Research Report

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What Makes Catastrophic Incidents Different?

Practical Implications for Emergency Managers and Suggestions for Training



HSOAC
HOMELAND SECURITY
OPERATIONAL ANALYSIS CENTER

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About This Report

Compared with other types of incidents, *catastrophic* incidents are generally understood to have more-severe consequences, cover larger geographic areas, and have a longer duration. Each of these characteristics poses unique challenges to emergency managers. However, whether an incident is—or becomes—catastrophic may depend on a variety of factors, some of which are inherent to the incident itself and some of which are external to it. This report focuses on how catastrophic incidents are different from other disasters and what this suggests for how emergency managers may need to prepare differently for them, including whether catastrophic incidents require different skills, training, and education from other kinds of incidents. Furthermore, the report provides suggested diagnostic questions intended to inform initial planning considerations that emergency managers can use to more rapidly identify incidents with the potential for catastrophic consequences.

This report is part of an ongoing effort by the Homeland Security Operational Analysis Center (HSOAC) to support the Federal Emergency Management Agency's (FEMA's) National Disaster and Emergency Management University (NDEMU). Since 2022, HSOAC has been engaged by NDEMU to systematically identify the most critical emerging challenges to the emergency management field; build knowledge about these issues across federal, state, local, tribal, and territorial governments, nonprofits, the private sector, and educators; and identify potential solutions. A key focus of these efforts is to bridge silos in the emergency management field, most importantly between government, the private sector, nonprofits, and educators.

The primary audience for this report is FEMA leadership, NDEMU, and the broader emergency management stakeholder community, including emergency managers in state, local, tribal, and territorial (SLTT) governments, the private sector, and nonprofits. However, the report may also be of interest to the wider emergency management field, including educators, as the report draws attention to a specific subset of incidents—catastrophic incidents—that may reveal gaps in SLTT capabilities where additional education and training may be needed. This research was sponsored by NDEMU and conducted in HSOAC.

Homeland Security Operational Analysis Center

This work was conducted within the RAND Homeland Security Research Division (HSRD), which operates the Homeland Security Operational Analysis Center (HSOAC). HSOAC is a federally funded research and development center (FFRDC) that provides the government with independent and objective analyses and advice in core areas important to the U.S. Department of Homeland Security (DHS) in support of policy development, decisionmaking, alternative approaches, and new ideas on issues of significance. HSOAC also works with and supports other federal, state, local, tribal, and public- and private-sector organizations that make up the homeland security

enterprise. HSOAC's research is undertaken by mutual consent with DHS and organized as a set of discrete tasks.

The results presented in this publication do not necessarily reflect official DHS opinion or policy.

For more information on HSOAC, visit www.rand.org/hsoac.

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Summary

Emergency managers are increasingly called on to prevent, respond to, and help in the recovery from catastrophic incidents. While catastrophic incidents are generally defined by their consequences, which are more severe than other emergencies', the underlying incidents themselves may take many forms: natural or manmade, cyber or physical, public health or national security.

In the research detailed in this report, we sought to answer two questions: First, are there characteristics and conditions that make an incident more likely to be catastrophic that emergency managers can detect, plan for, and respond to in advance of or during incidents? Second, given that the plans, partners, and perhaps even ways of thinking used in more-routine incidents may not be sufficient for catastrophic incidents, is there additional training and education that could help emergency managers detect and effectively mitigate the characteristics of catastrophic incidents?

The Homeland Security Operational Analysis Center research team interviewed subject-matter experts with expertise in emergency management and risk assessment to identify an initial set of factors, or precursors, of incidents that have the potential to become catastrophic. We found both *intrinsic precursors* that are features of the underlying incident itself and *extrinsic precursors* that are features of the context in which the incident occurs. The intrinsic precursors are geographic scale, timing and duration, intensity, novelty, and technical complexity, and the extrinsic precursors are governance, public trust, and simultaneity. These precursors each pose distinct challenges that can be grouped into four major impacts—scarcity, stress and other psychological impacts, uncertainty, and systemic failures—that often result from catastrophic incidents and may require specific education and training that differs from the requirements of more-routine emergencies. Table S.1 shows the eight precursors, specific challenges these precursors may create for emergency managers, and the challenges' associated impacts.

Unfortunately for emergency managers, a single incident can involve multiple precursors, challenges, and impacts. Some combination of problems of extreme scarcity, stress and other psychological impacts, uncertainty, and systemic failures may manifest within the same incident, pushing emergency management systems and personnel to their capacity. Fortunately, specialized training and education can increase preparedness for catastrophic incidents and their impacts. Although training will never fully mitigate the risks of catastrophic incidents, it may help to mitigate some of the challenges they present.

Training for Scarcity: Conditions of scarcity require thinking about trade-offs, including prioritizing where to focus finite resources and relying on communities and individuals to support themselves in order to reduce reliance on centralized efforts. Training can help emergency managers think about priorities and how to approach hard trade-offs during the response to a catastrophic incident. Opportunities include training on operating in resource-constrained conditions, in worst-case scenario exercises, and with nontraditional partners, as well as predeveloping protocols for managing scarcity.

Table S.1. Precursors, Challenges, and Impacts of Catastrophic Incidents

Precursor	Potential Challenge	Relevant Impact
Intrinsic		
Geographic scale	Geographic footprint of incident makes assistance from traditional mutual aid partners impossible	Scarcity, stress and other psychological impacts
Intensity	Severity or intensity of incident leads to consequences and requires decisions outside the emergency management team's experience	Scarcity, stress and other psychological impacts
Timing and duration	Duration of incident exceeds any prior incident of the same type	Scarcity, stress and other psychological impacts
Novelty	Incident presents conditions and circumstances beyond the experience of any available emergency management personnel	Uncertainty
Technical complexity	Incident calls for knowledge and skills not readily available to the responding emergency management personnel	Uncertainty
Extrinsic		
Governance	Plans and systems that are typically reliable fail because of flaws in management and execution	Uncertainty, systemic failures
Public trust	Public mistrust leads to official directions being disregarded	Uncertainty, systemic failures
Simultaneity	Attention, personnel, and other resources are divided across more than one challenging incident simultaneously	Scarcity, stress and other psychological impacts, systemic failures

Training for Stress and Other Psychological Impacts: Catastrophic incidents create extreme conditions of stress and other psychological impacts. To prepare, emergency managers can act now to reduce the stress of these incidents and equip staff with tools and support systems. Options include providing training on maintaining mental health and wellness, personal and family preparedness, historical catastrophic incidents, and storytelling and empathy, as well as expanding the use of peer-to-peer networks.

Training to Mitigate Uncertainty: The uncertainty associated with catastrophic incidents requires the skills to adapt rapidly in the moment and be prepared for multiple potential outcomes. To help mitigate uncertainty, emergency managers can be trained on sensemaking and meaning-making, adaptive leadership, decisionmaking under deep uncertainty, experiential learning, improvisation, identifying novel technologies and expertise, and low-regret decisionmaking.

Training to Mitigate Systemic Failures: Emergency managers cannot prevent systemic failures in partner institutions, but they can train to build skills to better respond to such failures. This includes testing assumptions and identifying gaps in planning; conducting full-scale real-world exercises; requiring public acknowledgment of emergency roles; continuity planning; use of peer-to-peer networks; working with nontraditional communication partners; transparency and information-sharing; and improved information gathering, fact-checking, and counter-messaging.

Catastrophic incidents may have many of the same characteristics as other emergencies and may begin as noncatastrophic incidents. Yet each has defined features or a tipping point that results in the incident becoming catastrophic. There is no single formula that will fit every incident. Rather, we

sought to develop a set of precursors that can be used as a tool to support the professional expertise of emergency managers as they evaluate an incident as it is unfolding and determine the characteristics of the incident with the greatest potential to lead to catastrophic consequences.

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Chapter 1

Introduction

The U.S. Federal Emergency Management Agency (FEMA) defines an *emergency* as

> any occasion or instance—such as a hurricane, tornado, storm, flood, tidal wave, tsunami, earthquake, volcanic eruption, landslide, mudslide, snowstorm, fire, explosion, nuclear accident, or any other natural or man-made catastrophe—that warrants action to save lives and to protect property, public health, and safety.[1]

And FEMA further defines a *disaster* as

> an occurrence of a natural catastrophe, technological accident, or human-caused event that has resulted in severe property damage, deaths, and/or multiple injuries . . . a "large-scale disaster" is one that exceeds the response capability of the local jurisdiction and requires State, and potentially Federal, involvement.[2]

Beyond emergencies and disasters, we consider *catastrophic incidents*, which are often defined in terms of their consequences rather than the precipitating hazard.[3] For example, the Post-Katrina Emergency Management Reform Act (PKEMRA) defines a *catastrophic incident* as

> any natural disaster, act of terrorism, or other man-made disaster that results in extraordinary levels of casualties or damage or disruption severely affecting the population (including mass evacuations), infrastructure, environment, economy, national morale, or government functions in an area.[4]

This and similar definitions are useful for characterizing incidents after they have occurred and their impacts are known. They also suggest some characteristics that might be useful to emergency managers in determining whether an emerging incident has the potential to be catastrophic. However, history demonstrates that while some characteristics that may lead to catastrophic consequences are intrinsic to the incident itself—such as the magnitude of a major hurricane—there may be other, extrinsic, factors that are more context-dependent or even related to the management of the incident. In two prominent examples, the final report of the Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina notes that, "If 9/11 was a failure of imagination,

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[1] FEMA, *Guide for All-Hazard Emergency Operations Planning*, September 1996, p. GLO-2.

[2] FEMA, 1996, p. GLO-1.

[3] This is different from the definitions of *emergency* and *disaster*, which are often defined by the precipitating hazard.

[4] PKEMRA was enacted into law as part of the Fiscal Year 2007 Department of Homeland Security Appropriations Act (Public Law 109-295, Department of Homeland Security Appropriations Act, 2007, October 4, 2006). The definition of *catastrophic incident* is found in Section 602 ("Definitions").

then Katrina was a failure of initiative."[5] This suggests that as devastating as the characteristics of the underlying hazards were, other factors—prior to, during, or after—can contribute greatly to whether an incident becomes catastrophic.

In the research detailed in this report, we sought to answer two related questions. First, are there characteristics and conditions—intrinsic or extrinsic—that make incidents more likely to be catastrophic (that is, have catastrophic impacts) and that emergency managers can detect, plan for, and respond to in advance of and during ongoing incidents? Second, are there additional training and education opportunities that could help emergency managers detect and effectively address these characteristics?

Background

FEMA's National Disaster and Emergency Management University (NDEMU) is responsible for training emergency managers and first responders throughout the country. Beginning in 2022, NDEMU asked the Homeland Security Operational Analysis Center (HSOAC) to work with stakeholders from federal agencies, state, local, tribal, and territorial, (SLTT) governments; nonprofits; and the private sector, as well as policymakers, trainers, and educators, to identify emerging challenges and related training needs for emergency managers. This report is a continuation of these efforts and focuses on one of the most important challenges emergency managers may confront: a catastrophic incident that exceeds their resources and experience and may be unexpected or without precedent.

Approach

Our analysis draws on four sources: historical disaster and threat data, national assessments of risks to the United States, a literature review of approaches to catastrophic incidents, and discussions with emergency management and risk assessment subject-matter experts (SMEs). For background and context, we began by analyzing five historical disaster and threat datasets to identify the most common types of disasters and which types of incidents pose the greatest risks to communities. We then compared these findings to national risk assessments, which provide perspective not only on the threats and hazards likely to affect a community but also on the incidents a jurisdiction is most concerned about, including emerging threats that may not have occurred yet.

The dataset analysis (see the appendix) formed the foundation for our literature review and discussions with HSOAC SMEs.[6] We conducted a literature review of academic and gray literature about catastrophic incidents and different approaches to prepare for and respond to such incidents. First, we conducted a broad review of published literature to determine how previous work has defined *catastrophic incidents* and identified the risks associated with them. We did not find a

[5] Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina, U.S. House of Representatives, *A Failure of Initiative: Final Report of the Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina*, Report 109-377, 2006, p. xi.

[6] The HSOAC SMEs interviewed for the report were not authors of the report.

consistent definition and elected to use the definition from PKEMRA, quoted above, to frame our work. We supplemented this initial literature review with additional targeted searches to identify literature providing insight into potential impacts from catastrophic incidents and options for enhancing preparedness. During this stage, we combined online search engine searches with large language model prompting to identify relevant literature.

We additionally asked six SMEs familiar with incident management to help define catastrophic incidents and discuss how they pose unique challenges to emergency managers. From these inputs, we identified eight potential precursors of catastrophic incidents that individually or in combination could drive an incident to be catastrophic. Collectively, these precursors create an assessment framework to help emergency managers identify whether an incident has the potential to lead to catastrophic consequences. For each precursor, we defined a set of questions intended to evaluate the ways in which an incident could lead to catastrophic consequences. The specific precursors indicate the unusually challenging characteristics that a jurisdiction would need to address to mitigate catastrophic outcomes. We used findings from this approach to develop recommendations to help SLTT governments and other NDEMU audiences be better prepared for and respond to catastrophic incidents.

Limitations

Because of external factors beyond the control of the project, we were unable to engage directly with external stakeholders, including the SLTT emergency management community, to gain their feedback and input. As a result, we were unable to solicit external feedback on whether we had identified a correct and useful set of indicators of catastrophic incidents. We addressed this limitation by using HSOAC SMEs, some of whom had direct SLTT emergency management experience. In the future, the precursors would benefit from additional validation and feedback from the broader emergency management community.

A second, related limitation is that, while we attempted to identify what different types of training and education SLTT and other personnel might need to deal with the distinct aspects of catastrophic incidents, we were unable to solicit input directly from the audiences who would use this training and other key stakeholders. Emergency management practitioners, educators, researchers, policymakers, and other stakeholders could likely identify a more robust and detailed set of potential gaps in current training and education offerings, as well as recommendations for how to best address these needs. Direct feedback from these stakeholders is likely to be a critical input in designing future training that supports preparedness for catastrophic incidents.

How This Report Is Organized

The remainder of this report is organized into three chapters and an appendix. Chapter 2 characterizes how catastrophic incidents are defined, based on our review of academic and practitioner literature and discussions with HSOAC SMEs; defines precursors of catastrophic incidents; and provides question prompts designed to help facilitate emergency managers in identifying whether an incident has the potential to result in catastrophic consequences. Chapter 3 discusses the types of impacts that catastrophic incidents can have on a jurisdiction. Chapter 4 discusses the ways that

training could help support federal, SLTT, and other regional emergency managers preparing for catastrophic incidents. The appendix describes our findings from analysis of five datasets documenting hazards and threats relevant to the United States.

Chapter 2

Precursors of Catastrophic Incidents

We sought to identify a set of factors, or precursors, that emergency managers could use to identify incidents that have the potential to develop into catastrophic incidents. Our intention was to identify precursors that could be applied both during "blue sky" periods—that is, before an incident occurs[7]—and during the initial hours and days of response to an incident. Identifying incidents during the planning process that could become catastrophic is important because it can enable emergency managers to better prepare. This may be particularly useful if the characteristics associated with potential catastrophic incidents are not obvious, or if they present challenges not found in more-routine, noncatastrophic incidents. During an emerging incident, faster identification of the potential to escalate to a catastrophic incident would help emergency managers respond more rapidly and effectively and mitigate catastrophic consequences. To the extent that catastrophic incidents present challenges that noncatastrophic incidents do not, specialized training in advance of the incident could help emergency managers and their teams be better prepared to meet those challenges. For the purposes of this report, we define *precursors* of catastrophic incidents as conditions or qualities that suggest that an incident could result in catastrophic consequences.[8]

We interviewed SMEs within HSOAC with expertise in emergency management and risk assessment to identify an initial candidate set of precursors. The SMEs we spoke with included academics as well as practitioners with direct experience managing real-world incidents that would meet the PKEMRA definition of a catastrophic incident. Our discussions focused on two primary questions. First, what are the characteristics that catastrophic incidents have in common, and what are the primary drivers of catastrophic consequences occurring? Second, do these characteristics present unique challenges to emergency managers and other crisis leaders, including challenges that might be mitigated by relevant education and training?

From these discussions, we identified and defined a set of precursors that are important to consider when preparing for catastrophic incidents. The set includes a mix of *intrinsic* factors that are

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[7] *Blue sky planning* refers to activities that can be done predisaster, during noncrisis periods, to increase preparedness.

[8] *Precursor* has been defined in a dictionary as "one that precedes and indicates the approach of another" (Merriam-Webster, *The Merriam-Webster Dictionary*, rev. ed., 2022). In the field of accident analysis, *precursors* have been defined "as the conditions, events, and sequences that precede and lead up to accidents" (National Academy of Engineering, *Accident Precursor Analysis and Management: Reducing Technological Risk Through Diligence*, National Academies Press, 2004, p. 6). See also Richard H. Taylor, Lorenzo G. A. van Wijk, John H. M. May, and Neil J. Carhart, "A Study of the Precursors Leading to 'Organizational' Accidents in Complex Industrial Settings," *Process Safety and Environmental Protection*, Vol. 93, January 2015. Because they occur earlier, precursors can be analyzed to help prepare for and, in the case of manmade accidents, prevent the occurrence of serious incidents. Our definition of *precursor* is consistent with these definitions, although we specify that precursors include those characteristics of *an incident itself* that signal that it may later result in catastrophic consequences. What connects our definition to both the dictionary definition and definitions from the literature is the focus on temporal sequence—precursors come before, and may provide warning about, a given (often negative) outcome.

inherent to the incident and *extrinsic* factors that are not directly related to the incident but could escalate its consequences dramatically. Emergency managers cannot change the intrinsic factors of an incident—but they can prepare for them. In this report, we focus on how emergency managers can improve capacity through training and education.

Applying the Precursors in Different Contexts

We identify precursors that could be applied by emergency managers working at different levels of government, in jurisdictions of different sizes, and in the public or private sector. Jurisdictions and organizations vary in terms of geography, hazard exposure, capacity, prior experience with specific incident types, and a host of other important factors. The precursors are intended to be applied from the point of view of the emergency management team, with the team assessing the degree to which each precursor is present based on local context. For example, an incident that significantly exceeds the magnitude of any prior incident the jurisdiction has experienced is likely to be more challenging, as would be an incident that has never occurred in that jurisdiction. However, two jurisdictions experiencing the same incident could have very different perspectives on it. A recent snowstorm provides a simple example. Baton Rouge, Louisiana, recorded 7.6 inches of snow on January 21, 2025, which was the highest total recorded since 1892, when recordkeeping for the area began.[9] While the same amount of snow might still present some challenges to a city in the northern United States, it would likely be a far more routine event and one with which the city has ample experience. As one SME noted, an incident that is catastrophic in one location might be more routine and manageable in another.

Approach for Identifying Potential Precursors for Catastrophic Incidents

In seeking to identify a set of precursors, our intent was not to identify conditions that are present in every catastrophic incident but instead those characteristics that, collectively and across the diverse variety of historical and potential catastrophic incidents, are (1) the most important for driving catastrophic consequences and (2) most distinct from noncatastrophic incidents. Although the identified precursors are intended to include the most common and important factors, they are not an exhaustive list of all factors that could cause an incident to have catastrophic consequences.

