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Editor's Note

New Year's Resolution – Stronger Communities

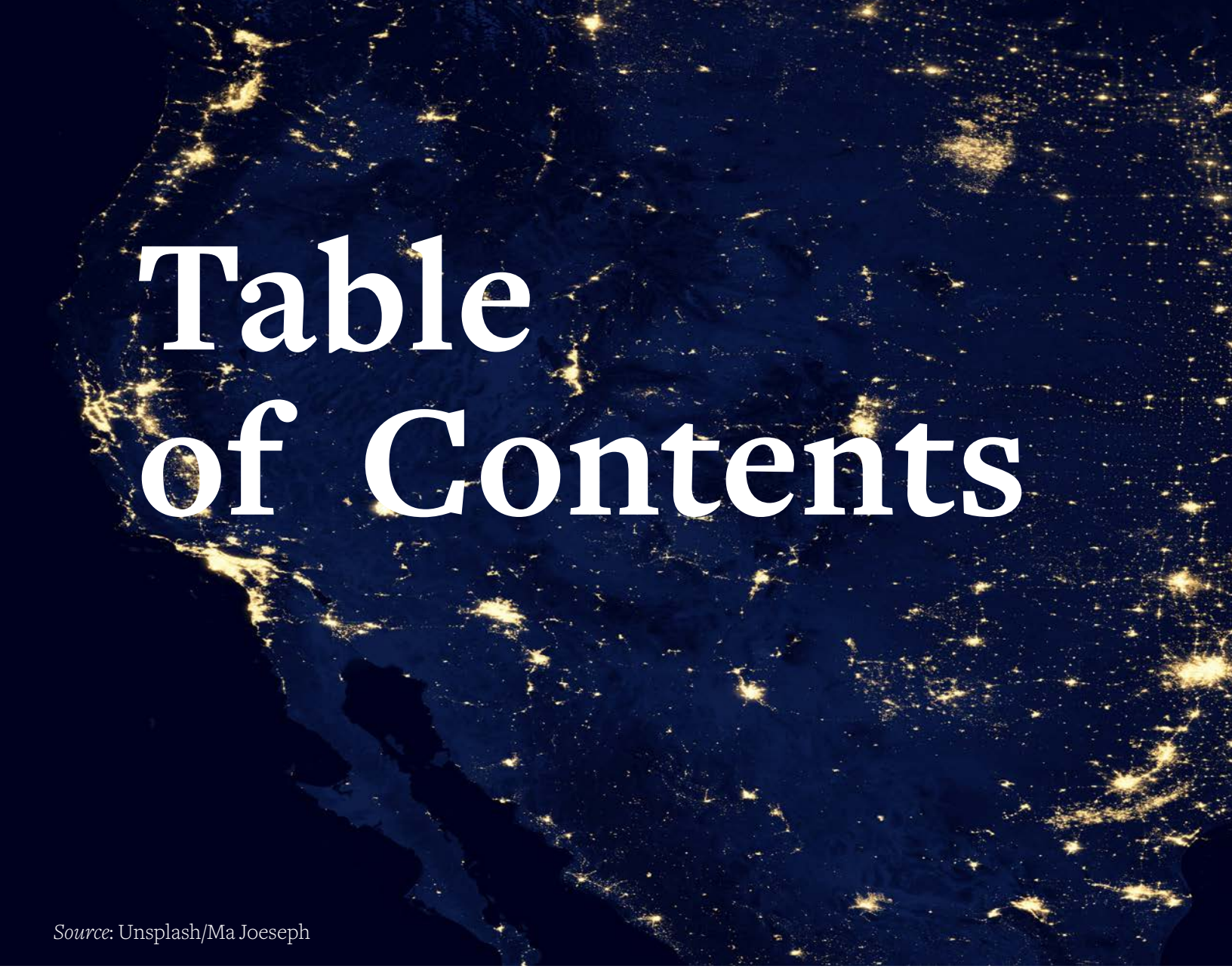
By Catherine L. Feinman

For many, January is a time for New Year's resolutions – opportunities to avoid making past mistakes and a renewed energy for change and setting higher goals. For Domestic Preparedness readers, this may mean learning lessons from past incidents, creating or updating plans and procedures, or acquiring equipment and resources. It takes strong leadership skills, education, training, and forward-thinking to anticipate potential threats and consequences that could impact communities. However, as the old cliché goes, there is strength in numbers.

The authors in this January edition of the Domestic Preparedness Journal describe how communities can strengthen their efforts to mitigate future threats and their impacts. One county discovered weather radar gaps that limited access to information needed to protect against incoming storms. Now they are installing a system to warn locals about impending threats and how to protect themselves. A group of researchers saw how low-lying homes and structural weaknesses could have catastrophic consequences in flood waters. This inspired them to create a new design tool to help homeowners safely raise buildings to better protect properties and lives.

Like in these two examples, collaborative efforts bring together knowledgeable stakeholders across disciplines to drive resiliency. For example, community leaders who listen to and communicate with local stakeholders can acquire information and develop relationships that promote stronger and safer jurisdictions. Information sharing helps communities prepare for emergencies and assists during and after an incident. Collaboration that helps community leaders identify and mitigate threats, track patients, and reunify families are just a few other examples mentioned in this month's issue.

The roles, responsibilities, vulnerabilities, and interdependencies of three more critical infrastructure sectors round out the issue. These sectors provide basic utilities and facilitate common daily activities. Collaboration and relationships help build actionable knowledge and resources to make the best decisions under difficult circumstances. This is a new year and an opportunity to make the changes and reach the goals needed to strengthen communities to address future threats and hazards. What is your New Year's resolution for your community?



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Weathering the Unknown: Inside Grant County Emergency Management

By Tara Leigh Goode

Source:Unsplash/NOAA

Gaps in weather radar coverage leave emergency responders guessing about some storms – but help could be on the way.

Every time threatening weather approaches Grant County, Minnesota, Emergency Management Director Tina Lindquist has a gut-wrenching decision to make. While taking steps to prepare for the unknown and inform the public, Lindquist also works with the six volunteer fire departments and the local sheriff's office as they decide whether and where to deploy their network of more than two dozen volunteer spotters. Increasingly, she worries that she does not have all the information she needs to keep them out of harm's way. So, she is now leading an effort to change that – for her fellow emergency responders and the public they serve.

To illustrate the threat, Lindquist points to May 2022. Twice that month, derechos – devastating, long-lived wind storms – swept across Minnesota, leaving damage in their wake. In advance of severe storms, Lindquist works with responders and dispatch to ensure response plans are ready to be set in motion. Two dozen or more firefighters and other emergency crews – almost all volunteers – fanned out across the area.

RESOURCE DEPLOYMENT DECISIONS

Choosing the right locations is critical for multiple reasons. Crews need to spread out so they can rapidly deploy wherever needed. They must also distribute equipment to reduce the likelihood of simultaneously damaging assets. Most importantly, the team focuses on keeping the responders safe. "Our volunteer responders are the heart of our community," said Lindquist. "They're the first group to step up because they're passionate about keeping their neighbors safe. We want to help them make good decisions."

Even when storms like derechos cover huge areas and are forecast well in advance, the targets facing the highest intensity and danger constantly shift. That kind of activity is challenging for the team to track. Grant County sits in a diamond-shaped area of Minnesota so far removed from National Weather Service Radars in the Twin Cities, Duluth, and the Dakotas that the radar beams are at 10,000 feet or higher by the time they reach this part of the state. Meteorologists and emergency responders cannot see what is happening at lower altitudes, where conditions can quickly turn deadly.

"Warnings were spotty," Lindquist said of the May 2022 storms. "And even when there were warnings issued, there were plenty of dangerous conditions outside the warned areas." For emergency responders, the results were terrifying and tragic. There were reports of high winds lifting volunteer responder vehicles off the ground and moving them into nearby fields. Miraculously, those responders walked away uninjured. However, in nearby Kandiyohi County, Ryan Erickson, a former fire chief with more than 40 years of experience, died when a silo blew over onto his vehicle.

"Tell me how you feel if you're the person making the decision to send out spotters," said Lindquist, whose 20-year-old son is training to be a volunteer responder. "It isn't safe sending responders out if we don't know what we aren't seeing."

Winter weather is even more difficult for weather radars to pick up at a distance, which is incredibly challenging for emergency managers in northern states like Minnesota. Lindquist pointed to a snowstorm that hit the night before Christmas Eve 2022, stranding many motorists in Kandiyohi County as roads became impassable. When rescued, most said they had looked at the radar before leaving home, and it did not show any impactful weather.

Minnesota emergency managers also experienced the gaps firsthand in February 2023. As they gathered near Minneapolis for a

Installation of a new X-band radar in Wendell, MN, which will help fill one of several gaps between weather radars in Minnesota (*Source*: Tara Goode, October 19, 2023).

statewide conference, severe winter weather moved into the Twin Cities. As officials left the event to drive home across the state, they traveled through heavy winter weather the entire way, most of which never appeared on the radar. "TV stations were reporting one inch or more of snow falling an hour from the Metro to St. Cloud (about an hour away), but they had no idea how bad conditions were farther out," Lindquist remembered.

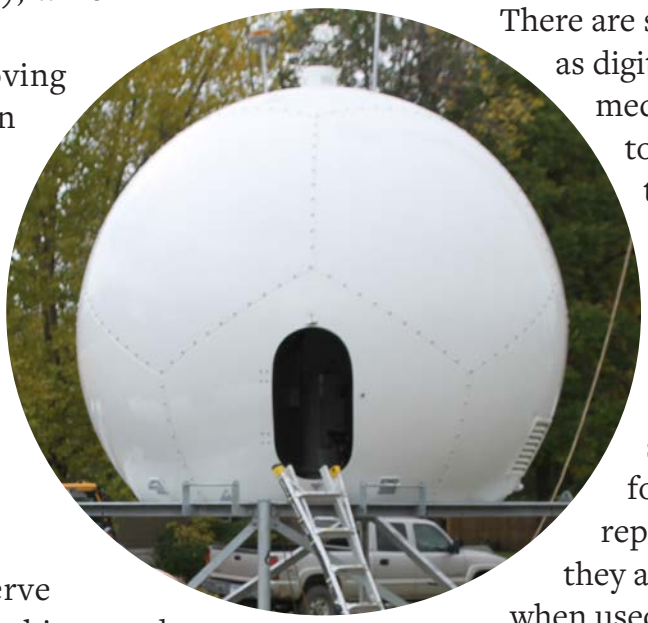
WORKING TOWARD CLOSING RADAR GAPS

Lindquist and others have formed a workgroup as part of the Association of Minnesota Emergency Managers. Their mission is to fill the radar gaps, which typically involves expensive technology. Most local governments cannot afford to buy and maintain their own radar systems, and the National Weather Service has not installed a new Next Generation Weather Radar (NEXRAD) since 1997. The group has also considered looking outside the government.

For example, Grant County has just partnered with a commercial weather tech company to install a new, high-resolution radar on top of a water tower in Wendell. The company is taking on the burden of ownership – they fund it, operate it, maintain it, and then provide the data to private clients, but Lindquist's team of responders in Grant County will also have access at no charge. "This will be the first time we're getting a real visual radar picture of what's happening on the ground in our area – and in the counties to our north, south, east, and west," Lindquist said. "It will help not only our emergency responders but also public works and the community as a whole."

Source/Unsplash/Jonathan Bowers

In November 2023, the U.S. House Committee advanced the Weather Act Reauthorization (H.R. 6093), which encourages public-private partnerships. The bill is moving toward a floor vote and then to the Senate. However it happens, plugging the gaps will benefit both rural and urban areas. Positioning emergency resources can be more complex in heavily populated areas, so providing data as storms are approaching through rural areas can be critical. Better data will also help serve urban residents as they travel into and through places like Grant County, whose population can sometimes double with resort and recreational traffic.



"Our partnership with the National Weather Service is extremely important to us," Lindquist said. "By no means are we dissatisfied with them. We want to help them. The more eyes on the sky, the better – that's how we feel about this." While officials explore the different types of radar technologies and possible plans for the state, she said the most important thing is for the public to realize radar gaps exist.

There are so many tools, such as digital applications and media platforms, available to communities today to help crowd-source official alerts, warnings, and even highly localized information about real-time weather situations. While these forums are helpful for reporting current impacts, they are most beneficial when used in conjunction with all of the pre-planning briefings and opportunities that the National Weather Service provides. When paired together, these information innovations help complete the weather picture, especially in the lower levels of the atmosphere. With so many mobile weather applications, people can get a false sense of security when they do not see any storms on their screens. "Just because the radar can't see a storm doesn't mean it isn't there," Lindquist said. "You don't know what you don't know."

Tara Leigh Goode, vice president for strategic partnerships and radar operations at Climavision, is a public service and weather technology veteran with almost 20 years of experience across both sectors. At the start of her career, she spent nearly a decade in public service, where much of her time involved preparing for and responding to severe weather events on both sides of the country, with populations ranging from 30 thousand to over 1 million. In a public service capacity, she oversaw grant writing efforts, helping to secure over $36 million in funding for critical infrastructure and community projects. For the past decade, she has worked on the leading edge of weather and energy technologies, helping to support sensor networks in over 90 countries. Goode helped launch Climavision, a weather technology start-up on a mission to close critical low-level and surveillance gaps in weather observation to expand weather data access and protect people and property. She has an MSIR in International Relations and a BA in English/Creative Writing with a minor in Education.

Beyond Patient Care: Family Reunification Planning for Hospitals

By Michael Prasad

Hospitals have the opportunity and responsibility to be a supportive partner to a community's family reunification needs. Collaborating with governmental and nongovernmental partners can benefit everyone by ensuring proper planning, organization, equipment, systems, training, and exercising.

FEMA personnel help Hurricane Ian survivors register for assistance in Florida, October 19, 2022 (*Source:* FEMA).

Following a disaster, friends and family will try to reconnect with those affected by the incident as soon as possible. This means that hospitals and other healthcare facilities must have plans and procedures in place for mass casualty incident response beyond patient care. Surge capabilities for *significant* additional activities include patient registration and tracking, family reunification, and coordination with external entities. If nonpatient-care activities are not planned, organized, equipped, trained, and exercised in advance, the impact could overwhelm any healthcare facility and compromise its ability to deliver lifesaving care:

> *Disasters and mass casualty incidents can strike at any time, separating families and friends from their loved ones or displacing them for long periods of time. Some patients will not survive, and family notification and support must be provided. Patient tracking and family reunification and support services are key aspects of disaster response and recovery, but also some of the most challenging. Hospital-based family support actions and centers must also integrate activities and referrals with community-based resources and Family Assistance Centers.* (ASPR/TRACIE/HHS, *2023*)

The Community's Need for Supporting Reunification Efforts in Disasters

In the U.S., emergency management categorizes family reunification under Emergency Support Function #6 (ESF-6) Mass Care during disasters because evacuations often involve sheltering – and shelters collect registration information from evacuees. Today's disaster shelter could also become tomorrow's community resource center. For example, when communications systems are down, residents gravitate to disaster operational sites to connect to the outside world. The same applies to hospitals, which may be a closer location and will generally have power and communications capabilities. Hospitals may also have casualties from the incident – and their friends and families will travel there to reunify. These reunification processes at different sites cannot operate in silos. They must be collaborative, coordinated, and communicative with each other. Hospitals should be a support partner to the Incident Command (through ESF-6 or ESF-8 – Public Health) for reunification, in the same way they are for mass casualty care.

As a complex mission under ESF-6, the safe and secure process of reuniting friends and family with those who were missing, injured, or even deceased should be a priority for any governmental or nongovernmental organization. Significant life safety and incident stabilization concerns exist if family reunification is not performed or is done incorrectly. Even without physical injuries, patients and their friends and families will enter hospitals with trauma and other concerns that the receiving facilities must triage. In most cases, hospitals will collaborate with external partners before making a reunification decision.

There will be requests for reunification support in languages other than English. There may be requests from law enforcement agencies for criminal investigations and missing persons. Requests may come from the American Red Cross and other nongovernmental organizations, such as the National Center for Missing and Exploited Children. Other nations may send requests via governmental public health organizations through embassies and consulates. All of these requests for reunification support are covered under the Health Insurance Portability and Accountability Act's distribution of patient health information

for the direct benefit of the patients. As such, hospitals should plan to:

- Be part of the existing governmental organization's emergency management plan for family reunification,
- Originate or activate their own family reunification plan, or
- Both (cascading or collectively).

Examples include:

- An incident of scale occurred at a site that did not have suitable facilities for family reunification, so several injured patients were transported to the hospital.
- A family reunification process began elsewhere. However, as the number of hospital transports increased, a collaborative decision moved the family reunification process to the hospital.
- Government officials requested that the hospital establish a family reunification process in anticipation of a mass casualty incident at a planned event (i.e., consequence management planning for Special Event Assessment Rating events).
- An incident occurred on hospital property, and it remained safe to establish family reunification on-site.

A hospital's family reunification protocol should be collaborative with other organizations – especially those that have custodial relationships with their constituents and will have their own protocols in place for family reunification when incidents occur at their own sites. Examples include: a K-12 school (a bus crash on an interstate highway generating a mass casualty incident); an adult day care center (transport vehicle's driver shot at, carrying people to a center); or a nursing home (evacuated due to fire).

However, there also may be situations where communications to the public should not be made for reunification protocols, for patient safety reasons – for example, domestic violence shelters, developmentally disabled group homes, or human trafficking concerns (i.e., incident evacuating a migrant shelter, generating patients to the hospital). Again, the coordination with emergency management officials in the jurisdiction – through their Emergency Operations Center – will be able to resolve these concerns in a timely manner.

Recommendations and Action Items

To ensure effective reunification plans are in place, the author strongly recommends that hospitals participate in governmental and nongovernmental organizations' family reunification training and exercises. In addition, hospitals should invite governmental and nongovernmental organizations to participate in their own family reunification training and exercises – especially partners with key response actions in the hospital's mass casualty and family reunification plans. Small and rural hospitals will benefit from the collaboration and coordination, which is needed in both sets of plans, which may require extra sites, staffing, and other resources beyond the capacity of the hospital itself. The following best practices emerged from research of family reunification planning models:

- Use a multi-site construct, one that houses a Friends and Family Reception Center, a Pediatric Safe Area, a formal Family Assistance Center (modeled after the design from the National Transportation Safety Board), and private or semi-private meeting room areas for direct interactions with families.

