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# How Multimodal AI Could Retool Global Crisis Response

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As government leaders battle increasingly severe and complex disasters, multimodal AI emerges as a promising tool for effective, coordinated crisis response.

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Imagine this future scenario: as a hurricane develops, both its intensity and the timing of landfall are recalculated every hour on desktop-grade computers. The nature of the impact, including noncorrelated crises that may occur and second-order effects of the hurricane, are modeled through multiple scenarios on city-scale digital twins that have property-level granularity. The output of these simulations results in a clear set of trigger-based action plans that are tailored, verified through human-in-the-loop mechanisms, and sent to emergency responders, community leaders, government agencies, and potentially even residents in affected areas. Community leaders have access to tools that allow them to understand what to expect, what resources to leverage, and what actions may make the most difference. Homeowners receive targeted suggestions of how to protect their assets, avoid falling victim to fraud, and navigate post-disaster support. Disinformation campaigns get countered by fact-based automated outreach.

This scenario isn't science fiction. Multimodal AI—AI that is capable of processing information from different modalities, including images, raw data, videos, and text—could make it a reality by the latter half of this decade (see sidebar, “What is multimodal AI?”). This could prove critical as major crises become more common. For example, billion-dollar disasters now occur in the United States every two to three weeks, up from one every three months in the 1980s.<sup>1</sup> And many of them develop with overlapping dimensions of stress—also known as “polycrises”; for example, natural disasters that arrive together with systematic, persistent cyberattacks or targeted disinformation campaigns.<sup>2</sup> Effectively responding to these crises is particularly challenging in the United States, given that US disaster response capabilities are distributed across federal agencies, state governments, and private sector companies.<sup>3</sup>

This article examines how multimodal AI could support these actors in providing coordinated, collaborative crisis response during each of the four phases of the disaster cycle: prevention, preparedness, response, and recovery.<sup>4</sup> While there are reasons for caution, which we outline below, thoughtful design and deployment of multimodal AI could potentially address the many challenges of effective disaster response, reducing both costs and societal harm.

- 1 “Time Series,” U.S. Billion-Dollar Weather and Climate Disasters, NOAA National Centers for Environmental Information, 2024.
- 2 HyoJin Park and Kate Whiting, “This is why ‘polycrisis’ is a useful way of looking at the world right now,” World Economic Forum, March 7, 2023.
- 3 “Disaster recovery: Actions needed to improve the federal approach,” US Government Accountability Office, November 15, 2022.
- 4 Tulane University School of Public Health and Tropical Medicine Blog, “What is a disaster management cycle?,” blog entry by Tulane University School of Public Health and Tropical Medicine, June 14, 2023.

## What is multimodal AI?

The lines between AI and generative AI are blurred in crisis management—and perhaps more broadly. A major crisis, whether from a weather event, infrastructure disaster, or pandemic, involves clashes among complex systems and considerable ambiguity. To navigate the complexity, users need AI that can process verbal, quantitative, and even visual information and generate a variety of products. Crisis managers may want updated maps, instructions for volunteers, or even geofenced text messages; speed and ease of use are key.

Researchers have begun pursuing multimodal AI—which is capable of processing information from different modalities, including images, raw data, videos, and text—as a way to ensure system flexibility that more closely mirrors human cognitive capacities.<sup>A</sup> Recent research has found that this would allow users to harness multimodal AI to develop a system for understanding ambiguous references to on-screen background context, which would allow for natural interactions.<sup>B</sup> We use the term “multimodal AI” because of its potential to deploy various AI tools and capabilities to solve challenges of varying complexity.

A Anton Belyi et al., “MMI: Methods, analysis & insights from multimodal LLM pre-training,” arXiv:2403.09611v4, April 2024.

B Halim Cagri Ates et al., “ReALM: Reference resolution as language modeling,” arXiv:2403.20329v1, March 2024.

# Phase one: Prevention

Multimodal AI could be used for early-warning systems and scenario simulations. The European Centre for Medium-Range Weather Forecasts, known for its accuracy over time, is powered by supercomputers and produces updates four times a day. Improvements in data collection, higher resolution observations, and precision data analyses have made forecast models more accurate over time.<sup>5</sup> Newer AI-powered predictive models, such as GraphCast from Google DeepMind, are trained on decades of historical weather data to provide equally accurate forecasts in less than a minute—all from a desktop computer.<sup>6</sup> While there may be important limitations, such as reduced ability to recognize chemical spills and other out-of-the-ordinary disasters, AI-powered forecasts are proving to be valuable tools. Combining these new models with additional sources of data—such as unmanned craft put in the path of hurricanes to better predict their intensity—can provide a much clearer understanding of the details of disaster impact. Texas A&M University’s Urban Resilience. AI Lab is also using AI to create predictive models for risk analysis, infrastructure failure assessments, real-time monitoring, and monitoring of recovery after disasters.<sup>7</sup>