In addition, we did not attempt to, nor could we, identify precursors that are mutually exclusive from one another. Incidents in the real world, particularly catastrophic incidents, are complex. For example, a major hurricane or other severe weather system knocking out power across a large geographic footprint may result in a significantly longer duration of power outage than would have occurred if the incident affected a smaller area requiring fewer resources to restore power. This example illustrates the potential interaction between two precursors: duration and geographic scale. In contrast, a terror attack that permanently disabled a piece of power transmission equipment that is not

[9] Haley Thiem and Nicole Collin, "Historic January 2025 Snowstorm in the Southern U.S.," National Oceanic and Atmospheric Administration, January 29, 2025.

easily replaced could have a much smaller geographic footprint but have a very long duration, leading to severe consequences for those affected. In a similar vein, we did not identify precursors that are individually sufficient to elevate an incident to the catastrophic level, nor is there a single, predictable combination of precursors that would do so. In some cases, the presence of a single precursor at a given level, or in each context, may be enough to elevate an incident to having catastrophic consequences. In other cases, even if multiple precursors are present, an incident may not result in catastrophic consequences. We provide examples throughout the chapter to illustrate the complex interactions between incident characteristics, drawing on both historical events and potential scenarios.

We identified the precursors through discussions with HSOAC SMEs in several ways. First, we shared the PKEMRA definition of *catastrophic incident* with our interview subjects to serve as a foundation for the discussion. We discussed the definition with SMEs and whether it implied any precursors for catastrophic incidents. Several emerged, including geographic scale, duration, and intensity, each of which is suggested by the PKEMRA definition. We also selected precursors that were repeated in all or most discussions. For example, novelty emerged as an important factor in multiple discussions. We selected the SMEs we spoke with to reflect a variety of backgrounds and experiences, including experience with specific incident types, such as cyberattacks, which might have characteristics that are distinct from those associated with other incidents. In this way, we sought to include precursors that, even if they did not come up in most discussions, could plausibly be identified as critical drivers in those incidents in which they occur. An example of this is technical complexity, which did not come up in every conversation but emerged clearly as a critical factor in select incidents.

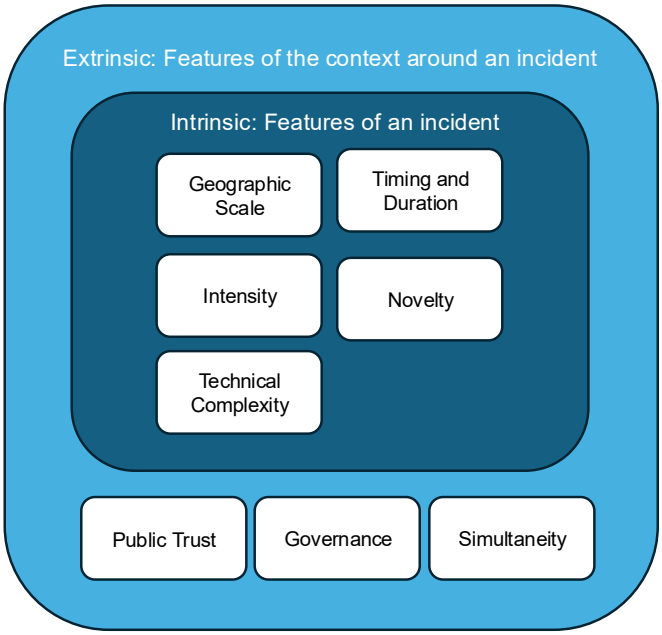
Building on input from our discussions with SMEs, we also developed sets of diagnostic questions that could be used to evaluate an incident to help emergency managers gauge the risks of an incident escalating to catastrophic consequences.

Precursors of Catastrophic Incidents

We identified an initial set of eight candidate precursors of potential catastrophic incidents: geographic scale, timing and duration, intensity, novelty, technical complexity, governance, public trust, and simultaneity. We organized our precursors into two types: *Intrinsic precursors* are features of the incident itself that could lead to catastrophic consequences, and *extrinsic precursors* are features of the context in which the incident occurs with the possibility of exacerbating the consequences of an incident, including the affected community, the government, and emergency management capabilities and capacity to respond.[10] Figure 2.1 shows how our precursors align within the intrinsic and extrinsic categories. In the sections that follow, we describe each precursor and provide an example of a historical or potential incident in which the characteristic may be a decisive driver of catastrophic consequences.

[10] A similar distinction was made in a National Academy of Engineering report on accident analysis that noted that "precursor events can be thought of loosely as 'building blocks' of accidents and can include both events *internal* to an organization (such as equipment failures and human errors) and *external* events (such as earthquakes and hurricanes)" [italics added] (National Academy of Engineering, 2004, p. 6).

Figure 2.1. Precursors of Catastrophic Incidents



Intrinsic Precursors

Intrinsic precursors describe the features of the incident itself. They reflect such features as the size, duration, or intensity of the incident that might lead to catastrophic consequences. Two of our precursors, novelty and technical complexity, refer to features of an incident that may make it atypical or require specialized expertise to respond to effectively.

Geographic Scale

The geographic scale, or simply the number of jurisdictions (whether cities, counties, states, regions, or the entire nation) affected by an incident, is one of the most straightforward indicators that an incident could lead to catastrophic consequences.[11] The SMEs with whom we spoke noted that the larger an incident's geographic scale, the more likely it would be that any individual jurisdiction could be overwhelmed, and the harder it would be for jurisdictions to aid one another. The lack of sufficient resources to respond to the incident in a timely manner, or simply the widespread nature of the impacts leaving no safe harbor areas nearby, could result in catastrophic consequences. At the extreme,

[11] The geographic scale of an incident's impacts can be influenced by human factors—such as economic interconnectedness or technological change—as well as by the natural features of the incident itself. Scholars have observed, for example, that "[a] crisis in one corner of Europe can now turn into a crisis for the entire continent: think of the Chernobyl explosion or the breakout of 'mad cow' disease, which affected multiple countries. Hurricane Katrina originated as a 'local' crisis but soon reached beyond geographical and functional boundaries to affect the nation and, indeed, many other countries and industries" (Arjen Boin, Louise K. Comfort, and Chris C. Demchak, "The Rise of Resilience," in Louise K. Comfort, Arjen Boin, and Chris C. Demchak, eds., *Designing Resilience: Preparing for Extreme Events*, University of Pittsburgh Press, 2010, p. 6).

a truly nationwide event would have a greater likelihood of straining or depleting resources than an event that affected only part of the country.

Wildfires in California, including the 2020 August Complex Fire and 2021 Dixie Fire, provide recent examples of how the geographic scale of an incident can result in catastrophic consequences. In each case, the fires covered massive geographic areas, so they required extensive resources and manpower to contain, resulting in more time needed to extinguish the fires and severe damage throughout a widespread area. The 2020 August Complex Fire burned more than 1 million acres and affected seven counties across northern California.[12] The 2021 Dixie Fire burned more than 960,000 acres, eventually spreading to five counties.[13] The fire suppression costs for these large and destructive fires were immense. Suppressing the 2021 Dixie Fire cost more than $600 million, making the fire significantly more costly—and more severe—than any fire that had struck California previously.[14] As an additional example, after Hurricane Maria, it took approximately 11 months to restore power distribution capacity across Puerto Rico.[15] The recovery has been described as the "longest blackout in U.S. history."[16]

Any jurisdiction evaluating whether an incident could lead to catastrophic consequences because of the incident's geographic scale should consider such questions as

- Physical footprint
  - What is the anticipated geographic scale of the incident?
  - How many jurisdictions are likely to be significantly affected?
  - Could the incident directly or indirectly affect surrounding jurisdictions or other peers?
  - Could it potentially become statewide or affect an entire region or industry/sector?
  - Could it become nationwide?
- Outside assistance
  - Are traditional mutual aid partners, emergency contractors, reserve personnel, or other surge resources likely to be affected by the incident? If so, how significantly?
  - Is it possible that no outside assistance or resources will be available? For how long?
  - How important is this assistance, and what are the consequences of it not being available?
- Escalation and uncertainty

[12] California Department of Forestry and Fire Protection, "August Complex (Includes Doe Fire)," webpage, undated-a.

[13] California Department of Forestry and Fire Protection, "Dixie Fire," webpage, undated-b.

[14] Brent McDonald, Sashwa Burrous, Eden Weingart, and Meg Felling, "Inside the Massive and Costly Fight to Contain the Dixie Fire," *New York Times*, October 11, 2021.

[15] See, for example, U.S. Army Corps of Engineers, "The Longest Blackout in U.S. History: Hurricane Maria," webpage, September 2022; Alexis Kwasinski, Fabio Andrade, Marcel J. Castro-Sitiriche, and Efraín O'Neill-Carrillo, "Hurricane Maria Effects on Puerto Rico Electric Power Infrastructure," *IEEE Power and Energy Technology Systems Journal*, Vol. 6, No. 1, March 2019.

[16] U.S. Army Corps of Engineers, 2022.

  - Is the geographic scale of the incident difficult to determine or subject to significant escalation beyond its current borders?
  - Does the incident, by nature, have the potential to rapidly or unpredictably exceed known boundaries (for example, cyberattacks, spread of a contagion or disease)?
- Impacts on responders
  - Are emergency management staff, first responders, and other government officials and their families and property likely to be directly exposed to the hazard and potentially face significant losses? (Also see the "Timing and Duration" and "Intensity" sections below.)

If an incident strains local resources and surrounding jurisdictions may not be available to provide aid because of other response efforts, then such an incident could result in catastrophic consequences, and a jurisdiction should consider how plans may need to be amended to support response to larger incidents.

Timing and Duration

The timing and duration of an incident also contribute to the potential for an incident to have catastrophic consequences. Of the two related criteria, duration is the more straightforward. The longer an incident lasts, the more likely it is to overwhelm a jurisdiction or region's capacity as resources are exhausted over time.[17] One SME noted that, when the consequences of an incident are severe and last so long that the affected community is irrevocably altered, the incident must be considered catastrophic. Hurricane Katrina provides one example of this. The storm led to population displacement and loss of housing stock that lasted so long that the affected communities were permanently reshaped.

Timing, or when an event occurs, can also be pivotal. A tsunami that occurs in the middle of the night, when most people are likely to be home asleep and less likely to notice an evacuation warning, may have more deadly consequences than one that occurs during working hours. The 2025 Texas Hill Country flash floods provide a recent example. The level of the Guadalupe River increased by almost 30 feet from 4:00 a.m. to 6:00 a.m., when many people were asleep and not aware of increasingly urgent warnings issued by the National Weather Service.[18] The converse can also of course be true—a terror attack occurring downtown during a busy workday would be likely to have more-severe impacts than one occurring in the same location on a weekend or after working hours.

Any jurisdiction evaluating whether an incident could lead to catastrophic consequences because of the timing or duration of the incident should consider such questions as

[17] It has been noted in the literature that "[l]arge-scale, long-duration incidents demand more resources—personnel, equipment, supplies, commodities, specialized capabilities—than any agency or government can keep on hand, so these resources must be obtained rapidly when a disaster occurs. This makes resource acquisition and management a major function of incident management. Unfortunately, while some materials are cached and pre-deployed, they are often inadequate to meet actual need" (Amy Donahue and Robert Tuohy, "Lessons We Don't Learn: A Study of the Lessons of Disasters, Why We Repeat Them, and How We Can Learn Them," *Homeland Security Affairs*, Vol. 2, Article 4, July 2006).

[18] Maura Barrett, "Deadly Texas Flood Unfolded After Days of Warnings," *KSBY*, updated July 8, 2025; Kalyn Norwood, "Deadly Texas Flash Floods Prompt Scrutiny of Emergency Alerts and Federal Response," *WCVB*, July 7, 2025.

- Duration
    - Do you expect the incident response and recovery to last an extended amount of time?
    - Is the anticipated duration for both immediate and longer-term emergency response and recovery activities such that it could result in resource depletion, unusually extended disruption to essential services, or prolonged displacement? How long will it take to restore lifeline resources? How long will it take to return to "normal" or mostly normal?
    - Are response and recovery measured in days or weeks? Or in months or years? Could the impacts of the event be multiyear or permanent?
- Adverse timing
    - Did the incident occur at a specific time that could exacerbate consequences?
    - Did the incident occur during peak tourist season or a period of unusually high population?
    - Did the incident occur with any sort of other adverse timing, such as during rush hour or overnight, while most of the population is sleeping and unlikely to see emergency messaging?
    - Did the incident occur during a major planned event (sporting event, convention) or during another ongoing incident? (Also see the "Simultaneity" section below.)
- No notice or warning
    - Did the incident occur with no notice or warning?
    - Did existing warning systems fail, underestimate the intensity of the incident, inaccurately project location or impacts, or otherwise misidentify key aspects of the incident?

Timing can exacerbate the consequences of an incident. The duration of the incident can create conditions of catastrophic impact and affect a community's ability to recover. If an incident could strain local resources because of either the timing or the duration of the incident, a jurisdiction should consider how response plans may need to be amended such that they are adaptable.

Intensity

The intensity of an incident is one of the most obvious precursors of a catastrophic incident on our list. For example, the stronger a storm is, the more likely it is to lead to catastrophic damage. Many incidents, such as hurricanes, tornadoes, or earthquakes, have established scales based on observable physical characteristics. Such scales can aid preparedness efforts in that the scales provide a consistent way to gauge intensity and help jurisdictions estimate the resources likely required to respond effectively. Hurricanes can be measured based on their "maximum sustained wind speed" using the Saffir-Simpson Hurricane Wind Scale.[19] Tornadoes can be rated using "estimated wind speeds and

[19] National Hurricane Center and Central Pacific Hurricane Center, "Saffir-Simpson Hurricane Wind Scale," webpage, National Oceanic and Atmospheric Administration, undated.

related damage" using the Enhanced Fujita Scale.[20] Either the Richter scale or the moment magnitude scale can be used to measure the size of an earthquake.[21] However, in some cases, scales do not exist and the intensity of an incident may be hard to define or may increase unexpectedly over time, making the required response harder to determine.

In the case of weather-related emergencies, meteorological data and modeling can help to inform understanding of an incident's likely intensity and potential for catastrophic consequences before it occurs.[22] Although forecasting the intensity of weather events involves uncertainty, refinements in forecasting techniques and technological advances have helped to improve forecasts' accuracy.[23] Incorporation of artificial intelligence (AI) capabilities into models and algorithms may enhance this capability further.[24] In the United States, notably intense disasters have led to severe damage and can remain ingrained in the public consciousness. Even 30 years after it made landfall in Florida as a Category 5 storm, Hurricane Andrew is still used as a reference for the "big one" that could reoccur and upend lives.[25] The damage was so severe that it led to policy changes, including strengthened local building codes.[26] An incident that occurs without warning can still provide signals about intensity before the incident ends, especially if it is protracted or involves multiple phases. For example, during the September 11, 2001, terrorist attacks, it became clear even as the attacks unfolded that the intensity of the incident was unparalleled and that the consequences would be catastrophic.[27]

Any jurisdiction evaluating whether an incident could lead to catastrophic consequences due to intensity should consider such questions as

- Measured intensity (if applicable)
  - Do standard intensity scales exist for this type of incident? If so, is the incident likely to be at or near the top of the scale?

[20] National Weather Service, "The Enhanced Fujita Scale," webpage, National Oceanic and Atmospheric Administration, undated.

[21] U.S. Geological Survey, "Moment Magnitude, Richter Scale—What Are the Different Magnitude Scales, and Why Are There So Many?" webpage, updated September 10, 2024.

[22] See, for example, the Hurricane Intensity Estimator created by the Interagency Implementation and Advanced Concepts Team (IMPACT) at the National Aeronautics and Space Administration (NASA) (NASA, "Hurricane Intensity Estimator," webpage, undated).

[23] National Oceanic and Atmospheric Administration (NOAA), "Thirty Years of Progress in Hurricane Forecasting Since Hurricane Andrew," August 22, 2022; NOAA, "Three Ways NOAA Research Works to Improve Our Weather Forecasts," March 5, 2025.

[24] See, for example, Alexander Bukvich, "NOAA and Google Team Up to Advance the Use of AI Hurricane and Tropical Weather Forecast Models," National Oceanic and Atmospheric Administration Technology Partnerships Office, July 8, 2025; Alexandra Witze, "This 'Impressive' AI Model Predicted Hurricane Melissa's Perilous Growth," *Nature*, October 29, 2025.

[25] See, for example, "What Hurricane Andrew Did to Us. See How the 'Big One' in Miami Changed Our Lives," *Miami Herald*, August 1, 2025; Melissa Feito, "33 Years After Hurricane Andrew, How It Changed Preparedness Forever," *WUSF*, August 24, 2025; and NOAA, 2022.

[26] NOAA, 2022.

[27] A timeline of the September 11, 2001, attacks, for example, shows how the events of the day unfolded over more than two hours (Federal Bureau of Investigation, "9/11 Investigation," webpage, undated).

- Historical intensity
    - Is the incident projected to be close to, equal to, or exceed the largest in the region's history, using any available metric?
- Uncertain intensity
    - Is the maximum intensity of the incident unclear and/or volatile, with the potential to escalate to the top of an objective measurement scale or equal or exceed a historical peak?
    - If no scale exists, are experts predicting that the incident is likely to be an outlier in intensity?
    - Is the incident novel in its intensity, and will it exceed recent or all experience? (Also see the "Novelty" section below.)
- Exceeds native capabilities
    - Is the incident likely to exceed the capabilities of the responding entity?
    - Does the incident have the potential to overwhelm capacity across common mutual aid partners?
- Severity and permanence
    - Are the impacts likely to be short term, or could they last for more than a year or be permanent?
    - Could the incident result in economic damage or in major changes in population, property, or infrastructure that exceed local capacity to rebuild or recover, require multiple years to recover, or have permanent or generationally lasting impacts?
    - Does the incident have the potential to include consequences with national impact?

An incident's intensity is directly correlated with the scale of the consequences it produces and whether they have the potential to reach catastrophic levels. If there is even the potential that an incident could reach a level of intensity that would produce catastrophic impacts, a jurisdiction should consider whether its plans are robust enough to meet this level of impact.

Novelty

Novelty refers to new or unique features of an incident that may make it unprecedented and response more challenging.[28] Novel incidents, by definition, fall outside direct experience and present unexpected challenges. Almost every SME we spoke with suggested novelty as an important feature that could result in catastrophic consequences. Incidents can be novel even if they have occurred before, if they predate recent memory and the direct experience of the emergency managers, institutions, and communities dealing with the incident. Similarly, incidents that have been

[28] See, for example, E. L. Quarantelli, Patrick Lagadec, and Arjen Boin, "A Heuristic Approach to Future Disasters and Crises: New, Old, and In-Between Types," in Havidan Rodriguez, Enrico L. Quarantelli, and Russell R. Dynes, eds., *Handbook of Disaster Research*, 1st ed., Springer Verlag, 2007.

anticipated by emergency planners, and even rehearsed in exercises, can still present the challenges of a novel incident if they have not actually occurred and provided opportunities to test plans in real-world conditions.