Source: Unsplash/Annie Spratt

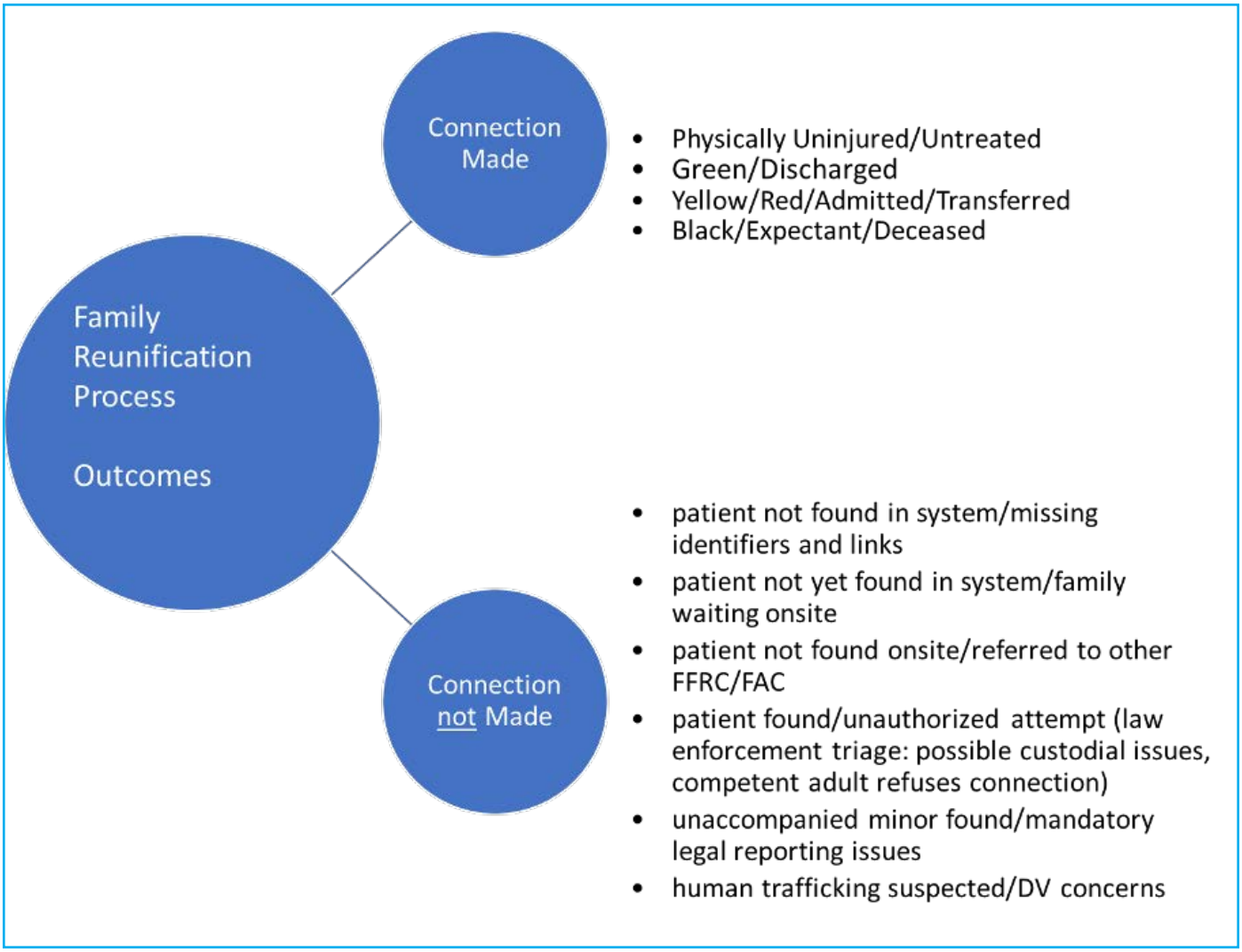


Fig. 1. Family Reunification Outcomes (*Source:* Barton Dunant, used with permission).

- A whole-of-community approach (both within the hospital and with its external partners) works best. Speed-to-scale is important, but so is a patient's safety and privacy. Nongovernmental organizations may be able to help with staffing for disaster health services, disaster mental health, and disaster spiritual care to supplement hospital staffing.
- The reunification process works best in person. Trying to reunify over the telephone or through the internet is fraught with problems and presents large windows for liability concerns and patient or staff risk.
- Triaging friends and family requires more space or rooms at a site or facility but will help preserve patient safety and privacy, provide consistent service and support, and move people efficiently through the family reunification process.
- Make decisions about media access early and communicate them broadly and quickly. Generally, media access is limited to specific sites. However, in today's hyperlocal news and social media environments, anyone with a smartphone can be *live* on national news from anywhere with a signal. The hospital's public information officers

(PIOs) must coordinate continuously with other PIOs.

Plan for a long duration of mission activity. Anticipate that the family reunification sites could be open for days or weeks. Decisions about relocation or demobilization must include consideration for the hospital's continuity of operations.

Partial outcomes (e.g., some patients were sent to one hospital, some to others, discrepancies over custodial rights, etc.) may be circular and continue in the family reunification process. If the incident is still surging, friends and family may repeat this process to reunite with other patients arriving at different times. In addition, the family reunification process may occur in multiple existing areas of the hospital or specifically designated new ones (the Friends and Family Reception Center, the Family Assistance Center, and the Pediatric Safe Area) and has the type of flow in Figure 2.

In this flowchart, as friends and family move *left to right* on the top row, beginning with the Friends and Family Reception Center, admitted patients move from the *middle to the right* after any necessary decontamination, triage, and treatment. Discharged (i.e., treated and "released") unaccompanied minors must go to a pediatric safe area. And discharged adults can go to the Family Assistance Center for reunification. It is important to note that many scenarios exist where a family cannot leave the hospital on the same day they are reunited. For these and other circumstances, the length of time that visitors remain at the hospital in the family reunification process varies and requires support from other mass care elements (feeding, sheltering, and distribution of emergency supplies such as comfort kits). To accommodate these

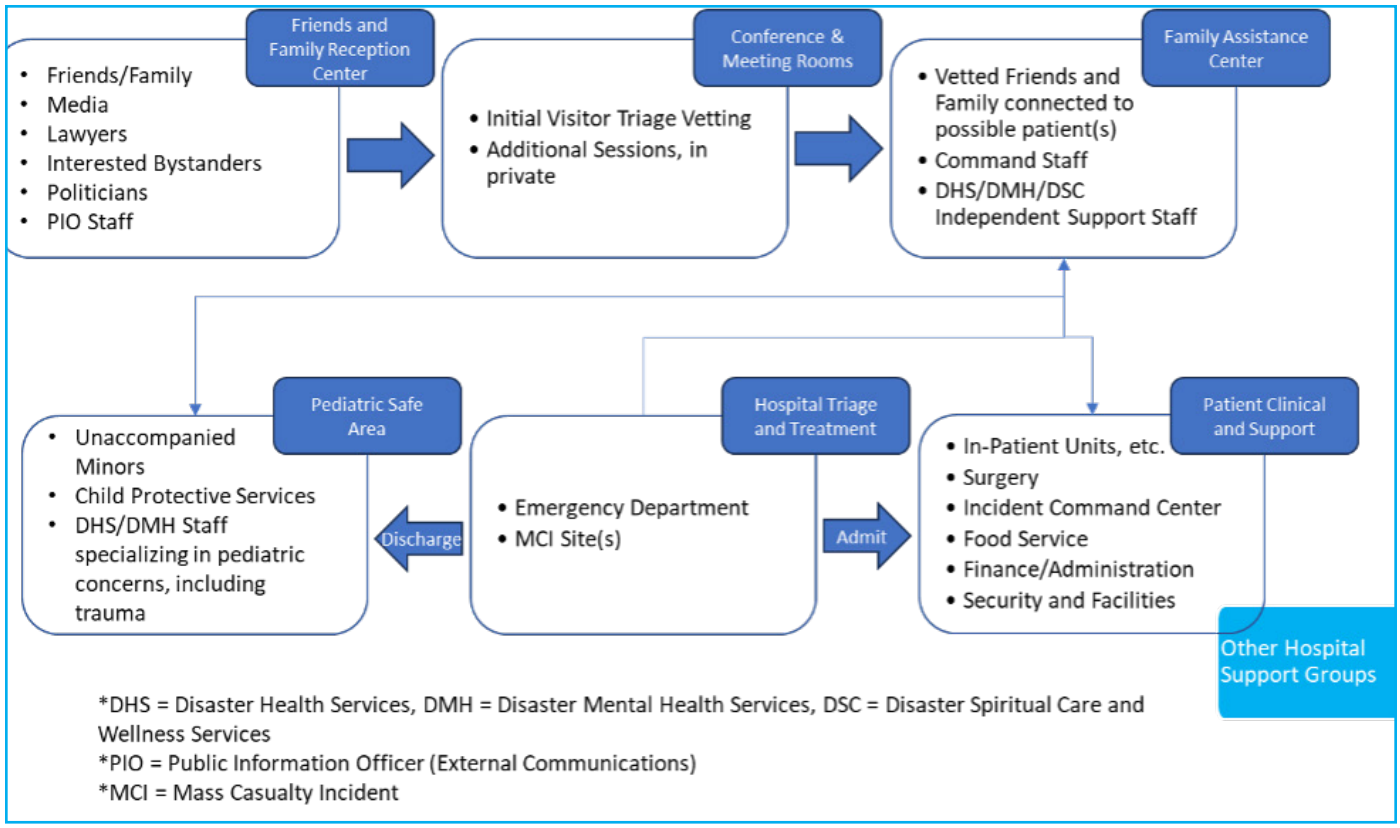
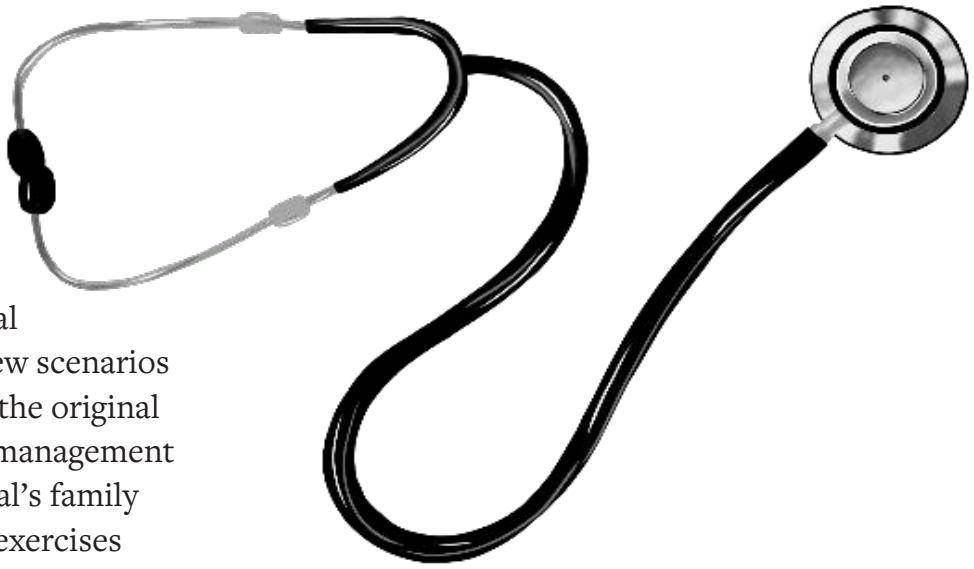


Fig. 2. Friends, Family, and Patient Flow Model (*Source:* Barton Dunant, used with permission).

variances, each staff role will need a backup, shift replacement support, etc., which may require additional temporary staff.



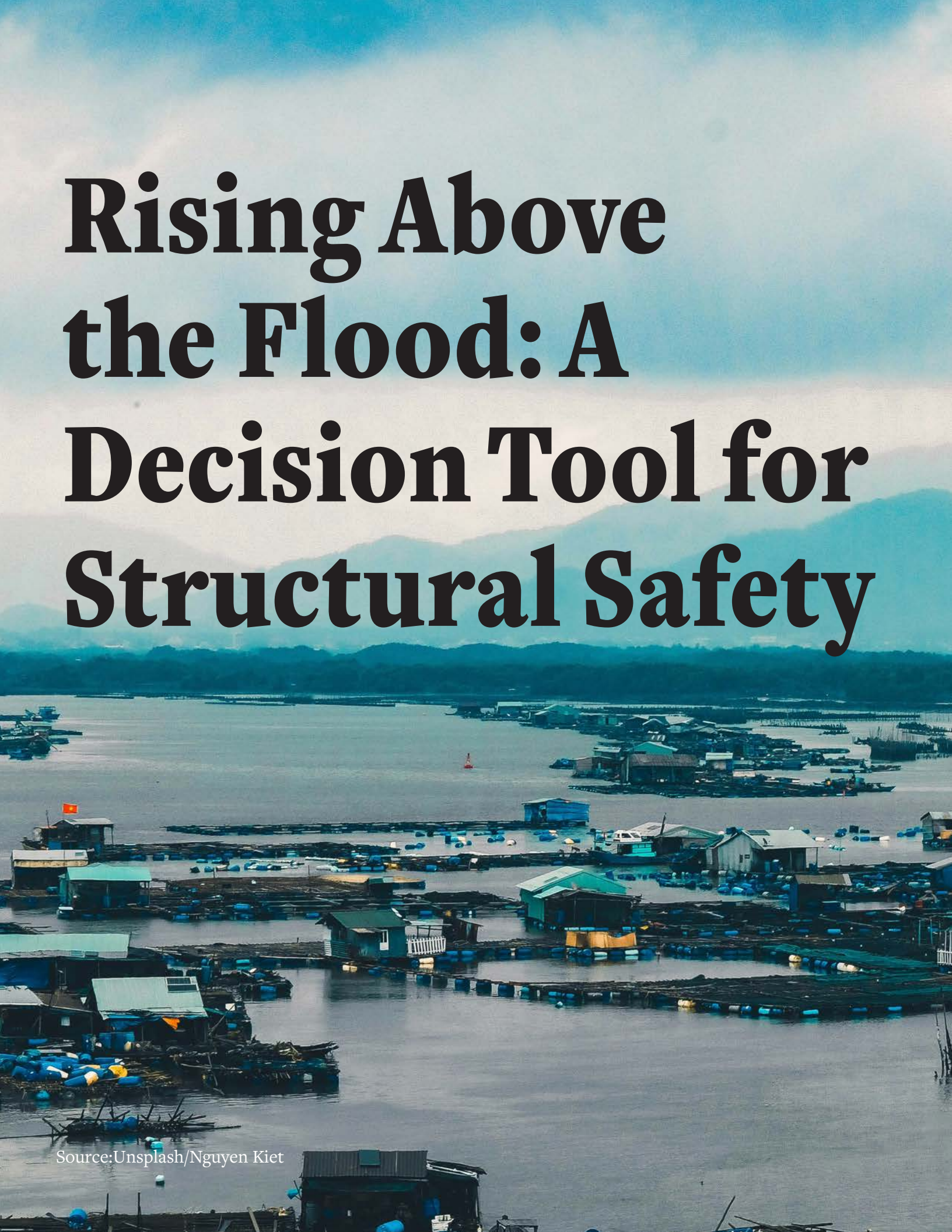
Incorporating exercises, real-world examples from this hospital system and its other sites, and new scenarios and injects that were not part of the original design – including consequence management scenarios – can improve a hospital's family reunification plan. For example, exercises could include how the hospital's family reunification process would be implemented differently if:

- The incident involved VIPs interwoven with other people, including private security details,
- The incident involved government officials, their staff, and family members with public law enforcement protection,
- One or more individuals were a Megan's Law offender (i.e., registered as a sexually violent person),
- COVID-19 or other public health emergency protocols were in place,
- The incident involved chemical, biological, radiological, nuclear, or high-yield explosives that require decontamination protocols,
- Severe weather conditions generated a shelter-in-place order, or
- The hospital was a direct target of an attack that generated the need for reunification.

Hospitals have the opportunity and responsibility to be a supportive partner to a community's family reunification needs. Collaborating with governmental and nongovernmental partners can benefit everyone by ensuring proper planning, organization, equipment, systems, training, and exercising.

Michael Prasad is a Certified Emergency Manager®, a senior research analyst at Barton Dunant – Emergency Management Training and Consulting (www.bartondunant.com), and the executive director of the Center for Emergency Management Intelligence Research (www.cemir.org). Mr. Prasad has held emergency management director-level positions at the State of New Jersey and the American Red Cross, serving in leadership positions on more than 25 disaster response operations, including Superstorm Sandy's response and recovery work. He researches and writes professionally on emergency management policies and procedures from a pracademic perspective. His first book, entitled "Emergency Management Threats and Hazards: Water," will soon be published by Taylor & Francis/CRC Press. He holds a Bachelor of Business Administration degree from Ohio University and a Master of Arts degree in emergency and disaster management from American Public University. Views expressed do not necessarily represent the official position of any of these organizations.

Rising Above the Flood: A Decision Tool for Structural Safety



Source:Unsplash/Nguyen Kiet

By Cedric Ling, Debashish Kar, Nur Yazdani, Eyosias Beneberu, Maria Koliou, and Yong Yoo

Communities along the U.S. Gulf Coast experience severe flooding events that cause extensive casualties and property damage. In 2005, Hurricane Katrina generated storm surges as high as 11.45 feet (3.5 m) along the state of Louisiana's coast and cost the country $161 billion in damage, according to the National Oceanic and Atmospheric Administration (NOAA). Robbie Berg at the National Hurricane Center reported that, in 2008, Hurricane Ike inundated the coastal communities of Texas with as much as 10 feet (3.1 m) of water and left damage worth a total of $19.3 billion.

After those and similar flooding events, homeowners may choose to elevate their homes above the base flood elevation, which is a viable mitigation method to reduce or eliminate flood damage. To do this, the existing concrete foundation slabs are typically cast in place directly on the soil support – about 4 inches (102 mm) thick with minimal reinforcement of a single layer of welded wire fabric. The slab perimeter is typically provided with a concrete-grade beam for added stiffness.

The elevation method involves raising the slab home and the attached beams to as much as 15 feet (4.6 m) and placing them on pier supports. For economy and practicality, solid concrete or stacked concrete masonry units are typically used for piers. These are usually placed below the grade beams or newly added steel beams if additional supports are required.

AN EXISTING KNOWLEDGE GAP

Elevating a home above the base flood elevation is a viable option for flood damage reduction. However, the elevation process may cause unanticipated deformations and stresses due to the changed support conditions. Such slabs are typically lightly reinforced, and the concrete degrades with age, reducing the capacity and safety. The elevated slabs, therefore, must be properly supported, and inadequacies in these areas can result in possible slab failure, leading to casualties and economic losses. With the proliferation of home elevations in flood-prone areas, the structural safety of such projects is of critical concern.

A knowledge gap exists in the design of elevated home slabs. The American Concrete Institute (ACI) 318-19 Building Code or governing bodies such as the Federal Emergency Management Agency (FEMA) do not provide relevant guidelines or instructions. The former includes guidance on the design of concrete slabs for specific support conditions. However, it does not cover the design of elevated home slabs. The FEMA Homeowner's Guide to Retrofitting defers such design aspects to trained engineers or contractors. Due to its comparatively low cost and simple design, the current home slab design process has found general acceptance among developers at the expense of an unknown risk of slab cracking, greater deflection, and possible failure. This unknown risk highlights the uncertainty of converting a soil-supported slab into an elevated frame slab without changing the original design.

Furthermore, under the International Residential Code (IRC), which is, by and large, the governing code for residential construction in the U.S., the floor of a single-family residential space must be able to support a minimum of 40 pounds per square foot (psf, or 1.9 kPa) of distributed live load. Any inability of the home floor to support at least that much live load is considered non-conforming according to the IRC provisions. Because of the inherent weakness of the elevated home slab support configuration, several elevated home collapses have been reported to date:

- In 2011, a home in Louisiana collapsed while being lifted as part of the post-Hurricane Katrina relief effort.

