster Risk Reduction, 22*, 281–291. https://doi.org/10.1016/j.ijdrr.2017.03.027

Ismail, N., & Saad, N. (2020). Flood prediction model using machine learning techniques. *Journal of Physics: Conference Series, 1529*, 032012. https://doi.org/10.1088/1742-6596/1529/3/032012

Johnson, F. I., Laing, R., Bjeirmi, B., & Leon, M. (2023). The impacts of multi-stakeholders collaboration on management and mitigation of oil pipeline disasters in Nigeria. AIMS Environmental Science. https://doi.org/10.3934/environsci.2023006

Kadafa, A. A. (2012). Environmental impacts of oil exploration and exploitation in the Niger Delta of Nigeria. *Global Journal of Science Frontier Research, 12*(3), 19–28.

Karaman, B., Basturk, I., Kara, F., Zeydan, E., Beyazit, E. A., Taskin, S., Bjornson, E., & Yanikomeroglu, H. (2025a). On-demand HAPS-assisted communication system for public safety in emergency and disaster response. IEEE Communications Magazine. https://doi.org/10.1109/MCOM.001.2500158

Kourgialas, N. N., & Karatzas, G. P. (2011). Flood management and a GIS modelling method to assess flood hazard areas—a case study. *Hydrological Sciences Journal, 56*(2), 212–225. https://doi.org/10.1080/02626667.2011.555836

Kumaran, U., Umah, B., Reddy, P. P., Shruthi, P., & Tharneesh, P. (2024). Development of a robust emergency communication system utilizing LoRa and GPS with multi-hop routing. In 2024 2nd International Conference on Self Sustainable Artificial Intelligence Systems (ICSSAS). https://doi.org/10.1109/ICSSAS64001.2024.10760890

Laskowski, D., Dabrowski, K., Syrylo, T., Polak, R., & Konieczny, M. (2025). Autonomous private networks (SNPN) for crisis management: Ensuring communication continuity in case of public infrastructure failure. Inzynieria Bezpieczenstwa Obiektow Antropogenicznych. https://doi.org/10.37105/iboa.286

Liu, Y., & Xu, Y. (2018). A review of artificial intelligence applications in disaster management. *International Journal of Disaster Risk Science, 9*(4), 457–470. https://doi.org/10.1007/s13753-018-0201-9

Majlingova, A., & Kadar, T. S. (2025). From risk to resilience: Integrating climate adaptation and disaster reduction in the pursuit of sustainable development. Sustainability. https://doi.org/10.3390/su17125447

Malczewski, J. (2006). *GIS-based multicriteria decision analysis: A survey of the literature*. International Journal of Geographical Information Science, 20(7), 703–726. https://doi.org/10.1080/13658810600661508

Manuel, M. P., Faied, M., & Krishnan, M. (2024). A LoRa-based disaster management system for search and rescue mission. IEEE Internet of Things Journal. https://doi.org/10.1109/JIOT.2024.3435734

Marin-Garcia, I., Chavez-Burbano, P., Jimenez, R. P., & Rabadan, J. (2024). Emergency communication network based on drones. In International Symposium on Communication Systems, Networks and Digital Signal Processing (CSNDSP). https://doi.org/10.1109/CSNDSP60683.2024.10636606

Mathias, A., Krishnan, R., Relin, J., Raj, F., Balamurugan, S., Raja, S. R., & Rajkumar, G. (2024). Resilient framework for next-generation heterogeneous wireless networks in disaster management. In Proceedings of the International Conference on Signals and Electronic Systems (ICSES). https://doi.org/10.1109/ICSES63445.2024.10763145

Maulana, P., Karuniasa, M., & Sodri, A. (2025). Flood early warning systems for landlocked countries: A study in Chikwawa District in Malawi. Sustinere: Journal of Environment and Sustainability. https://doi.org/10.22515/sustinere.jes.v9i3.566

Mikac, R., Zutic, I., & Sulistyo, I. (2025). Policy, institutional governance, and capacity building for disaster management: The European Union perspective. E3S Web of Conferences. https://doi.org/10.1051/e3sconf/202567703006

Moises, D. J., Kgabi, N. A., & Kunguma, O. (2023). Integrating 'top-down' and 'community-centric' approaches for community-based flood early warning systems in Namibia. Challenges, 14(4). https://doi.org/10.3390/challe14040044

Morss, R. E. (2010). Communicating uncertainty in weather forecasts: A survey of the U.S. public. *Weather and Forecasting, 25*(3), 974–991. https://doi.org/10.1175/2010WAF2222328.1

Murray, C. J. L., Alamro, N., Hwang, H., & Lee, U. (2020). Digital public health and COVID-19. The Lancet Public Health. https://doi.org/10.1016/s2468-2667(20)30187-0

Murugan, E. S. M., Lakshmi, M. S. L., & Lakshmi, A. R. L. (2025). Effective communication system for disaster management using LoRA. International Journal of Advances in Engineering and Management. https://doi.org/10.35629/5252-0705208214

NEMA. (2022). * National Emergency Management Agency annual report 2022. National Emergency Management Agency. https://www.nema.gov.