The COVID-19 pandemic is an example of both aspects of novel incidents. The nation had experienced a pandemic of this scale before, but the most recent incident was more than 100 years earlier and well beyond the memory or direct experience of both responding authorities and affected communities.[29] And although pandemic plans had existed in many communities for years, and may have been regularly exercised and refined, they had never been used in a real-world event of the magnitude of the COVID-19 pandemic (if they had, they might have been improved based on lessons learned).[30] Social media added to the novelty of COVID-19: It provided unprecedented reach for emergency management organizations to communicate to communities about shutdowns and public health guidelines, but it also served at times to stoke fear and distrust in government organizations, which hampered response.[31] It is easy to conceive of a variety of potentially novel incidents that could reasonably occur in the near future, including malign activities by nation-states, cybersecurity incidents of unprecedented scale or consequence, or incidents that result from or are exacerbated by rapid changes in AI and other emerging technologies.[32]

Any jurisdiction evaluating whether an incident could lead to catastrophic consequences because of novelty should consider such questions as

- Recency and direct experience

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[29] This was the global influenza pandemic of 1918, which resulted in the deaths of approximately 675,000 Americans (Barbara Jester, Timothy Uyeki, and Daniel Jernigan, "Readiness for Responding to a Severe Pandemic 100 Years After 1918," *American Journal of Epidemiology*, Vol. 187, No. 12, December 2018).

[30] In the years before COVID-19, federal agencies and state and local governments developed a variety of pandemic preparedness plans and strategies. See, for example, the U.S. Department of Health and Human Services (HHS), *HHS Pandemic Influenza Plan*, November 2005; Connecticut Department of Public Health, "Pandemic Influenza Response Plan," last revised November 2010; and Los Angeles County Emergency Medical Services Agency, *Annex to the Los Angeles County Hospital Regional Response Plan: Recommended Actions for Hospitals to Prepare for and Respond to Pandemic Influenza*, last updated April 2010. For a general discussion of the development of plans for pandemic preparedness in the United States before COVID-19, see John Iskander, Raymond A. Strikas, Kathleen F. Gensheimer, Nancy J. Cox, and Stephen C. Redd, "Pandemic Influenza Planning, United States, 1978–2008," *Emerging Infectious Diseases*, Vol. 19, No. 6, 2013.

[31] On the use of social media by public health or emergency management organizations during COVID-19, see Jeannette Sutton, Scott L. Renshaw, and Carter T. Butts, "The First 60 Days: American Public Health Agencies' Social Media Strategies in the Emerging COVID-19 Pandemic," *Health Security*, Vol. 18, No. 6, December 2020; and Aqdas Malik, M. Laeeq Khan, and Anabel Quan-Haase, "Public Health Agencies Outreach Through Instagram During the COVID-19 Pandemic: Crisis and Emergency Risk Communication Perspective," *International Journal of Disaster Risk Reduction*, Vol. 61, 2021. On the role of social media in reducing trust in public health messages during COVID-19, see Rupali Jayant Limaye, Molly Sauer, Joseph Ali, Justin Bernstein, Brian Wahl, Anne Barnhill, and Alain Labrique, "Building Trust While Influencing Online COVID-19 Content in the Social Media World," *Lancet Digital Health*, Vol. 2, No. 6, June 2020; and Sander Van der Linden, "Misinformation: Susceptibility, Spread, and Interventions to Immunize the Public," *Nature Medicine*, Vol. 28, 2022.

[32] For a general overview of the future threat landscape, including nation-state actors, cyberattacks, and AI-enabled threats, see U.S. Department of Homeland Security (DHS), Office of Intelligence and Analysis, *2025 Homeland Threat Assessment*, 2025. Previous RAND research has examined future threat scenarios involving AI specifically: Elika Somani, Anjay Friedman, Henry Wu, Marianne Lu, Christopher Byrd, Henri van Soest, and Sana Zakaria, *Strengthening Emergency Preparedness and Response for AI Loss of Control Incidents*, RAND Corporation, RR-A3847-1, 2025; and Michael J. D. Vermeer, Timothy M. Bonds, Emily Lathrop, and Gregory Smith, *Averting a Robot Catastrophe: Preparing for Converging Trends in Robotics and Frontier AI*, RAND Corporation, PE-A3691-7, September 2025.

  - Has this type of incident (including the underlying incident type, an incident of this intensity and scale, and other relevant factors) occurred before in recent memory? Here? Somewhere else? How long ago?
  - Do current staff have direct experience? Do experts from elsewhere?

- Precedence
  - Is the incident one that is generally well known and has precedent, even if it is unusual here or outside this team's recent, direct experience?
  - Does the incident have only some novel elements and/or has it happened before but only rarely? Or is it fundamentally novel—that is, it has either never occurred or not occurred within a relevant time period that could provide guidance (for example, a significant space weather incident in today's technological environment)?

- Planning and exercises
  - Does the responding entity have a plan for this type of incident?
  - Has the jurisdiction planned for or exercised responding to this type of incident? If so, do plans seem to be working (ongoing assessment)?
  - If an incident of this type was the subject of an exercise, how challenging was the exercise? Did the exercise result in findings of gaps or other issues? Were they addressed? Do they appear to be issues now?
  - If no plans exist, what existing protocols and plans might be adapted for this incident? Where or how might they not be suited?

- Need for innovation
  - Is rapid innovation or improvisation required to respond to, manage, or contain the incident?
  - Does the incident require new techniques, tools, or strategies on an accelerated timeline to address novel challenges?
  - Are standard procedures sufficient, is some improvisation needed but existing protocols are largely applicable with some modification, or is major innovation required because there are urgent conditions for which standard procedures are insufficient?

Novel incidents create conditions outside the scope of existing experience or plans. Such conditions require adaptable and creative approaches to emergency management. Emergency management organizations may need to change their approach to planning for incidents to build the skills that staff need to identify and respond to novel incidents.

Technical Complexity

Incidents that have a unique technical component requiring highly specialized skill sets, expertise, or other resources may also be more likely to become catastrophic. Like novel incidents, technically

complex incidents may present unexpected challenges, which can result in delays in addressing and containing the consequences of these incidents, allowing them to become more severe.[33]

The *Deepwater Horizon* oil spill illustrates this point. Because of the depth at which the leak occurred, only a small number of people had the technical knowledge to design a solution to stop the oil release.[34] The amount of time it took to engage experts and create a solution resulted in a substantial oil release with significant ecological and economic impacts to the Gulf region.[35] As another example, cyber incidents and other incidents triggered by AI threats are emerging technically complex incidents with the potential to challenge the capabilities of emergency management agencies across the United States.[36]

Any jurisdiction evaluating whether an incident could lead to catastrophic consequences because of technical complexity should consider such questions as

- Level of complexity
  - Does the fundamental response to the incident require the expertise of specialized SMEs with whom the jurisdiction does not have prior experience working?
  - Have technical aspects of the response been solved in previous events, and does a defined approach exist?
  - Has at least some significant part of the incident not previously occurred or not appeared in a defined plan or response procedure?
- Needs for specialized capability
  - Is the incident defined by a technically complex cause or consequences that the responding entity does not have the knowledge, skills, or other capabilities to mitigate or respond to?
  - Would an effective response require guidance from highly specialized professionals or others whose skills are not readily available within the local jurisdiction and must be requested through mutual aid or other channels?
  - Are there established relationships or lines of communication with such experts?

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[33] For example, it has been noted that "[t]he capacity to mobilize rapid response operations depends" in part on "the degree to which a community has invested in the resources, training, and interorganizational skills necessary to muster a 'surge capacity' in response to a major threat" (Boin, Comfort, and Demchak, 2010, p. 4).

[34] A 2011 report from the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling noted that the "government depends upon the resources and expertise of private industry to contain a blown-out well and to respond to a massive subsea oil spill," but that "both government and industry" were "woefully unprepared" for the *Deepwater Horizon* oil spill, as "[a]ll parties lacked adequate contingency planning, and neither government nor industry had invested sufficiently in research, development, and demonstration to improve containment or response technology" (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, *Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling—Report to the President*, January 2011, p. 243).

[35] For a timeline of the response efforts, see Office of Response and Restoration, "The Deepwater Horizon Oil Spill," webpage, National Oceanic and Atmospheric Administration, undated.

[36] See, for example, Center for Strategic and International Studies, "Significant Cyber Incidents," webpage, undated; and Benjamin Boudreaux, Michael J. D. Vermeer, Kamaria Horton, and Nidhi Kalra, *The Case for AI Loss of Control Response Planning and an Outline to Get Started*, RAND Corporation, PE-A4232-1, October 2025.

  - Is it unclear what specialized expertise is required or whether or where it exists?
- Unfamiliar partners
  - Are new partnerships, forms of expertise, or coordination with atypical partners needed?
  - Will managing the incident require establishing new relationships, mutual aid agreements, or specialized resource sharing?
  - Will response and recovery require only some new partners or many new and unfamiliar partners?

Technically complex incidents require specialized and specific expertise for an effective response. Effective response requires access to SMEs or specialized local training to ensure that emergency managers have access to the skills necessary to respond to technically complex events.

Extrinsic Precursors

Extrinsic precursors include features of the community responding to an incident and the context surrounding the incident. These precursors reflect how the situation surrounding an incident can exacerbate impacts and have the potential to lead to catastrophic consequences. Prominent extrinsic precursors include governance, public trust, and the presence of concurrent incidents.

Governance

Plans are ineffective without effective execution. Our discussions with SMEs suggested that governance—or, more accurately, failures of governance—are an important potential precursor of a catastrophic incident.[37] Before disasters, governance failures can mean that vulnerabilities are not identified or mitigated. During disasters, governance failures can mean that basic needs, such as public safety, temporary shelter, food and water distribution, and medical care, are not met. As a result, deaths and injuries are likely to increase. *Governance* refers to the rules, decisionmaking authorities, and oversight through which public decisions are made.

As discussed in Chapter 1, the report of the Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina described the September 11, 2001, attacks as "a failure of imagination"[38] and Hurricane Katrina as a "failure of initiative."[39] In both cases, this is a

[37] We follow the definition of *governance* as "the act or process of governing or overseeing the control and direction of something (such as a country or an organization)" (Merriam-Webster, "Governance," online dictionary, updated December 2, 2025). As this definition suggests, both government agencies and other organizations can have governance functions. Consistent with this broad focus, one scholar has defined *disaster governance* as "the interrelated sets of norms, organizational and institutional actors, and practices (spanning predisaster, transdisaster, and postdisaster periods) that are designed to reduce the impacts and losses associated with disasters arising from natural and technological agents and from intentional acts of terrorism" (Kathleen Tierney, "Disaster Governance: Social, Political, and Economic Dimensions," *Annual Review of Environment and Resources*, Vol. 37, 2012, p. 344).

[38] National Commission on Terrorist Attacks upon the United States, *The 9/11 Commission Report: Final Report of the National Commission on Terrorist Attacks upon the United States*, July 22, 2004, p. 10.

[39] Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina, 2006, p. xi.

reference to failures of governance. During Hurricane Katrina, for example, U.S. government agencies struggled with coordination, planning, evacuation, and provision of medical care before, during, and after the storm.[40] Resource or personnel shortfalls can further reduce the ability of governments and organizations to prepare for and respond to disasters. For example, weak enforcement of building codes due to a lack of trained inspectors can lead to a housing stock that is more vulnerable to damage during severe earthquakes or other natural disasters.[41]

Any jurisdiction evaluating whether an incident could lead to catastrophic consequences because of gaps in governance should consider such questions as

- Capacity
  - Is the severity of the incident compounded by ineffective governance?
  - Is the capacity of the responding entity sufficient to meet the needs of the incident?
  - Is the entity (1) fully functioning as normal, (2) stretched and experiencing partial failures, or (3) experiencing significant failures and not maintaining basic services and operations?
  - Are normal levels of personnel and/or required levels of personnel needed to surge to meet increased needs available and sufficient to the demands of the incident?
- Coordination and decisionmaking
  - Are there intergovernmental or other coordination challenges that are having a significant negative impact on decisionmaking, operations, or other key aspects of incident management?
  - Are required partners within and outside the responding entity in alignment on decisionmaking?
  - Are efforts (1) well coordinated, (2) functional but encountering challenges that reduce efficiency and effectiveness, or (3) breaking down?
- Communications
  - Are information and other communications flowing freely and effectively within the responding entity, with key partners, and with the public?
  - Are there technological barriers or breakdowns hindering information flow?
- Legal and regulatory barriers
  - Are there legal or regulatory barriers, such as laws, ordinances, or regulations, impeding timely application of resources or emergency response strategies?

[40] See, for example, Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina, 2006.

[41] See, for example, FEMA, *Building Codes Enforcement Playbook*, P-2422, June 2025b, p. 15, which notes that government "jurisdictions often face significant challenges that can hinder their ability to enforce codes effectively," including "staffing shortages and resource constraints."

  - Are there procurement restrictions, requirements for emergency declarations and aid activation processes, or limitations in authority preventing an effective response? Are these clear or ambiguous?

- Leadership
  - Is there an effective continuity-of-government plan in place that can offset risks posed if key personnel are missing or unavailable?
  - Are key structures intact, functional, and operating as during regular operations?
  - Are governance functions compromised and/or is capacity exhausted, resulting in lower ability of government agencies to fulfill basic functions?

Emergency incidents can strain government services and governance functions as demand increases. Furthermore, government staff are balancing the needs of their families while trying to fulfill their government roles. When planners are considering catastrophic incidents, contingency plans for delivering basic government functions should be reviewed and backstopped as needed. Additional training of government staff with emergency management staff can help promote coordination across agencies during response.

Public Trust

Emergency managers rely on the public's trust in them and in other authorities and institutions throughout any response effort. This trust is seen when the public follows evacuation orders, adheres to restrictions on water or food allocations at distribution sites, and follows rules and guidelines at mass shelter sites or in response to mask mandates. When this trust erodes, the public may refuse to follow guidelines, conflicts among the public can arise, and emergency managers and law enforcement may be confronted with challenges in maintaining public safety, in addition to restoring services damaged in the event. Public trust and the prior precursor, governance, also create a feedback loop. Good governance (among other factors) can inspire public trust and can mitigate lack of trust.[42] Public trust and governance do not always go together, but when distrust is heightened following governance failures, managing an emergency can become more complex and the consequences more severe.

The effects of a loss of public trust can be seen in the aftermath of the 2021 Colonial Pipeline cyberattack and the COVID-19 pandemic. In the case of the Colonial Pipeline ransomware incident, government officials offered reassurances about gasoline availability and urged the public to refrain from hoarding, but public mistrust resulted in panic buying and long lines at gas stations.[43] In the case of COVID-19, mistrust of guidance provided by public health officials appears to have discouraged

[42] Will Jennings, Gerry Stoker, Viktor Valgarðsson, Daniel Devine, and Jennifer Gaskell, "How Trust, Mistrust and Distrust Shape the Governance of the COVID-19 Crisis," *Journal of European Public Policy*, Vol. 28, No. 8, 2021.

[43] Ben Gittleson, "Energy Secretary: No Need to Hoard Gasoline amid Pipeline Shutdown," ABC News, May 11, 2021; Vanessa Romo, "Panic Drives Gas Shortages After Colonial Pipeline Ransomware Attack," National Public Radio, May 11, 2021.

compliance with stay-at-home orders, distancing guidelines, and masking requirements and may have led to further spread of the disease.[44]

Any jurisdiction evaluating whether an incident could lead to catastrophic consequences because of loss of public trust should consider such questions as

- Public reception
  - Are public interactions with emergency management entities, law enforcement first responders, experts, institutions, and other relevant authorities generally positive?
  - Is the public following direction from officials?
  - Are public interactions often negative, and does the public show signs of widespread mistrust, hostility, or skepticism?
  - Are announcements from officials on social media typically followed by public pushback or alternative narratives that undermine these efforts?
- Prior experience
  - Has the relationship between the public and emergency management entities been positive and effective historically and in similar scenarios?
  - Are there any present-day circumstances that have the potential to negatively influence this dynamic, such as controversial policy decisions or recent issues raising concern in a specific community or more broadly among the general public?
- Willingness to comply with official directions
  - Are we asking too much of the public?
  - Is guidance disruptive enough to people's day-to-day lives that there is an incentive for people to ignore directions?
  - Are people being asked to evacuate, ration resources, or take or abstain from an action that may cause significant inconvenience or disruption?
  - Does the public generally adhere to directions from officials? Are they doing so now?
  - Is there only some noncompliance or skepticism within the public, or is there widespread noncompliance or instances of directions being ignored?

Emergency incidents can strain the public's trust in government and emergency management organizations and result in people resisting guidelines and instructions intended to promote public safety. Building public trust must happen before an incident occurs, and emergency management organizations should consider approaches to build community engagement and promote public

[44] Qing Han, Bang Zheng, Mioara Cristea, Maximilian Agostini, Jocelyn J. Bélanger, Ben Gützkow, Jannis Kreienkamp, PsyCorona Collaboration, and N. Pontus Leander, "Trust in Government Regarding COVID-19 and Its Associations with Preventive Health Behaviour and Prosocial Behaviour During the Pandemic: A Cross-Sectional and Longitudinal Study," *Psychological Medicine*, Vol. 53, No. 1, 2023. For examples based on experiences outside of the United States, see Olivier Bargain and Ulugbek Aminjonov, "Trust and Compliance to Public Health Policies in Times of COVID-19," *Journal of Public Economics*, Vol. 192, December 2020; and Simone Dohle, Tobias Wingen, and Mike Schreiber, "Acceptance and Adoption of Protective Measures During the COVID-19 Pandemic: The Role of Trust in Politics and Trust in Science," *Social Psychological Bulletin*, Vol. 15, No. 4, 2020.

preparedness as a way to help the public see emergency managers as competent and trustworthy and the public as partners supporting incident response.

Simultaneity

Simultaneous incidents are combinations of incidents (and incident effects) that interact or occur in close succession and are likely to exacerbate the strain on responding organizations.[45] For example, if a malign foreign information campaign targets public messaging about evacuation procedures preceding landfall of a major hurricane, the combination of these incidents could undermine public compliance with emergency orders and other aspects of the response, resulting in higher death tolls or, at worst, catastrophic impacts. As technological and human-caused hazards increase in number and variety through pathways such as cyberattacks, including AI-enabled attacks, and foreign information campaigns, the risk of hybrid events is only increasing.[46] Such combinations stress local jurisdictions in ways that are different from larger-scale versions of single events and must be considered and exercised specifically to identify the capabilities that may need to be developed or where capacity may need to be added. As another example of simultaneity, Hurricane Sandy illustrates the damage that can occur when storm impacts cascade and combine with other factors present at the time. Sandy was rated as a post-tropical cyclone, not a hurricane, when it made landfall in New Jersey, but high tide conditions compounded impacts of the storm, which extended into New York, flooding the subway and road tunnels into Manhattan.[47] As another example, Winter Storm Uri, which hit Texas in February 2021, caused road closures and damaged power infrastructure.[48] As a result, the storm led to widespread blackouts. Then, given freezing temperatures, power outages cascaded into many residents being without heat and, subsequently, frozen and burst water pipes.[49]

Any jurisdiction evaluating whether an incident could lead to catastrophic consequences because of concurrent or cascading incidents should consider such questions as

- Related incidents

[45] See, for example, Susan L. Cutter, "Compound, Cascading, or Complex Disasters: What's in a Name?" *Environment: Science and Policy for Sustainable Development*, Vol. 60, No. 6, 2018; Gianluca Pescaroli and Alexander David, "A Definition of Cascading Disasters and Cascading Effects: Going Beyond the 'Toppling Dominos' Metaphor," *Global Risk Forum Davos Planet@Risk*, Vol. 3, No. 1, March 2015; and Claire Leppold, Lisa Gibbs, Karen Block, Lennart Reifels, and Phoebe Quinn, "Public Health Implications of Multiple Disaster Exposures," *Lancet Public Health*, Vol. 7, No. 3, March 2022.