Fig. 1. Experimental two-way concrete slab with concrete masonry unit piers (*Source:* Authors, 2023).

- In 2013, after Hurricane Sandy, during elevation, a home in New Jersey slid off its foundation and collided with another as the former was being raised.
- A house in New York also collapsed as it was being raised in the wake of Hurricane Sandy. Many other such examples can be found in the literature.

To address the knowledge gap and safety concerns that exist when elevating a home, the authors conducted a study with two key objectives:

- Examine the safety of elevated home slab configurations and determine the maximum allowed pier spacing to safely support the IRC minimum floor live load.
- Develop a simple tool to check the safety of desired elevated slab configurations that FEMA guidelines or the ACI Building Code do not address.

EXPERIMENTAL PROCEDURE

An experimental study was performed in 2020-2021 to determine how much floor load the typical raised concrete home foundations in residential homes around the Texas Gulf Coast region could safely carry (see Figure 1). Increased floor loads stress the slab to higher levels that can eventually cause the slab to fail through concrete or steel failure. The tests involved pouring water on top of plywood troughs built atop each slab to simulate typical floor loads from everyday use. Data gathered from testing showed how these types of slabs failed and where to expect such failure. It was found that the typical practice of limiting support pier spacing to 10 feet (3.1 m) was adequate to safely carry the building code-specified minimum load. Square-shaped slabs were more susceptible to failure than rectangular-shaped ones. Additional information about the experimental work may be found in the literature (Ling et al., 2023),

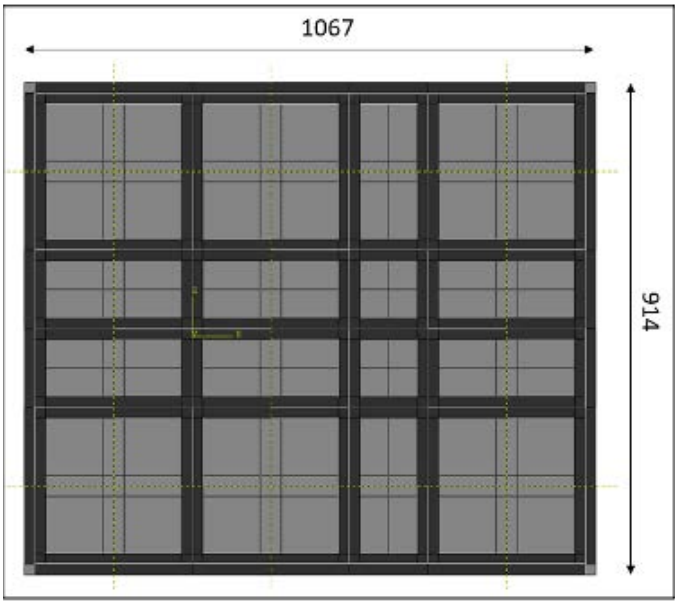


Fig. 2. Sample model home floorplan (dimensions in cm) (*Source:* Authors, 2023).

which is currently under review with the *Journal of Coastal Research*.

The results from the experimental study were used to create computer models that replicated the behavior of real-life slabs. The verified models were then used to explore slabs of various sizes, shapes, and support conditions, such as the one shown in Figure 2. The model results were then configured to link to the decision tool, as discussed below. In these simulations, the maximum applied floor load was 80 psf (3.8 kPa), which is double the minimum value specified by the IRC for single-family residential homes.

TOOL DEVELOPMENT

Based on the numerical modeling results, a Home Elevation Decision Tool was developed in 2022 by Nur Yazdani with assistance from Cedric Ling, Debashish Kar, Maria Koliou, and Yoo Yong as a software interface. It allows users to determine the floor load capacity of an elevated home slab rapidly and conveniently, based on the governing building code provisions. The user must log in or create a new account to access the full data set of features, or they may proceed as a guest to use a more limited portion of what the application offers. A disclaimer and a user manual are also available from the home screen (see Figure 3). The Excel-based tool is freely available on Android, iOS, and desktop platforms. It may be found by searching App stores for "Home Elevation Decision Tool."

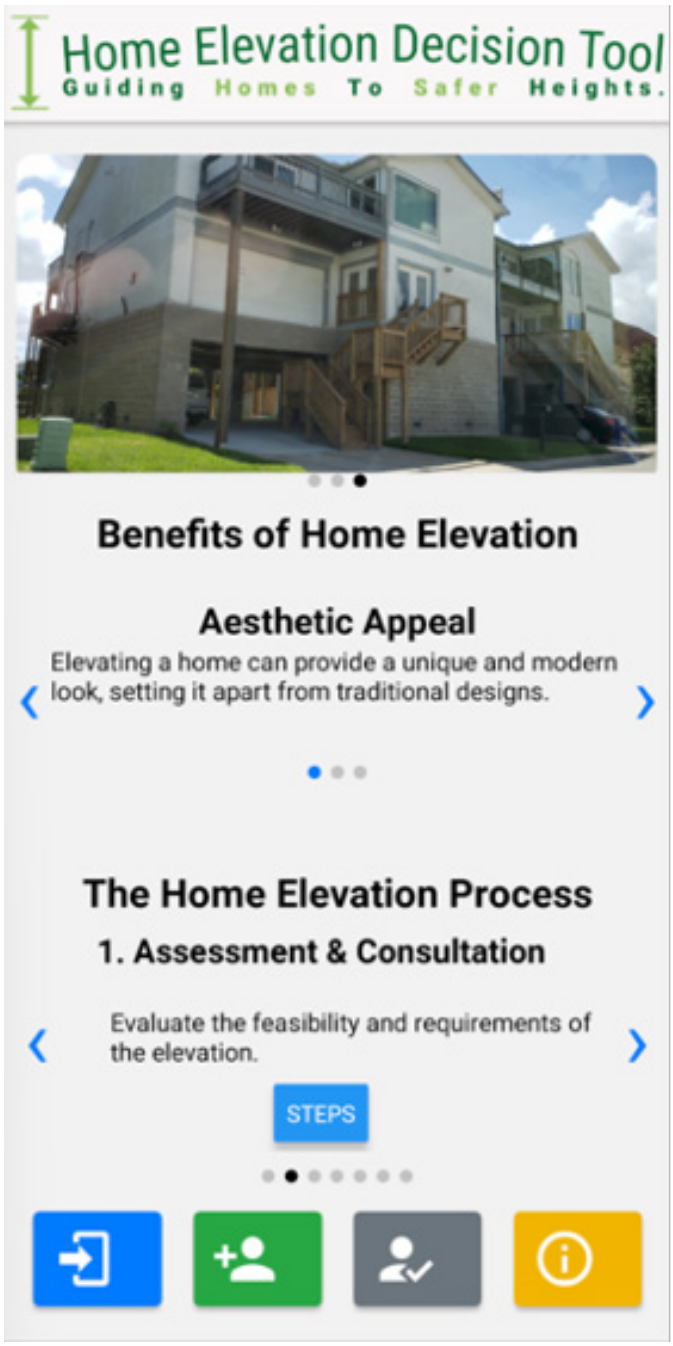


Fig. 3. Decision tool application home screen (*Source:* Authors, 2023).

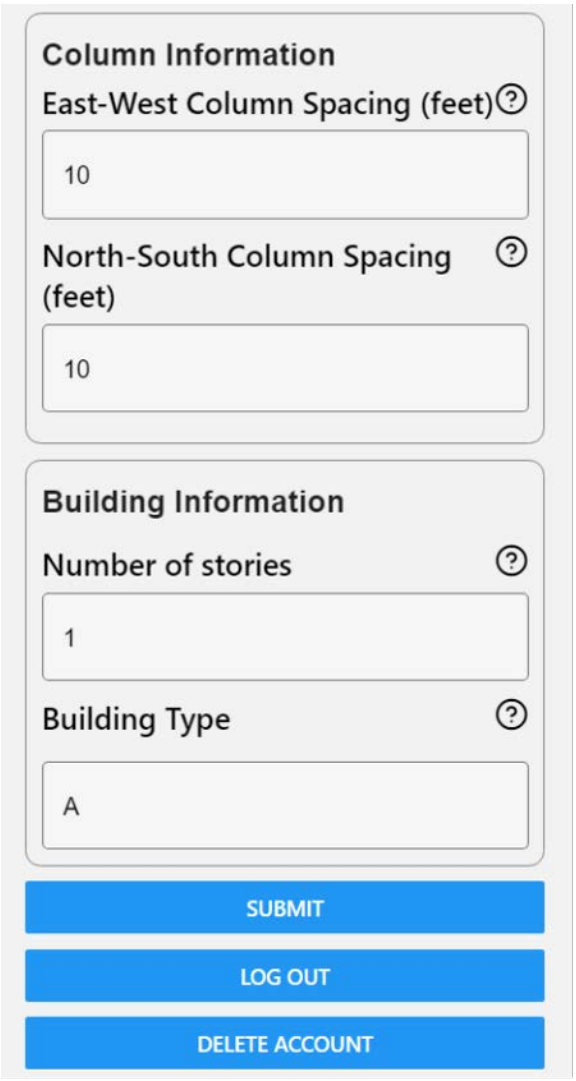


Fig. 4. Decision tool application parameter selection screen (*Source:* Authors, 2023).

The user selects a home model from five available archetypes that most closely resemble the actual home being considered. The selection is tied to the home floor area, number of stories, and roof configuration. The pier spacings in the two directions are then selected, determining the total number of piers in the configuration (see Figure 4).

When prompted via the "submit" link, the tool compares the entered selections with a hidden internal database of numerical values. It then outputs whether the specific support beam-pier configuration can safely support the minimum floor loading. A sample results screen from the application is shown in Figure 5, showing the output when the entire elevated slab can safely support the minimum IRC live load.

Since its first release in 2022, the research team at the University of Texas Arlington and Texas A&M University College Station has expanded the study by including the superstructure of the elevated homes (walls, roofs) and considered the effects of applied lateral loads such as flooding and wind. The authors envision that the first version of the decision tool will be enhanced with additional results if future funding for such efforts becomes available.

Cedric Ling received a Ph.D. degree in structural engineering from the University of Texas at Arlington. He earned his Bachelor of Science degree in Ocean Engineering at Texas A&M University College Station and a Master of Engineering degree in Civil Engineering at the University of Houston. During his master's program, he worked at Bechtel, Inc., in Houston as part of the offshore group as both a naval architect and a marine terminal engineer. Currently, he is working as a design engineer at Volkert, Inc., Houston.

Debashish Kar is a front-end User Interface (UI) developer specializing in creating engaging and responsive web applications. He has a master's degree in computer science from the University of Texas at Arlington and has over three years of professional experience. He has developed six software applications in both private industry and public institutions, including a COVID Management System and the Home Elevation Decision Tool described in this article. He is currently working as a full stack developer at the Texas A&M AgriLife.

Dr. Nur Yazdani is a professor and past chairperson of the Civil Engineering Department at the University of Texas at Arlington. He received his Ph.D. and master's degrees from the University of Maryland College Park and the University of Oklahoma, Norman. A fellow of the American Society of Civil Engineers (ASCE), American Concrete Institute (ACI), and ASCE Structural Engineering Institute (SEI), he is the author of more than 180 articles in journals and proceedings and an invited speaker at conferences and seminars. Dr. Yazdani is well known for his research on bridge design, evaluation and rehabilitation, resilient and high-performing infrastructure design and rehabilitation, natural and man-made hazards, coastal infrastructure, and engineering education. He has secured more than $18 million from research projects. He has been highly successful in finding and applying technology to improve the inspection, repair, rehabilitation, safety, durability, and performance of concrete bridges. Research results have been widely adopted and practiced, primarily by state and federal agencies. Leadership roles included the chair of national professional chapters. As part of the committee activities, he was instrumental in developing and modifying governing codes, standards, and guidelines from ACI and ASCE. Dr. Yazdani has served as an ASCE-certified civil engineering program evaluator for the Accreditation Board for Engineering & Technology (ABET).

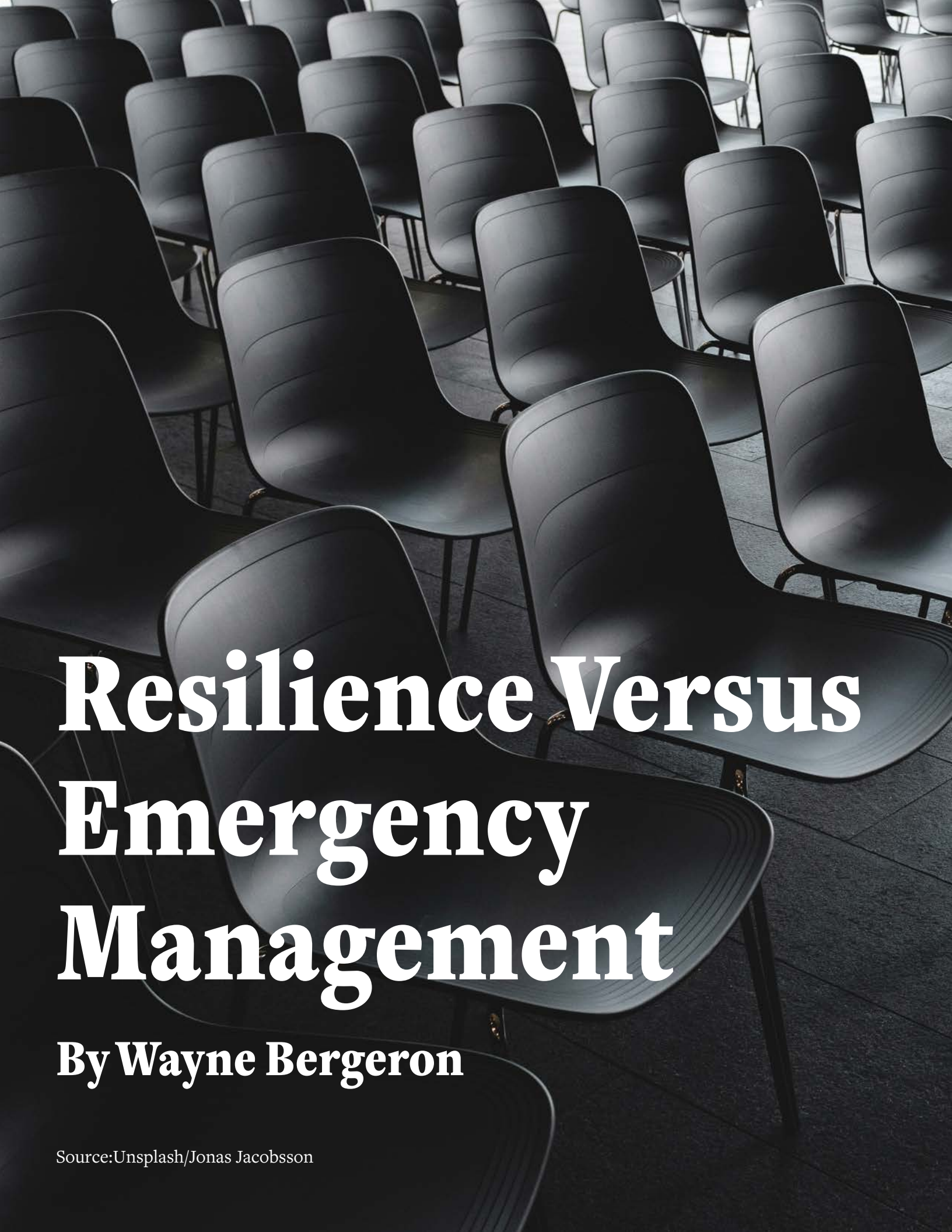
Dr. Eyosias Beneberu is an associate professor of research in Civil Engineering at the University of Texas at Arlington and a practicing bridge engineer. His academic experience ranges from teaching to researching various topics in structural engineering and hazard mitigation. His areas of expertise include repair and rehabilitation of structures, structural fire engineering, non-destructive evaluation, and health monitoring of bridges. Dr. Beneberu is a member of the ASCE-SEI Technical Activities Division for Bridge Management, Inspection and Rehabilitation Committee, ASCE Fire Protection Committee, and reviewer for various ASCE, ACI, and Elsevier journals. Dr. Beneberu's industry experience encompasses the structural design of high-rise buildings and bridges as well as construction inspections of transportation infrastructure. He is a licensed professional engineer in multiple states and a fellow of the ASCE-SEI.

Dr. Maria Koliou is an associate professor at the Zachry Department of Civil and Environmental Engineering (CEE) at Texas A&M University. Her research contributions focus on developing resilient and sustainable structures and communities against extreme events to safely and functionally accommodate growing populations in urban areas. Her work includes system-level and community-level simulations that analyze the performance of structures and communities to extreme events. She is developing novel resilient structural designs and systems against various natural hazards and formulating fundamental mathematical frameworks to assess risk-based system functionality and community resilience. Dr. Koliou has received over $3 million in external research funding from federal, state, and private sources, and she is currently leading a multi-institution National Science Foundation (NSF) project on the "Gulf Resilience Coastlines and People Focused Research Hub" focusing on the recovery of tribal communities in the Gulf region. Dr. Koliou received the 2018 Structural Engineering Institute's Young Professional Scholarship, 2021 Research Impact Award by the Department of CEE at Texas A&M, 2021 Engineering Genesis Award for multi-disciplinary research by the Texas A&M College of Engineering, and the 2021 NSF CAREER award. She has very recently been selected as one of the NSF and Kaleta A. Doolin Foundation Ocean Decade Champions.

Yong Yoo has a Ph.D. in civil structural engineering with 11 years of research experience. In particular, Yong Yoo has conducted various research projects using Finite Element (FE) and structural analysis programs.