By scanning accurate real-time data and response clusters and enabling connections between disparate systems, generative AI (gen AI) allows more-accurate early-warning systems, targeted communications, and adaptive messaging that can buy precious time for emergency managers. These disaster warnings apply to all kinds of crises, from natural (hurricane, earthquake) and epidemiological (pandemic) disasters to security (terrorist or state-backed attack) and human-caused threats.<sup>8</sup> In recognition of the importance of speed in weather forecasting, the International Telecommunication Union, the World Meteorological Organization, and the UN Environment Programme are currently partnering to research tools for faster forecasts.<sup>9</sup>

Gen AI can also create digital twins for emergency planners using historical data such as location, community impact, and financial consequences to improve modeling for disasters, including hurricanes and wildfires. These simulations enable leaders to study the potential impacts of individual crises or polycrises and develop response plans for any situation.

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5 Hannah Ritchie, “Weather forecasts have become much more accurate; we now need to make them available to everyone,” *Our World in Data*, March 12, 2024.

6 Google DeepMind Blog, “GraphCast: AI model for faster and more accurate global weather forecasting,” blog entry by Remi Lam, November 14, 2024.

7 Alyson Chapman, “Leveraging big data and AI for disaster resilience and recovery,” Texas A&M University College of Engineering, June 5, 2023.

8 “How AI predictive analysis detect natural disaster,” GLAIR, June 7, 2022; Rayhan Ahamed et al., “Potential use of artificial intelligence (AI) in disaster risk and emergency health management: A critical appraisal on environmental health,” *Environmental Health Insights*, 2023, Volume 17.

9 “Focus Group on AI for Natural Disaster Management (FG-AI4NDM),” ITU, accessed May 16, 2024.

## Crisis management tools for prevention include the following:

**Data collection and processing.** The constant growth of data sources creates a great need for efficient, accurate, and computationally responsive data collection, quality control, and assurance. Given gen AI's inherent ability to recognize patterns and its computational resources, it is well suited to conduct continuous data collection and quality control.

**Event prediction.** A large volume of data is available from a multitude of sources— including sensors, satellite imagery, and weather stations—to assess, monitor, and predict crises. And with continued innovation come new sources, such as unmanned aerial vehicles.<sup>10</sup> Google and Harvard University are creating an AI system to forecast seismic aftershocks based on the magnitude and patterns of prior earthquakes and aftershocks.<sup>11</sup>

**Scenario simulations.** Based on historical, predicted, and real-time data points, gen AI can create and analyze thousands of scenarios to assess the probabilities of various crises and their impacts across a range of severities, conduct risk assessments, and help authorities prepare appropriate response strategies.

**Results interpretation and action planning.** With the volume of data produced by scenario simulations and event predictions, gen AI can identify the most vulnerable areas in any crisis, develop appropriate response plans, and highlight potential mitigations that can be employed to minimize impacts ahead of any crisis. For example, the US Department of Homeland Security recently announced that hazard mitigation planning would be one of three pilot initiatives for its initial use of gen AI in 2024.<sup>12</sup>

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10 Innovation in disaster management: Leveraging technology to save more lives, UNDP and OCHA, 2023.

11 Phoebe M. R. DeVries et al., “Deep learning of aftershock patterns following large earthquakes,” *Nature*, August 2018, Volume 560.

12 “Department of Homeland Security unveils artificial intelligence roadmap, announces pilot projects to maximize benefits of technology, advance Homeland Security mission,” Department of Homeland Security, March 18, 2024.

# Phase two: Preparedness

Multimodal AI can safeguard lives and livelihoods before crisis strikes. Its capacity to prepare people and communities for crises could transform key aspects of preparedness.

## Pre-disaster action

Gen AI holds the potential to enhance crisis preparedness for better resource and personnel allocation as well as advance warning for the public. AI often does work that exceeds human capacity, such as identifying unusable roads during hurricane evacuations.<sup>13</sup> This visibility allows emergency managers to improve their mobilization and response capabilities, enabling better decisions and increased effectiveness across various crisis situations. Additionally, gen AI can support members of the public in advance of a disaster by directing them to the nearest shelters, distribution centers, and evacuation routes, leveraging the large amount of geospatial data available today.

