Designing a Resilient Campus

By Ryan Kmetz, ENV SP

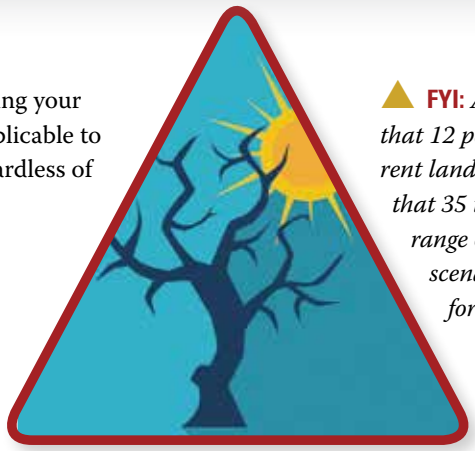
The term "resilience" has increasingly been heard in conferences, project proposals, design charrettes, or from emergency managers. This is an emerging hot topic for those who work within the built environment. But what does "resilience" really mean and how does it apply to you specifically?

DEFINING RESILIENCE

The U.S. Department of Homeland Security (DHS) defines resilience as "the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions." Simply stated, it's the capability to return to normal. Over the past five years, various organizations have designed operational and service-related rating systems. These credentials are based on best practices, and the organizations offer resilient-design certifications. Some examples include the U.S. Resiliency Council's Earthquake Building rating system, the Institute for Sustainable Infrastructure's Envision rating system for civil projects, and the US Green Building Council's Leadership in Energy and Environmental Design (LEED) v4 pilot credits, which are focused on design and planning for resilience. All of these systems are designed to aid us in adapting to our environments while constructing more suitable infrastructure. Most recently, some of these systems have focused on including sensitivity analysis and modeling projections related to the potential impacts of climate change.

There are many different approaches, methods, and programs available to us when thinking about this topic both at work and at home. Let's

outline the common steps for building your organization's resilience that are applicable to all facilities management assets regardless of location, age, or design.



IDENTIFY HAZARDS

Disasters can and will occur. Unfortunately, severe natural events are occurring more frequently. Fortunately, facilities managers (FMs) understand their facilities and know where, when, and what kind of problems typically occur. But what about nonroutine problems or an extreme event? What happens if your facilities are untouched but the surrounding area is devastated? When thinking about how to improve our facilities' readiness, we need to identify and consider all potential vulnerabilities from natural hazards that can impact continuity of operations.

Every location presents its own unique challenges. It is important to use traditional resources and local knowledge to have the best understanding of your specific challenges. By engaging employees and community members, we can gain invaluable knowledge. Their historical knowledge may reveal an extreme event that disrupted the area in some manner. These "once in a lifetime" events were potentially considered anomalies; therefore, mitigation techniques may not have been incorporated in designs, buildings, or retrofits.

Additionally, there are many readily available and accessible traditional resources that we can use to identify hazards. These resources vary in detail, accuracy, and intended audience. The most common and familiar resource is your state/province, region, or municipality's Hazard Mitigation Plan. These plans, designed for a more technical audience, are highly detailed and developed to meet U.S. Federal Emergency Management Agency (FEMA) approval by planners and emergency managers for hazard identification. A newer resource, the National Oceanic and Atmospheric Administration (NOAA) U.S. Climate Resilience Toolkit (*toolkit.climate.gov*), provides a plethora of data and interactive tools for all types of professionals to utilize when evaluating their location and assets.

Examples of hazards to evaluate in the toolkit include:

- Flooding (coastal and riverine environments)
- Drought
- Wildfires
- Landslides
- Earthquakes
- Severe weather

FYI: *A 2012 NOAA study in New Hampshire found that 12 percent of culverts are already undersized for current land use and the recent shifts in precipitation. And that 35 to 70 percent of culverts were undersized for a range of likely population growth and climate change scenarios. (http://www.caryinstitute.org/newsroom/forefront-shoreline-management)*

DEVELOP A PLAN

Ideally, both your organization and the greater community will contribute to the design of a plan to address your unique challenges. However, for various reasons, this scenario may not be technically or economically feasible. Fortunately, the basics of resilience planning are applicable to both large-scale collaborative efforts and small departmental efforts.

A good plan, derived from FEMA guidance, constitutes the use of a three-tiered approach to address your location's specific challenges. This plan allows the consideration of engineering solutions in conjunction with the development of mitigation policies for both the built and natural environment. The ultimate goal of the plan is to identify ways to substantially minimize threats to health, safety, and property. Furthermore, FMs may consider augmenting their planning process with a continuity-of-operations component. This provision will allow organizations to consider impacts to physical infrastructure beyond their scope of operational control.