Source: Unsplash/Shen Hooley

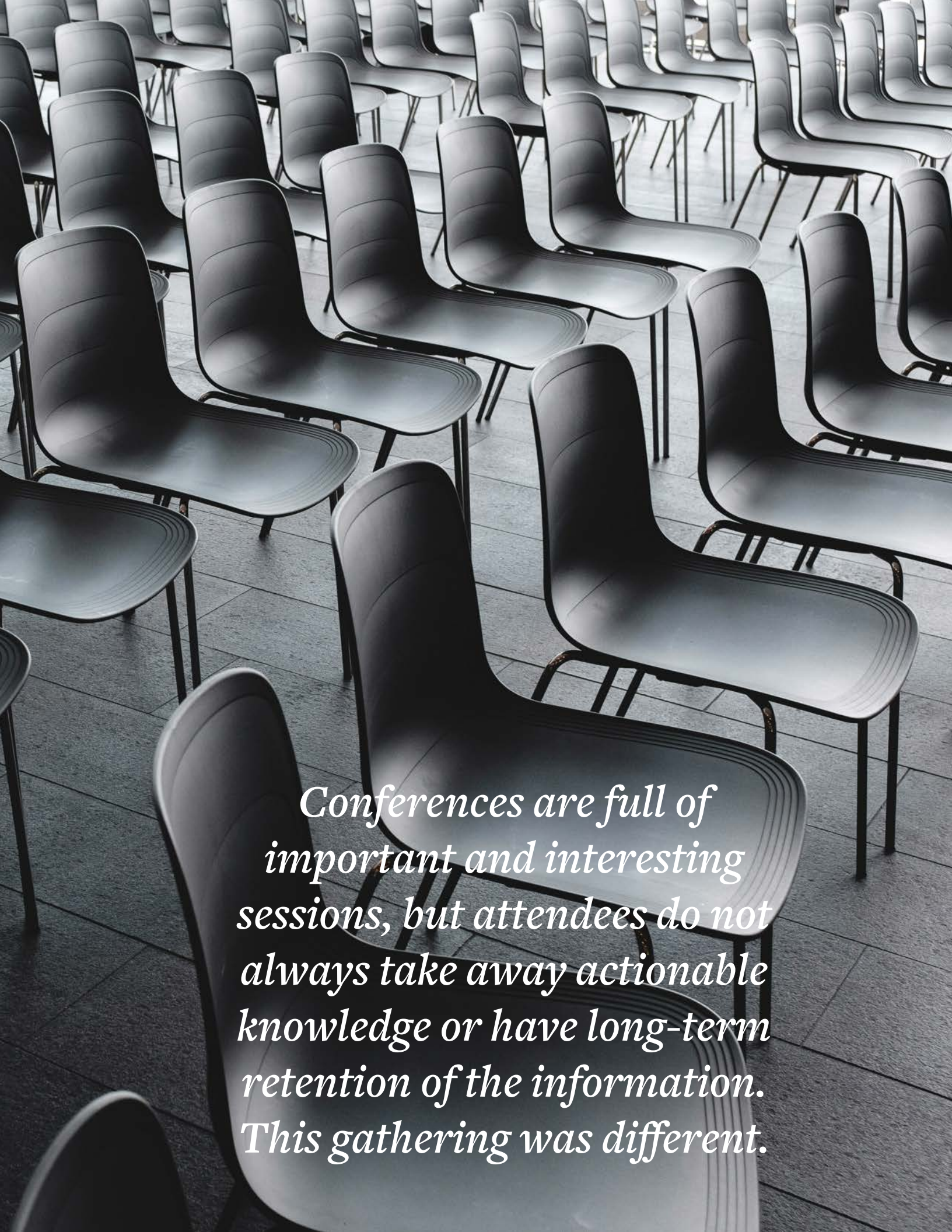
Elevated home in Nassau Bay, Texas (*Source*: Cedric Ling, August 11, 2020).



Resilience Versus Emergency Management

By Wayne Bergeron

Source:Unsplash/Jonas Jacobsson



Conferences are full of important and interesting sessions, but attendees do not always take away actionable knowledge or have long-term retention of the information. This gathering was different.

Conferences provide important and interesting sessions, but attendees do not always take away actionable knowledge nor have long-term retention of the information. Even when conference participants take notes, gather business cards from new acquaintances, and make new connections on LinkedIn, those notes and cards can end up in a folder or piled into a desk drawer with little or no follow-up.

> *"A conference is a gathering of important people who singly can do nothing, but together can decide that nothing can be done."*
> *– Fred Allen*

In April 2023, the author had the opportunity to go to ResCon International 2023, with the opportunity to organize and moderate one of the conference's plenary panel discussions. The panel – entitled "Where Does Emergency Management Stop and Resilience Begin?" – included the following panelists:

- Marissa Aho, policy director and chief resilience officer, Washington State Department of Natural Resources
- Russ Strickland, secretary of emergency management, Maryland Department of Emergency Management
- Jonathan Gaddy, subject matter expert, Center for Homeland Defense and Security (CHDS)
- Royce Woodruff, adjunct faculty, University of North Alabama

Unlike conferences that had little lasting impact, this time would be different. This group would not just decide that nothing could be done. So, while the panel took the normal format of questions to draw out essential thoughts on the topic, the author collected the live audience and online participants' perspectives in addition to the moderator and panel members.

The author submitted an exempt Institutional Review Board (IRB) research proposal, which the University of North Alabama Human Subjects Research Committee approved, to allow for research as part of the panel process. The proposed methodology included a pre-conference/session quantitative online survey distributed to the conference panel attendees, live polling conducted during the panel session, and a qualitative open-ended comment card. Additionally, given the recent interest in and popularity of large-language models and artificial intelligence, the author also decided to add Chat GPT as a "fifth" panel member by running all the panel questions through the platform to get its perspective. This interactive method aimed to create a more engaging and memorable experience for conference participants and panelists.

QUESTION 1: DEPENDENCY BETWEEN EMERGENCY MANAGEMENT AND RESILIENCE

The first question for the panel was, "Arguably, you can have effective emergency management and response without resilience, but can you have resilience without adequate emergency management and response?" All panel members agreed with 73% of the survey participants who did not feel it was possible to have true resilience without adequate emergency management and response. They believe that effective emergency management and response is critical to achieving resilience in individuals and communities by reducing

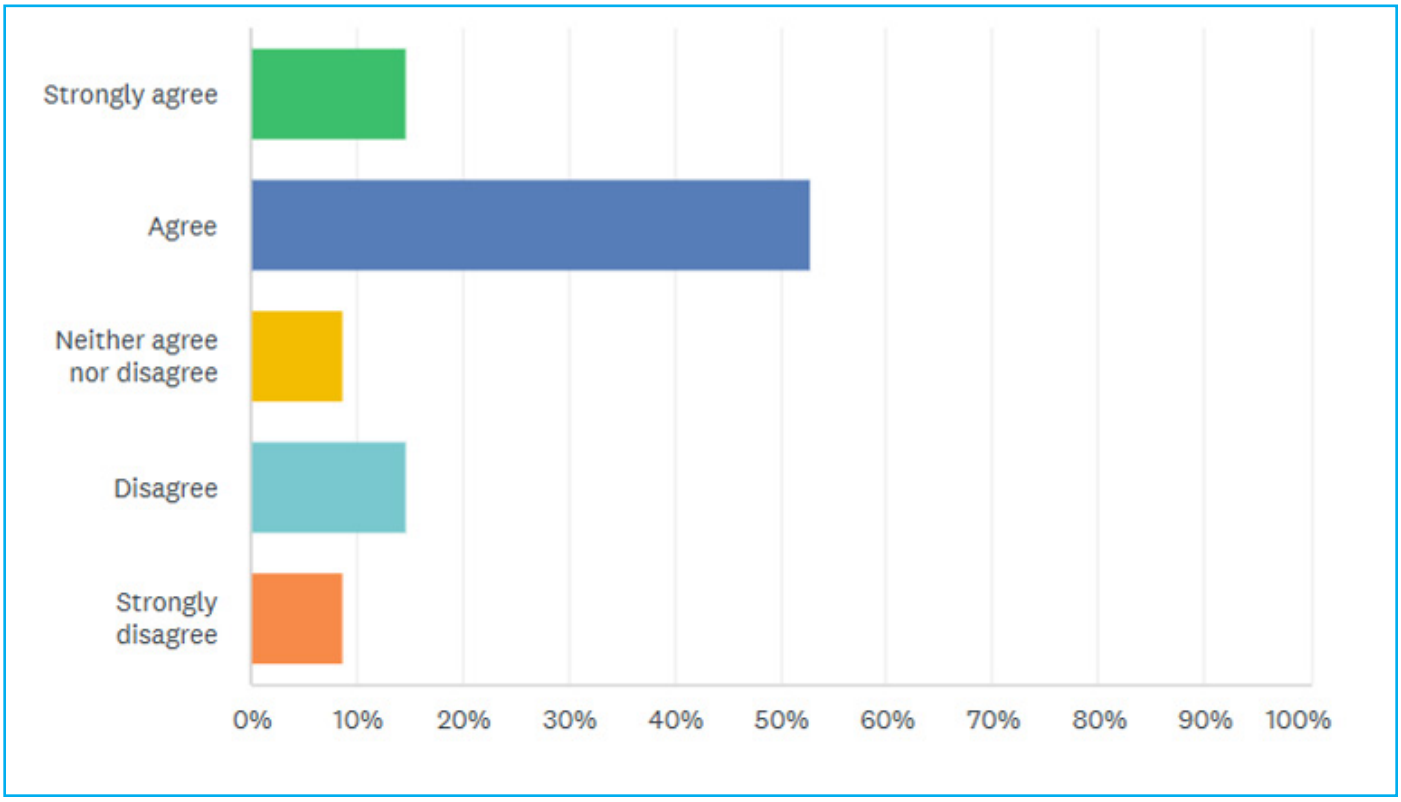


Fig. 1. Online survey responses from 34 participants to the question of whether they agree with emergency management being defensive or reactive and resilience being offensive or proactive (*Source:* Bergeron, 2023).

the impact of disasters and facilitating a quicker and more complete recovery.

However, the other 27% of those survey participants believe it is possible to achieve resilience even without effective emergency management and response and that, while the two were related and complementary, they were also distinct concepts. Interestingly, unlike the panelists, Chat GPT agreed with this assessment and stated that:

> *While effective emergency management and response can certainly contribute to resilience, it is not the only factor. A community or individual with strong social support networks and a robust economy may be more resilient and better able to recover from a disaster, even if emergency management and response are inadequate. Similarly, an individual with strong coping skills and a positive mindset may be more resilient and better able to overcome adversity, even if emergency management and response are lacking.*

QUESTION 2: THE NATURE OF EMERGENCY MANAGEMENT VERSUS RESILIENCE

The panel saw the next question via a live poll of the audience:

> *Some would say that emergency management is inherently defensive or reactive in nature with an overarching focus on response. Resilience is seen by many as being more offensive or proactive, focusing more on the intersection of shocks and stresses, which leads to more prevention, preparedness, mitigation, and adaptation. Would you agree or disagree with this assessment?*

The live audience, panel members, and online survey participants overwhelmingly agreed that emergency management is defensive/reactive and response-focused (see Figure 1). In contrast, resilience is more offensive and proactive, focusing on the broader view of the phases of emergency management. Chat GPT also agreed with the majority and noted that it saw:

> *Emergency management and resilience as related concepts, but they have different emphases. Emergency management focuses on responding to and recovering from emergencies and disasters. At the same time, resilience takes a more proactive approach, emphasizing strategies to prevent or mitigate the impact of disasters and build capacity to withstand future challenges.*

QUESTION 3: RESILIENCE'S DEPENDENCY ON EMERGENCY MANAGEMENT

The panel then considered the question:

> *We know by its very nature that resilience is made up of many different components, with emergency management being only one of them. What percentage of resilience would you say that effective emergency management comprises?*

In this case, the panel members clustered within the survey participants' distribution range and outlined the reasons for their percentage choices. Figure 2 reflects 33 total responses, with the largest cluster below the mean between 15-40% and a more even distribution above the mean. Chat GPT, on the other hand, decided to punt on this question with a non-answer that included:

> *It is not possible to assign a specific percentage of resilience that effective*

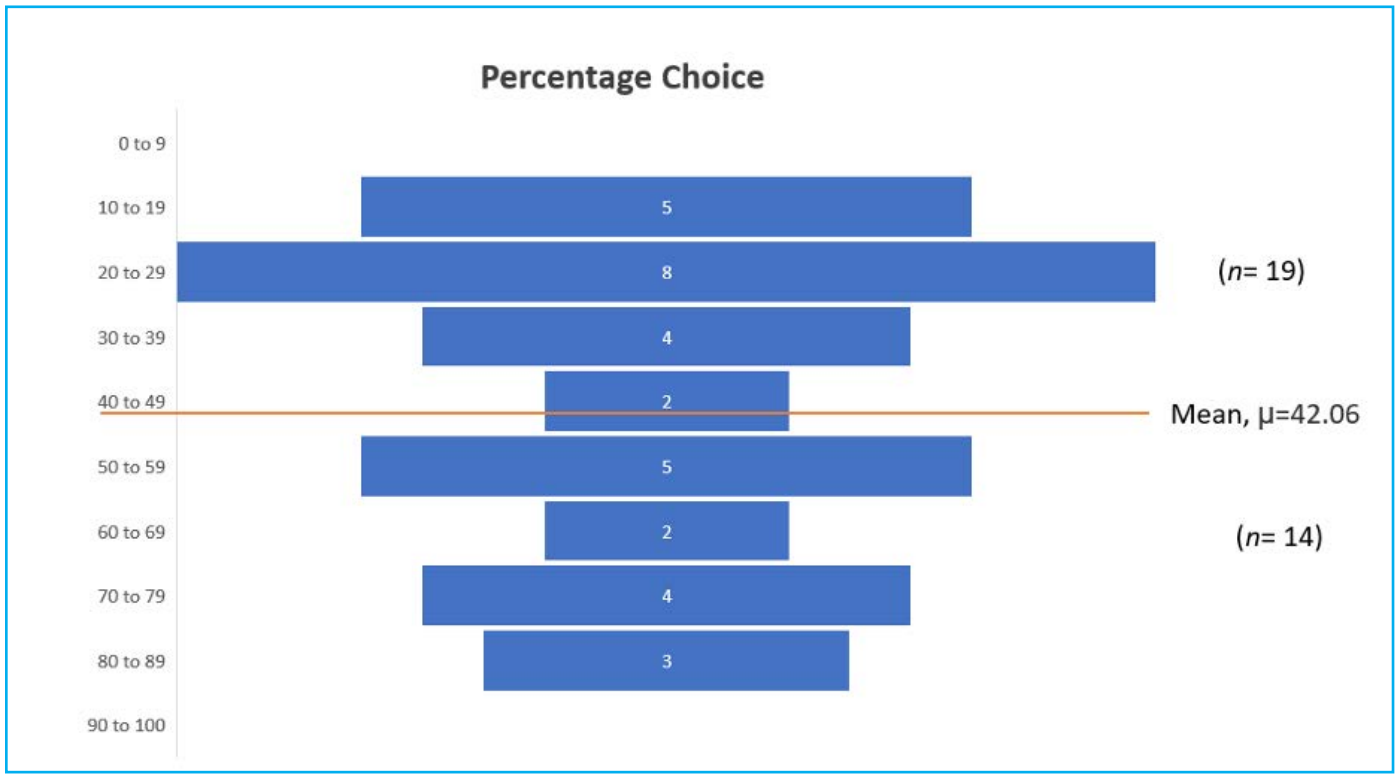


Fig. 2. Online survey participant responses to the question of what percentage of resilience effective emergency management comprises (*Source:* Bergeron, 2023).

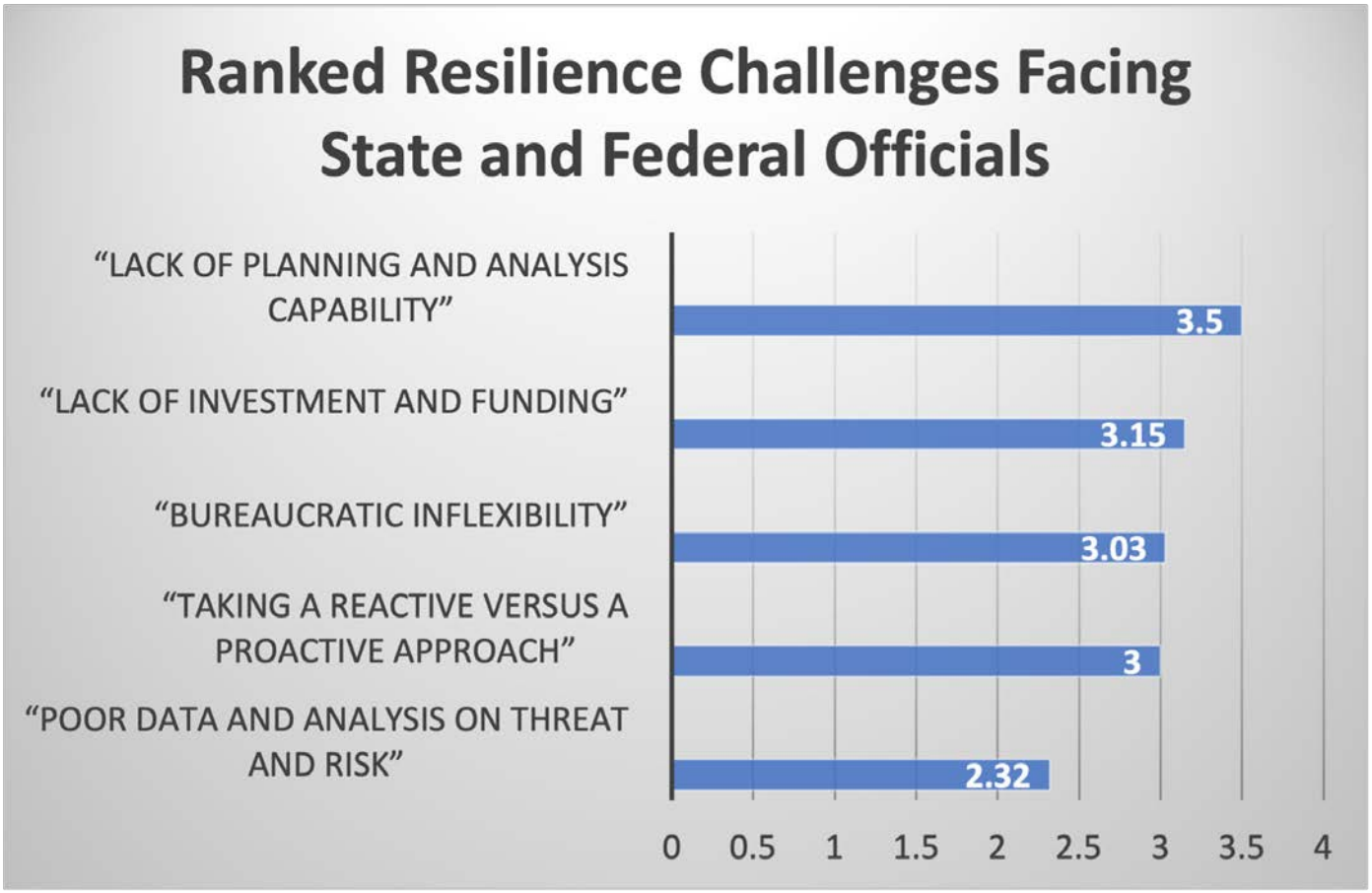


Fig. 3. Online survey participants' ranking of resilience challenges facing state and federal officials (*Source:* Bergeron, 2023).

> *emergency management comprises, as resilience is a complex and multifaceted concept that is influenced by many factors.*

QUESTION 4: THE ROLE OF EMERGENCY MANAGEMENT IN RESILIENCE

The next question was about understanding resilience and the role of emergency management:

> *Some of the struggles we seem to be having in understanding resilience are actually debates about how emergency management (as a discipline and profession) should adapt and pivot to "operationalize" resilience as an objective or an end-state. This has led to a debate or open question on "What is our job, now?" in terms of where traditional responsibilities and mission focus of EM organizations need to change or evolve. Do EMs need to get more involved in issues like: building codes; social vulnerability; economic development; sustainable development?*

In this case, the panel, Chat GPT, and 34 survey participants were in general agreement, with a clear majority of 62% responding yes, 12%, and 26% maybe. In line with the panel participants, Chat GPT concluded that:

> *Emergency management organizations may need to broaden their focus beyond traditional emergency response and recovery activities to effectively promote resilience. This may involve getting more involved in issues related to building codes, social vulnerability, economic development, and sustainable*

development, among others. By addressing these issues, emergency management organizations can help to build more resilient communities that are better prepared for future challenges.