Crisis management tools for pre-disaster action include the following:

**Predictive modeling.** The predictive models of gen AI can be used to develop potential outcomes of future crises, whether they're a few days away or more than a year. These projections assist decision makers in creating appropriate contingency plans and playbooks to determine how best to respond to each crisis. For more near-term situations, this modeling can provide early intelligence to guide actions such as preparing for evacuations or mobilizing response agencies with enough lead time to achieve public safety goals.

**Public warning systems.** Once emergency managers announce mandatory or voluntary actions for the public, such as evacuations or shelter-in-place orders, they could use gen AI to offer citizens next steps. For example, the technology could provide optimized evacuation routes (potentially coordinating a dispersion of traffic to minimize traffic congestion); the nearest emergency distribution site for sandbags, water, or masks; checklists to review emergency supplies; and digital storage for important documents for post-disaster recovery.

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<sup>13</sup> "Applying artificial intelligence for social good," McKinsey Global Institute, November 28, 2018; Kylie Foy, "With lidar and artificial intelligence, road status clears up after a disaster," MIT News, April 21, 2020.

# Real-time coaching

Gen AI could potentially help responders and volunteers in real time as they respond to a crisis. For example, gen AI could listen to government call-center conversations during large disasters, when these centers may receive hundreds of thousands of calls from survivors seeking information.<sup>14</sup> The gen AI could then help staff provide relevant information.

Crisis management tools for real-time coaching and training include the following:

**Virtual simulations and role-playing.** Emergency managers can train using VR simulations powered by gen AI to create fully immersive experiences based on what the predictive modeling expects to occur. This technology allows decision makers to experience crises in the most realistic setting possible and sets up transformational experiences for simulations and war games.<sup>15</sup>

**Personalized learning, feedback, and coaching.** AI can provide an adaptive training platform that adjusts content, feedback, and suggestions based on the performance and progress of the trainees.

# Safeguarding

During the period before crises start, the use of AI tools could assist in planning evacuations, allocating and stocking resources, and educating the public.

Crisis management tools for safeguarding include the following:

**Evacuation planning.** AI tools can help in determining the fastest and most optimal evacuation routes for different areas by analyzing road conditions, traffic patterns, population density, availability of transportation, and other real-time updates. Emergency services personnel can use this information to reduce chaos and direct people away from highly congested gridlocks and choke points to safe zones. For example, AI can help determine the most effective timing to activate contraflow operations and move traffic toward inland locations in anticipation of a hurricane.<sup>16</sup>

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14 Ben Ellencweig, Mihir Mysore, and Jon Spaner, "Generative AI is set to transform crisis management," Nextgov/FCW, October 17, 2023.

15 Mikaela Cohen, "Here's how A.I. and virtual reality can help companies boost employee engagement and productivity," CNBC, April 5, 2023.

16 Paolo Bocchini, Brian D. Davison, and Wenjuan Sun, "Applications of artificial intelligence for disaster management," *Natural Hazards: Journal of the International Society for the Prevention and Mitigation of Natural Hazards*, September 2020, Volume 103, Number 3.

**Identifying and supporting vulnerable populations.** By analyzing vast amounts of geospatial data, demographic information, and socioeconomic indicators, AI algorithms can highlight communities at higher risk, such as elderly or marginalized communities, and tailor evacuation interventions and alerts to ensure they get the help they need. A study by SEEDS India used AI to analyze satellite imagery of Puri, India, to identify homes that were most likely to be damaged by Cyclone Yaas and warn and evacuate those who were in the most danger. It did so with 92 percent accuracy.<sup>17</sup>

**Resource allocation.** By predicting high-impact zones and analyzing resource availability within those zones, AI tools can help determine where to send critical disaster equipment and supplies, such as food, water, and medicines, before the disaster hits and direct local communities on how to access these resources.

**Communication and query resolution.** AI-powered chatbots can be deployed to address frequently asked questions related to evacuation routes and means, shelter and backup facilities, and emergency procedures. They can also provide personalized guidance and support to community workers and residents.

## Phase three: Response

Multimodal AI could help emergency management professionals make decisions, visualize data, and analyze public sentiment.

### Decision support

Gen AI could use data—such as population features, infrastructure statistics, and real-time weather data—to help those displaced or otherwise affected by disasters. For example, it could suggest where to find shelter and resources.

Crisis management tools for decision support include the following:

**Communication and information dissemination.** AI-powered communication tools can disseminate critical information rapidly, reaching a larger audience (including in multiple

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<sup>17</sup> Tammy Waitt, “3 ways AI can help govts prevent disaster impact for at-risk citizens,” American Security Today, August 4, 2022.

languages) and providing guidance on safety measures, evacuation procedures, and the availability of resources. Tools such as chatbots and virtual assistants can ease the burden on human responders by providing accurate, real-time responses to frequently asked questions.