[46] On the frequency of natural disasters, see National Centers for Environmental Information, "Billion-Dollar Weather and Climate Disasters: Overview," webpage, National Oceanic and Atmospheric Administration, 2025; and World Meteorological Organization, "Weather-Related Disasters Increase over Past 50 Years, Causing More Damage but Fewer Deaths," August 31, 2021. On human-caused threats, see DHS, Office of Intelligence and Analysis, 2025.

[47] Eric S. Blake, Todd B. Kimberlain, Robert J. Berg, John P. Cangialosi, and John L. Beven II, "Tropical Cyclone Report: Hurricane Sandy," National Oceanic and Atmospheric Administration, National Hurricane Center, February 12, 2013; and City of New York, *A Stronger, More Resilient New York*, 2013.

[48] Texas Division of Emergency Management, "Texas Severe Winter Storm DR-4586," webpage, undated.

[49] National Centers for Environmental Information, "The Great Texas Freeze: February 11–20, 2021," National Oceanic and Atmospheric Administration, February 24, 2023.

  - Do the characteristics of the incident increase the risk factors of a different incident (for example, mudslides after a wildfire) or cascading impacts, such as across critical infrastructure systems (power outages leading to water outages)?
  - Does the initial incident fundamentally change the physical conditions in the region or create other vulnerabilities that could increase the risk of other incidents?
- Planning
  - Do plans consider the cascading impacts of an incident, including one incident triggering another?
  - Do plans address the potential resulting shortages in personnel, equipment, attention, and other key resources from managing multiple incidents?
  - What are the most likely follow-on incidents that the main incident might trigger?
  - Even if unlikely, what sort of simultaneous incident is realistically possible and would present the greatest challenge?
- Ability to spread
  - Are the conditions that led to the incident widespread, meaning that similar incidents could readily occur in other jurisdictions?
  - Were the conditions that led to the incident isolated, or are they occurring across a broader area, increasing the potential for spread or additional incidents?
- Capacity
  - Does the responding organization have the capacity to respond if two incidents occur simultaneously?
  - What are the largest incidents that could be managed simultaneously using existing resources?
  - Which resources would be under the greatest strain in different scenarios and would likely run short first?

When multiple incidents interact or effects cascade following an initial incident, emergency response capabilities can be particularly taxed. As natural disasters increase in frequency, the potential for these types of incidents increases and jurisdictions need to prepare specifically for these types of interactions.

How Emergency Managers Can Operationalize Identified Precursors

In this chapter, we introduced eight precursors of catastrophic incidents, including questions that emergency managers can ask to help determine whether a precursor is or could become present. The questions are intended to serve as a flexible tool to help facilitate emergency managers' and planners' practical application of the precursors. They can be employed during an actual incident as a

supporting planning tool to surface and test assumptions or to develop particularly challenging scenarios for exercises.

The questions presented in this chapter should be considered as a starting point and can be amended or augmented to include additional precursors identified by emergency managers or to address scenarios specific to the user. For example, while we include a general question on whether mutual aid is available, this question could (and should) be modified by the user to ask about the specific partner organizations, surrounding jurisdictions, emergency contracts, or other forms of surge support that the emergency management organization employs in real-world incidents. Table 2.1 provides an example of how these types of questions could be applied to characterize the *Deepwater Horizon* oil spill of April 2010.

Real-world incidents are unique and complex. There is no "one size fits all" indicator that an event will become catastrophic. While the presence of multiple indicators of a potential catastrophic incident is generally cause for greater concern, the opposite is not necessarily true: Even a single precursor could be enough to lead to catastrophic consequences. The intention of the questions is to facilitate a reflective process that considers an incident from multiple perspectives. Furthermore, the questions provide a baseline that can be referred to and evolve over time with changing threats, resources, technology, and the myriad other factors emergency managers must take into consideration.

Challenges Posed by Catastrophic Incidents

True catastrophic incidents are rare, and many of the precursors involve conditions and circumstances that may be outside of many emergency managers' prior experience. In some cases, this is inherent to the incident, such as with novelty (an incident type that has not been experienced before) or technical complexity (an incident whose management requires knowledge and skills that are not readily available to the emergency management team). In other cases, while emergency managers may have prior experience with an incident type, the intensity, timing and duration, or geographic scale of a catastrophic incident exceeds anything in their experience, putting unusual stress on personnel and creating the need for rationing of scarce resources. Finally, other precursors imply that tactics used in prior incidents may break down for extrinsic reasons, including a lack of public trust in official direction, a governance breakdown that affects the ability to execute plans and distribute resources, or the need to respond to multiple demanding events simultaneously, diluting resources and attention.

Different precursors can create similar challenges. For example, incidents with a large geographic footprint, up to and including nationwide incidents; incidents lasting for an extended time period; or incidents that are unusually intense or severe all have the potential to create conditions of scarcity beyond what occur in more-routine emergencies. In the real world, an individual incident may manifest multiple precursors. For example, an incident with a large geographic footprint may be more likely to have a long duration because of its wide geographic impact. Accordingly, the same response may be useful across multiple precursors. In the next chapter, we continue to explore the impacts of catastrophic incidents in more detail as a first step to considering how emergency managers can plan and train for catastrophic incidents.

Table 2.1. *Deepwater Horizon* Oil Spill, 2010

Precursor	Analysis
Geographic scale	• Affected multiple states along the U.S. Gulf Coast (Louisiana, Mississippi, Alabama, Florida) and offshore waters under federal jurisdiction[a] • Substantial federal and international support because of scale and complexity[c] • Seafood industry, tourism, and offshore drilling policy involved[a, c] • Nearby coastal states also affected[a]
Intensity	• Coastal and marine habitats affected for years, some irreversible losses in species[a, c] • Risk of economic collapse in coastal communities[a, b]
Timing and duration	• Occurred during evening hours, but with active crew[a] • Oil capped after 87 days, decade-long cleanup efforts[a]
Novelty	• Rapid coordination with global SMEs, engineers, agencies[b, d]
Technical complexity	• Needed rare deepwater well-capping experts[b, d] • Innovative containment solutions or adjustments to existing tactics (cofferdam, relief wells) needed on shorter timeline[d]
Governance	• Basic government services sustained but coastal rescue and cleanup stretched—reliance on federal command[b, c] • BP, U.S. Coast Guard, U.S. Environmental Protection Agency, and NOAA faced delays, miscommunication, and overlapping authority[c, d] • Jurisdictional and liability issues under the Oil Pollution Act[d]
Public trust	• Criticism of BP and perceived slow government response; trust damaged[a, b] • Mixed compliance with fishing ban[e] • Misinformation and skepticism on spill size, safety, and cleanup effectiveness[b] • BP response plan criticized for factual errors[d]
Simultaneity	• Other active Gulf Coast offshore oil and gas industry infrastructure, including other deepwater structures[f, g] • Offshore oil and gas platforms are physically separate; failure at one platform should not increase risk of failures at other platforms[f] • Response to the incident required extensive capability commitments and specialized expertise, likely limiting resource availability for other incidents[d]

SOURCES: Features information from the following:

[a] Aastha Agarwal, Soham Chakraborty, and Shivangi, "Impact and Aftermath of the Deepwater Horizon Oil Spill, 2010," *Disaster and Development*, Vol. 10, No. 1, 2021.

[b] Thomas G. Safford, Jessica D. Ulrich, and Lawrence C. Hamilton, "Public Perceptions of the Response to the Deepwater Horizon Oil Spill: Personal Experiences, Information Sources, and Social Context," *Journal of Environmental Management*, Vol. 113, December 30, 2012.

[c] Romain Schumm and Julien Rochette, "What Regulation of the Offshore Sector 10 Years After the Deepwater Horizon Oil Spill?" blog post, IDDRI, May 28, 2020.

[d] National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011.

[e] A. McCrea-Strub, K. Kleisner, U. R. Sumaila, W. Swartz, R. Watson, D. Zeller, and D. Pauly, "Potential Impact of the *Deepwater Horizon* Oil Spill on Commercial Fisheries in the Gulf of Mexico," *Fisheries*, Vol. 36, No. 7, July 2011.

[f] U.S. Department of the Interior, Bureau of Safety and Environmental Enforcement, "Data Center—Platforms," online map, undated.

[g] U.S. Department of the Interior, Bureau of Ocean Energy Management, "Gulf of America Permanent Deepwater Structures," webpage, updated May 3, 2026.

Chapter 3

Potential Impacts of Catastrophic Incidents

In Chapter 2, we identified a set of precursors that could suggest enhanced risk of a catastrophic incident. We also described the challenges that emergency managers may face when responding to incidents exhibiting each precursor. It is unlikely that catastrophic incidents can be addressed through planning alone. Yet, training can support staff development in ways that will make them more resilient and prepared to face the uncertainty and key features of catastrophic incidents. Given NDEMU's role in providing training for the nation's emergency managers, we focused specifically on what different types of training might be needed. Before describing specific training options in the next chapter, we first describe the impacts emergency managers may experience from catastrophic incidents exhibiting the precursors described in Chapter 2. We grouped these impacts into four categories: issues of scarcity, stress and other psychological impacts, uncertainty, and systemic failures.

Table 3.1 summarizes some of the potential challenges posed by each precursor and the relevant impact category. In the rest of this chapter, we explore each of the four impact categories and how incidents exhibiting these precursors can result in the specific impacts. We defined these impact categories after reviewing the impacts observed from the historical catastrophic incidents we reviewed as a part of work defining the precursors. Although not comprehensive, they provide a starting point to understanding the types of impacts most likely to affect emergency managers and how they respond to these types of incidents.

Scarcity

Incidents that cover a large geographic area, have a long duration, are of unusual severity, or are compounded by other simultaneous incidents are likely to create conditions of scarcity—in personnel, physical resources, and funding. Incidents occurring simultaneously put competing demands on leaders, teams, supplies, and resources, including the resources of time and attention. Incidents with these characteristics may exceed all existing planning thresholds, rendering established plans irrelevant. Traditional mutual aid partners may be dealing with the same incident, making outside assistance impossible. In the most extreme case—a global incident—every country and local jurisdiction would be competing for supplies, creating massive shortages. As incidents continue, resources are depleted and run out. Substitutes are potentially not available because of the lack of mutual aid, breakdowns in the supply chain, the long duration of the incident consuming resources, or its sheer scale.

Table 3.1. Challenges for Emergency Managers Presented by Each Catastrophic Incident Precursor

Precursor	Potential Challenge	Relevant Impact	Relevant Cases
Intrinsic			
Geographic scale	Geographic footprint of incident makes assistance from traditional mutual aid partners impossible	Scarcity, stress and other psychological impacts	• Hurricane Maria • California 2020 August Complex and 2021 Dixie Fires
Intensity	Severity or intensity of incident leads to consequences and requires decisions outside the emergency management team's experience	Scarcity, stress and other psychological impacts	• Hurricane Andrew • September 11, 2001, terrorist attacks
Timing and duration	Duration of incident exceeds any prior incident of the same type	Scarcity, stress and other psychological impacts	• 2025 Texas Hill Country flash floods
Novelty	Incident presents conditions and circumstances beyond the experience of any available emergency management personnel	Uncertainty	• COVID-19 pandemic
Technical complexity	Incident calls for knowledge and skills not readily available to the responding emergency management personnel	Uncertainty	• *Deepwater Horizon* oil spill
Extrinsic			
Governance	Plans and systems that are typically reliable fail because of flaws in management and execution	Uncertainty, systemic failures	• Hurricane Katrina
Public trust	Public mistrust leads to official directions being disregarded	Uncertainty, systemic failures	• Colonial Pipeline cyberattack • COVID-19 pandemic
Simultaneity	Attention, personnel, and other resources are divided across more than one challenging incident simultaneously	Scarcity, stress and other psychological impacts, systemic failures	• Hurricane Sandy • Winter Storm Uri

Scarcity is likely to present emergency managers with difficult choices, including the need to prioritize across incidents, ration scarce resources among disaster survivors, or, in the most trying cases, alter standards of medical care for the ill and injured. The difficulty of these decisions can be exacerbated by the extreme stress and exhaustion present in major incidents. Emergency managers, elected officials, and other stakeholders may confront moral and ethical dilemmas they have not previously encountered and that may be well outside their training and protocols. Long-duration and simultaneous incidents may also create additional pressure for resolution from affected communities,

the media, and elected officials. Exhaustion and burnout are likely at all levels of the emergency management organization, among partners and elected officials, and in affected communities.

Stress and Other Psychological Impacts

Catastrophic incidents may take a psychological toll on emergency management teams and other responders.[50] The consequences of more-intense, longer, or geographically broader incidents may be worse than any historical incident. The number of injured, ill, or killed could be unprecedented. Impacts to irreplaceable resources, iconic locations, and displaced populations, including a sense that an affected community will never be the same again, can be overwhelming. Recovery timelines may be measured in years, or even decades, making returning to normal life seem impossible.

Catastrophic incidents may create uniquely stressful conditions for emergency managers. Long-duration incidents may exhaust and demoralize the emergency management workforce, as well as affected communities. Leaders, responders, and others may have to make difficult choices about how to prioritize scarce resources, provide a lower standard of care than they are trained to do, or simply be unable to meet all the needs of all the people they serve, and these stresses may take a toll. Incidents covering large geographic areas may leave no safe harbor for emergency management staff. Their own homes may be destroyed and their families displaced, and, during the early stages of an incident, there may be a great deal of uncertainty about how the incident has affected them, making it difficult to engage in ongoing operations. Stress, burnout, and other mental health issues may be widespread and severe.

Uncertainty

Each incident is unique, and often an affected community will need to start responding before the cause or extent of an incident is completely understood. Misreading an incident is another type of uncertainty; an emergency management team may believe that a familiar incident type is occurring again and not recognize critical differences.[51] This can lead to all manner of missteps, including communicating to the public and elected officials that the incident is something that it is not, falsely claiming that it is under control, and misstating what the impacts of the incident will be. Uncertainty can also result in a loss of public confidence: The emergency management agency might be unable to credibly communicate its ability to contain the incident or may even lack the vocabulary to explain the incident to the public. These problems may manifest internally as well, creating tension with elected officials and within the emergency management team.

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[50] On the psychological impacts of disaster response work, see, for example, Carolyn Deans and Shannon Carter, "Evidenced Interventions Supporting the Psychological Wellbeing of Disaster Workers: A Rapid Literature Review," *International Journal of Environmental Research and Public Health*, Vol. 22, No. 9, September 2025; William Berger, Evandro Silva Freire Coutinho, Ivan Figueira, Carla Marques-Portella, Mariana Pires Luz, Thomas C. Neylan, Charles R. Marmar, and Mauro Vitor Mendlowicz, "Rescuers at Risk: A Systematic Review and Meta-Regression Analysis of the Worldwide Current Prevalence and Correlates of PTSD in Rescue Workers," *Social Psychiatry and Psychiatric Epidemiology*, Vol. 47, 2012.

[51] Karl Weick, "The Collapse of Sensemaking in Organizations: The Mann Gulch Disaster," *Administrative Science Quarterly*, Vol. 38, No. 4, December 1993.

Decisions may have been made to deploy resources and take measures that are incorrect; at best, this can waste time and resources, and, at worst, this can exacerbate the problem. When uncertainty drives ineffective decisions or inefficient use of resources, time is lost and with it the possibility of mitigating the incident in its earliest stages. Even if the nature of the incident is clear, its technical complexity might exceed available technical ability. Because of a lack of expertise, equipment, and other resources, it might not be clear how to contain, mitigate, or stop the incident.

When an incident includes uncertainty, the results can cause operational surprise, confusion, and decision paralysis. There may be disagreements within the emergency management team, with SMEs, or with elected leaders regarding the nature of the incident or the best initial steps, which can critically slow and disrupt a focused response. Leaders may revert to decisions and management styles that are most familiar and not apply the critical thinking and adaptive leadership styles best suited to managing uncertain and evolving incidents. Durable processes that are understood and accepted by all can help reduce this occurrence and support leaders in maintaining effective decisionmaking. When there is no clear management direction, teams may be working hard but ineffectively. In some instances, it might not be clear what is needed or where to seek input.

New and emerging technologies, including AI, can add complexity to already challenging incidents.[52] AI-assisted attacks can find gaps in security systems or modify attacks to adapt to countermeasures taken by responders.[53] AI can be harnessed to create and propagate more targeted and effective disinformation, including suggesting that dangerous incidents are not occurring or calling for action by the public that contradicts guidance from officials.[54] Nation-state actors may have asymmetric AI-enabled capabilities that vastly exceed those of their targets, making it impossible for the affected entity to mitigate the incident on its own.

Systemic Failures

Failures in governance can occur when incidents are considered impossible, emergency plans fail because of flaws or failures in execution, or the public loses trust in emergency management teams or elected officials. Flaws in well-intended plans can be due to failures of imagination, faulty assumptions, or gaps in understanding the potential impacts from an incident. A threat could be well known, yet

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[52] See, for example, Quentin E. Hodgson, Kamaria Horton, and Matthew J. Malone, *Facing the Artificial Intelligence–Cyber Nexus: A Structured Approach to Government Decisionmaking to Address Emerging Artificial Intelligence Capabilities for Cyber Attacks*, RAND Corporation, RR-A4250-1, 2025.

[53] "AI algorithms learn and adapt in real time. In the same way that these tools continuously evolve to provide more accurate insights for corporate users, they also evolve to help adversaries improve their techniques or avoid detection" (Lucia Stanham, "AI-Powered Cyberattacks," webpage, part of "Cybersecurity 101: The Fundamentals of Cybersecurity," CrowdStrike, January 16, 2025).

[54] On AI and misinformation, see Ben Buchanan, Andrew Lohn, Micah Musser, and Katerina Sedova, *Truth, Lies, and Automation: How Language Models Could Change Disinformation*, Center for Security and Emerging Technology, May 2021; Jiawei Zhou, Yixuan Zhang, Qianni Luo, Andrea G. Parker, and Munmun De Choudhury, "Synthetic Lies: Understanding AI-Generated Misinformation and Evaluating Algorithmic and Human Solutions," *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, No. 436, Hamburg, Germany, April 23–28, 2023; and Danni Xu, Shaojing Fan, and Mohan Kankanhalli, "Combating Misinformation in the Era of Generative AI Models," *Proceedings of the 31st ACM International Conference on Multimedia*, Ottawa, Ontario, Canada, October 29–November 3, 2023.

inadequate planning or preparation, including up-front investment, can lead to failure. Flaws in execution can stem from entities failing to uphold their part of a plan because of inadequate understanding of authorities and resources available to them in their current role or failing to take the steps that were expected of them, including properly training and equipping personnel or stockpiling equipment and supplies. Key personnel may not be available when needed, either because they have deserted their posts or because they cannot be reached, physically or virtually. At the most extreme, the incident can cause a decapitation of government in which key leaders are unable to direct the response. These conditions can lead to cascading consequences and escalating loss of public and workforce confidence.