QUESTION 5: RESILIENCE CHALLENGES FACING STATE AND FEDERAL OFFICIALS

The final panel question asked the following of the panel and participants:

> *In January 2023 the Pew Charitable Trust organization hosted a summit on the disaster resilience challenges facing state and federal officials. Out of the following areas they identified, which do you think is the most significant?*
>
> - *Lack of planning and analysis capability,*
> - *Lack of investment and funding,*
> - *Poor data and analysis on threat and risk,*
> - *Bureaucratic inflexibility, and*
> - *Taking a reactive versus a proactive approach.*

The participants ranked these items in terms of their relative importance as challenges. The ranking by the panel and the responding participants provided a weighted average for each item outlined in Figure 3. While differences were apparent in the top and the bottom resilience challenge areas, the middle three results were similar.

The resilience challenge that participants deemed most significant was *lack of planning and analysis capability*. Conversely, the resilience challenge with the lowest weighted average was poor data and analysis on threat and risk. The three resilience challenges that clustered in the middle were: *lack of investment and funding*, *bureaucratic inflexibility*, and *taking a reactive versus a proactive approach*.

Panelists at ResCon International conference (*Source*: Bergeron, April 2023).

The takeaway from this question is that information and data were not as much of an issue as other areas that deal with what can be done with that data and the capabilities to do it. Interestingly, Chat GPT said that:

> *All of the areas identified by Pew Charitable Trust are important for addressing disaster resilience challenges, the lack of investment and funding is likely the most significant, as it can impact many other aspects of disaster resilience.*

CONCLUDING PANELIST COMMENTS

The final activity for the panel discussion was a reflective "Your Take" comment card that all session participants received as they entered. It asked, "What would you consider the most important aspect of resilience to be? Why?" These cards were gathered near the end of the session and provided the focus for the panel members' concluding comments. Each panel member was given about six cards, had a few minutes to consider them, chose one or two that spoke the most to them, and highlighted the card's perspective in their concluding panel comments.

When Chat GPT shared its perspective on the participants' comments on the most essential aspect of resilience, it identified the following themes as particularly relevant: community engagement and trust, defining the community, interconnectedness of systems, collaboration and coordination, and addressing vulnerable populations. It summarized these by noting that:

> *Defining the community being served accurately from the onset is particularly important; it goes beyond geographical boundaries and demographics because resilience depends on meeting communities where they are and involves the ability to learn, grow, and become stronger after facing disasters. Collaboration and coordination among organizations, agencies, and groups contribute to building social capital and cooperation between government and communities is essential for establishing long-term resiliency.*

This conference session exercise was successful and exceeded the author's expectations. The dialogue was lively and informative. Tapping into the live audience and the participants' perspectives to help drive the panel members' discussion proved particularly valuable. While Chat GPT did not reveal anything earth-shattering and often parroted much of the panel question and previous answer language (particularly further in the session), it aligned with the panel members' and participants' knowledge and perspective. While this methodology involving significant preparation and planning might not be the best fit for every conference presentation, it is worth considering this method for future presentations.

Dr. Wayne P. Bergeron, lieutenant colonel (retired), served in the United States Army for 23 years within the Military Police Corps and Special Operations Forces. He currently serves as an associate professor teaching criminal justice and security as well as emergency management. He is the founding director of the North Alabama Public Service Training Center at the University of North Alabama in Florence, Alabama, providing continuing education and training to the region's law enforcement, fire/rescue, emergency medical services, and emergency management communities. His education includes undergraduate degrees in criminal justice and political science, a master's degree in international relations, and a doctorate in emergency management.

Unleashing Community Resilience Through Collaborative Leadership

By Michael R. Valiente

Source: unsplash/Samson

Collaborative relationships with local stakeholders are the driving force for more resilient and secure communities

Elected officials and emergency response personnel form the nucleus of community leadership, a driving force for collaborative relationships with local stakeholders. In the 2018 book "Transforming Disaster Response," Professor William Lester offered three fundamental factors for transformational leadership to occur: the desire to make a change, the development of a new approach, and the commitment to change. As such, community leaders who adopt the tenets of transformational leaders may be better positioned to effectively promote resilience and security in their jurisdictions.

Collaborative leadership implementation can directly affect disaster preparedness, response, and recovery efforts. For instance, the public's safety and welfare rely on:

- Identifying the challenges community leaders and emergency response personnel face;
- Maintaining collaboration and cooperation between community stakeholders;
- Filling gaps that affect collaboration; and
- Expeditiously delivering resources to those impacted by disasters.

All of the above requires effective local stakeholder collaboration, the hallmark of which is the ability to communicate effectively – from risk communication, which focuses on awareness before disasters, to crisis communication during disasters. Regardless of the term, all levels of government and community leadership must be able to communicate and coordinate in delivering resources and personnel to affected areas.

Bottom-to-Top Structure and Decentralization of Authority

Research studies have focused on the challenges of collaborative leadership to achieve community resilience. Some studies advocate for a bottom-up hierarchical structure and decentralization of authority to bridge the communitywide gaps that can affect disaster operations. For example, a study published in 2018 in Disaster Prevention and Management suggested that one advantage of this structure for emergency response involves comprehending the local community's socioeconomic, cultural, political, and infrastructural adjustments to disaster events. These constructs are unique to the local jurisdiction and are factors to consider in disaster planning.

A decentralized disaster planning system could give local and state governments greater autonomy in developing their own response and recovery measures unique to their jurisdictions and, thus, more flexibility. Empowering local community stakeholders can help foster the transformational leadership skills, resources, and capabilities needed to develop plans for future disasters.

Capabilities and operational structures change over time, which could impact operations. Therefore, before conducting multi-organizational response operations, assess and evaluate the cooperation and coordination between community leaders, emergency response personnel, business interests, nonprofit organizations, healthcare providers, and community members, as well as their capabilities, resources, and expertise. Moreover, these evaluations can reveal resource, response, and capabilities gaps directly affecting disaster operations, such as training personnel assigned to work in emergency operations centers.

Involvement in the collaborative process through interagency cooperation and information sharing is essential for successful disaster operations. Social media's scope and influence have become a key component for disseminating information to a broad audience and engaging the whole community to facilitate the planning, execution, and effectiveness of community resilience policies.

Some impact factors include examining community needs, developing traditional and social media communication networks, and establishing communication interoperability. A 2018 study found that reactive decision-making processes can lead to authority centralization, negatively impacting disaster operations. However, training exercises and drills help facilitate emergency response efforts and improve disaster planning and coordination.

Enhancing Social Capital to Drive Resilience

Emergency management professionals and government officials use modes of communication to disseminate information to community stakeholders – including business interests, nonprofit organizations, faith-based organizations, healthcare facilities, and community members. The effectiveness of preparing for and responding to crises is contingent upon these dynamic relationships to address human needs. Additionally, community engagement can help prepare for future disasters by using community outreach to reinforce preparedness plans, promulgate policies, and organize resources and personnel. This community structure improves the ability of government agencies and community stakeholders to work together. The interpersonal connections that bring people together within a community (i.e., social capital) can be a more powerful force for resilience than external factors.

Disseminating information to community stakeholders – including businesses, nonprofits, faith-based organizations, healthcare facilities, community members, and emergency response personnel – improves interactive and dynamic relationships to

Source:Unsplash/Joel Muniz

promote resilience and security. Effective disaster management requires communication before, during, and after a crisis.

Social capital enhances the capacity to prepare for future disasters by using community outreach to support preparedness plans, promote policies, establish mutual aid agreements, and coordinate resources and personnel. Boosting collaboration and cooperation between government agencies, neighboring jurisdictions, and community stakeholders requires joint efforts to:

- Regularly review emergency plans and maintain resources and capabilities;
- Plan and implement policies, such as preparedness campaigns; and
- Create, enhance, and sustain mutual aid agreements to help and support jurisdictions.

Guidance and Resources for Change

The Federal Emergency Management Agency's (FEMA) Threat and Hazard Identification and Risk Assessment (THIRA) and Stakeholder Preparedness Review Guide are valuable resources to help communities conduct risk assessments to identify hazards, threats, vulnerabilities, and consequences. After completing the risk assessment, community leaders, emergency response personnel, and local stakeholders can develop disaster preparedness plans, policies, and procedures.

In addition to THIRA guidance, urban and rural jurisdictions must consider the all-hazards approach when planning for disasters. Part of the planning process is ensuring community members know about local information resources and use toolkits to evaluate and enhance their household preparedness. Rural communities can improve their disaster management and crisis communication by developing a digital communication infrastructure and expanding their use of social media platforms in risk and crisis communications. Emergency management personnel can use dedicated and reliable internet capabilities to broadcast to and receive information from community members directly affected by the crisis.

Community Outreach

Community involvement is a key focus in achieving security and resilience in local communities. Community leaders, emergency response personnel, volunteer groups, nonprofit organizations, and business interests each have a responsibility to:

- Facilitate information-sharing efforts with community members,
- Exchange information to enhance decision-making during disasters, and

Identify socioeconomic losses after a crisis.
In addition to resources and capabilities, effective collaborative leadership and cooperation at the local level are vital for achieving community resilience and security. Community outreach programs, social media platforms, and traditional media are essential when disseminating risk and crisis communication and enhancing cooperation and collaboration for disaster preparedness and response. Such outreach enables local community stakeholders to assist and support risk mitigation efforts. Active communication during daily operations or disasters can build a stronger community foundation.

Application of Research and Recommendations for Practice

To further explore the impact of collaborative leadership, the author conducted one-on-one interviews in 2022 with 15 community leaders and emergency response personnel from two rural and one urban county in the West

South Central United States. The responses were similar across topics such as community resilience, decentralization of authority, interagency cooperation, and funding challenges, with the following 13 themes emerging:

- Preparedness and community engagement are relevant elements of community resilience.
- Communication and funding are the main challenges for collaborative leadership in communities.
- A strong community leadership team and emergency management coordinator are vital to disaster planning.
- County governments have better working relationships with the state than the federal government.
- The emergency management team's dedication and visibility directly impact community engagement.
- Community leaders that trust their personnel's proficiency in their roles and responsibilities enable them to make operational decisions during disasters.
- Interagency cooperation begins locally, establishes relationships with neighboring communities and regional partners, and maintains collaboration with state and federal agencies.
- Conducting annual training exercises is not enough.
- Communication challenges impact interoperability due to outdated technology and insufficiently trained personnel.
- Public information officers are beneficial to county-level jurisdictions for information dissemination. Members of at least one vulnerable population (e.g., older adults) may not use digital technology, which introduces challenges.
- While Facebook is the most common social media platform, all jurisdictions use their websites or the city/municipality to notify stakeholders and residents.
- Community Emergency Response Team (CERT) units benefit each jurisdiction's community outreach program.
- Additional funding is needed to hire more personnel, update equipment such as communications and computers, and improve digital technology infrastructure for rural entities, which is essential for all jurisdictions.

Through these interviews and research, the findings produced six recommendations:

- Create organizations like the Combined Emergency Services Organization (CESO, a local organization composed of emergency responders exercising mutual aid agreements) in each county so that suburban jurisdictions can effectively collaborate and cooperate – with disaster preparedness planning and training exercises as part of their best practices.
- Establish a CERT program in each suburban community or municipality within a county. Counties can use FEMA's curriculum to offer training on-site or by mobile training teams for larger counties.
- Update county and municipality disaster plans regularly (e.g., annually or after an incident or exercise), depending on the size of the jurisdiction.
- Conduct a needs assessment in rural counties to upgrade communications and equipment and submit a report to the state-level emergency management division for funding allocation and action.

Source:Unsplash/Mike Erskine

- Survey vulnerable residents (e.g., elderly, homeless persons, and people with functional needs) in municipalities to maintain public-private relationships and encourage them to sign up for the STEAR (State of Texas Emergency Assistance Registry) Program as part of disaster preparedness planning.
- Have a grant writer in each jurisdiction (e.g., city and county) to research funds from federal and state sources.

Future studies should investigate quantitative research to measure the effectiveness of collaborative leadership and community resilience. In doing so, the mathematical formulas could better calculate the leadership and resilience scales and quantify each jurisdiction's numerical value.

Ongoing Challenges and Vulnerabilities

Local community leaders and emergency response personnel face challenges in achieving collaboration and cooperation between stakeholders and community members. Vulnerable populations are significantly affected by communications issues during disasters. The consensus among the community leaders and emergency response personnel interviewed was that communication interoperability and funding are the primary challenges in their jurisdictions. Collaborative leadership and including vulnerable community members in disaster preparedness planning can fill critical planning and response gaps and transition communities from current to collaborative systems for improving community resilience.

Conclusion

The tenets of contemporary emergency management include four Cs: collaboration, cooperation, communication, and continuity. The hallmark of emergency management involves "neighbors helping neighbors" – the collaborative and cooperative efforts between community members. As digital technology and communication infrastructure continue to evolve, emergency responders must train and be proficient in all modes of communication. Redundancy and communication interoperability are imperative in today's ever-changing environment. Moreover, business continuity and continuity of operations must be integral in disaster planning. Businesses need to incorporate resilience in their business plans, and the public sector must understand that continuity of operations is part of emergency planning. As communities continue to prepare for and respond to crises, stakeholders expect their leaders and emergency responders to be innovative, proficient, and proactive in strengthening the security and resilience of the whole community.

Michael Valiente is the Senior Training Officer of the Training Division at the Texas Division of Emergency Management. He is a retired U.S. Marine with 23 years of active-duty service. He did two tours as an instructor and academics supervisor with Marine Corps University and one tour as a Marine Embassy Guard with the U.S. State Department. His initial emergency management experience came from participating in Operational Unified Assistance, the U.S. military humanitarian relief efforts during the December 2004 tsunami in Southeast Asia. After retiring in 2005, he taught at the University of Phoenix and Alamo Colleges in San Antonio, Texas. He has a master's degree in international relations from Troy University and a Doctor of Emergency Management degree from Capella University.

Critical Infrastructure

Source: Unsplash/Jan Huber

Commercial Facilities Sector Perspectives

By Kole (KC) Campbell

Source: Unsplash/Vinicius Amano

The commercial facilities sector dominates the U.S. economy, contributing trillions of dollars to the U.S. gross domestic product while employing and supporting millions of jobs.

The Commercial Facilities Sector is one of the 16 critical sectors identified by the U.S. Department of Homeland Security. The versatility, resilience, and capacity of commercial facilities are exemplified by the fact that they often serve as shelters during disasters. In January 2024, fans near Houston's NRG Stadium were urged to shelter in the stadium and other areas due to severe winds prior to the start of College Football Playoff Championship. During the coronavirus pandemic in 2020, an indoor training facility at Arthur Ashe Stadium was used as a makeshift hospital for COVID-19 patients. During the devastating Maui fires in the summer of 2023, residents needing to evacuate farm and ranch animals were offered the use of Oskie Rice Arena. In 2007, wildfires in San Diego prompted the largest evacuation in the region's history and 15,000 evacuees to use Qualcomm Stadium for shelter.

What Makes This Sector Critical to the Nation and What Possible Effects Does It Have on States and Local Communities?

The commercial facilities sector includes sites and properties used to conduct business, purchase retail products, and enjoy recreational events and accommodations. Although most of the industry is privately owned and operated, it includes publicly traded companies and some publicly owned buildings, such as the approximately 17,000 public library locations (there are only 19 private, membership-based libraries) and 33,000 museums (only 59 art museums are private). The assets range from small nightclubs to large stadiums that can host national special security events (NSSEs).

The U.S. government divides the sector into eight subsectors to coordinate facilities with similar functions, operations, and security issues:

- The *entertainment and media* subsector includes media production facilities (e.g., television and motion pictures), print media companies (e.g., newspapers, magazines, and books), and broadcast companies (e.g., television and radio stations).
- The *gaming* industry includes commercial and tribal casino operators, cyber and physical assets, suppliers, and other affiliated entities.
- *Lodging* includes nongaming resorts, hotels, motels, hotel-based conference centers, and bed-and-breakfast establishments.
- The *outdoor events* subsector comprises amusement parks, fairs, exhibitions, parks, parades, marathons, and other outdoor venues and events.
- *Public assembly* includes assets where large groups of people gather, such as convention centers, auditoriums, stadiums, arenas, movie theaters, and cultural properties like museums, zoos, planetariums, aquariums, libraries, and performance venues.
- *Real estate* includes office buildings, office parks, apartment buildings, multifamily towers, condominiums, self-storage facilities, and property management companies.
- *Retail* includes tenant space in enclosed malls, shopping centers, strip malls, and freestanding retail establishments.
- The *sports leagues* subsector comprises major sports leagues and associations.

Commercial facilities dominate the U.S. economy, contributing trillions of dollars to the U.S. gross domestic product while employing and supporting millions of jobs. Federal, state, and local-level entities use these facilities to run the government, conduct

business, purchase retail products, and enjoy recreational events and accommodations. The entertainment and media subsector and retail subsector are two of the most critical to the nation's economy, with 2022 revenues of $2.32 trillion and almost $5 trillion, respectively. Within the entertainment and media subsector, the film and television industry employs 2.4 million people in every state across diverse skills and trades. The gaming subsector similarly has a national impact; some form of gaming is legal in all but four states. And the retail subsector supports one in four U.S. jobs – 52 million working Americans.

What Are This Sector's Key Assets and Interconnected/Interdependent Systems (Physical or Cyber)?

Commercial facilities are built to be resilient. They must withstand substantial human traffic, weight from office and other equipment, and adverse weather. Thus, most commercial buildings use structural-grade building materials with proven reliability that can resist the loads and stresses acting on the structure. The building materials comprise natural (e.g., stone and wood) and manufactured (e.g., concrete and steel) building materials.

Once built and occupied, commercial facilities require many systems and services inside. For example, they need electrical power, water – including potable water – waste removal, telecommunications, and internet access.

Almost all the sector's subsectors also require private and public sector security. Some government offices reside within commercial facilities as tenants, so the facility and government must collaborate on security. For NSSEs, including major sporting events, the U.S. Secret Service is the lead agency for planning, coordinating, and implementing security operations. Cybersecurity requirements for NSSEs include ensuring the Secret Service and the supporting contractor protect personally identifiable information for credentialing production. The Federal Bureau of Investigation (FBI) is the lead federal agency for crisis management, counterterrorism, hostage rescue, and intelligence. The Federal Emergency Management Agency (FEMA) is the lead federal agency for consequence management (response and recovery operations).

What Are This Sector's Dependencies (Physical, Cyber, Geographic, and Logical) and Interdependencies With Other Critical Infrastructures?

Commercial facilities could not sustain operations without the water and wastewater systems, energy, and communications sectors:

- The water and wastewater systems sector provides potable water, water for fire suppression systems, and wastewater treatment for commercial facilities.
- Electricity and natural gas accounted for roughly 94% of energy consumed in commercial facilities. According to the U.S. Energy Information Administration, in 2018, over 30% of energy use for commercial buildings, which includes health care and religious worship buildings, was for space heating – the most energy-intensive item in U.S. commercial buildings.
- In addition to communications required for telephone calls, commercial facility fire alarm systems use the communications sector for off-premises signaling. This signaling includes sending fire alarm notifications to a supervising station or public communication center to initiate the appropriate response, such as notifying the local fire department.