**Emergency response risk assessment and optimization.** By helping predict where and when a crisis will strike, gen AI can also support authorities in optimizing all aspects of their response. Scenario analysis combined with real-time data analysis can help responders understand the scope of the crisis, identify the risks of various responses, allocate resources, and streamline relief efforts. The analysis could consider factors such as historical data, environmental conditions, and community demographics, and relief efforts might be streamlined by guiding displaced people to the best evacuation routes, navigating affected areas more safely, speeding up the assessment of the situation, and improving the accuracy of the assessment.

**Rescue and recovery operations.** By analyzing satellite imagery and telecommunications, gen AI can point responders to survivor locations and identify areas to concentrate resources for rescue and recovery operations.

## Real-time data visualization

Multimodal AI can create data visualizations and process text to equip leaders with real-time dashboards, maps, and graphics to enable rapid decision making in real time. Given the increasing amount of information flowing into emergency-operations centers, visuals that allow emergency managers to focus on the most important data points and most timely decisions would support the most efficient and effective crisis response.

Crisis management tools for real-time data visualization include the following:

**Decision dashboards.** Gen AI can predict which decisions are most urgent for emergency managers to make and prioritize where humans should be in the loop, while also recommending actions to accelerate the crisis response.

**Risk and response heatmaps.** By collecting incoming data from 911 calls, satellites and sensors, and emergency response personnel, gen AI can build heatmaps to highlight where emergency response is needed now and predict where response may be needed in the future to better direct personnel to the most urgent needs.



# Sentiment analysis

Gen AI also excels in analyzing broad public sentiment. Integrated with traditional and social media, gen AI can empower leaders to understand public sentiment—including potential actions in response to information it shares or intends to share—detect bad actors, identify misinformation, and tailor communications.

Crisis management tools for sentiment analysis include the following:

**Social media monitoring.** Gen AI can synthesize early signs of crises such as public unrest, protests, disease outbreak, and security threats by analyzing social media platforms. To collect the appropriate data to analyze, AI can monitor factors such as specific keywords or phrases, hashtags, geotagged data, and trending topics. This allows it to provide valuable insights to authorities in real time and identify emerging issues that might need swift response.

**Sentiment analysis.** Gen AI can use natural language processing techniques to analyze text and gauge public sentiment during a crisis. For example, it could categorize public opinions as positive, negative, or neutral to swiftly educate leaders on how the crisis and response are being perceived.

**Public opinion polling and surveys.** Gen AI can design, and facilitate the implementation of, public opinion polls and surveys to collect data on public sentiment during a crisis. These polls can also help leaders assess people's experiences when seeking information and services.

**Issue tracking and media monitoring.** AI can monitor how the crisis is being portrayed to the public by analyzing traditional news sources, including the tone and narrative being used about the crisis. This helps leaders determine when they might need to counter misinformation.

# Phase four: Recovery

Multimodal AI could also support disaster recovery efforts through the two actions listed below and others.

## Aid community recovery efforts

After a disaster, gen AI could locate strongly affected communities, provide them with real-time information, and convey basic knowledge about first aid and health—helping to foster community goodwill in times of recovery.

Crisis management tools for supporting goodwill efforts include the following:

**Resource management and allocation.** AI can analyze data on the community’s needs and available resources to optimize their allocation. To prevent bias and scarcity of resources, it could consider objective, predetermined factors such as population density, economic needs, and delivery of critical health and human services.

**Predictive analysis for specific populations.** Gen AI can synthesize data to identify specific populations that might have extra or specific needs, such as those of a certain socioeconomic status, college students, or the elderly. With that information, emergency managers could proactively allocate the appropriate resources. Data for this analysis could include factors such as age, employment, housing, business operations, and concentration of Medicare enrollees. This analysis can close bias gaps and help target specific recovery plans for affected individuals, families, and businesses.

## Postcrisis analysis

Gen AI could be used to analyze the effectiveness of response and recovery efforts and adjust emergency management protocols. By analyzing large volumes of data, including response times, incident reports, social media data, resource allocation, and evacuation plans, gen AI could integrate additional real-time data into its predictive modeling and analytics. This could help emergency management leaders identify ways to improve and refine future crisis management strategies.

## Crisis management tools for postcrisis analysis include the following:

**Performance evaluation and impact assessment.** Gen AI can assess the performance of various response strategies and evaluate their effectiveness. By adding actual outcomes data to the predicted scenarios, AI can identify best practices and areas that need improvement for future crises.