Effective emergency response also depends in part on cooperation from the public and other affected entities. Systemic failures can result when the public refuses to heed warnings or other directions from officials. These could include failures to take a threat seriously and act prior to an incident, including failures to stockpile supplies or develop personal preparedness plans. Furthermore, failures during a developing incident include ignoring orders to evacuate or orders to take other protective actions. In the most extreme case, affected communities may question whether an incident is occurring or question the legitimacy of the responding officials to manage it. Some individuals or groups may seek to actively undermine a response, whether from malicious intent or ignorance. These conditions can exacerbate the consequences of an incident, leading more persons to be injured or in need of rescue and support or to a myriad of other adverse consequences.

Under these conditions, emergency managers will find more of their scarce time, attention, personnel, and other resources devoted to communications and, potentially, to countering false information than would normally be the case. Gaps in situational awareness may develop, with officials unable to receive accurate information from the field about the nature of the incident and its scale, location, and consequences. The information environment may change constantly, either because of intentional action by an adversary or because of lack of trust causing public opinion to change day to day.

Emergency managers, elected officials, and the public need to understand the potential impacts catastrophic events can have on communities and how those impacts can vary based on the precursors. The four categories of impacts we have described—scarcity, stress and other psychological impacts, uncertainty, and systemic failures—provide an organizing structure intended to help jurisdictions think about the impacts of catastrophic incidents and what they can do to prepare. In the next chapter, we discuss different forms of training that can help emergency managers be more prepared for these incidents.

Chapter 4

Training Suggestions for Emergency Managers Preparing for Catastrophic Incidents and Next Steps

Building on Chapter 3, this chapter discusses options for training that may help emergency managers increase preparedness for catastrophic incidents. Although training will never fully mitigate the risks associated with catastrophic incidents, our intent in this chapter is to discuss how training might help to mitigate some of the challenges catastrophic incidents present. The training suggestions in this chapter are not exhaustive and are offered as a baseline for further iteration with relevant stakeholders. We derived these suggestions through our discussions with six HSOAC SMEs and our review of academic and gray literature and after-action reports (AARs) from historical catastrophic events. Structurally, we organized our training options by the four impact categories we defined in Chapter 3: scarcity, stress and other psychological impacts, uncertainty, and systemic failures.

Training Options for Scarcity

Conditions of scarcity require communities to think about trade-offs. These trade-offs include prioritization of where to focus limited response efforts and how emergency management organizations may need to rely on communities and individuals to support each other, reducing reliance on centralized entities. Training can help emergency managers build preparedness to offset these factors and to help think about their priorities and how they want to approach difficult trade-offs during response to a catastrophic incident.

Operations in Resource-Constrained Conditions

Plans can be developed that focus explicitly on scenarios in which resources of all kinds are depleted, traditional mutual aid is not available, and emergency managers shift from being managers of *resources* to managers of *scarcity*. Lessons about managing scarcity may be gleaned from past catastrophic real-world incidents, such as COVID-19, when hospital administrators and emergency managers faced difficult decisions about how to distribute scarce medical supplies and equipment.[55]

[55] A 2020 paper in the *New England Journal of Medicine* examining decisionmaking under such conditions stressed "the need to adequately prepare for the allocation of scarce resources before it becomes necessary" (Ezekiel J. Emanuel, Govind Persad, Ross Upshur, Beatriz Thome, Michael Parker, Aaron Glickman, Cathy Zhang, Connor Boyle, Maxwell Smith, and James P. Phillips,

Incidents that have occurred outside the United States may also provide insights. NDEMU is actively exploring lessons from other nations that have experienced nation-state threats and other more-extreme conditions. Work such as this could inform NDEMU-developed training materials intended to support emergency managers dealing with extreme incidents. Specific lessons from the experiences of other nations include planning and training to employ the public and private sectors as part of the response workforce and cross-training personnel from non–emergency management agencies to serve in emergency management roles. Lessons of this sort could be incorporated into emergency management training both to provide planning practice and to teach emergency management staff how to train nontraditional partners through such means as train-the-trainer or just-in-time training models that can rapidly expand the available workforce.[56]

Worst-Case Scenario and Maximum-of-Maximums Exercises

Emergency managers can learn to conduct exercises that put themselves, their teams, elected officials, and partner organizations into the "headspace" of needing to address seemingly impossible, unprecedented incidents. Furthermore, exercises can be used to ask tough questions, including "What can you do without?" and "What can you make or repurpose?" A variety of models exist, including worst-case scenario planning and "maximum-of-maximum" scenarios, which involve planning for an incident in which multiple incident characteristics have been elevated to maximum plausible severity.[57] NDEMU could consult with federally funded research and development centers that have experience designing and conducting these types of exercises. For example, HSOAC employs "day after" exercises, which put participants into a scenario the day after an otherwise unimaginable incident has occurred and force participants to think about how they would respond in those circumstances.[58] RAND's Inverted Rook—a classified wargame—draws on expertise from a variety of government stakeholders and considers the trade-offs, decisions, and risk management implications associated with balancing military operations with civilian needs preceding a conflict. Inverted Rook and other

"Fair Allocation of Scarce Medical Resources in the Time of Covid-19," *New England Journal of Medicine*, Vol. 382, No. 21, 2020). See also Susanne Hempel, Rita Burke, Michael Hochman, Gina Thompson, Annie Brothers, Jennifer Shin, Aneesa Motala, Jody Larkin, Maria Bolshakova, Ning Fu, and Jeanne Ringel, "Allocation of Scarce Resources in a Pandemic: Rapid Systematic Review Update of Strategies for Policymakers," *Journal of Clinical Epidemiology*, Vol. 139, 2021; HHS, Administration for Strategic Preparedness and Response, "Crisis Care and Scarce Resource Decision-Making," part of "Hospital Readiness and Response: An Online Guidebook," undated.

[56] For an example of the train-the-trainers approach in use in emergency management today, see training materials for the Community Emergency Response Team (CERT) program: FEMA, *CERT Train-the-Trainer Course: Instructor Guide*, September 2011. For more on CERT, see FEMA, "Community Emergency Response Team (CERT)," webpage, updated April 4, 2025a.

[57] On worst-case scenario planning, see Cass R. Sunstein, *Worst-Case Scenarios*, Harvard University Press, 2009. For an example of worst-case scenario planning, see Kerry Solan, "Worst-Case Scenario Forecasting Helps District Plan for Hurricane Season," U.S. Army Corps of Engineers, Norfolk District, June 6, 2014. On maximum-of-maximums scenario planning, see Kate Lahey, "Maximum of Maximums," *Australian Journal of Emergency Management*, Vol. 28, No. 4, October 2013; and Robert McCreight and Wayne Harrop, "Uncovering the Real Recovery Challenge: What Emergency Management Must Do," *Journal of Homeland Security and Emergency Management*, Vol. 16, No. 3, 2019.

[58] For examples of RAND studies that employ the "day after" exercise methodology, see RAND Corporation, "Day After Methodology," webpage, undated.

similar games create realistic but dramatically compounding scenarios to force participants to make difficult choices regarding prioritization.[59] Although it is not possible to plan for every scenario or difficult decision, these exercises encourage emergency managers and other participants to see rare, extreme incidents as possible; spend time thinking about them; and practice making the types of decisions they could entail.

Training with a Wider Variety of Regional and Nontraditional Partners

Emergency managers could train to identify a wider set of regional peers and develop mutual aid agreements and other forms of memorandums of understanding (MOUs) with peers less likely to be simultaneously affected by the same incident. The participating organizations can cross-train with one another on local geography, hazards, organizational procedures, and plans so that they can supplement, or even step in for, the team in the affected area. While emergency management agencies already use virtual work arrangements, creating contingencies for managing incidents from outside the impact zone could be a useful extension. Peer-to-peer networks, such as FEMA's Vanguard Executive Crisis Leaders Fellowship program, which is discussed in greater detail in a later section, can introduce entities to valuable partners from outside their traditional networks.[60] During an incident, these partners may be able to contribute fresh perspectives, different types of expertise, additional resources, and additional personnel.

Identifying distant or atypical partners that may be available when traditional mutual aid partners are not expands a jurisdiction's network of training partners. From there, emergency managers can establish contracts or MOUs with nontraditional providers, creating more resiliency in partnership options ahead of an incident. Planning can be performed at broader geographic scales. For example, incorporating an entire region may allow for deconflicting contract agreements with private-sector providers so that entities within the same region are less likely to call on the same suppliers in a large-scale crisis.

Protocols for Managing Scarcity

Protocols for operating in conditions of unique scarcity should be developed before incidents occur, when participants are not under the extreme stress of an incident, and should include practitioners, researchers, community members, and ethicists. Drawing on lessons learned from past incidents or scenario exercises, teams can reexamine, stress test, and refine existing protocols and

[59] See Bridget R. Kane, Stephen Webber, Katherine H. Tucker, Sam Wallace, Joan Chang, Devin McCarthy, Dennis Murphy, Daniel Egel, and Tom Wingfield, *Defending the Homeland Against Critical Infrastructure Attacks: Exploring a Hypothetical Campaign of Cascading Impacts*, RAND Corporation, RR-A2397-3, 2024a; and Bridget R. Kane, Stephen Webber, Katherine H. Tucker, Sam Wallace, Joan Chang, Devin McCarthy, Dennis Murphy, Daniel Egel, and Tom Wingfield, *Threats to Critical Infrastructure: A Survey*, RAND Corporation, RR-A2397-2, 2024b.

[60] For more on the Vanguard program, see NDEMU, "Vanguard Executive Crisis Leaders Fellowship," webpage, undated-b.

identify gaps.[61] Training can also focus on identifying potential opportunities to stretch resources by waiving rules or changing standard operating procedures, if this can be done safely. Training curricula for emergency managers can include a more pronounced focus on ethics and can include frameworks, such as value-based decisionmaking, that train staff in how to think about decisions rather than offering specific plans and protocols.[62] Training can also be provided to senior leaders outside the emergency management enterprise, including policymakers and elected officials, who may be responsible for making no-win decisions in a crisis. In addition to providing training to these officials directly, emergency managers and their teams can be trained in how to counsel and support these external decisionmakers.

Training Options for Stress and Other Psychological Impacts

Catastrophic incidents create extreme conditions of stress and can lead to psychological impacts. Such conditions can make it hard for emergency managers to respond effectively to incidents. To prepare, emergency managers can act ahead of future incidents to reduce the stress of these incidents and equip staff with the tools and support systems to effectively manage stress.

Additional Training in Maintaining Mental Health and Wellness

A first potential solution is to provide additional training in maintaining mental health and wellness and develop additional resources and support to have available during a crisis. Training can convey that, even for veteran responders, the psychological impact of a catastrophic incident will be different: It will take a greater toll, the impacts will differ from previous incidents, and some situations are impossible to fully prepare for in advance.[63]

Personal and Family Preparedness

Emergency managers can prepare for a situation in which their own teams, staff, and families are victims. Emergency management organizations can make relevant activities non-optional, dedicating work time to training and planning for personal preparedness. For example, some agencies use 12-

[61] The Lessons Learned Information Sharing program provides public access to the AARs and other lessons learned reports on past incidents. Relevant documents are available through the Homeland Security Digital Library. See FEMA, "Lessons Learned Information Sharing," webpage, Homeland Security Digital Library, undated-a.

[62] See, for example, Jonathon P. Leider, Debra DeBruin, Nicole Reynolds, Angelica Koch, and Judy Seaberg, "Ethical Guidance for Disaster Response, Specifically Around Crisis Standards of Care: A Systematic Review," *American Journal of Public Health*, Vol. 107, No. 9, 2017; Philip C. Butler, Rhona Flin, Chris Bearman, Peter Hayes, Greg Penney, and Jim McLennan, "Emergency Management Decision-Making in a Changing World: 3 Key Challenges," *Australian Journal of Emergency Management*, Vol. 39, No. 4, October 2024; and Dianne J. Hall and Robert A. Davis, "Engaging Multiple Perspectives: A Value-Based Decision-Making Model," *Decision Support Systems*, Vol. 43, No. 4, August 2007.

[63] For examples of existing training resources, see U.S. Substance Abuse and Mental Health Services Administration, *A Guide to Managing Stress for Disaster Responders and First Responders*, released 2005, updated 2022; and U.S. Substance Abuse and Mental Health Services Administration, *Tips for Disaster Responders: Preventing and Managing Stress*, Publication PEP23-01-01-006, revised 2023.

hours-on, 12-hours-off mandatory schedules during 24/7 operations to ensure sufficient rest time for staff and prevent burnout.[64] Some jurisdictions develop and distribute personal preparedness pamphlets or other materials that provide guidance to community members for what supplies to keep on hand—batteries, flashlights, extra food—in the event of an emergency. These types of emergency kits increase the resilience and self-sufficiency of individuals during disasters, including the families of first responders.

Exposure to Historical Catastrophic Incidents

Exercises can help emergency management personnel conceive of the inconceivable, by focusing on incidents in which an entire region, or even the entire nation, is affected. Emergency management training can look to and study historical catastrophic incidents to draw lessons from them about the toll these events took on emergency management professionals. The scenarios can be used in exercises to help emergency managers put themselves in those situations and consider ahead of time their priorities and how they hope to respond. Wartime experience, from the U.S. military or from nations affected by war, could offer useful lessons on the impacts and management of stress.

Storytelling and Empathy

Storytelling and empathy are helpful skills in a catastrophic incident.[65] Emergency managers who can shape information into relatable stories may be able to help listeners better absorb needed guidance and talk about their own experiences under conditions of stress and uncertainty.[66] Emergency managers and their staff can benefit from communication training and specialized storytelling training to improve how they share stories with the public. Effective stories can help the public understand and empathize with emergency managers mitigating an incident. Furthermore, emergency managers can be trained in how to discuss uncertainty and manage expectations and, by extension, build credibility with the public, which can be crucial for convincing the public to adhere to lifesaving guidance.[67]

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[64] Paula A. Burgess, "Optimal Shift Duration and Sequence: Recommended Approach for Short-Term Emergency Response Activations for Public Health and Emergency Management," *American Journal of Public Health*, Vol. 97, Suppl. 1, 2007.

[65] On storytelling in emergency management, see Bob Freitag, Thad Hicks, Alessandra Jerolleman, and Wendy Walsh, "Storytelling—Plots of Resilience, Learning, and Discovery in Emergency Management," *Journal of Emergency Management*, Vol. 18, No. 5, September/October 2020; and Paola Mazzoglio, Stefano Macchia, Enrico Gallo, Julia Winter, and Pierluigi Claps, "Disaster Tales as Communication Tool for Increasing Risk Resilience," *International Journal of Disaster Risk Science*, Vol. 12, 2021. On empathy in crisis and emergency communication, see Lieze Schoofs, Gijs Fannes, and An-Sofie Claeys, "Empathy as a Main Ingredient of Impactful Crisis Communication: The Perspectives of Crisis Communication Practitioners," *Public Relations Review*, Vol. 48, No. 1, March 2022; HHS, Office of the Assistant Secretary for Strategic Preparedness and Response, *A Guide to Compassionate and Empathic Dialogue*, 2021; FEMA, "Key Planning Factors and Considerations for Response to and Recovery from a Biological Incident," August 2022; and Cheryl Mattingly, *Healing Dramas and Clinical Plots: The Narrative Structure of Experience*, Cambridge University Press, May 1999.

[66] See, for example, Freitag et al., 2020.

[67] Examining emergency communication during pandemics, one article noted that "[t]he uncertainty surrounding an emerging infectious disease coupled with the rapidly changing science create unique communication challenges. Effective communication is

Expanded Use of Peer-to-Peer Networks

Peer-to-peer programs match officials with peers who are outside of their regions or sectors or who are no longer active in the field but have prior or other relevant experience with the type of incident an emergency manager is facing. Such a support network can help mitigate the isolating and negative psychological impacts of responding to such devastating incidents. NDEMU already offers the Vanguard Executive Crisis Leaders Fellowship, which brings senior emergency managers from the public and private sectors together with researchers engaged in identifying evidence-based and emerging best practices, educators interacting with the next generation of the emergency management workforce, and policymakers.[68] These sorts of peer-to-peer networks could be replicated at all levels of an organization, including senior elected leaders, such as governors and mayors, and for specific roles, such as public information officers.

Training Options to Mitigate Uncertainty-Related Challenges

The uncertainty associated with catastrophic incidents may be one of the most difficult challenges to prepare for as it requires the skills to adapt rapidly in the moment and be prepared for multiple potential outcomes. Fortunately, there are training solutions available that may help to mitigate these challenges.

Understanding Sensemaking and Meaning-Making

Emergency managers can be trained in sensemaking to help them recognize potentially novel incidents and emergent crises in their earliest stages. *Sensemaking* refers to the process of converting disorganized, dynamically occurring information inputs from a particular situation (often a surprising or confusing incident) into a structured mental model that can provide meaning and suggest ways forward.[69] A key component of sensemaking is the use of language to identify and describe the core features of a situation. As one article observes, "[s]ensemaking involves turning circumstances into a

necessary during pandemics to enable individuals to understand the evolving situation, maintain public trust and organizational credibility, and facilitate informed decision-making" (Melissa MacKay, Taylor Colangeli, Abhinand Thaivalappil, Ariana Del Bianco, Jennifer McWhirter, and Andrew Papadopoulos, "A Review and Analysis of the Literature on Public Health Emergency Communication Practices," *Journal of Community Health*, Vol. 47, 2022, p. 150).

[68] Participants in the Vanguard Fellowship program have come from FEMA; other federal agencies, including the U.S. Coast Guard, HHS, and the U.S. Department of War; state, local, and tribal emergency management agencies; nonprofits; professional associations; consulting firms; universities and other research institutions; and major businesses. To see alumni of the Vanguard Fellowship program, see NDEMU, "Fellowship Alumni," webpage, undated-a.