> The communications sector also relies on the commercial facilities sector. The former almost entirely houses its operations and critical nodes in commercial facilities.

In addition, the transportation systems sector allows employees and customers to travel to and from commercial facilities and enables these facilities to receive supplies. In turn, the transportation sector earns revenue from customers traveling to these facilities. The importance of this interdependency is evident before, during, and after some sports games when public transportation authorities increase transport availability and extend operating times.

Strong interdependencies also exist between the commercial facilities sector and the financial services sector. The latter needs commercial facilities to conduct daily business operations. All eight subsectors of the commercial facilities sector rely on all financial services sector categories: (1) deposit, consumer credit, and payment systems products; (2) credit and liquidity products; (3) investment products; and (4) risk transfer products.

As mentioned, government offices sometimes reside within commercial facilities as tenants. For example, the General Services Administration (GSA) leases office space in commercial buildings for federal agencies and manages the lease agreements. In December 2023, the GSA had over 7,600 leases with commercial properties. All levels of government that occupy commercial buildings also rely on private sector security, often in addition to government security.

Source:Unsplash/Patrick Robert Doyle

What Are This Sector's Current and Emerging Vulnerabilities, Hazards, Risks, and Threats?

In the U.S., the commercial facilities sector has suffered significant fatalities at the hands of foreign and domestic terrorists.

- The estimated number of people killed at the World Trade Center in the September 11, 2001, terrorist attack is 2,750.
- In the worst terrorist attack on American soil since the September 11 attacks, in June 2016 a gunman killed 49 at the Pulse nightclub in Orlando, Florida.
- Three employees and 15 children in the America's Kids Day-Care Center, which was in the Alfred P. Murrah Federal Building in Oklahoma City, were killed in the 1995 truck bombing of the building.
- In August 2019, a self-described white nationalist killed 23 people at a Walmart in El Paso, Texas.

However, commercial facilities are also vulnerable to other threats and hazards.

Natural Disasters

Increasingly severe weather events – including water and climatic hazards such as hurricanes, tornadoes, and floods – can devastate commercial facilities. Hurricane Katrina caused almost $200 million in damages to the Louisiana Superdome, which sheltered 30,000 people during the disaster. Reportedly, roughly 730,000 retail, office, and multi-unit residential properties risk flood damage in the contiguous U.S., with over $13.5 billion annually in associated structural damage and $50 billion in economic impacts. As an indicator that the frequency and intensity of extreme weather events are increasing, nine of the top 10 costliest hurricanes in the U.S. have occurred since 2005, and five of the top 10 since 2017.

The commercial facilities sector is also prone to geological hazards like earthquakes and tsunamis. The U.S. Geological Survey and its partners in California assess that an earthquake in the San Francisco Bay region could result in business interruption. Damaged buildings could affect 40% of establishments and employees in central Alameda County. Industrial and warehouse establishments could experience disproportionate harm. A New Madrid Seismic Zone earthquake in the central U.S. could moderately or completely damage almost 170,000 multifamily residences and other commercial facilities in eight states, according to a 2009 study.

Construction of commercial facilities in flood zones, inadequate building codes, poor building practices such as placing critical facility structures (e.g., mechanical, electrical, and plumbing systems) below the base flood elevation, and inadequate business insurance can exacerbate the effects of natural disasters and extreme weather. Hurricane Sandy in 2012 and Hurricane Harvey in 2017 exemplified these additional factors.

Armed Attackers

Armed attacks at shopping centers, office buildings, and open arenas are difficult to predict or prevent, particularly given the sector's open access design – a necessity that is vulnerable. Of the 333 active shooter incidents between 2000 and 2019, businesses open to pedestrian traffic had the most incidents at 96. In businesses open and closed to pedestrian traffic and malls, 147 active shooter incidents occurred – 44% of all incidents. Of the 178 mass public shootings (i.e., four or more victims murdered with firearms – not including the offenders) between 1966 and 2021, at least 60% occurred in the commercial facilities sector.

Another indicator of the sector's vulnerability to armed attackers is that two of the deadliest

mass shootings in recent U.S. history occurred at commercial facilities – the 2017 massacre at the Route 91 Harvest Festival in Las Vegas and the Pulse nightclub shooting in Orlando in 2016.

Pandemics

For at least the past two decades, government officials and virologists have repeatedly warned about the possibility of a global pandemic. This forecast came to fruition in 2020 with COVID-19. As occurred with COVID-19, another pandemic could severely threaten the large workforce of the commercial facilities sector, compromising facility operations or limiting services. Pandemics can spread easily through commercial facilities, as large groups congregate daily. Insufficient or inadequate ventilation, filtration, personal protective equipment, administrative controls (e.g., policies that encourage ill employees to stay at home without fear of any reprisals), work practices (e.g., social distancing), and engineering controls (e.g., installing sneeze guards between customers and employees) in commercial facilities could facilitate the spread of infections during a pandemic. Rising vaccine skepticism can also impact infection rates.

Internet Outages and Cyberattacks

The commercial facilities sector uses the internet for business intelligence, marketing, merchandising, ticketing, and reservations. A mass communications or cloud service failure leading to an internet disruption could affect large swaths of the sector and have cascading economic effects. Cyberattacks could pose a reputation risk, disrupt operations, compromise private information, and result in revenue loss or ransom payments.

The August-September 2023 hacking of MGM in Las Vegas paralyzed MGM-owned hotels from Las Vegas to the East Coast, affecting reservation systems, registration, room keys, and slot machines. The criminal actors obtained personal information, including social security and passport numbers. MGM estimates the attack cost the company $100 million and an additional $10 million in "technology consulting services, legal fees and expenses of other third party advisors." The breach at Caesars in Las Vegas around the time of the MGM hack compromised Caesars customers' driver's license numbers and social security numbers. Caesars reportedly paid a $15 million ransom.

Theft

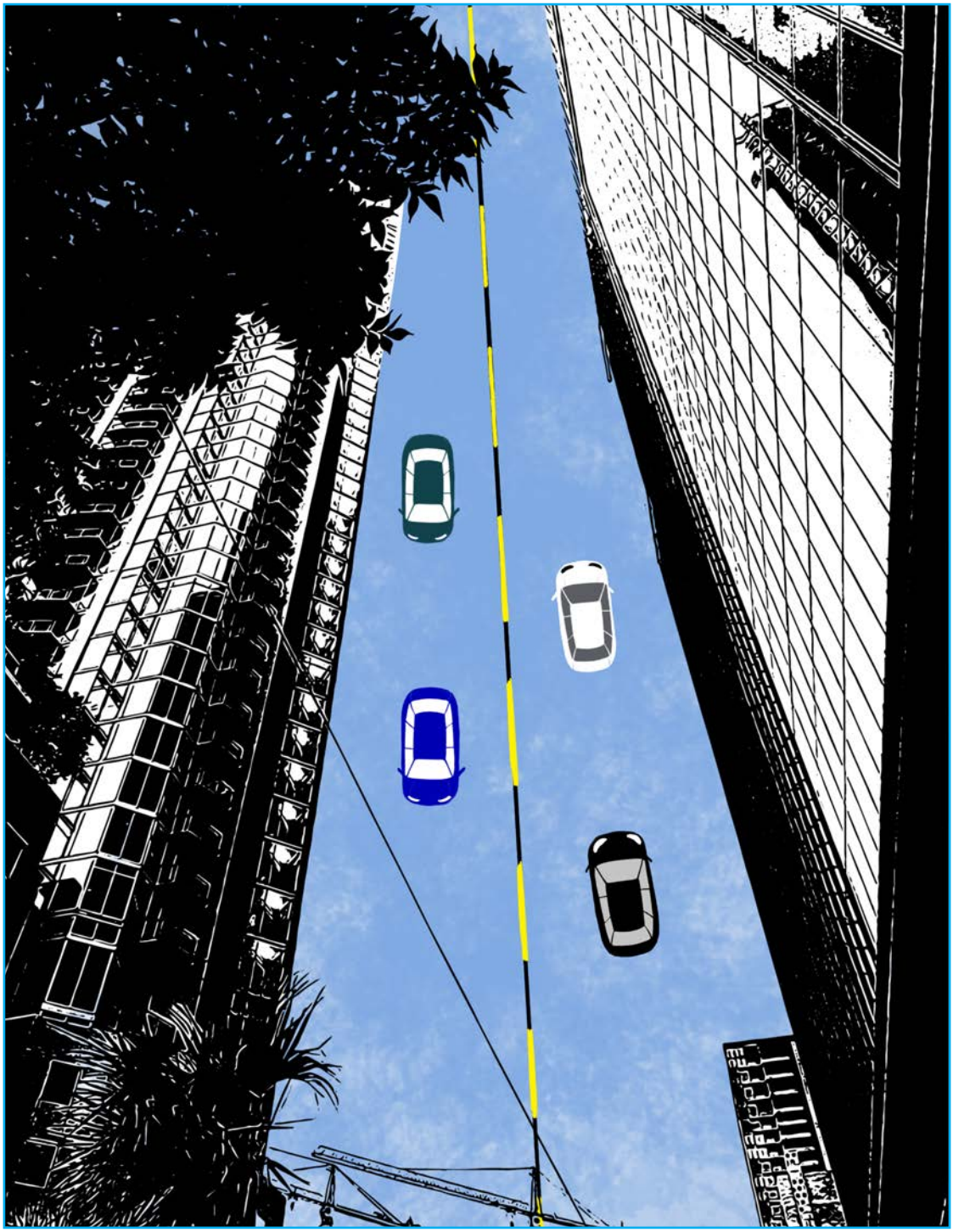
The commercial facilities sector, especially the retail subsector, is impacted by a range of theft crimes – including internal (employee) and external theft, fraud, and organized retail crime. The splintered nature of the retail subsector makes it difficult to collect reliable figures on theft, especially organized retail crime. However, recent estimates indicate roughly $112 billion in total losses in 2022. Additionally, intellectual property theft threatens a company's ideas and inventions, including trade secrets, proprietary products, media, and software.

Explosive Devices

Attackers have used homemade explosives, or improvised explosive devices, to attack commercial facilities, causing mass casualties and property damage. Open public access, particularly facilities with limited screening, makes many facilities vulnerable to explosives. In 2022, there were 966 explosions in the U.S., 334 of which were bombings, although it is unclear how many were against commercial facilities. In 2020, on Christmas Day in Nashville, Tennessee, a bomb in a recreational vehicle detonated in the vicinity of several commercial facilities. The apparent target of the bombing was a vital but not well-publicized AT&T communications hub. The attack

impacted several states' emergency, health and healthcare, and airport services.

Commercial entities within or near government facilities can lead to collateral damage from attacks against those government facilities. As previously mentioned, 18 people at a daycare in the Alfred P. Murrah Federal Building in Oklahoma City were killed in the 1995 truck bombing of the building. Damage from the explosion covered an estimated 48-square-block area. The Regency Tower, a 24-story, 273-unit apartment complex located one block from the Murrah Building, sustained extensive structural damage.



Suspicious devices and hoaxes can significantly disrupt commercial facilities for hours. In May 2023, authorities reportedly evacuated two hotels within and just beyond the mandatory 640-foot evacuation zone after a man attempted to drive a large U-Haul truck close to the White House. In 2022, there were more than 5,500 reported suspicious or unattended package incidents and over 300 hoax device incidents.

Uncrewed Aircraft Systems

Malicious actors could use drones to gain security knowledge or private information about a facility or event, and the drones can also be weapons. Open-air events such as concerts, sports games, and political events are at greater risk of drone incursion because it is more difficult for a drone to access a building through its doors. Drones also pose accidental injury risks should they malfunction or collide with other objects. Additionally, drones can

be armed with a deadly weapon, as seen in modifications by the Ukrainian military and also terrorist and militant groups. Due to the limited payload capacity of most commercially available drones, the panic-induced crowd crush and trampling in the aftermath of a drone attack could pose more of a risk than the attack itself.

Facility Collapse

Although rare, commercial facilities can collapse if built using outdated building codes or poor engineering, mandated inspections are not performed, or inspection results are neglected. More than a dozen collapses in the commercial facilities sector have occurred in the U.S. since 1979. Updated building codes and increased inspections by regulators can mitigate these collapses. Collapses since 2000:

- *May 18, 2000 – Pier 34 and Club Heat, Philadelphia, Pennsylvania.* Pier 34 collapsed under its weight, plunging the recently opened outdoor nightclub at the end of the pier into the water. Three women were killed, and 43 others were injured.
- *June 29, 2003 – Chicago apartment balcony, Chicago, Illinois.* When an overloaded apartment balcony collapsed during a party, 13 people died, and 57 others were seriously injured. It remains the deadliest porch accident in U.S. history. In 2006, inspectors found 6,670 porch violations throughout Chicago.
- *July 7, 2007 – Crab House Restaurant, Wildwood Crest, New Jersey*. Nine persons were injured when the floor of the restaurant collapsed.
- *June 5, 2013 – Market Street Building, Philadelphia, Pennsylvania.* A four-story building being demolished collapsed onto a one-story Salvation Army store, killing six and injuring 14.
- *June 16, 2015 – Berkeley apartment balcony, Berkeley, California*. The balcony of a 5th-floor apartment collapsed, killing six and injuring seven others.
- *January 13, 2018 – Merriweather Post Pavilion, Columbia, Maryland.* The roof overhanging the reserved seating at the outdoor concert venue suffered a total failure and collapsed. It was in the final stages of a project to raise the structure.
- *October 12, 2019 – Hard Rock Hotel, New Orleans, Louisiana*. The hotel under construction partially collapsed, killing three workers and injuring dozens of others.
- *June 24, 2021 – Champlain South Tower Condo, Surfside, Florida*. The 12-story condominium partially collapsed, causing the deaths of 98 people and injuring almost a dozen others.

What Else Do Emergency Preparedness, Response, and Recovery Professionals Need to Know About This Sector?

The commercial facilities sector is perhaps the most diverse critical infrastructure sector in terms of types of buildings and occupants. Facilities built by the same company for the same purpose – such as apartments constructed by the same real estate development company – will have vastly different designs, vulnerabilities, and risks. Familiarity with a facility before an emergency can mitigate the effects due to facility variations.

Emergency professionals should also be aware of the possibility of mass casualties in assembly areas and facilities. Audiences and crowds are susceptible to crowd crush and trampling because of panic or inadequate safety and security measures, such as at the Astroworld music festival in November 2021.

Sometimes, a disaster occurs simply because of a crowd's perception of potential harm (e.g., a loud noise perceived to be gunshots), a facility's structural failure (e.g., the collapse of a railing due to excessive crowd weight), or ill-advised crowd management and crowd control (e.g., Indonesian police firing tear gas into the crowd after a soccer match in October 2022, which resulted in 125 deaths from trampling and suffocation).

Emergency professionals must be prepared and willing to provide unsolicited advice and recommendations to facility managers and security professionals at commercial facilities. Commercial facilities often have unaddressed vulnerabilities, as most facilities have never had a holistic risk assessment – or even a cursory risk assessment. Risk assessments are sometimes limited to "guns, guards, and gates," neglecting other risks that can negatively impact safety, security, and business continuity. For example, numerous commercial facilities have no numbering on exterior doors, which could facilitate emergency response in certain situations. Emergency professionals could mention such observations to a facility's appropriate stakeholders during a familiarization visit or after an alarm response.

Partnerships between commercial facility operators and the first responders prior to disasters are vital. Facility operators should also be acquainted with relevant guides produced by the U.S. Department of Homeland Security (DHS) and its Cybersecurity & Infrastructure Security Agency (CISA). For example, stadium and arena operators should be familiar with the DHS "Evacuation Planning Guide for Stadiums." Based on the expertise of first responders, security professionals, and information provided by DHS (including FEMA), commercial facility operators should write formal policy, plans, and procedures, and occasionally conduct exercises.

The commercial facilities sector is vast and diverse and has an outsized impact on the U.S. economy. This sector's interdependency with other critical infrastructure sectors is extensive, complicating the risks inherent in building, operating, and occupying commercial facilities. Understanding this immense sector is crucial in preparing for the unfortunate and inevitable repeats of the sector's past mishaps, catastrophes, and disasters.