**Evaluate strategies and processes.** AI can examine risks and potential vulnerabilities the crisis brought to light and develop mitigation strategies with input from emergency managers to shore them up before the next crisis occurs.

**Support transparency.** Gen AI can disclose vital information that helps members of the public assess the efficacy of the response.

**Policy and procedure refinement.** Gen AI can inform adjustments to existing policies or procedures.

## Areas for caution and care

By integrating multimodal AI tools into crisis management systems and protocols, public authorities could benefit from improvements in timeliness and accuracy, communications to constituents, and effectiveness in initial response. However, they must be sure to understand the ethical implications and potential risks.

- 1. Potential for bias.** AI algorithms are trained on data, and data can be biased, replicate bias from its sources, or present biased information as neutral. Consequently, emergency management leaders should consider how to design systems with safeguards against biased outcomes, inaccurate predictions, and false alarms—all of which could have serious consequences.
- 2. Privacy.** AI early-warning systems draw data from a variety of information sources, including utility usage and emergency responder calls. Community engagement can ensure that the data collection addresses concerns about privacy, disclosure of personally identifiable information, or historic discrimination. For example, special care must be given to monitoring processes, which may lead to additional surveillance or scrutiny of historically marginalized people.

- 3. Limiting access to resources and shaping markets.** When AI predicts that an area is likely to have a crisis, the decisions that follow may move markets or result in significant resource allocations. Because such decisions could have an impact on key market elements—such as home insurance, supply chains, and travel—these models will need to clarify the level of certainty in their analysis and validate predictions.
- 4. Ensuring data accuracy and combating misinformation.** AI algorithms analyze information from a broad spectrum of data, but that spectrum may be too broad for creating simulations and potential disaster scenarios on which to train emergency responders. Emergency managers may want to ensure the data used is tailored enough to accurately represent the potential disaster scenarios of their given location, including considerations such as geography, historical trends, changing weather patterns, and population dynamics. And it's important to verify the reliability of the data to ensure the simulations' outcomes are as accurate as possible.<sup>18</sup> It is also important to address the potential risks of content generated by gen AI, including the risk that images, videos, and text will be weaponized to spread climate disinformation and panic. Specific guardrails on mission-critical tools as well as transparency about their use can help.
- 5. Ethical oversight and legal compliance.** Ethical guidelines and legal regulations could govern the use of AI technologies. Leaders could consider prioritizing the protection of individual rights, privacy, and data security, and avoid any potential misuse of personal information—in accordance with all relevant laws.
- 6. Human collaboration, engagement, and governance.** Human engagement promotes understanding of AI's role and limitations.<sup>19</sup> Designing AI systems to ensure human responsibility and accountability where possible can avoid system errors or bias.
- 7. Traceability, sourcing, and transparency.** The ability to track, understand, and explain the origins of gen AI algorithms and models fosters trust and allows both emergency managers and the community at-large to engage with system development. By allowing public access to AI data and operations detail, leaders can improve reliability and transparency.<sup>20</sup>
- 8. Continual assessment and improvement.** Leaders could consider establishing mechanisms for continual assessment and improvement of AI-driven simulations and programs.

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18 For more, see Siobhan Hanna, "Adopting ethical generative AI," Fast Company, June 20, 2023.

19 Katharine Miller, "AI overreliance is a problem. Are explanations a solution?," Stanford Institute for Human-Centered Artificial Intelligence, March 13, 2023; Paul R. Daugherty and H. James Wilson, "Collaborative intelligence: Humans and AI are joining forces," Harvard Business Review, July–August 2018.

20 Intelligent Artifacts Blog, "Auditing information: Traceable artificial intelligence," blog entry by Emily Mathwich, May 10, 2023.

**9. Safety protocols and contingency plans.** Robust safety protocols and contingency plans can address any unforeseen issues or challenges that may arise during AI-driven simulations. Participants should understand safety procedures and know that there are clear mechanisms in place to handle unexpected situations and prioritize individual well-being.

**10. Community engagement and public trust.** Community involvement in the development and implementation of AI-driven disaster preparedness strategies could build public trust and allow leaders to design with community needs in mind. Early engagement, communication, and transparency can build trust and ensure that the use of AI technologies aligns with the needs and values of the communities these tools are meant to serve.

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Responsible deployment of multimodal AI has the potential to retool crisis response by expediting decision support, real-time coaching, and administrative functions. These interventions can help responders coordinate efforts to mitigate the impact of polycrises and enable quicker and more resilient community recovery.<sup>21</sup>

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<sup>21</sup> Hakan Kantas, "The role of AI in crisis management and business continuity," AI Business, June 8, 2023.