[69] Marlys K. Christianson and Michelle A. Barton, "Sensemaking in the Time of COVID-19," *Journal of Management Studies*, Vol. 58, No. 2, March 2021. See also Jörgen Sandberg and Haridimos Tsoukas, "Making Sense of the Sensemaking Perspective: Its Constituents, Limitations, and Opportunities for Further Development," *Journal of Organizational Behavior*, Vol. 36, 2015; Sally Maitlis and Scott Sonenshein, "Sensemaking in Crisis and Change: Inspiration and Insights from Weick (1988)," *Journal of Management Studies*, Vol. 47, No. 3, May 2010; and Karl E. Weick, Kathleen M. Sutcliffe, and David Obstfeld, "Organizing and the Process of Sensemaking," *Organization Science*, Vol. 16, No. 4, July–August 2005.

situation that is comprehended explicitly in words and that serves as a springboard into action."[70] Sensemaking is often collaborative or "social" in its implementation, as people use language to advance collectively toward a shared understanding of a situation.[71]

Sensemaking is a valuable concept in emergency management because the profession requires emergency managers and other stakeholders to come together to understand and respond to incidents that, by their nature, involve "a high degree of uncertainty, complexity, scarce information, time constraints, cascading events, interdependent decisions, a diverse number of actors, and high stakes."[72] Training in sensemaking for emergency managers could be especially worthwhile for catastrophic incidents, because these incidents are rare and have a variety of distinctive features (including novelty, intensity, and increased technical complexity) that may make it harder for emergency managers to make sense of them quickly. Sensemaking includes the ability to both (1) interpret facts about the incident as it is evolving and then (2) update and learn from that narrative over time as the incident evolves. These skills support coherent storytelling to describe the incident and to translate that story to inform effective decisionmaking.[73] However, sensemaking can result in leaders comparing a novel incident to past incidents in such a way that they draw the wrong conclusions about how to respond. Leaders will often need to draw on a variety of techniques to properly characterize an incident. Emergency managers can be trained to look for novelty and technical complexity, during or before an incident. Staff can be trained to conduct assessments of regional risks to determine where there is a risk of technically complex incidents and establish plans to respond to those incidents. Furthermore, sensemaking is in part based on good storytelling, skills that can be built through practice and some types of media training. Exercises designed to train a person's ability to interpret events, retain details, and then develop and update an incident narrative over time are a useful complement to other sensemaking training.[74]

Related to the concept of sensemaking is the idea of meaning-making, which involves being able to interpret and then communicate about an uncertain incident, which can foster more-productive public communications.[75] This can be particularly important where there are concerns about loss of public trust. Part of the meaning-making process is to define characters (i.e., heroes, villains) and organize them and their actions to form a story and make sense of complex events. This approach can include

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[70] Weick, Sutcliffe, and Obstfeld, 2005, p. 409.

[71] Weick, Sutcliffe, and Obstfeld, 2005, p. 412.

[72] Lawrence M. Ward, Lilia Yumagulova, Zoe Greig, Manvir Taunk, and Ilan Vertinsky, "Sense-Making in a Simulated Emergency Operations Centre," *International Journal of Mass Emergencies and Disasters*, Vol. 38, No. 3, November 2020.

[73] Ward et al., 2020.

[74] Ward et al., 2020.

[75] For general discussion of meaning-making, see Crystal L. Park, "Making Sense of the Meaning Literature: An Integrative Review of Meaning Making and Its Effects on Adjustment to Stressful Life Events," *Psychological Bulletin*, Vol. 136, No. 2, 2010. For discussion of meaning-making with a focus on disaster recovery, emergency management, and crisis communication, see Crystal L. Park, "Meaning Making in the Context of Disasters," *Journal of Clinical Psychology*, Vol. 72, No. 12, 2016; Madeleine Thomas, Celine Klemm, Brett Hutchins, and Stefan Kaufman, "Unpacking the Realities and Complexities of Sensemaking: Government Practitioners' Experiences of Emergency Risk Communication," *Risk Analysis*, Vol. 42, No. 11, 2022; and Wouter Jong, "Meaning Making by Public Leaders in Times of Crisis: An Assessment," *Public Relations Review*, Vol. 43, No. 5, December 2017.

reinforcing for the public the positive role public agencies play in supporting communities during incident response and recovery. Peer-to-peer networks can also be useful for managing uncertainty, by contributing new and different perspectives from other sectors, or, in the best case, by providing experts who, through their real-world experience in managing the same type of incident, can reduce novelty.

Adaptive Leadership, Decisionmaking Under Deep Uncertainty, Experiential Learning, and Improvisation

Training is also available to manage uncertainty during catastrophic incidents using such approaches as adaptive leadership and decisionmaking, decisionmaking under deep uncertainty, and iterative and experiential learning, including the observe, orient, decide, act (OODA) loop, as well as methods that encourage creativity, innovation, and improvisation.[76] Exposure to leadership theories and frameworks such as these can provide a broader toolbox for addressing novel and uncertain situations. Training emergency managers in different leadership theories is a two-step process. First, classroom training in various theories provides a framework to help emergency managers organize their approaches; second, exercises and targeted scenarios provide the opportunity for experimentation and individual testing of different leadership and decisionmaking approaches. Leaders can then further develop and apply the approaches that work best for them. Managing uncertainty often relies on a different mindset whereby the individual can adapt, change course, and make decisions with imperfect information. Training can encourage open-mindedness and flexibility and can support emergency managers in developing the ability to adapt and rapidly change courses of action as an incident evolves. Training in crisis leadership, rather than crisis management, is focused on this sort of adaptive decisionmaking.[77] Training in thinking about how to think, as opposed to training in specific tactics, and in reverting to first principles, may also be useful. Humility and skepticism can be encouraged in a safe learning environment.

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[76] On adaptive leadership, see Ronald Heifetz, Marty Linsky, and Alexander Grashow, *The Practice of Adaptive Leadership: Tools and Tactics for Changing Your Organization and the World*, Harvard Business Press, 2009. On decisionmaking under deep uncertainty, see Vincent A. W. J. Marchau, Warren E. Walker, Pieter J. T. M. Bloemen, and Steven W. Popper, eds., *Decision Making Under Deep Uncertainty: From Theory to Practice*, Springer, 2019. On experiential learning, see David A. Kolb, *Experiential Learning: Experience as the Source of Learning and Development*, 2nd ed., Pearson FT Press, 2014. The OODA loop is a structured model for taking action based on informed decisionmaking. See James Johnson, "Automating the OODA Loop in the Age of Intelligent Machines: Reaffirming the Role of Humans in Command-and-Control Decision-Making in the Digital Age," *Defence Studies*, Vol. 23, No. 1, 2023. On creativity and improvisation in leadership, see Min Basadur, "Leading Others to Think Innovatively Together: Creative Leadership," *Leadership Quarterly*, Vol. 15, No. 1, February 2004; Christine M. Pearson and S. Amy Sommer, "Infusing Creativity into Crisis Management: An Essential Approach Today," *Organizational Dynamics*, Vol. 40, No. 1, January–March 2011; and McKenzie Lloyd-Smith, "The COVID-19 Pandemic: Resilient Organisational Response to a Low-Chance, High-Impact Event," *BMJ Leader*, Vol. 4, No. 3, 2020.

[77] On the role of adaptive leadership during crises, see, for example, Chiemi Hayashi and Amey Soo, "Adaptive Leadership in Times of Crisis," *PRISM*, Vol. 4, No. 1, 2012; and Ronald Heifetz, Alexander Grashow, and Marty Linsky, "Leadership in a (Permanent) Crisis," *Harvard Business Review*, July–August 2009.

Identifying Novel Technologies and Expertise

Emergency managers sometimes describe themselves as experts at finding experts. In novel or technically complex incidents, this capability becomes more important than ever. There are techniques for identifying novel technologies and expertise, such as technology foraging, that are not typically part of emergency management training but could become part of curricula.[78] Similarly, a more general willingness to seek out nontraditional partners could be fostered through training. Emergency managers can be encouraged to bring in novel and diverse partners, both before and during emerging incidents, to draw in divergent perspectives that may be helpful in identifying and attacking novel incidents. Resources such as the Cybersecurity and Infrastructure Security Agency's Stakeholder Engagement division maintain partnerships with diverse stakeholders, both national and international, to facilitate information-sharing.[79]

Low-Regret Decisionmaking

Low-regret decisions are ones that try not to limit the decisions available in the future. Such decisions make it easier for the decisionmaker to adapt over time and change course as the incident evolves and more information becomes available. In some instances, accepting some risk early on can enable a decisionmaker to maintain more options in the long run. For example, when the nature of a hazard is uncertain, emergency managers might consider erring on the side of taking protective actions, such as closing a facility or asking a population to shelter in place. If the directive is for a relatively short period of time, even if in hindsight the protective action proves likely to have been unnecessary, the emergency manager is unlikely to regret (or be criticized for) erring on the side of caution in the short term and taking an action intended to protect the population while additional information is gathered.[80]

Information-sharing is another example of a potential low-regret decision. Information-sharing has long been encouraged among public safety entities, but inclusion of nontraditional partners outside the public safety community may be necessary to diagnose an unusually challenging incident, identify solutions, and find experts. The time needed to share information more broadly could be seen

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[78] Technology foraging involves "scanning the horizon for technologies that are already in use or being developed, and adopting these technologies for new purposes, new environmental conditions, or at new scales" (Tara O'Toole, "Overview of Science and Technology Research and Development Programs and Priorities at the Department of Homeland Security," testimony of the Under Secretary for the Science and Technology Directorate, U.S. Department of Homeland Security, before the U.S. House of Representatives Committee on Science, Space, and Technology, Subcommittee on Technology and Innovation, March 15, 2011).

[79] Cybersecurity and Infrastructure Security Agency, "Stakeholder Engagement Division," webpage, undated.

[80] Low- or no-regret decisionmaking aims to minimize risk from actions taken under conditions of uncertainty. For example, in the climate policy context, low-regret actions have been defined as those that "would generate net social and/or economic benefits under current climate and a range of future climate change scenarios" (Intergovernmental Panel on Climate Change, Working Group II, *Fifth Assessment Report: Impacts, Adaptation, and Vulnerability*, Annex II: *Glossary*, 2014, p. 1769). For additional explanation of the concept of regret in statistical decisionmaking and of the related principle of mini-max decisionmaking, see, for example, Robert J. Lempert, Steven W. Popper, and Steven C. Bankes, *Shaping the Next One Hundred Years: New Methods for Quantitative, Long-Term Policy Analysis*, RAND Corporation, MR-1626-RPC, 2003; and L. J. Savage, "The Theory of Statistical Decision," *Journal of the American Statistical Association*, Vol. 46, No. 253, 1951.

as diverting efforts away from direct response activities, or even risking that information will be used improperly, but such information-sharing may ensure that additional resources can be called into action faster in the future. Related to information-sharing is knowledge management, whereby systems are set up to provide ready access to expertise gained from previous incidents and knowledge gained about an incident as it evolves. Such systems can include readily accessible record-keeping systems and integration of staff across different levels of experience in exercises in which junior staff can learn from more experienced staff.

The willingness to take measured risks can be developed and may require overcoming existing tendencies in the field to follow established and proven protocols. Training can encourage emergency managers to identify and act on low-regret decisions, which are likely to be helpful in most situations, even before they are fully understood.

Training Options to Mitigate Systemic Failures

Systemic failures can be particularly difficult to prepare for because they require strong government and civic institutions that can function even under the extreme stress of a catastrophic incident. Building such institutions is nearly always outside of the purview of emergency management organizations. Yet, there are some ways emergency managers can train to build skills to better respond to systemic failures.

Testing Assumptions and Identifying Gaps in Planning

Training in red teaming and similar systems can help emergency managers find flaws in assumptions and weak points in plans.[81] Bringing in outside groups, especially those inclined or empowered to be highly critical, can provide fresh and objective perspectives. Training in *premortems* can help emergency managers detect gaps in planning before an incident occurs. During a premortem, participants imagine that a project or activity has failed and come up with explanations for the failure, which can then be incorporated into planning.[82]

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[81] Red teaming involves the simulation of "adversary or adversarial decisions or behaviors, where the purpose is informing or improving defensive capabilities"; red teaming tests "existing standard operating procedures and plans at the strategic, operational, and tactical levels against emerging threats and hazards by exposing them to the machinations of adaptive, creative adversaries and other potentially problematic actors" (Gary Ackerman and Douglas Clifford, "Red Teaming and Crisis Preparedness," *Oxford Research Encyclopedia: Politics*, August 31, 2021). Previous research from RAND Europe has defined red teaming in the cybersecurity context as "adversarial activities carried out by a group or individuals on a system with the support of the system's host organisation or owner. This can include attempts to breach defences, compromise systems or achieve another malicious act" (Marie-Laure Hicks, Ella Guest, Jess Whittlestone, Jacob Ohrvik-Stott, Sana Zakaria, Cecilia Ang, Chryssa Politi, Imogen Wade, and Salil Gunashekar, *Exploring Red Teaming to Identify New and Emerging Risks from AI Foundation Models*, RAND Corporation, CF-A3031-1, 2023, p. 3).

[82] A premortem has been described as "a group brainstorming exercise that leverages prospective hindsight to imagine that an event has already occurred and to generate an explanation for it—to reduce the likelihood of a poor outcome" (Rinad S. Beidas, Shannon Dorsey, Cara C. Lewis, Aaron R. Lyon, Byron J. Powell, Jonathan Purtle, Lisa Saldana, Rachel C. Shelton, Shannon Wiltsey Stirman, and Meghan B. Lane-Fall, "Promises and Pitfalls in Implementation Science from the Perspective of US-Based Researchers: Learning from a Pre-Mortem," *Implementation Science*, Vol. 17, No. 55, 2022, p. 2). See also Gary Klein, "Performing a Project *Pre*mortem," *Harvard Business Review*, September 2007.

Rigorous, completely honest AARs should be conducted by emergency managers on prior incidents they and others have managed. A primary objective should be to identify and learn from failure. Different jurisdictions and entities can work together and form networks to share these lessons. While preparing and sharing AARs is already an almost universal practice, too often these efforts omit essential information—and the best opportunities to learn and improve—and are not shared widely because of fear of embarrassment, external criticism, or worse. However, learning is impossible without honesty and transparency.

Full-Scale Exercises in the Real World

Entities can also ramp up their exercise efforts to supplement the more traditional tabletop exercises with full-scale exercises conducted in the real world that require the movement of personnel and equipment. Although these sorts of exercises are far more time-consuming and expensive, they can provide the opportunity to generate objective, practice-based data to validate—or invalidate—assumptions about the ability to execute essential tasks, such as moving equipment or evacuating populations. Emergency managers may need to recruit outside partners, including members of the community, to truly test their plans for worst-case scenarios. Although exposing weaknesses in response to the public can appear to be a risk, the community will likely appreciate the inclusion and the opportunity to provide input and build trust. It is, of course, equally essential that emergency managers be genuinely willing to listen to, learn from, and act on input from these outside groups.

Public Acknowledgment of Responsibility for Emergency Plans

A seemingly basic but sometimes neglected step that emergency managers can take is to require leaders and entities with responsibilities in emergency plans to acknowledge, formally and publicly, their understanding of their responsibilities and agreement to execute them. This includes providing the appropriate resources to support all parties with responsibilities. In resource-constrained situations, entities should be given the opportunity to signal what they can and cannot commit to with provided resources. When resources are not adequate to meet their missions, entities should openly discuss limitations and priorities such that all entities can meet agreed-on commitments and realistic plans are developed for each jurisdiction.

Continuity-of-Government Planning and Use of Peer-to-Peer Networks

While most entities now have some sort of continuity-of-government (COG), continuity-of-operations (COOP), or succession plan, real-world events often expose that these plans have gaps. For example, the COVID-19 pandemic presented challenges for many entities' existing COOP plans. This is understandable, as this type of planning can be extremely difficult. Something as seemingly basic as identifying a set of essential employees may be exceedingly complicated to do, given the interconnected nature of roles, and may vary by incident type and other conditions. During the COVID-19 pandemic, the nature of the incident, its extended duration, changes in technology enabling remote work, and other factors combined to require a reevaluation of existing plans across

sectors and society as a whole. As with other forms of planning, COOP and succession plans should be regularly (re)assessed and stress tested with such methods as red teaming and premortems.

The potential for decapitation of government leadership is a more extreme continuity problem. In this instance, entities might develop contingency plans to turn over management of their operations to another entity. This other entity could be the next higher level of government in their region, a neighboring jurisdiction that knows them well and with whom they have preplanned, or a preidentified peer in a region that is unlikely to be affected by the same incident. At the individual level, peer-to-peer networks, such as the FEMA Vanguard program, can help to fill critical personnel gaps with trusted and experienced individuals from outside the affected area.

Working with Nontraditional Communications Partners

To boost public trust, or mitigate distrust, emergency managers can seek out nontraditional communications partners. These might include leaders from community groups and even known critics. Increasingly, polling reveals that individuals gather their news and opinions from different sources than in the past and may be more likely to trust local sources or "people like me."[83] Emergency managers should work to identify critical constituencies and identify who these groups seek information from and in what form of communication. The most effective format for communicating with some groups may involve new technologies, informal systems, or formats that are not regularly used for official communications. However, the goal is simply to communicate effectively. To be effective, it is critical that partnerships be mutually beneficial. Officials cannot simply expect to develop a message and have partners deliver it for them; they must be willing to hear and accept constructive feedback from these partners and alter not only their message but potentially their actions in response.

Transparency in Information-Sharing

In addition to the messenger and communication format, the message itself is critical. Officials must be transparent, acknowledge mistakes, and share whatever information they can, including indicating when they simply do not know the answer. None of these steps are easy, and they may require training in new formats of communication and ways to work effectively with nontraditional partners. It is critical that emergency managers devote the time, resources, and key personnel necessary to achieve transparency in information-sharing.

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[83] According to a 2025 survey of adults in the United States, "people like me," along with "friends" and "family," were found to "outrank mainstream news as trusted sources of accurate information" (Institute for Public Relations and Leger, *Disinformation in Society Report*, April 2025). See also Kirsten Eddy and Elisa Shearer, "How Americans' Trust in Information from News Organizations and Social Media Sites Has Changed over Time," Pew Research Center, October 29, 2025; Michael Lipka and Elisa Shearer, "Audiences Are Declining for Traditional News Media in the U.S.—with Some Exceptions," Pew Research Center, November 28, 2023; and "CBS News Poll: In What Ways Has Public Opinion Changed over 40 Years?" CBS News, September 14, 2018.

Information Gathering, Fact-Checking, and Counter-Messaging

Finally, emergency managers can invest in additional training in information gathering, including training in fact-checking to identify and debunk misinformation, and training to develop effective counter-messaging to address misinformation. This may include learning how to use technology to fact-check information and detect and counter misinformation, as well as training in leveraging social media, sensor data, and novel and emerging technologies to develop situational awareness. Emergency managers can invest in identifying and developing redundant information sources and systems, which may require additional training. Training from non–emergency management fields, such as intelligence gathering and information operations, may be valuable.[84]

Table 4.1 summarizes potential impacts and training options for the four challenges associated with catastrophic incidents discussed in this chapter.

Table 4.1. Catastrophic Incidents: Challenges, Potential Impacts, and Training Options

Challenge	Potential Impacts	Training Options
Scarcity	• Invalidation of plans assuming full resource availability • Shortfalls in assistance to affected communities • Use of rationing and triaging to allocate scarce resources • Heightened pressure for relief and incident resolution from the media, elected officials, and the public • Exhaustion and burnout among emergency managers and responders	• Training in resource-constrained operations, including repurposing resources and adjusting standard operating procedures as appropriate • Worst-case scenario and maximum-of-maximums exercises • Training in the use of nontraditional personnel for response (including train-the-trainer and just-in-time training models) • Training with a wider variety of regional partners • Training in managing operations from outside disaster zones • Ethics and value-based decisionmaking training • Enhanced training in disaster communication, including storytelling

[84] For example, DHS lists several "FEMA-approved" courses on its website (including a "DHS Basic Intelligence and Threat Analysis Course" and a "Foundations in Intelligence Analysis Training") that are designed for intelligence analysts but that may contain information useful for non-intelligence-focused emergency managers seeking to navigate the information environment effectively. These courses are "approved by FEMA for inclusion" in the FEMA National Preparedness Course Catalog, according to the DHS website (DHS, "FEMA Approved Intelligence Analyst Training Courses," webpage, updated January 6, 2025).