FYI: *In 2013, DHS established the Campus Resilience Pilot Program. Seven different higher education campuses throughout the United States participated in using a whole-campus approach to identify 13 functional and mission-critical campus service areas and to identify resilient practices and approaches to share with other schools. (https://www.dhs.gov/news/2013/02/01/dhs-announces-campus-resilience-pilot-program-colleges-and-universities)*

HARDENING BUILDINGS AND INFRASTRUCTURE

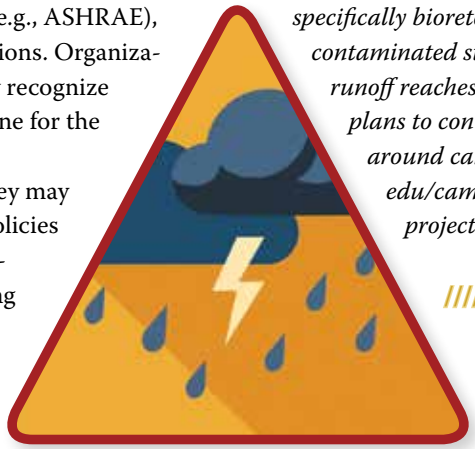
Organizations should consider how to protect and improve existing assets. Many times, these options include retrofits or new construction; often these are physical measures we can engineer and construct to mitigate hazards. Such approaches typically involve traditional methods: building barriers, structural/fenestration reinforcement, elevating critical equipment, installing automatic and manual redundancy measures, etc. Furthermore, over the past few years, several newer options have become available, such as microgrids and low-impact development (LID) techniques.

FYI: *The University of California, San Diego integrated solar, fuel-cell, and cogeneration technologies to establish a microgrid on their campus. The microgrid generates nearly 92 percent of the annual electricity used on campus. (http://sustainability.ucsd.edu/initiatives/energy.html#Clean-Energy-Production)*

BUILT ENVIRONMENT POLICIES

When designing new projects or making significant improvements, organizations should consider codes, standards, planning strategies, and best management practices. FMs should only pursue options that adequately address the risks and are economically and technically feasible. Traditional examples of these policies include floodplain management, building codes (e.g., the International Code Council), standards (e.g., ASHRAE), zoning, and applicable governmental regulations. Organizations seeking to enhance their resilience may recognize that current codes and standards are a baseline for the safety of the occupants and the property.

FMs should consider the probable risks they may face and should, whenever possible, adopt policies that mitigate them. This may include upgrading HVAC for more extreme seasons, building in quick generator hookups, constructing stormwater collection systems, using permeable surfaces, or building structures so they can easily support the added weight of additional resilience measures (e.g., renewable energy systems). Additionally, we should consider where to build and what data is used to make those determinations. For example, FEMA flood maps only consider historical data and do not yet include a sensitivity analysis for climate impacts.



FYI: *In 2001, a tropical system flooded the University of Texas (UT) Medical School Building basement and first floor, causing $205 million in losses. UT responded by spending $12 million on designing and constructing a flood-resistant building. UT designed the space based on a 500-year flood (0.2% annual chance) elevation plus 1 foot. Some of the hardening included reinforcing concrete flood walls, installing flood doors to maintain egress, retrofitting windows with submarine glass, installing backflow valves on water lines, retrofitting the basement to resist flood loads and buoyancy, etc. (FEMA P-936, 2013)*

NATURAL ENVIRONMENT POLICIES

Protection and maintenance of natural features allows the opportunity to further protect your organization's physical assets. Many ecosystems provide invaluable services—sometimes referred to as "natural capital." These services can range from water-quality improvement and flood storage capacity to reduction of heat islands. We should consider these services when choosing the site for new infrastructure by building on areas that have been previously disturbed and improve those areas with aesthetically pleasing elements from the natural environment. Policies may include maintaining a certain percentage of area for natural vegetation, implementing low-impact development (LID) wherever possible, ensuring that only native species are planted, or building in stable areas.

FYI: *The University of Maryland (UMD) uses LID, specifically bioretention and filtration, to catch and filter contaminated stormwater from parking lots before the runoff reaches Campus Creek. Additionally, UMD plans to continue to expand the riparian buffer around campus. (http://www.sustainability.umd.edu/campus/low-impact-development-lid-projects)*

CONTINUITY OF OPERATIONS

Continuity-of-operations planning allows organizations to design a strategy to continue to provide essential services to their students, faculty, and staff during emergencies. This is the opportunity for the campus to identify events that might have more of an effect on their region than right at their doorstep. Many organizations have clauses in their contracts for vendors to supply continuous delivery of food, water, and fuel during times of crisis. We can engage our vendors and ask them how they plan to honor the contracts if the delivery systems are compromised; i.e., if major routes to campus are impassable due to landslides, flooding, bridge failure, road buckling, etc.