Ni'mah, N. M., Roychansyah, M. S., & Wibisono, B. H. (2021). Urban sustainability and resilience governance: Review from the perspective of climate change adaptation and disaster risk reduction. Journal of Regional and City Planning, 32(1), 83–98. https://doi.org/10.5614/jpwk.2021.32.1.6

Nithya, E., Harini, M., Sujisree, V., & Shruthi, V. (2025). Optimized emergency communication system for effective disaster management. In 2025 International Conference on Computing and Convergence Technology (ICCCT). https://doi.org/10.1109/ICCCT63501.2025.11019468

Nkwunonwo, U. C. (2020). Current issues in early warning and development initiatives towards enhanced flood-related resilience in Nigeria. In F. Filho (Ed.), *Flood impact, mitigation and resilience enhancement*. IntechOpen. https://doi.org/10.5772/intechopen.89425

Oboatare, I. A. K., Ayuwo, J. G. I., Amama, S. A., & Obafemi, A. A. (2025). Mass media contribution in resilience capacity building before, during and after disaster in the Niger Delta Region, Nigeria. European Journal of Theoretical and Applied Sciences. https://doi.org/10.59324/ejtas.2025.3(2).47

Ogbuefi, E., Aifuwa, S. E., Olatunde-Thorpe, J., & Akokodaripon, D. (2025). Resilience in critical infrastructures: Conceptual frameworks addressing convergence of communication, energy, finance, and healthcare systems. International Journal of Advanced Multidisciplinary Research and Studies. https://doi.org/10.62225/2583049x.2025.5.5.5023

Oke, M., Adeyinka, A. T., & Oluseyi, O. (2018). Media and disaster management: Analysing communication trends in flood ravaged communities in Benue State, North Central Nigeria. Journal of Media and Communication Studies, 10(4). https://doi.org/10.5897/JMCS2018.0626

Olowu, D. (2010). The Hyogo Framework for Action and its implications for disaster management and reduction in Africa. *Jàmbá: Journal of Disaster Risk Studies, 3*(1), 303–320. https://doi.org/10.4102/jamba.v3i1.27

Omoruyi, U., Nzewi, O., & Mpofu, V. (2025). A collaborative integrated indigenous knowledge-based flood risk reduction model. Jamba: Journal of Disaster Risk Studies. https://doi.org/10.4102/jamba.v17i1.1913

Otuogha, A. C. (2024). Disaster risk reduction through early warning systems (Nigeria case). World Journal of Advanced Research and Reviews. https://doi.org/10.30574/wjarr.2024.23.3.2521

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *bmj*, *372*.

Pahuriray, A. V., & Cerna, P. D. (2025). IoT-enabled flood monitoring and early warning systems: A systematic review. International Journal of Computer Science and Mobile Computing, 14(4), 50–67. https://doi.org/10.47760/ijcsmc.2025.v14i04.005

Paul, B. K. (2011). Environmental hazards and disasters: Contexts, perspectives and management. *Wiley-Blackwell*.

Permana, I., & Yudistira, F. (2025). Strengthening collaborative governance based on local wisdom: A study on disaster risk reduction in the indigenous communities of the Kulawi tribe. Journal of Cultural Analysis and Social Change. https://doi.org/10.64753/jcasc.v10i2.2239

Permatasari, T. O., & Sinduwiatmo, K. (2024). Improving disaster response in Indonesia through culturally integrated communication strategy. Journal of Geosciences and Environmental Studies, 1(2), 1–13. https://doi.org/10.53697/ijgaes.v1i2.3346

Prakash, P., Mishra, P., Bhardwaj, K., Umamaheswari, S., & Srilekha, M. K. (2025). LiFi in disaster management: A case study of dam monitoring. In 2025 International Conference on Recent Advances in Electrical, Electronics, Ubiquitous Communication, and Computational Intelligence (RAEEUCCI). https://doi.org/10.1109/RAEEUCCI63961.2025.11048265

Proulx, G. (2001). Occupant behaviour and evacuation. *Fire Safety Science, 6*, 219–232. https://doi.org/10.3801/IAFSS.FSS.6-219