Challenge	Potential Impacts	Training Options
Stress and other psychological impacts	• Exhaustion and demoralization of emergency management workforce and affected communities • Increase in burnout and other mental health issues • Inability of emergency management workforce to sustain high operational tempo and focus	• Additional training in mental health and wellness • Personal and family preparedness training for emergency managers • Development of resources and support for use during a crisis • Training that addresses the unique psychological impacts of catastrophic incidents • Training exposure to historical catastrophic incidents • Expanded use of peer-to-peer networks to allow emergency managers to learn from peers with relevant experience
Uncertainty	• Misunderstanding of incident severity and effects • Paralysis, shock, and/or indecision among responders • Inability to identify effective mitigation and response options • Unclear capability needs and misallocated resources • Delayed and disrupted response • Communication failures (due to challenges providing accurate information and setting expectations appropriately) and loss of public confidence	• Training in sensemaking and meaning-making, including for novel and technically complex incidents • Adaptive leadership and crisis leadership training • Training in decisionmaking under deep uncertainty • Training in iterative and experiential learning, including the OODA loop approach • Training focused on “how to think,” rather than specific tactics for specific scenarios • Training in techniques for identifying novel technologies and expertise, such as technology foraging • Training in identification of nontraditional partners and partners with diverse and novel perspectives • Training in low-regret decisionmaking
Systemic failures	• Unavailability of key personnel • Inability of leaders to effectively direct response • Breakdown in government capabilities • Gaps in situational awareness • Loss of public and workforce confidence • Elevated need for public communication • Higher casualties and greater need for assistance	• Training to challenge assumptions and identify planning gaps, including training in red teaming, premortems, and use of outside partners • Training in the rigorous use of AARs • Tabletop exercises • Full-scale real-world exercises • Training in information-sharing between partners • Training in continuity-of-government planning and use of peer-to-peer networks to fill personnel gaps • Training in new communication formats and working with nontraditional partners • Training in information gathering, fact-checking, and counter-messaging

Potential Next Steps

This report is intended to help emergency managers consider what characteristics make catastrophic incidents different from other emergencies before they occur, when it may still be possible to mitigate or even entirely avoid the worst of those consequences. However, this report is only a first step in a challenging and potentially rich area for further exploration. In this section, we suggest some potential next steps for consideration. We have grouped these steps into several broad categories: those related to refining our initial set of precursors for catastrophic incidents, those related to identifying potential catastrophic incidents before they occur and while they are developing, and those related to training and exercises to deal with catastrophic incidents.

Refining the Catastrophic Incident Precursors

Future efforts should validate and refine the set of precursors we identified in the report. As noted, the precursors in this report were identified through discussions with a relatively small set of SMEs in HSOAC. The precursors should be reviewed, assessed, and refined using insights from conversations with a much broader group of emergency management practitioners and other experts, including experts outside of the emergency management profession who can offer diverse and outside perspectives.

One source of experts is individuals who have experienced catastrophic incidents firsthand. In previous work conducted for NDEMU, RAND researchers interviewed emergency managers across the United States who had been involved in unusual, or unusually challenging, incidents. This work was used as an input for this report but could be extended further and with a focus on catastrophic incidents or particularly novel and distinctive incidents. Interviews could explore whether there are other important factors that make catastrophic incidents different, how the individuals successfully dealt with them or what they would have done in hindsight, and what training could be provided to support developing these skills in emergency management organizations. Existing groups, such as alumni of the FEMA Vanguard program, could be used to review and provide input on the precursors.

Future efforts could also include conducting retroactive reviews of catastrophic incidents. It may be possible to identify and conduct a comparative assessment with similar events that did not become catastrophic or near-miss incidents to determine why some incidents became catastrophic and others did not. In some cases, the difference may be luck; if so, the insight that some outcomes are contingent and probabilistic can help prevent complacency, overconfidence, or learning the wrong lessons from prior experience.

Identifying Potential Catastrophic Incidents

We developed a generalizable framework to help identify potential catastrophic incidents before they occur. Identifying which specific threats and hazards could become catastrophic for any given jurisdiction is highly dependent on local context but, if possible, would be a valuable exercise. Factors such as geography, exposure to natural hazards, underlying infrastructure and its condition,

population vulnerability, and the capabilities of the affected jurisdiction or entity will determine whether a specific incident could become catastrophic. In some cases, these factors are static and easily apparent. For example, coastal states may be exposed to severe hurricanes that can produce catastrophic consequences. However, in other cases, these conditions may be dynamic. Incidents are novel until they are not. Current emergency management departments have limited to no experience with a nationwide pandemic incident prior to 2020. Cyberattacks and other incidents that were once novel now occur regularly. Technology changes and generates new threats. Human adversaries emerge or develop new tactics. Capabilities change, as well. Jurisdictions may be well resourced at one time but not at another. Mutual aid partners may become unavailable.

Emergency managers could identify specific threats and hazards that could become catastrophic incidents for them. While every entity is likely to already have a threat and hazard assessment, we encourage emergency managers to consider looking at these assessments with a new lens, applying the indicators identified in this report, as well as some of the tactics discussed in this chapter, such as red teaming and conducting premortems. Critically, assessments of potential catastrophic incidents should be updated regularly. Technology changes, hazards may change, and novel threats emerge. Even if the underlying incident may not be subject to change, the personnel, technology, resources, and capabilities used to meet it may be capable of change, which could make the difference between catastrophic and noncatastrophic consequences occurring.

Discussing which incidents have the potential to become catastrophic, beyond the most obvious threats and hazards, and focusing on areas of disagreement can be a useful way to identify when parties are holding different assumptions or other valuable insights. Identifying potentially catastrophic incidents can also be a means of starting important conversations about what capabilities entities may want to develop, particularly when resources are scarce. Emergency managers might consider identifying individuals or groups, such as a catastrophic incident planning cell, specifically tasked with identifying and thinking about rare but potentially catastrophic risks so that they are not overlooked in the mix of day-to-day responsibilities.

Training and Exercises for Catastrophic Incidents

This report has focused on how emergency managers can identify which incidents may be most likely to be catastrophic and whether an incident may be on the verge of escalating to having catastrophic consequences. While we identified some ways in which catastrophic incidents are different from other incidents and how different forms of training may be needed to deal with these challenges, here we suggest some specific potential first steps for training and exercises.

First, explicit training could be provided to make clear the ways in which catastrophic incidents are different from noncatastrophic incidents. We suggest in this report that catastrophic incidents require different skills—and even mindsets—from those used to address more-routine events. Training could stress that catastrophic incidents are not like other incidents and could introduce the precursors for identifying them and ways to apply them to assess local or regional threats and hazards.

While this report focuses on helping emergency managers ask whether an incident might be catastrophic, future efforts could focus on identifying what emergency managers should do when the answer to this question is yes—that is, what should an emergency manager do when they believe a

catastrophic incident is imminent? What should emergency managers do when it is too late to provide pre-incident training? Topics could include steps related to just-in-time training, raising awareness, or simply helping personnel and communities brace for and deal with the coming impact.

NDEMU or other entities could develop courses targeting specific incident types or parts of the framework. For example, training could focus on novel incidents and how to recognize and deal with them, or on the challenges of managing simultaneous incidents. Discipline-specific training could be developed to address difficult topics, such as providing altered standards of care in a mass casualty scenario. Case studies from prior events or experts who lived through these events could be leveraged to provide insights and lessons learned.

NDEMU, other parts of FEMA, or other entities could develop exercise materials specific to catastrophic events that explicitly draw out the distinct qualities of such events and call on emergency managers to practice such skills as sensemaking, decisionmaking under scarcity, and developing on-the-fly response plans to address the novelty or technical complexity inherent to some catastrophic incidents. Exercises that force players to deal with scarcity and make difficult decisions on prioritization will never substitute for real-world experience but can be a useful starting point that begins to prepare emergency managers to address and, hopefully, to avoid the incidents and decisions that will challenge them the most.

Appendix

Analysis of Disaster Databases

This appendix summarizes our analysis of historical disaster databases. We analyzed publicly available datasets to provide actionable insights for emergency management curricula on the state-level prevalence and relevance of catastrophic events. We identified five publicly available datasets that could provide insights on the prevalence and relevance of catastrophic incidents for state-level training. Given PKEMRA's wide definitional scope—which includes both natural and nonnatural (i.e., human-caused) incidents—utilizing multiple datasets, each with distinct strengths and areas of focus, provides a more comprehensive look at the full range of responsibilities emergency managers might face.

Methodology

To support the modernization of emergency management curricula in addressing disaster preparedness in an evolving society and climate, the quantitative analysis is refined to more recent data from 2000 onward (inclusive of 2000). We selected public datasets based on their data and evidence quality and contribution in providing a comprehensive range of incident types covered under the chosen definition from PKEMRA.[85] The procedures used to extract and evaluate each dataset are detailed in Table A.1.

Because of the wide variety in the types of disasters, it is common practice to organize them through categorization frameworks or coding constructs. Each public dataset selected for quantitative analysis employs its own unique approach to classify natural hazard incidents. For consistent presentation of results, this section adapts the individual categorizations within each dataset to align with the standardized threat and hazard coding scheme below, built on and refined from a previous RAND report, *Improving Assessments in Emergency Management*.[86] While the categorizations have been standardized for clarity, the results themselves remain uncompromised, maintaining integrity of the original data. Table A.2 shows our coding scheme.

[85] As noted earlier, PKEMRA was enacted into law as part of the Fiscal Year 2007 Department of Homeland Security Appropriations Act (Public Law 109-295, 2006).

[86] Jason Thomas Barnosky, Andrew Lauland, Jessica Jensen, Susan A. Resetar, Sara Stullken, Jay Balagna, R. J. Briggs, Christy Foran, Emily Hoch, Kristin J. Leuschner, Karen M. Sudkamp, and Rachel Steratore, *Improving Assessments in Emergency Management: Analysis of the Threat and Hazard Identification and Risk Assessment and the Hazard Identification and Risk Assessment*, Homeland Security Operational Analysis Center operated by the RAND Corporation, RR-A2437-1, 2024.

Table A.1. Public Data Sources

Dataset	Procedure	Years Covered[a]	Variables
Dataset 1: FEMA Disaster Declarations	1. Downloaded FEMA disaster declaration data and imported the data into Microsoft Excel 2. Truncated the data to the state level by major DRs only, performed deduplication of FEMA Declaration Strings 3. Categorized disasters according to internal framework	Post-2000	1. State 2. Incident type 3. Fiscal year (FY) declared
Dataset 2: FEMA National Risk Index (NRI)	1. Downloaded NRI dataset in table format (comma-separated value [CSV]) of nationwide, state-level, and territory-level expected annual loss (EAL) 2. Truncated the data to the state level, made composite calculations of all natural hazards	1953–2025	1. State 2. Composite expected annual loss score, rating, and total value
Dataset 3: Emergency Events Database (EM-DAT)	1. After registration, downloaded flat table in Excel format (.xlsx) 2. Separated post-2000 U.S. data with technological events only from international dataset[b]	2000–2024	1. State 2. Incident type 3. FY, month
Dataset 4: Global Terrorism Database (GTD)	1. Downloaded GTD and separated the data into a U.S.-only Excel workbook	2000–2020	1. State 2. Weapon type, target type, internationally related 3. FY, month
Dataset 5: U.S. Energy Information Administration (EIA) *Electric Power Monthly* (EPM) Archives	1. Downloaded Table B.2 of February editions from the EPM Archives for annual data on major U.S. electrical disturbances and unusual occurrences 2. Refined to variables of interest and compiled all years into a single Excel sheet; excluded outages and disturbances with a duration of less than 60 minutes	2013–2023	1. Area affected (state), North American Electric Reliability Corporation (NERC) region 2. Type of disturbance 3. FY, month 4. Duration, customers affected

NOTE: DR = disaster declaration.

[a] The "Years Covered" column does not represent years available for public download but instead the years selected from those available in accordance with the targeted time frame interest of this project. Therefore, more years further back than 2000 may be available for public use. An exception is for Dataset 2: FEMA NRI, for which calculations for annual expected loss are based on cumulatively collected data going back to the 1950s, as stated in the technical documentation.

[b] Dataset 3 (EM-DAT) included both technological and natural emergency incidents. However, given the international focus of the dataset, it was determined that only the technological incidents had sufficient state-level documentation that matched the needs of our analysis.

Table A.2. Incident Coding Scheme

Type	Category	Description
Natural (caused or adjacent to natural processes and phenomena)	Geophysical	Earthquakes, volcanic eruptions, landslides
	Droughts and extreme heat	Extended periods of low or no precipitation; water shortages; heatwaves
	Cold and snow events	Periods of extreme cold temperatures; blizzards; winter storms
	Severe storms, precipitation	Floods, hail, ice storms
	Severe storms, wind	Straight-line winds, tornadoes
	Coastal hazards	Hurricanes, tsunamis, typhoons, subsidence, sea level rise
	Wildfires	
	Biological	Human infectious diseases, agricultural diseases, mass mortality events of animals
	Astronomical	Space weather, geomagnetic storms, asteroid impacts
Human-caused (a result of intentional, deliberate human actions, often with malicious or strategic intent)	Civil disturbances	Riots, arson, protests that escalate into violence, sabotage of equipment, targeted assaults
	Cyberattacks	Intentional disruptions to critical systems, such as power grids, manufacturing systems, or communication networks
	Active shooter incidents	Criminal threats involving firearms or related weapons
	CBRN incidents	Chemical, biological, radiological, or nuclear events
	Other terrorism	Bombings, high-yield explosions, hijackings
	Nation-state threats[b]	Specifically non-terrorist-led, nation-level adversaries challenging the United States across physical, cyber, economic, military, and diplomatic domains[a]

Type	Category	Description
Technological (a result of unintentional human actions or accidents, often paired with failures in technological or engineered systems)	Critical infrastructure failures	Power outages, transportation accidents (e.g., air, rail, water), bridge or building collapses
	Industrial accidents	Explosions (e.g., factories, gas pipelines, oil platforms), mining incidents, hazardous material incidents (e.g., oil spills, water contamination, accidental release of pollutants or radiation exposure, power plant leaks)
	Dam or levee failures	Structural failures specifically leading to flooding
	AI and foreign information campaigns	Use of AI, social media, or mass information campaigns to sow confusion and chaos and hamper incident response
Other	Hybrid	Incident that includes features of incidents in more than one category
	Miscellaneous	Unique or rare disasters not covered by standard categories above (e.g., accidental large structural fires, human stampedes)

NOTE: CBRN = chemical, biological, radiological, and nuclear.
[a] Glen Woodbury, "Growing Foreign Threats to National Security, Part 1: Challenges and Considerations," *Domestic Preparedness*, October 23, 2024.
[b] *Nation-state threats* is a nonexclusive category and is specifically included to provide context regarding the portion of human-caused events that stem from nation-states.

Data Limitations

While our approach of converting multiple datasets into a unified coding scheme facilitates insights across diverse catastrophic incident types, there are limitations in the data we analyzed that need to be addressed.

First, the five datasets are inconsistent in their definitions and chosen methodologies. The unified coding scheme works as a standardization tool to address this limitation and supports relative comparison. Second, there is no single dataset that is comprehensive across incident types, and, therefore, each of the five datasets chosen lacks coverage in certain categories, leading to potentially incomplete comparisons. By integrating multiple datasets, we attempt to compensate for these gaps. Third, temporal and geographical differences may influence comparisons and relative incident counts across datasets. For clarity and transparency, details from each dataset are individually covered in their own sections below. Finally, given the time-intensive nature of integrating, cleaning, and standardizing multiple datasets, the five datasets chosen for this analysis do not encompass all publicly available resources.

Dataset 1: FEMA Disaster Declarations

Under DHS, FEMA provides public access to its list of incidents that received official disaster declarations, dating back to its first on record in 1953.[87] There are two primary types of declarations a disaster can receive outlined in the Stafford Act: emergency declarations and major disaster declarations.[88] Our analysis of FEMA's dataset was focused on major disaster designation entries since 2000.

Most catastrophic incidents tracked by FEMA that received a major disaster declaration fall under the **natural** type of disaster, as defined by the catastrophic incident coding scheme previously introduced in Table A.2. Under **natural**, severe storms account for the majority of declarations, notably constituting more than half of the recorded incidents. No *biological* incident ever received major disaster declaration status until 2020, when COVID-19 accounted for over 50 percent of all declarations that year. This included all 56 states and U.S. territories, with three (Alabama, Arizona, and Florida) receiving the declaration twice, resulting in 59 total declarations. For **human-caused** and **technological** types of disasters, there is little representation in FEMA's dataset. Two major disaster declarations in the dataset were assigned as **human-caused** under our coding construct, specifically, in the *other terrorism* category: the states of New York and Virginia and the September 11, 2001, terrorist attacks. For **technological** incidents, FEMA recorded three: California and Michigan experiencing *dam/levee failures* and Texas experiencing an *industrial accident*.

Dataset 2: FEMA National Risk Index (NRI)

The NRI is an interactive tool used to identify communities most at risk in the United States from catastrophic hazards.[89] This is done by leveraging available source data from FEMA, as well as contributions from collaborative stakeholders in government, academia, and industry. The NRI is relevant to emergency management, as it provides additional context for how state and local emergency managers might prepare for and respond to disasters. The NRI uses three main components when calculating overall risk, but we focused on the natural hazard component, otherwise known as *expected annual loss* (EAL). EAL "represents the average economic loss in dollars resulting from natural hazards each year."[90] Potential implications of this tool for emergency management include regions with high frequencies of disasters and high economic loss scores further investing in disaster mitigation strategies, resilient infrastructure, and emergency planning. Additionally, states

[87] FEMA, "OpenFEMA Dataset: Disaster Declarations Summaries—v2," 2026b (data accessed November 17, 2025). This product uses FEMA's OpenFEMA application programming interface (API) but is not endorsed by FEMA. The federal government or FEMA cannot vouch for the data or analyses derived from these data after the data have been retrieved from the agency's website(s).

[88] Public Law 100-707, Robert T. Stafford Disaster Relief and Emergency Assistance Act, November 23, 1988; amending Public Law 93-288, Disaster Relief Act of 1974, May 22, 1974.

[89] FEMA, "National Risk Index Dataset," 2026a (data accessed November 17, 2025). This product uses FEMA's OpenFEMA API but is not endorsed by FEMA. The federal government or FEMA cannot vouch for the data or analyses derived from these data after the data have been retrieved from the agency's website(s).

[90] FEMA, "National Risk Index: Determining Risk," webpage, undated-b.

with fewer disasters yet higher losses may reassess vulnerabilities in their emergency management responses to minimize impacts.

Dataset 3: Emergency Events Database (EM-DAT)

The EM-DAT is a global database created by the Centre for Research on the Epidemiology of Disasters.[91] We focused on U.S. entries in this database to supplement our efforts to quantify different types of catastrophic events, specifically **technological** types of disasters or hazards. Between 2000 and 2024, the EM-DAT database recorded 97 technological disasters, of which 68 were classified as *critical infrastructure failures* and 13 as *industrial accidents*. The remaining incidents were categorized as 15 *miscellaneous* events and one *hybrid* event, according to the catastrophic incident coding scheme. Nearly 87 percent of critical infrastructure failures were transportation-related, with 9 percent involving structural collapse. Industrial accidents mainly consist of explosions and hazardous material incidents, with explosions accounting for roughly three-fourths of the total. Geographically, 27 out of 50 states contributed to the 68 critical infrastructure failures, with roughly 60 percent occurring in California, Florida, New York, and Texas. Industrial accidents were reported in seven states, with frequencies more evenly distributed.