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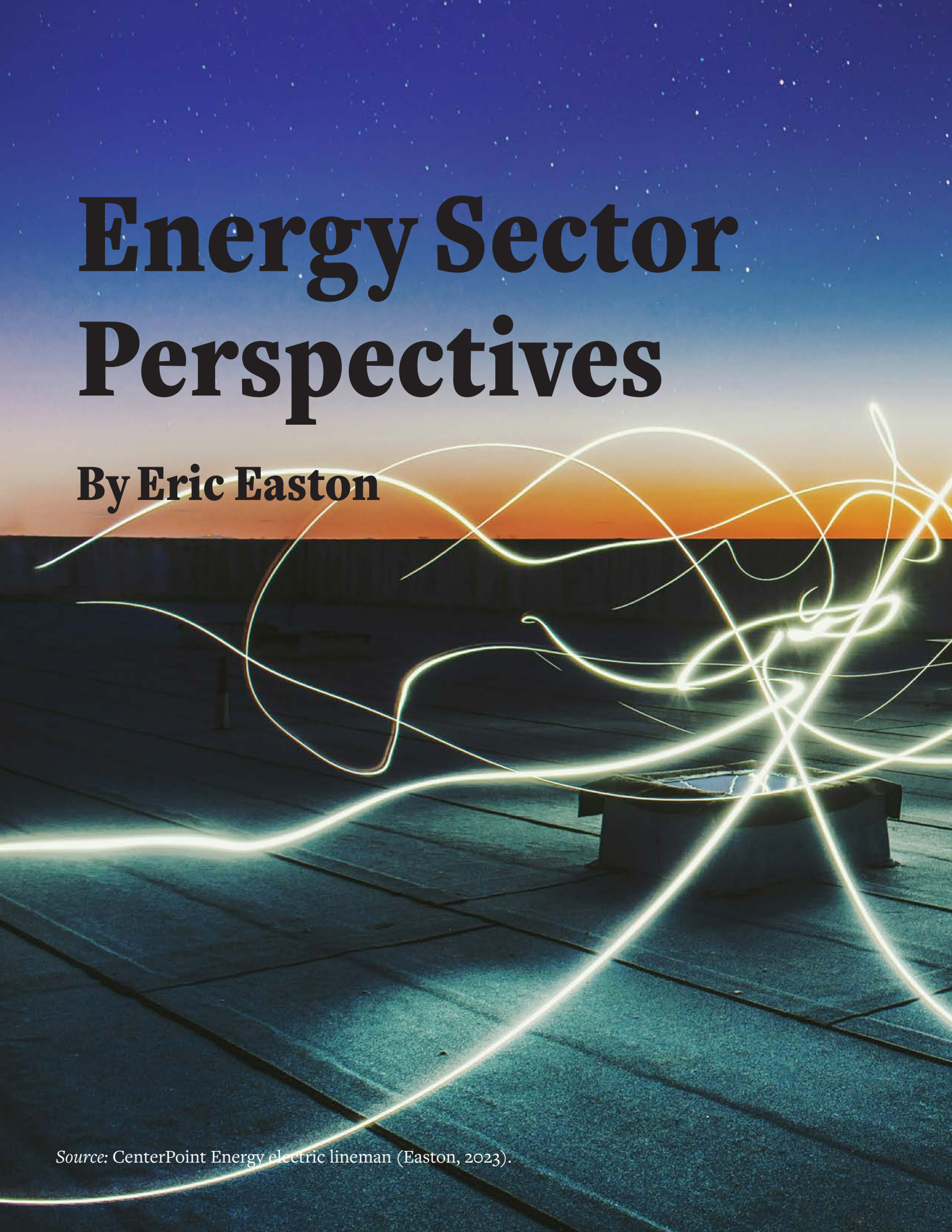
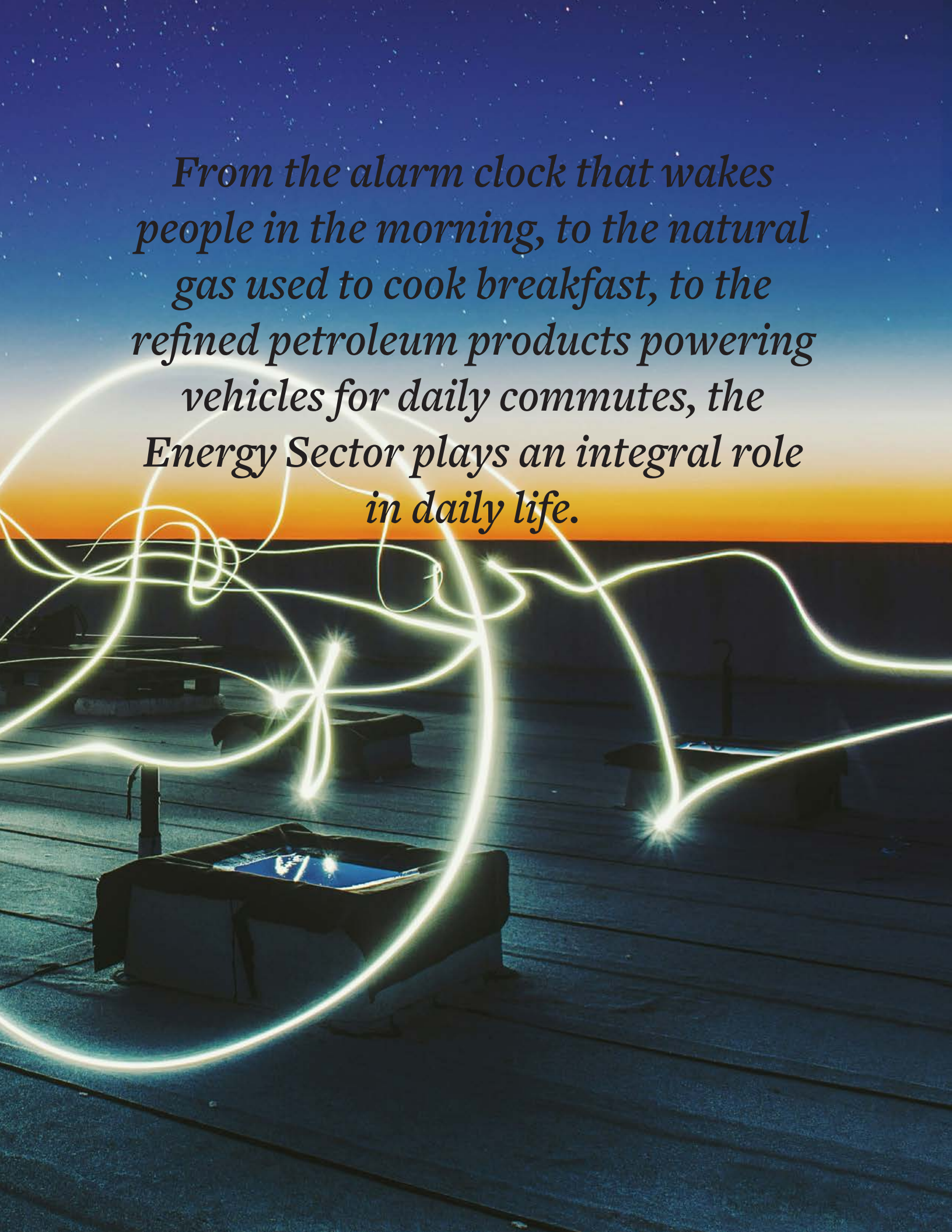
Energy Sector Perspectives

By Eric Easton



Source: CenterPoint Energy electric lineman (Easton, 2023).



From the alarm clock that wakes people in the morning, to the natural gas used to cook breakfast, to the refined petroleum products powering vehicles for daily commutes, the Energy Sector plays an integral role in daily life.

From the alarm clock that wakes people in the morning, to the natural gas used to cook breakfast, to the refined petroleum products powering vehicles for daily commutes, energy is a constant in our lives each and every day. The Energy Sector was identified as one of the 16 critical infrastructure sectors outlined by Cybersecurity & Infrastructure Security Agency (CISA) in its Energy Sector-Specific Plan and comprises electricity, oil, and natural gas subsectors, which enable a thriving society and economy by powering essential functions of the modern world.

The sector's roles include generating, transmitting, and distributing electricity and producing, refining, storing, and distributing oil and gas. While ownership models vary globally, private, federal, state, and local entities own the U.S. Energy Sector's critical infrastructure. In certain instances, market consumers, such as energy-producing industrial customers and financial institutions, own these assets. According to the U.S. Energy Information Administration energy facts, petroleum and natural gas account for almost 70% of energy sources, with transportation and industrial sectors representing 70% of consumption. In addition to meeting the nation's critical energy needs, the Energy Sector employs 8.1 million Americans, with growth outpacing overall U.S. employment.

The Energy Sector spans coast to coast, delivering technologies, opportunities, and challenges. These assets require safe and reliable operation for national security, which increases innovation demand to address evolving hazards and threats to critical infrastructures' safety and reliability.

What Makes This Sector Critical to the Nation, and What Possible Effects Does It Have on States and Local Communities?

The Energy Sector's criticality to the nation stems from its interdependencies with all other sectors – from healthcare to transportation to industrial manufacturing to electricity for homes and businesses, not to mention governmental agencies and first responders. The impacts on energy disruptions can be observed from events such as hurricanes, which have been increasing in number and intensity since the 1980s, according to a review by NASA.

The high winds and flooding that result from hurricanes can have a devastating effect on coastal communities. According to NOAA, hurricanes have caused the most weather-related disaster costs, totaling $1.3 trillion from 1980 to August 2023. The impacts on communities have been felt from Texas to Florida and as far north as New York City. Forcing residents within these areas to flee the path of the storm. Those who cannot are left to face the devastating impacts and resulting strain and resource limitations immediately after the storm. These storms can also directly impact energy infrastructure by knocking down poles and wires and leaving communities without electricity. Improving infrastructure resiliency, local energy sources, and production facilities for critical components can help speed recovery for the impacted communities.

Additionally, an overreliance on external energy sources can pose a strategic risk from supply chain disruptions, changes in production levels, and intentional sabotage. These factors increase the importance of domestic energy production. For example, recent military conflicts limited energy supplies to European countries, the global pandemic challenged supply chains, and the 2021 winter storm reiterated the

interdependencies between electricity delivery, power generation, and natural gas. In each example, Energy Sector disruptions had acute and impactful effects on health and public safety.

The potential for such significant effects requires industry collaboration with critical infrastructure owners, operators, and all levels of government, as impacts at the state and local levels can significantly differ from national priorities. An example of this collaboration often occurs during major events where critical infrastructure representatives convene in emergency operations centers to ensure efficient communication between multiple owners and operators. These representatives work side by side 24/7 and remain in the facility for days until systems are stabilized or returned to normal levels. Public interest meetings, which allow community members to present and discuss concerns, often address stakeholder expectations specific to a local community.

Similarly, Energy Sector owners and operators often meet with regulatory bodies responsible for industry oversight. These interactions assist in prioritizing operational activities that may affect the community, particularly during states of emergency. For example, during various weather-related events such as hurricanes and winter storms, the Energy Sector has supported transportation, heating, and medical services. Although some people take readily available energy for granted, the absence of a functioning Energy Sector greatly impairs state and local community resilience. Regarding the electric utility sector in particular, mutual assistance agreements under which an electric utility that is being hit by a hurricane, for example, can call upon other electric utilities to send trucks, crews, and equipment to help restore power. This is often seen as large convoys of utility trucks on a major highway right after a storm.

What Are This Sector's Key Assets and Interconnected/Interdependent Systems (Physical or Cyber)?

Each Energy subsector relies on complex equipment with long manufacturing lead times, including compressors, pumps, and valves in the oil and gas subsector. Large transformers are common to all subsectors but are of particular concern for electric utilities. With lead times potentially exceeding 36 months, many entities use front-end engineering and design processes to anticipate equipment requirements and mitigate risks.

Additionally, spare equipment strategies facilitate faster recovery following an equipment failure. These strategies can rely on assets owned by a single entity or through participation in a consortium of operators to gain access to a pool of common equipment types. Operators are constantly evaluating the most effective methods of risk mitigation based on the age and condition of in-service assets and dynamic lead times.

The Energy Sector has several interdependencies, with electricity required for producing, refining, and distributing petroleum-based products. In 2021, Winter Storm Uri in Texas underscored these interdependencies with a simultaneous increase in electricity and natural gas demand and a shortfall of electricity generation. An analysis of the event was conducted, resulting in a series of recommendations by the Federal Energy Regulatory Commission. The report highlighted the need for enhanced inter-sector coordination and planning. In 2022, natural gas accounted for approximately 40% of electricity production.

The scale and complexity of systems in the Energy Sector necessitate using advanced computer systems to monitor and control critical processes. These computer systems

are key assets for certain functions and can provide autonomous actions based on predetermined logic. The geographic disparity of asset locations also increases the dependency on these systems. Such systems allow for remote human control of devices using Supervisory Control and Data Acquisition. Technologies that support remote controls and monitoring continue to evolve to meet the operational demands and the need to mitigate cyberthreats.

What Are This Sector's Dependencies (Physical, Cyber, Geographic, and Logical) and Interdependencies With Other Critical Infrastructures?

The Energy Sector relies on other critical infrastructures to operate safely and reliably. The digitization of systems has increased the interdependencies in information technology and communications. Significant interdependencies also exist with transportation, water, financial, and government services.

Electricity provides energy to electrified transportation systems, pumps in water treatment plants, and transmission equipment in communication systems. Communication system equipment installed on electric infrastructure assets such as poles and towers creates additional interdependencies as an event can impact both.

The oil and natural gas subsector provides fuels for electric generation – large-scale power generation and smaller diesel generators with backup power for critical facilities or restoration efforts should a system-wide event result in a blackout. The Transportation Sector relies on fuel to operate vehicles to transport goods and equipment for multiple critical sectors, and, of course, there is a growing adoption of electric vehicles of all types. Although electricity is typically the primary power source for water and communication systems, oil and natural gas often serve as backup energy sources if electric service is interrupted.

As information technology systems have increased in importance, the intra-sector dependencies have also increased. The commonalities in cybersecurity practices lead to cross-sector collaboration and jointly developed frameworks. Energy Sector operators are constantly monitoring for cyberthreats and work across sector boundaries using trusted relationships with the government, peers within the industry, and other industries.

What Are This Sector's Current and Emerging Vulnerabilities, Hazards, Risks, and Threats?

The Energy Sector faces a dynamic risk environment from modern technologies, climate change, and regulatory constraints. The threats faced by each subsector can vary widely depending on the market forces and geographic location. When prioritizing mitigation strategies, entities must weigh the potential consequences and probability of occurrence. Therefore, each subsector performs an array of risk assessments in coordination with peers and regulatory bodies to identify the sequence of plans to deploy.

The electric subsector follows guidance set forth by the North American Reliability Council and Federal Energy Regulatory Commission to address the following:

- Cyber and physical security,
- Natural disasters and extreme weather conditions,
- Equipment failure and aging workforce, and
- Changes in fuel mix.

Source: A Madison Leeves creation (2024).

With many of the same challenges, the oil and natural gas subsector has the following subsector-specific concerns:

- Transportation infrastructure constraints,
- Operational hazards such as blowouts and spills,
- Volatile price and demand, and
- Disruption due to political instability.

Lastly, a common challenge is the need for a skilled workforce as retirements increase and erode the institutional knowledge in many organizations. The need for talent extends across all sectors and roles, including technical design, engineering, and skilled trades. Training has become a priority to meet the next generation's talents and development demands. An additional skill gap exists due to the new skills required to support energy transition. The International Renewable Energy Agency (IRENA) estimated that a transformed Energy Sector will have 122 million jobs in 2050. These jobs will be needed to support each component in the energy transition; however, the majority will be related to renewables, energy efficiency, and electrification.

The number of "green" job postings is outpacing the available talent, driven by the increase in investments planned due to the support from the Inflation Reduction Act. The skills required for the energy transition vary greatly but include digital technology, engineering, waste management, and skilled trades. Most training is offered through government programs aimed at upskilling or reskilling the workforce based on the anticipated skills needed for the transition. Industry and government need to partner in a manner to ensure the correct skills are being developed, opportunities are communicated to the potential workforce, and schools are aligned with the training required.

How Would a Human-Caused, Natural, or Technological Disaster Impact This Sector's Preparedness, Response, and Recovery Efforts?

The Energy Sector has recorded three times as many Operational Technology and Industrial Control System cybersecurity incidents as other sectors. Disasters related to the Energy Sector are impactful based on interdependencies with other critical infrastructures. The consequences of disruption cascade quickly, impairing the ability to complete routine everyday tasks. The 2021 ransomware attack on Colonial Pipeline exemplifies how quickly the effects can propagate from operational impairment to economic and societal disruption. The ransomware attack resulted in some Americans panicking and causing long lines at gas stations out of fear of not knowing how long and severe the impacts would be. Such events highlight the need for effective communication with the industry when security postures need to change.

Attempted attack vectors include external remote services, removable media, remote services, and supply chain compromise; however, the most used approach is phishing. The ability to remotely initiate such attacks has required strengthening of cyber protections, including defense in depth, complex passwords, 24/7 threat monitoring, and segmentation of networks. In response to phishing, entities continuously train staff to avoid phishing scams and provide proactive awareness of the latest attempts. Cyberattacks can have adverse effects, from data loss to an inability to operate control systems. These same systems may directly support response and recovery efforts, which makes network

segmentation a vital strategy to limit network access to personnel.

Natural disasters differ from human-caused attacks due to the ability to assess impacts more directly. While a cyberattack may slowly evolve without detection, many naturally occurring events typically have some advanced warning. Energy Sector operators typically have emergency operations plans for foreseeable disasters such as hurricanes and ice storms that may damage physical assets. As noted above, depending on the event's severity, operators may call upon external resources in the form of mutual assistance. Trained operations personnel from areas outside the affected region can provide supplemental resources to speed up critical infrastructure restoration.

Technological disasters can result from complex interactions in interconnected systems. Due to the reliance on technology, an impaired or inoperable system may greatly reduce operational capabilities. The inability to operate a critical subsystem may lead to cascading conditions. As a result, operators in the Energy Sector often utilize redundant subsystems to increase technological resiliency. Manual processes are developed when possible as a backup in case the digital or technological solution is impacted, and personnel are trained to ensure the highest reliability achievable by the organization.

What Else Do Emergency Preparedness, Response, and Recovery Professionals Need to Know About This Sector?

The Energy Sector is a diverse and complex interconnection of technologies and processes developed over decades. As the sector moves toward an increasing level of renewable sources and outputs, maintaining the historical levels of reliability will require increased innovation. These innovations will require significant investment in research and development, often starting with demonstration projects at a smaller scale before achieving production levels. Government plays a vital role in risk reduction and acceleration by providing expertise and funding. The vast capabilities of U.S. national laboratories and universities working in collaboration with industry have long added to the success of the Energy Sector. Universities also assist by providing a talent-rich candidate pool with skills specific to current needs.

Many companies in the Energy Sector are pursuing cleaner energy, carbon reduction, and energy transition strategies. Much of the Inflation Reduction Act funding is tax credits intended to incentivize investment in cleaner energy, such as wind, solar, and hydrogen. Successful outcomes from the strategy will aid in pursuing ambitious carbon emissions goals and a supply chain less dependent on nondomestic manufacturing. Examples of such opportunities include battery manufacturing in Georgia, a solar complex in Alabama, hydrogen hubs throughout the U.S., and a wind turbine facility expansion in Colorado. Process facilities looking to deploy electrification to reduce emissions will need renewable sources to power the next generation of equipment. Renewable sources such as wind and solar require large sites, often located further from load centers. As a result, new high-capacity electric transmission lines must deliver electricity, often requiring extensive routing studies and permitting processes. Regulators are realizing the challenges, and, in some regions, efforts are optimizing processes to decrease project timelines.

Ultimately, an evolution of energy sources will take technical and nontechnical changes and public acceptance of new technologies and construction. While nuclear power remains a small portion of total energy production, one utility is in the process of bringing online

the first new major nuclear site in the U.S. in decades. Developing small modular reactors may increase use and complement the intermittency of wind and solar. Intermittency (i.e., that solar power is not available when the sun does not shine, and wind power is not available when the wind does not blow) will pose the greatest challenge to the electric subsector's continued reliability.

While large-scale generation sources are necessary for industrial customers, smaller-scale resources are beginning to proliferate on lower voltage distribution systems. As a result, the distribution system will also require significant changes to accommodate bidirectional power flow on a historically unidirectional system. Introducing producers/consumers, which act as generators and loads at the same point of system interconnection, will require electric subsector operators to have increased visibility and control across the electric grid.

Oil and natural gas will face alternative challenges, including an uncertain market environment regarding demand and the fuel cost for internal combustion engines. Some of the uncertainty stems from the adoption of electric vehicles. As electric vehicle makers increase production, decreasing the total cost of ownership from tax credits and price reductions may incentivize more individuals to purchase electric vehicles. Such market shifts have led Energy Sector companies to explore nonfuel revenue sources, including renewable energy, electric charging, biofuels, hydrogen, and liquid natural gas. Oil and gas

Source: CenterPoint Energy electric lineman (Easton, 2023).

companies invested in renewable energy and electric charging as a first step to diversifying from fossil fuels to lower carbon alternatives. However, carbon capture sequestration technologies could aid in delaying a more significant shift.

Acquisitions are often part of the diversification strategy and joint ventures, which allow entrance into the renewable sector at lower risk. Biofuel production and consumption, including ethanol, biodiesel, and renewable diesel, have increased yearly since the early 1980s. Government policies and programs have aided by promoting and sometimes requiring biofuels. Except for 2020, biofuel usage has expanded nearly 6% annually for the past five years and is likely to continue through 2030. Hydrogen may also be pivotal in resolving energy challenges in use cases including transportation, oil refining, blending into natural gas networks, and power generation. An advantage of hydrogen is its ability to be transported as a gas by pipelines or in liquid form by ships, much like liquefied natural gas (LNG). Hydrogen has potential beyond its common uses in oil refining and fertilizers and can assist in the energy transition through adoption in other sectors, assuming challenges can be overcome. This will require reduced hydrogen production costs, hydrogen infrastructure development such as refueling stations, and regulations for safely transporting and storing large volumes.