Putra, B. K. (2024). Profiling disaster risk management research: A bibliometric analysis. Calamity: A Journal of Disaster Technology and Engineering. https://doi.org/10.61511/calamity.v2i1.2024.1018

Raharjo, A., Ariyanto, J., & Jannah, F. (2025). Essential competencies of public health professionals in disaster management: A scoping review. Advances in Healthcare Research, 3(2), Article 505. https://doi.org/10.60079/ahr.v3i2.505

Rajput, H. (2025). AI-driven disaster management: Integrating digital media, GIS, and IoT for early warning systems. International Scientific Journal of Engineering and Management. https://doi.org/10.55041/isjem.imcd042

Rokhideh, M., Fearnley, C. J., & Budimir, M. (2025). Multi-hazard early warning systems in the Sendai Framework for Disaster Risk Reduction: Achievements, gaps, and future directions. International Journal of Disaster Risk Science, 16, 103–116. https://doi.org/10.1007/s13753-025-00622-9

Santos, A. S., Goncales, I., Silva, A., Neves, R., Teixeira, I., Barbosa, E., Gava, V., & Yoshida, O. (2024). Smart resilience through IoT-enabled natural disaster management: A COVID-19 response in São Paulo state. IET Smart Cities, 6(2), Article 12082. https://doi.org/10.1049/smc2.12082

Saputra, N., Putera, R. E., Zetra, A., & Azwar. (2025). Innovative capacity building strategies for sustainable disaster risk management: A systematic review, conceptual framework, and future research directions. E3S Web of Conferences. https://doi.org/10.1051/e3sconf/202560403004

Sikder, A. S., & Harvey, K. (2014). Techno-resilience: Unraveling the impact of cutting-edge information technology in crisis management and emergency response for enhanced disaster preparedness and response efficiency. International Journal of Imminent Science & Technology. https://doi.org/10.70774/ijist.v1i1.17

Spence, P. R., & Lachlan, K. A. (2010). Race, gender, and information seeking for a natural disaster: A test of the social-mediation model. *Journal of Applied Communication Research, 38*(2), 147–164. https://doi.org/10.1080/00909881003639569

Teku, D., & Tariku, G. D. (2025). Effectiveness of early-warning systems and disaster risk reduction for rural food security under hydro-meteorological hazards in sub-Saharan Africa: Systematic review. International Journal of Sustainable Development & World Ecology. https://doi.org/10.1080/13504509.2025.2595056

Uchenna-Ogbodo, E. E. (2023). Vulnerabilities and resilience of coastal communities: Disaster risk management for flooding in Bayelsa State, Nigeria. World Journal of Advanced Research and Reviews. https://doi.org/10.30574/wjarr.2023.19.1.1467

Vanjare, G. D. (2025). AI-enabled emergency communication networks: Transforming crisis response through intelligent connectivity. European Modern Studies Journal, 9(4), 187. https://doi.org/10.59573/emsj.9(4).2025.20

Veil, S. R., & Husted, R. A. (2012). Best practices as an assessment for crisis communication. *Journal of Communication Management, 16*(2), 131–145. https://doi.org/10.1108/13632541211217560

Wei, H. (2026). Review of geographic information technology applications in disaster prevention and mitigation for urban infrastructure. ITM Web of Conferences. https://doi.org/10.1051/itmconf/20268403022

Wibowo, A. (2021). Machine learning approaches for flood prediction in Indonesia. *International Journal of Advanced Computer Science and Applications, 12*(3), 45–52.

Xia, Z., Ren, L., Zhu, W., Liang, Y., & Wu, Q. (2023). Integrated emergency communication system based on low earth orbit satellite and BeiDou satellite technology. In 2023 International Conference on Integrated Intelligence and Communication Systems (ICIICS). https://doi.org/10.1109/ICIICS59993.2023.10421558

Yadav, N., Thalakiya, R., Srivastava, S., Yadav, N., & Ostadtaghizadeh, A. (2026). Scoping review of early warning systems in improving disaster risk outcomes: Perspective from evolution to usage in Southeast Asian countries. BMC Public Health. https://doi.org/10.1186/s12889-026-26292-w

Yamah, D., & Folorunsho, T. (2026). Leveraging social media and mobile technology for disaster communication in Nigeria. International Journal of Disaster Risk Management. https://doi.org/10.66050/x77jr639

Zhang, Y., & Li, X. (2019). Application of artificial intelligence in emergency management: A systematic review. *Natural Hazards, 98*(1), 1–19. https://doi.org/10.1007/s11069-019-03684-3