Dataset 4: Global Terrorism Database (GTD)

The GTD contains more than 200,000 records of terrorist attacks and is maintained by the National Consortium for the Study of Terrorism and Responses to Terrorism (START) at the University of Maryland.[92] This publicly available dataset covers categories under the **human-caused** type of catastrophic incidents, with an emphasis on terrorism.

In the original dataset, there are 757 terrorism incidents recorded in the GTD between 2000 and 2020, dominated by civil disturbances, terrorism, and active shooter events. CBRN incidents are less frequent, and notably no cyberattacks are reported in the GTD. However, cyberattacks remain an evolving threat that emergency managers might face. Unlike the other human-caused categories, the category of *nation-state threats* is nonexclusive, meaning its designation often overlaps with the other human-caused categories. The GTD does not specifically track nation-state threats to the United States. However, categorical variables related to components of the attack, such as whether the target population or perpetrator group was international or nationality-related, were used for this purpose. Of the incidents assigned under nation-state threats and classified as specifically non-terrorist-led, nation-level adversaries challenging the United States across physical, cyber, economic, military, and diplomatic domains,[93] 124 qualify. It is important to note that the international categorical variable used was often reported as unknown, accounting for 601 out of the 757 total terrorism incidents. Beyond incident count, the GTD tracks additional catastrophic event variables relevant to refining

[91] Centre for Research on the Epidemiology of Disasters, EM-DAT: The Emergency Events Database, 2026; Damien Delforge, Valentin Wathelet, Regina Below, Cinzia Lanfredi Sofia, Margo Tonnelier, Joris A. F. van Loenhout, and Niko Speybroeck, "EM-DAT: The Emergency Events Database," *International Journal of Disaster Risk Reduction*, Vol. 124, 2025.

[92] START, "Global Terrorism Database, 1970–2020," data file, University of Maryland, 2022.

[93] Woodbury, 2024.

emergency preparedness efforts but outside the scope of this report. This includes the tracking of weapon types, target populations, and affected institutions of each incident offering insight into both tactical methods and ideological patterns in U.S.-based terrorism. These variables can assist in informing how emergency managers allocate resources and improve response capabilities.

Dataset 5: U.S. Energy Information Administration *Electric Power Monthly* Archives

To provide a clearer understanding of the prevalence and causes of catastrophic incidents affecting electric power systems across U.S. states, we examined data from the U.S. Energy Information Administration (EIA) *Electric Power Monthly* (EPM) Archives cumulatively looking at the annual reporting of outages and disturbances from 2013 to 2023.[94] This reporting highlights the scale, nature, and potential implications of disruptions to power infrastructure for state and local emergency managers to consider.

A total of 1,538 electric power outages or disturbances were reported, with 720 entries meeting disaster-related criteria. These outages and disturbances exclude operational or management-related incidents and outages lasting less than 60 minutes. Most of the 720 outages and disturbances are attributed to severe weather, with 55 specifically listed because of a natural disaster. However, the EIA annual reports also list examples of **human-caused** incidents as the culprit of electrical difficulties, such as two cyberattacks in California (2016 and 2022) and six disturbances classified under civil unrest involving physical attacks, vandalism, or theft. The characteristics of outages and disturbances underscore the vulnerabilities of electric power infrastructure to both natural and human-caused incidents, emphasizing the relevance for emergency management preparation and mitigation strategies.

Summary of Findings

Organizing each dataset according to the incident coding scheme enables direct comparison of cumulative counts across the wide variety of incidents, whereas a single dataset is often limited to incident or disaster categories under one of our three main event types: **natural**, **human-caused**, and **technological**. This comparative approach provides policymakers, emergency managers, and other state officials a holistic view of the relative risks and frequencies across incident types, enabling a more informed and proactive approach to disaster management. We conducted this analysis as background to inform our understanding of the breadth, types, and number of historical incidents and what could lead to a disaster becoming a catastrophic incident. The quantitative data collected on historical incidents were not sufficiently descriptive to allow us to estimate the number of catastrophic incidents that have occurred historically. Table A.3 lists the total count of each incident category and event type across the multiple datasets selected.

[94] EIA, *Electric Power Monthly*, February ed., Table B.2, 2013–2023.

Table A.3. Cumulative Incident Reporting Across Datasets

Type	Category	Total Incident Count[a]	Count of Incidents ≥ 24 hours	Total Injury Count[b]	Total Casualty Count[b]
Natural	Geophysical	28	20	–	–
	Droughts and extreme heat	0	0	–	–
	Cold and snow events	57	57	–	–
	Severe storms, precipitation	**289**	264	–	–
	Severe storms, wind	39	21	–	–
	Coastal hazards	190	180	–	–
	Wildfires	53	53	–	–
	Biological	59	59	–	–
	Astronomical	0	0	–	–
Human-caused	Civil disturbances	**336**	2	316	41
	Cyberattacks	0	0	–	–
	Active shooter incidents[c]	176	1	1,232	360
	CBRN incidents	33	2	48	7
	Other terrorism	183	0	22,246	3,033
Technological	Critical infrastructure failures	**1,037**	446	2,981	1,371
	Industrial accidents	14	2	1,376	131
	Dam or levee failures	2	2	–	–
Other	Hybrid	182	1	–	–
	Miscellaneous	15	2	–	–

SOURCES: Features data from FEMA, 2026b; START, 2022; and Centre for Research on the Epidemiology of Disasters, 2026.

NOTE: Data from datasets 1, 3, and 4 are shown here. Dataset 2 was excluded in this summary because it does not report data organized by incident but rather evaluates overall risk. Dataset 5 was excluded because EIA outage data are reported but not indexed by incident in a way such that data could be deduplicated with other datasets.

[a] *Total count* is the number of incidents or events across all datasets, following deduplication if more than one dataset reported the same event (e.g., 9/11).

[b] Dashes (–) indicate that the corresponding column variable is not available for the given row category from any of the sample of selected datasets. For example, the OpenFEMA Dataset: Disaster Declarations Summaries—v2 (FEMA, 2026b), which primarily covers the incident counts for "natural" categories, does not include reports on total injury or casualty counts. Additionally, some row categories feature partial or incomplete reporting on column variables. For example, out of the 1,037 critical infrastructure failures, only 68 from EM-DAT had injury and casualty data available.

[c] The active shooter incident count from the GTD is terrorist centered and is not inclusive of school shooting incidents.

Cumulatively, across the three overarching disaster types—natural (715), human-caused (728), and technological (1,053)—certain categories emerge as the most prevalent when examining categories within each type across datasets:

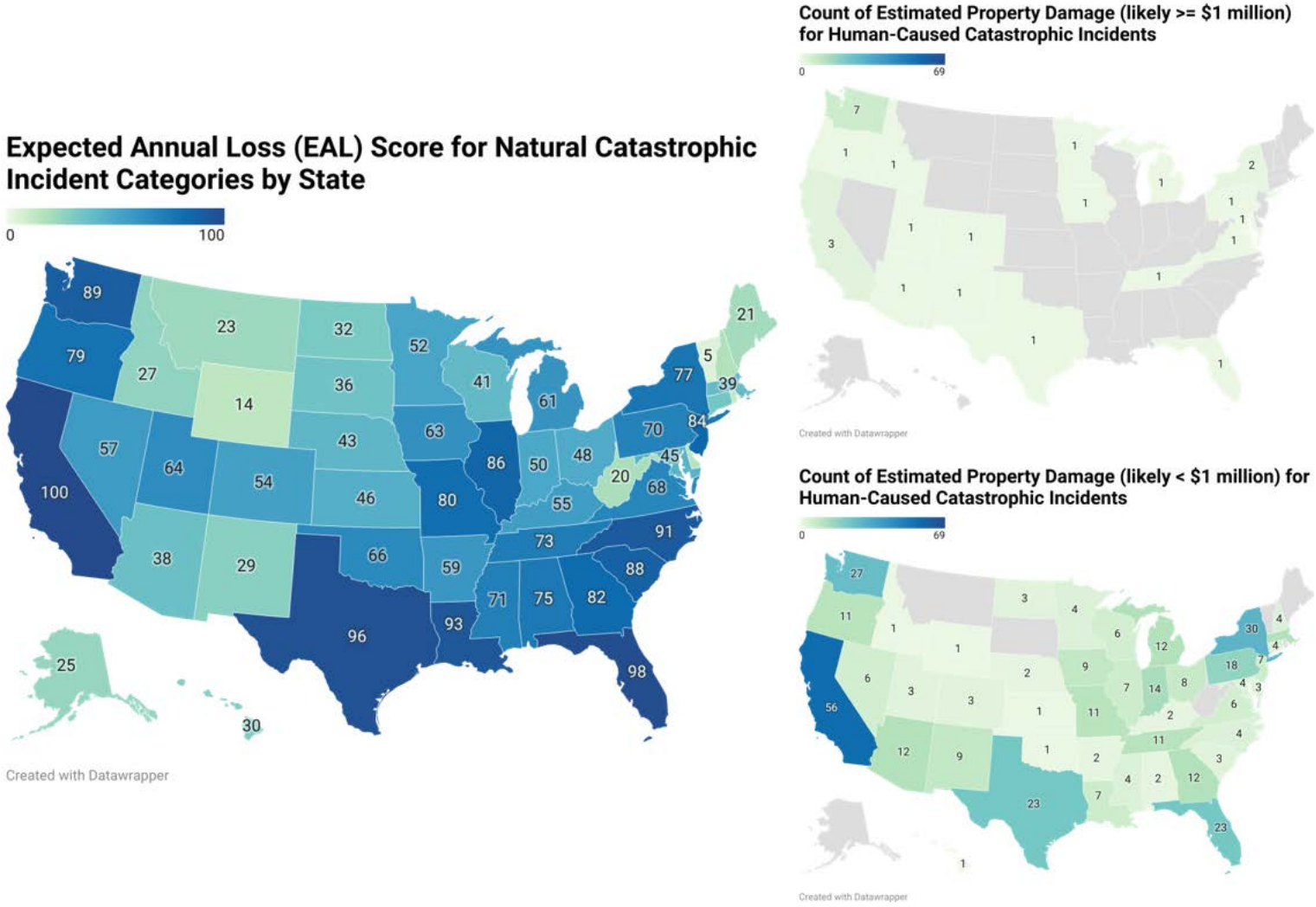
- **Natural:** *Severe storms, precipitation* (total category count: 289). This includes heavy rainfall, floods, hail, and ice storms.
- **Human-caused:** *Civil disturbances* (total category count: 336). This includes instances of riots, arson, violent protests, sabotage of equipment, and targeted assaults.
- **Technological:** *Critical infrastructure failures* (total category count: 1,037). This includes power outages, transportation accidents (e.g., air, rail, water), and bridge or building collapses.

An important consideration to note is that 969 of the critical infrastructure failures are due to power outages. When attempting to determine what hazards or threats are most severe, factors including incident duration and resulting injuries and casualties are often considered. However, the recording of these variables across the publicly available selected datasets is inconsistent compared with overall incident counts. Therefore, we approach comparison across variables and incident types with caution.

For incident duration, the data shown in Table A.3 indicate that natural disaster incidents are more likely to last longer than 24 hours compared with human-caused and technological incidents. Human-caused incidents rarely extend beyond 24 hours, and the same holds true for technological incidents outside of critical infrastructure failures. Notably, all 446 critical infrastructure failures lasting longer than 24 hours were due to electric power outages or disturbances. The datasets we used do not provide adequate data regarding casualties and injuries from natural hazards. However, among human-caused and technological incident types, the "other terrorism" category exhibits a high casualty and injury rate despite only 183 reported incidents. This is largely attributable to the events of 9/11, which account for 21,886 of the 22,246 injuries and 3,007 of the 3,033 total casualties for the category. In addition, industrial accidents, despite also having a low relative incident count, have a disproportionately high casualty and injury rate.

In addition to incident duration and resulting injuries and casualties, reported metrics on financial loss or property damage can help to characterize the relative severity of incidents. Unfortunately, similar to casualty and injury data, these metrics are not consistently recorded across all three incident types. Therefore, we consider only natural and human-caused incidents and their corresponding datasets. Figure A.1 shows state-level variation in the financial and property impacts of natural and human-caused incidents.

Figure A.1. Reporting on Expected Annual Loss and Estimated Property Damage Across Human-Caused and Natural Incident Categories from 2000 to 2020



SOURCES: Features data from START, 2022; and FEMA, 2026a.
NOTE: All scores are constrained to a range of 0 (lightest on maps, lowest EAL relative to other states) to 100 (darkest on maps, highest EAL relative to other states).

While differing in focus and methodology, the two datasets used in Figure A.1 measure financial impact. From FEMA's NRI dataset,[95] an EAL score "represents the average economic loss in dollars resulting from natural hazards each year."[96] This accounts for cumulative future losses in areas including population, building value, and agricultural value. This differs from START's GTD, which tracks financial impact through broader categories of direct property damage resulting from human-caused incidents.[97] Notably, states with high EAL scores for natural incidents (e.g., California, Florida, Texas) also tend to have higher counts of property damage for human-caused incidents. This could suggest overlapping vulnerabilities or simply reflect the relatively higher population and economic activities compared with neighboring states. In addition, coastal states show overall higher vulnerability across both natural and human-caused categories, whereas interior states (e.g., Montana, Wyoming, North Dakota) generally report low EAL and infrequent human-induced incidents.

Protocols and training must continuously evolve for effective emergency management that addresses the dynamic and increasing range of catastrophic risk and disaster types affecting the United States. By leveraging multiple public data sources, each with its own areas of focus, emergency management personnel can gain a more comprehensive understanding of these risks. This quantitative analysis at the state level highlights the importance of tailoring emergency management strategies to the specific geographical characteristics and vulnerabilities of each community. Continuing efforts to collect and integrate diverse datasets will assist emergency management's ability to minimize the impacts of catastrophic events.

Historical datasets do not accurately capture the frequency or risk associated with emerging hazards and threats. To fill this gap, we reviewed national hazard and threat risk assessments to identify the event types identified as posing the greatest risk to SLTT communities in the United States. The results of this review are presented in the next section.

Comparison with National Hazard and Threat Risk Assessments

We reviewed national and international hazard and threat assessments from a subset of U.S. and international organizations and governments to compare our analysis of the hazards and threats most likely to threaten SLTT communities with those identified in national assessments. The text box summarizes the top threats and hazards identified from this review and shows the categories (from Table A.2) for each.

[95] FEMA, 2026a.

[96] FEMA, undated-b.

[97] START, 2022.

Summary of Priority Threats and Hazards from National and International Assessments

National Threat and Hazard Identification and Risk Assessment (2023)[a]	Homeland Threat Assessment (2025)[b]	Third Quadrennial Homeland Security Review (2023)[c]	World Economic Forum Global Risk Perceptions Survey (2025)[d]
• Cyberattack (*cyberattacks*) • Pandemics (*biological*) • Floods (*severe storms, precipitation*) • Active shooter incidents (*active shooter incidents*) • Earthquakes: considered most damaging (*geophysical*) • Hurricanes/ typhoons: considered most damaging (*coastal hazards*) • Wildfires: specific to Western United States (*wildfires*) • Tornadoes: specific to Midwest United States (*severe storms, wind*)	• Terrorism: international and domestic violent extremism and targeted violence (*civil disturbances; other terrorism*) • Chemical, biological, radiological, nuclear, and explosives (CBRNE) (*CBRN incidents*) • Illegal drugs (*civil disturbances*) • Nation-state threats (*nation-state threats*) • Migration and watchlist encounter trends (*miscellaneous*) • Transnational criminal organizations (*miscellaneous*) • Human trafficking (*miscellaneous*) • Disruptive and destructive cyberattacks (*cyberattacks*) • Physical attacks on critical infrastructure (*critical infrastructure failures*) • Intelligence collection against critical infrastructure networks (*critical infrastructure failures*) • Economic manipulation and coercion (*nation-state threats*) • Economic espionage and influence (*nation-state threats*) • Climate change and natural disasters (*natural: hybrid*)	• Dynamic terrorist threats (*other terrorism*) • Cyber attack (*cyberattacks*) • Crimes of exploitation • Transnational organized crime • Proliferating cyber threats (*cyberattacks*) • Strategic competition (*nation-state threats*) • Climate change (*natural: hybrid*) • Emerging infectious diseases (*biological*) • Complex and interconnected incidents (*hybrid*)	• State-based armed conflict includes international terrorism (*nation-state threats*) • Extreme weather (*severe storms, precipitation; severe storms, wind; coastal hazards*) • Geoeconomic confrontation • Mis- and disinformation (*AI and foreign information campaigns*) • Societal polarization • Economic downturn • Critical change to earth systems (*natural: hybrid*) • Lack of economic opportunity • Erosion of human rights • Inequality

SOURCES: Features data from the following:
[a] FEMA, *2024 National Preparedness Report,* December 2024.
[b] DHS, Office of Intelligence and Analysis, 2025.
[c] DHS, *Third Quadrennial Homeland Security Review*, April 2023.
[d] World Economic Forum, *The Global Risks Report 2025*, 2025, Appendix B: Global Risk Perception Survey 2024–2025.
NOTE: The incident category from Table A.2 associated with each hazard or threat is shown in italics.

We compare these lists with the results from our quantitative analysis of historical datasets. Unsurprisingly, the historical data show a high frequency of natural disasters, such as hurricanes, and technological incidents, such as critical infrastructure failures, whereas the assessments we reviewed focus on human-caused threats, such as terrorism, nation-state threats, and cyberattacks, among others. We hypothesize that the federal government, SLTT governments, and the public anticipate or perceive these incidents as having more-severe consequences than other types of incidents. Hurricanes and wildfires may be more frequent and cause more collective damage, but these are hazards that SLTT governments have been preparing for over many years and likely have well-developed response capabilities for. In contrast, nation-state threats, cyberattacks, and AI are all emerging threats for which SLTT governments are likely less prepared and therefore consider greater risks.

Abbreviations

AAR	after-action report
AI	artificial intelligence
API	application programming interface
CBRN	chemical, biological, radiological, and nuclear
CBRNE	chemical, biological, radiological, nuclear, and explosives
CERT	Community Emergency Response Team
COOP	continuity of operations
COVID-19	coronavirus disease 2019
DHS	U.S. Department of Homeland Security
EAL	expected annual loss
EIA	U.S. Energy Information Administration
EM-DAT	Emergency Events Database
EPM	*Electric Power Monthly*
FEMA	Federal Emergency Management Agency
FFRDC	federally funded research and development center
FY	fiscal year
GTD	Global Terrorism Database
HHS	U.S. Department of Health and Human Services
HSOAC	Homeland Security Operational Analysis Center
MOU	memorandum of understanding
NASA	National Aeronautics and Space Administration
NDEMU	National Disaster and Emergency Management University
NOAA	National Oceanic and Atmospheric Administration
NRI	National Risk Index
OODA	observe, orient, decide, act
PKEMRA	Post-Katrina Emergency Management Reform Act
SLTT	state, local, tribal, and territorial
SME	subject-matter expert
START	National Consortium for the Study of Terrorism and Responses to Terrorism

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