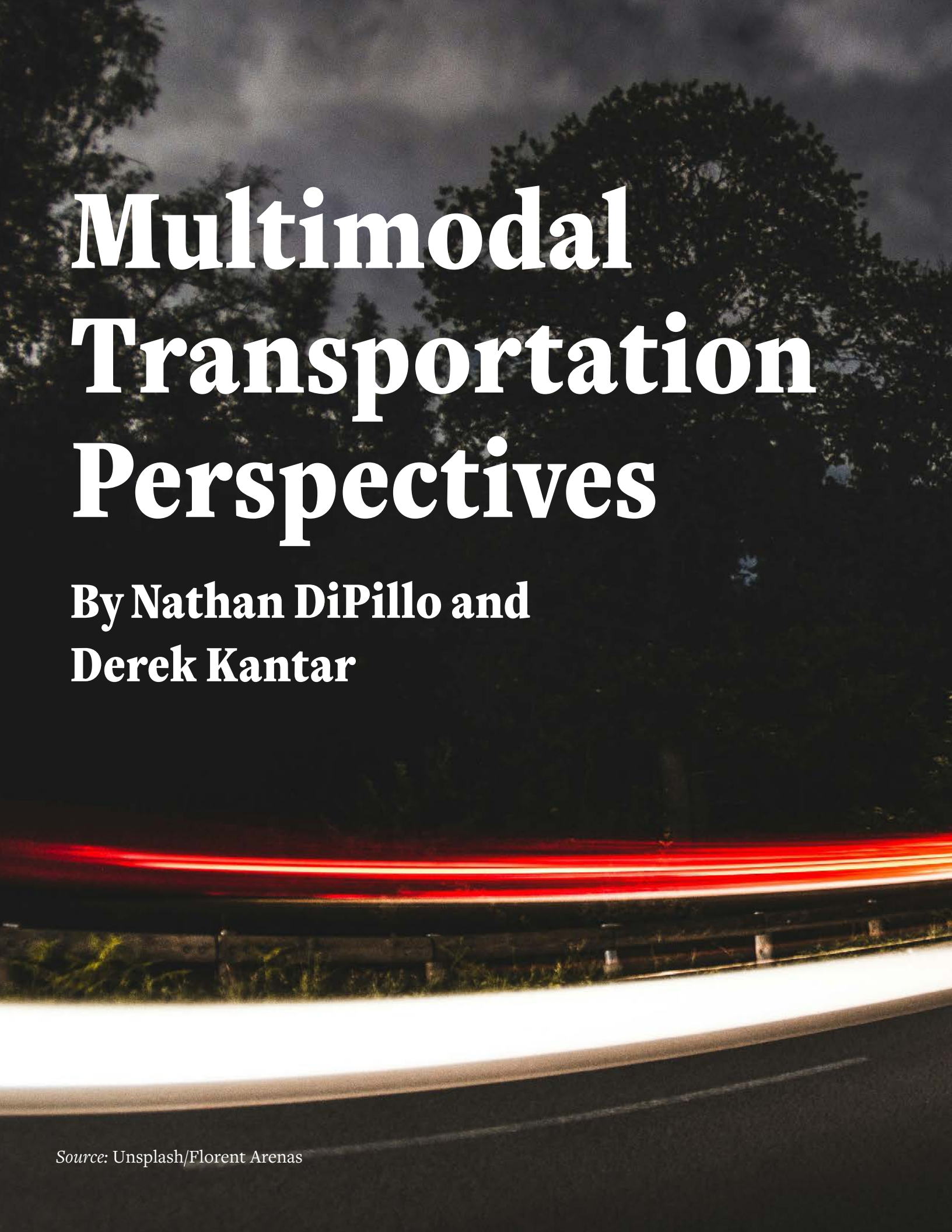
Lastly, international LNG shipments led to the U.S. becoming a net exporter of natural gas in 2017 and of total energy in 2019. Exports have grown steadily and are forecasted to grow, with two new liquefication projects planned to come online in 2024. LNG can assist in the transition to a low-carbon future by reducing carbon dioxide production compared to other fossil fuels. Its use can provide an affordable energy source as the challenges of intermittency and grid stability are resolved.

The Energy Sector continues to evolve as it supports the economic growth and national security of the United States. In addition to the possibilities delivered to end consumers, this sector is vital to all other critical infrastructures. Of the many challenges discussed, one of the most important is the recruiting and retention of talented problem-solving individuals dedicated to navigating a dynamic energy future. Through partnerships and innovation, it is possible to collectively achieve tomorrow's goals with today's reliability. Innovation will assist in mitigating future potential energy crises and avoiding scenarios such as the 1970s energy crisis, which resulted in the establishment of the U.S. Department of Energy. The ability to coordinate efforts among national laboratories, universities, and the private sector will once again be needed to introduce and integrate the next generation of energy innovations.

Eric Easton, Ph.D. is CenterPoint Energy's vice president of grid transformation and investment strategy. In this role, he manages the company's plans and response to transformative challenges, such as distributed generation, electric vehicles, and mass electrification. He ensures that executed plans provide the modern and resilient service that customers demand. The views expressed in this article are solely his and do not necessarily express the views or opinions of CenterPoint Energy, Inc.

Multimodal Transportation Perspectives

By Nathan DiPillo and Derek Kantar



Source: Unsplash/Florent Arenas

Over the next few years, estimating impacts may be costly and delay or disrupt infrastructure resilience and improvements. This should be emergency managers' radar as they evaluate recovery efforts and resource positioning.

Without transportation and communications, emergency response can move at an uncomfortably slow pace, enough so that life, property, and the environment may be unnecessarily compromised. Although functioning roads and bridges during such times are critical, transportation support is a multimodal endeavor involving the rail, transit, aviation, and maritime sectors. These modal sectors, along with roads and bridges, are considered critical infrastructure in federal, state, and regional response plans and must be protected as an integrated network from threats and other risks.

What Makes This Sector Critical to the Nation, and What Possible Effects Does It Have on States and Local Communities?

In 1919, Lieutenant Colonel Dwight D. Eisenhower took part in the 62-day U.S. Army's transcontinental motor convoy that drove 3,251 miles between Washington, D.C., and Oakland, California. After becoming president, Eisenhower signed the Federal Highway Act of 1956 on June 29. This bill set the map for the 41,000 miles of a new National System of Interstate and Defense Highways. The intent was to:

> *[E]liminate unsafe roads, inefficient routes, traffic jams and all of the other things that got in the way of "speedy, safe transcontinental travel." At the same time, highway advocates argued, "in case of atomic attack on our key cities, the road net would permit quick evacuation of target areas." For all of these reasons and more, the 1956 Act declared that the construction of an elaborate expressway system was "essential to the national interest."*

The U.S. multimodal transportation system is an essential and complex system of highways, local arterials and roads, pipelines, maritime systems, rail networks, and air facilities that is of vital national interest – connecting people, services, and goods across the country. The U.S. Department of Homeland Security (DHS) designated the Transportation Sector as an individual sector comprising aviation, highways, motor carriers, maritime resources, mass transit, pipeline systems, freight rail, and postal shipping. Each sub-sector critically impacts the nation, states, and local communities. While these modes are unique to each industry, they also represent the cascading impact they can have on each other should one fail, as defined within the DHS critical infrastructure sectors and Emergency Support Functions (ESF).

Section 1016 of the USA Patriot Act (42 USC 5195e) provides the current definition of critical infrastructure, describing systems and assets that are:

> *[S]o vital to the United States that the incapacity or destruction of such systems and assets would have a debilitating impact on security, national economic security, national public health or safety, or any combination of those matters.*

As seen in human-caused and natural disasters, the Transportation Sector plays a significant role in supporting the movement of goods and services to communities during blue-sky and dark-sky conditions. Equally important, most ESFs rely on an unimpeded multimodal transportation system to carry out their essential services. For example, ground and air assets are vital to firefighting efforts during a wildfire response. However, the same roads and airspace could be needed for human and livestock evacuations, law enforcement, life-sustaining freight movements, and other response activities.

During the 2021 wildfire season, a fire in Northern California burned a large section of the Black Butte rail freight line. As a result, rail services were diverted to trucks, which congested Modoc and Shasta County roads and delayed delivery schedules. The Black Butte line is the main line into California from Oregon. Aviation support was also challenged when ingress and egress routes to airfields became constrained. Some of these roads and bridges can be more critical than others and are important to federal and state Critical Infrastructure Protection units. Criticality can be impacted by specific functions and flow along with events. These roads can become chock points and, in some cases, the only means of egress and supply chain movement.

What Are This Sector's Key Assets and Interconnected/Interdependent Systems (Physical or Cyber)?

The Transportation Sector has many complex interconnections to key assets. Working through the National Response Framework ESFs, these assets can include highway, road and bridge surface conditions, mass transit movements for elderly and disabled citizens (Access and functional needs communities), airports and aircraft systems, maritime and seaport systems, and pipelines, all of which should be initially considered as one interconnected system. Maritime shipping, air cargo, rail haul, and surface freight are linked and scheduled for daily operations and economic stability. Local emergency managers must consider these networked shipping movements during emergencies to avoid unnecessary impacts on local, regional, and national economies.

Within the cyber environment, the American Public Transportation Association (APTA) shares that:

> *Cybersecurity is a growing concern for public transit agencies. The most common cybersecurity incidents threatening transit agencies involve email compromise, data breaches, ransomware, counterfeit hardware, and supply chain risks.*

These risks are ever evolving and can cause significant cascading impacts on more than just the transportation sector. As more transportation systems become dependent on cloud-based technologies, the risk for cyberthreats increases the likelihood that multiple modal systems could be compromised or failed by cascading cyberattacks or the results thereof. This includes the transportation systems themselves and above and underground utilities that use the transportation right-of-way.

Also, when moving around an impacted area, the proliferation of autonomous vehicles requires real-time communication with various network systems to ensure such vehicles do not block responder movements. For example, stranded autonomous vehicles caused by cyberattacks or other incidents could block responders.

What Are This Sector's Dependencies (Physical, Cyber, Geographic, and Logical) and Interdependencies With Other Critical Infrastructures?

An often-overlooked interdependency is the number of utilities buried or co-located in road rights-of-way, including fuel pipelines, overhead utilities, and buried utility conduits. The Energy Sector depends on open transportation systems, so operations can be disrupted if roads are damaged during incidents. Access to utility repairs can also be delayed when minimal access road repairs are underway. As roads are needed for responder, medical, and commodity movements, it becomes a heavy weight to

balance when to take them out of service to restore and service them.

Moreover, the Transportation Sector is an extremely complex web of modal systems and touchpoints. Multimodal transportation and the proliferation of technology, such as intelligent transportation systems and artificial intelligence, is considered by some scholars to be a "marvel" of engineering connecting the broader Transportation Sector. As the sector moves from basic hardscape, flat, and linear systems into a mature, rapidly advancing, and complex prodigy of technology moving goods and services across the different modes, the threats from cyberattacks can severely hinder emergency response and recovery.

What Are This Sector's Current and Emerging Vulnerabilities, Hazards, Risks, and Threats?

Pipeline systems transport almost all of the nation's bulk liquid and natural gas to home and business retailers across the U.S. This is vital during emergencies and throughout harsh weather seasons where sustaining communities and industries is paramount. Texas experienced this in 2021 when over a million people went without power for days, and some outages lasted for weeks. Short delays or temporary shutdowns of pipeline systems can have devastating local and economic impacts, even resulting in localized panic buying.

Add to these examples of hackers infecting IT systems with ransomware attacks, and more than local inconveniences become widespread. One operator, Colonial Pipeline, paid hackers for a decryption key to allow the utility to get its IT systems back online. President Joe Biden declared a state of emergency for this incident. Had this situation not been resolved quickly, it could have resulted in panic buying, delayed interstate fuel movements, limited retail operations, and price gouging for supplies.

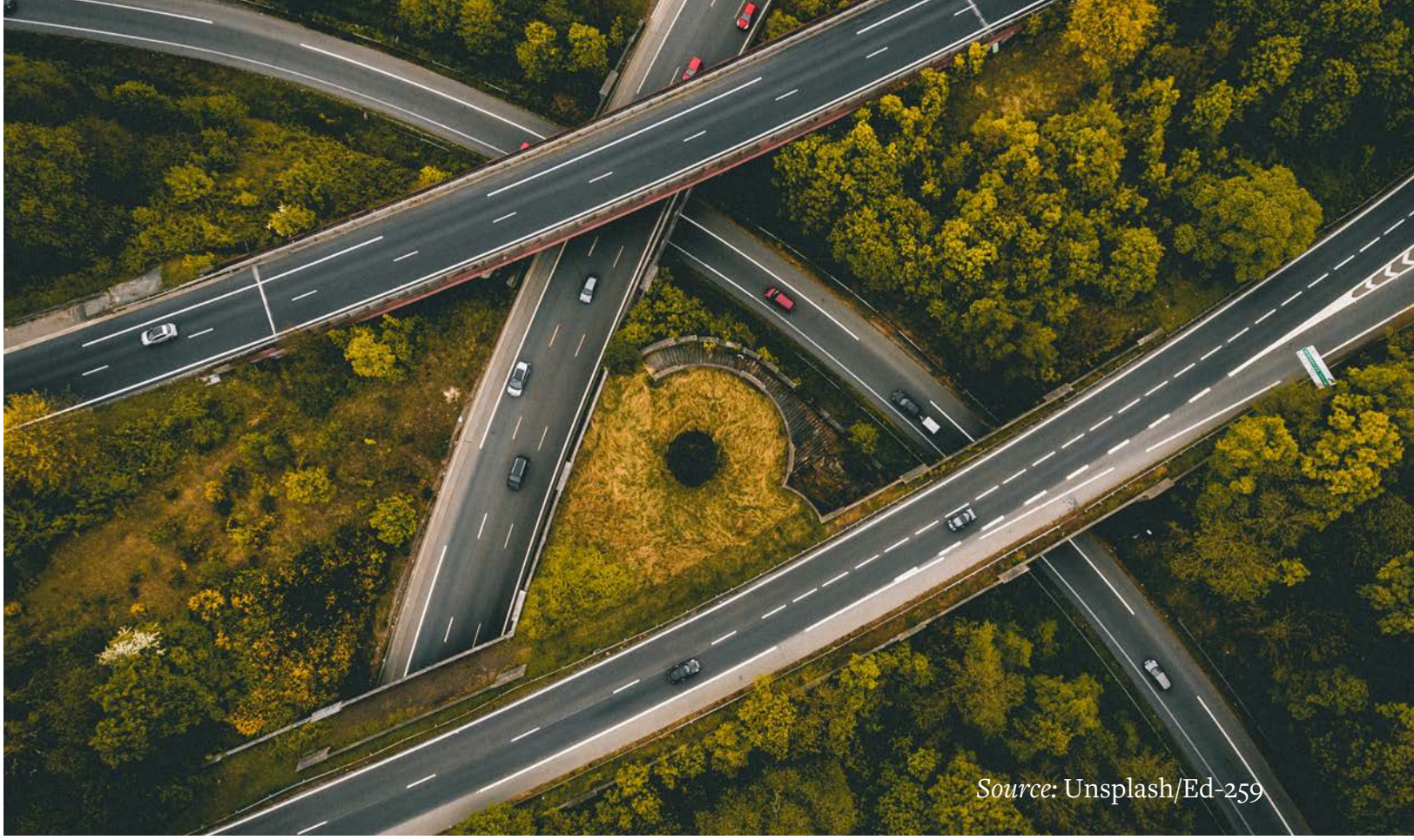
How Would a Human-Caused, Natural, or Technological Disaster Impact This Sector's Preparedness, Response, and Recovery Efforts?

The growing interconnected nature of modal transportation via wired and wireless technology will increase its vulnerability to intentional or unintentional disruptions in service. For example, early-warning earthquake monitoring systems are being applied to all forms of transportation. But if the connections between these systems and public devices are compromised, the value of such systems could be questioned. Also, consider the number of bridges with electronic earthquake monitoring devices installed.

If these wired and wireless systems become compromised, physical inspections would be needed before the facility could be deemed safe for emergency response purposes. A response phase delay could be considerable. The human-caused threats remain a factor in protecting critical assets. For example, in 2021, a bridge between Chicago and Canada shut down due to a bomb threat. Authorities had to shut down the bridge to all traffic, severely disrupting daily flow and impacting businesses and communities.

What Else Do Emergency Preparedness, Response, and Recovery Professionals Need to Know About This Sector?

The Transportation Sector needs to be seen as a multimodal system that is interconnected in ways not always observable or directly actionable. Many states' Departments of Transportation (DOT) do not own or operate modal systems outside of their state highway systems. While there are notable exceptions, DOTs become heavily involved in supporting other emergency functions by helping coordinate communication among the transportation modes to responders. To support response efforts, interagency



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coordination becomes paramount. But this represents its own challenge for the transportation community.

A DOT has a tremendous workload just opening and coordinating impacts on transportation networks. Without preestablished communications plans with the other ESFs, considerable delays in communicating status and needs will stress human and physical abilities. A related challenge is that much of the sector is operated with proprietary or security-related information. Advanced partnering with the modal community is needed to predetermine which information can be released and to whom, without compromising proprietary or security concerns.

Part of interagency cooperation also includes public-private partnerships. Obvious examples include private toll roads, Class A railroads, airlines, container ships, transit agencies, and more. The government may have some policy authority to help adjust movements, but private system operators are typically on the front line of such response and recovery efforts. Developing relationships with private sector partners is fundamentally important to all decision-makers.

Climate resiliency also cannot be overlooked. The national dialogue around critical infrastructure impacts that could be affected by changes in the climate and sea levels will continue for decades. Grant funds are becoming available to help advance this research, but discussions with the emergency transportation community need to advance concurrently. Investment firms are looking into investment decisions regarding large capital infrastructures. Over the next few years, estimating impacts may be costly and delay or disrupt infrastructure resilience and improvements. This should be emergency managers' radar as they evaluate recovery efforts and resource positioning.

Conclusion

The multimodal Transportation Sector is a massive, complex, and dynamic industry. It combines lead and support roles, private and public entities, wired and non-wired technologies, and aged and new infrastructure. New partnerships must evolve to embrace the myriad of demands and threats placed on transportation. Minimizing physical threats, reducing human suffering (especially to those with access and functional needs), and continually staying ahead of cyberthreats will keep this sector forever pushing new boundaries.

Emergency preparedness professionals must continually plan and address each sub-sector and micro-sector for the communities in their jurisdiction. Regular training and exercising of these plans will remain paramount from a practical and psychological standpoint. The Homeland Security Exercise and Evaluation Program (HSEEP) is a nationally known resource for state, local, and private entities to help with exercise planning, design, and execution. Key stakeholders working together more often will build greater community resilience.

For further reading:

The Interstate Highway System - Definition, Purpose & Facts (history.com)

The Complex History of the U.S. Interstate Highway System (interestingengineering.com)

Transportation Systems Sector | Cybersecurity and Infrastructure Security Agency CISA

Review of Smart Transportation and Challenges: Cyber Security Perspective | IEEE Conference Publication | IEEE Xplore

Systems | Free Full-Text | Distributed Control of Cyber Physical System on Various Domains: A Critical Review (mdpi.com)

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