"Don't let the first time you meet someone be during an emergency. Establish these important contacts prior to actually needing them."

—Scott Gesele, director of facilities management, Christopher Newport University; president of VAPPA (APPA Virginia chapter)

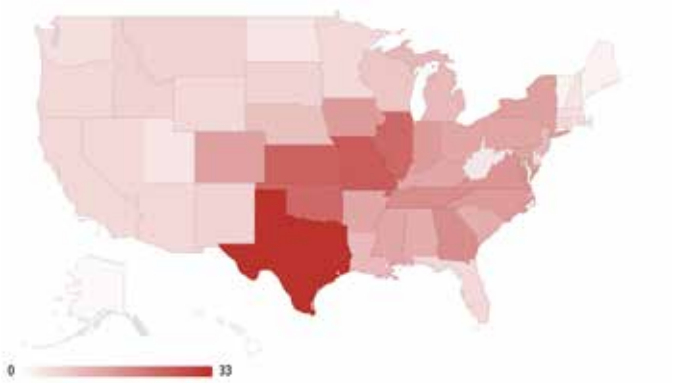
CONSIDERING THE COSTS

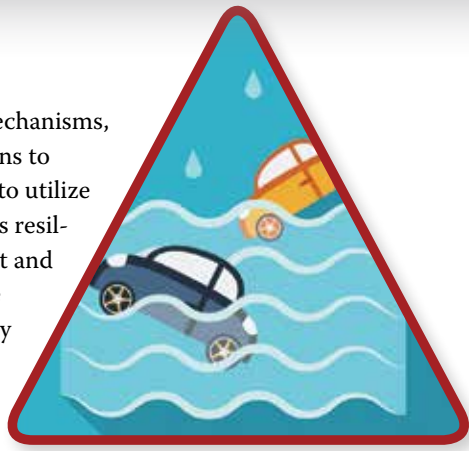
Every organization has financial priorities and constraints. Some resiliency measures are budget neutral; whereas others may require significant capital. However, historical data suggests it is only a matter of time before an organization feels the negative impacts of an extreme event.

NOAA's National Centers for Environmental Information (CEI) provide historical data that tracks the geospatial distribution, event frequency, and monetary impacts of extreme events from 1980 to the present. CEI reports that from January 2011 to July 2016, there were "62 billion-dollar weather and climate disaster" events—that's $13.7 billion per year (Figure 1).

Each of these events are coupled with losses exceeding a collective $1 billion per event (USD 2016 Consumer Price Index adjusted). These events occurred throughout the continental United States and included droughts, floods, severe storms, tropical cyclones, wildfires, and winter storms. A 2006 FEMA report estimated that annualized earthquake losses up to that time were $5.3 billion per year. Seventy-seven percent of those losses occurred on the West Coast of the United States. The remaining 23 percent of losses ($1.1 billion) were distributed throughout the rest of the country (including Alaska and Hawaii).

Figure 1: 2011-2016 billion-dollar weather and climate disasters by state. Please note that the map reflects a summation of billion-dollar events for each state affected (i.e., it does not mean that each state shown suffered at least $1 billion in losses for each event). *Source:* NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2016). *(https://www.ncdc.noaa.gov/billions/)*





There are many funding mechanisms, ranging from low-interest loans to grants, for your organization to utilize when bolstering their facilities resilience. The federal government and many state governments have funding available for resiliency projects. Additionally, there are private foundations that are also interested in advancing these kinds of projects. Some national examples include:

- FEMA Hazard Mitigation Assistance
- FEMA Preparedness Grants
- EPA Smart Growth Grants
- USDA Natural Resources Conservation Service
- Kresge Environment Program

RESILIENT SOLUTIONS

Every organization will have its own challenges and priorities in determining and implementing solutions. It's extremely important to engage your employees, students, staff, and external communities. Someone closer than you think may have begun to consider and work on these issues. Conversely, your stakeholders may have never considered or thought about these topics.

Finally, it is important to understand our risk tolerances and to focus on the areas of highest concern first. Some resilient solutions are low-hanging fruit that provide easy and affordable wins for your organization, whereas other solutions may take years of planning and capital to implement. For some of us, the major concern might be flooding, earthquakes, wildfires, or other extreme events. But for all of us, the number one goal is to protect our people and property.

▲ *"Remember, on a college campus, it takes the whole campus community to educate our students. On a bad day it really takes the entire team to get the campus back to normal operations."*

—Scott Gesele, Christopher Newport University

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