



Learning from the 2017 Disasters to Create a Reliably Resilient U.S.

Understanding the deadly disaster outbreak to disrupt the “Build-Destroy-Rebuild” cycle and forever improve the quality of life for communities in harm’s way.

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I. Introduction

On May 2, 1935, Winston Churchill stated, “Want of foresight, unwillingness to act when action would be simple and effective, lack of clear thinking, confusion of counsel until the emergency comes, until self-preservation strikes its jarring gong - these are the features which constitute the endless repetition of history.”

George Santayana put it even more simply in 1905, “Those who cannot remember the past are condemned to repeat it.”

These wise words are generally accepted, yet, when it comes to taking proven steps to create resilience in the face of natural disasters, we often fail to act. Perhaps the best example is whether we adopt and enforce the latest model building codes.

Building failure investigations have proven again and again that codes are the first and most important line of defense from natural disasters, yet far too many communities overlook this proven tool to ensure swift and successful “bounce back” after earthquakes, floods, hurricanes, tornadoes, or wildfires. The breakdown not only occurs before the disasters strike, but often during disaster recovery as well.

This sets up a cycle known as “Build-Destroy-Rebuild” where we build either without codes or with outdated codes, then natural disasters destroy our buildings, and we then rebuild them the same way, thereby perpetuating the cycle.

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We have worked as a disaster safety and resilience movement for many years to overcome this problem, and we have enjoyed clear successes. But is there a more systematic way to accomplish our goals? Is this breakdown as simple as a communication problem? Do leaders and homeowners simply not know how important codes are to survivability from the storm?

We researched this question through a national survey during the first quarter of 2018 and validated that, yes, it may be that straightforward. Our findings indicated that while most homeowners were “very” or “extremely” concerned about the impacts of natural disasters, many admitted they did not understand the linkage between building codes and disaster resilience. Further, most incorrectly assumed that they already had adequate building codes in place and enforced in their communities. Finally, when asked how they would feel to learn they did not have codes at all, 67 percent reported they would be “extremely” or “very concerned” to learn that their home was built without the benefit of building codes and standards.

Building codes, standards, and floodplain regulation policies are complex and removed from everyday life. Typical consumers are not involved when key decisions are made. Even elected officials may be somewhat separated from the details as they balance limited resource allocation in the face many competing, more near-term priorities and rely on the technical expertise of others.

Our survey findings support this assumption and make it clear that there is a gap between public understanding of the link between building performance in disasters and the presence of well-enforced, modern building codes. With that in mind, this commentary will review last year's "season of disasters" along with an examination of ways to move science and policy findings into practice with a special focus on improved risk communication.

It's time we break the cycle so common in disaster-affected communities. When we do, we will honor the legacy of those who have lost so much in the past and provide a safer future for those who reside in harm's way.

II. The "Build-Destroy-Rebuild" Barrier to Resilience

By now, it is well established that 2017 was a year for the disaster record-books. The 2017 hurricane season delivered 17 named storms, with 10 forming hurricanes.ⁱ For the first time in recorded history, three category 4 hurricanes hit the U.S.ⁱⁱ Harvey set a new tropical rainfall record with over 60 inches in Texas.ⁱⁱⁱ Irma maintained a record-breaking category 5 strength for 37 hours.^{iv} The 2017 California wildfires were the deadliest wildfire disaster in state history.^v Even Ireland had a hurricane.

The 2017 Tubbs, Atlas, and Thomas fires in central and southern California each exceeded \$1 billion in losses.^{vi} Insurance claims from 2017 California wildfires have reached \$11.8 billion, the most expensive series of wildfires in California history.^{vii} Hurricanes Harvey, Irma, and Maria caused approximately \$265 billion in damage, with each hurricane joining Katrina and Sandy as the new top five costliest U.S. hurricanes on record.^{viii}

This is just a portion of the destruction. According to NOAA, the 2017 total loss picture for all weather and climate disasters exceeded \$300 billion, making it the costliest disaster year in modern history.

So, what are our opportunities to address the rising costs of disasters?

First, it is important to understand America's natural disaster policy history and the repeating pattern we have observed. This pattern is a reoccurring cycle with little divergence. Earthquakes, floods, hurricanes, tornadoes, and wildfires happen causing catastrophic loss of life and property. Temporarily, the events rivet the public's attention, and (sometimes) motivate post-event solutions like better building codes, improved floodplain regulations, retrofitting programs, strengthened infrastructure, and a more prepared and aware populace in the disaster-affected communities.

All too soon, the disasters fall out of the nation's view and become a strictly local matter. After all, disasters are local events. The affected local community next moves through recovery for years, sometimes even a decade. But somewhere along the line, the original passion to rebuild better or leverage new building science solutions can fall away either due to more concern for short-term costs, overwhelming bureaucracy, or in response to opposition from those that eschew strong and strict development and building rules. Perhaps even worse, sometimes the original solutions that incorporate better practices may be implemented only to be diluted or reversed over time.



Alabama Adopts a Statewide Code Without Enforcement

One example of how initial commitments can wane is in Alabama where the infamous 2011 Tuscaloosa tornado outbreak caused 65 deaths and 1,500 injuries. According to NOAA, the outbreak cost an estimated \$100 million to remove the debris from Tuscaloosa alone.^{ix} And this was one tornado of the tornado outbreak between April 25th and 28th, responsible for nearly 350 deaths. According to academic, post-tornado engineering reports, lives would likely have been saved if Alabama had a residential building code in place before the tornadoes occurred. This insight supported a policy debate that led to enactment of the first statewide Alabama building code.

Unfortunately, the Alabama statewide code is only voluntary, ergo not enforceable. At its best, it is weak as a tool to drive resilience.

It is important to note that some coastal Alabama leaders have adopted and do enforce model building codes as well as beyond-code programs like the Insurance Institute for Business and Home Safety FORTIFIED™ program. However, the balance of the state is still without the certainty of minimum life-safety protections afforded by a well-enforced statewide building code.

Jacksonville, Alabama was struck by deadly EF3 tornadoes in March of 2018. We believe that forensic engineering examinations will reinforce the same message as in the past: that well-enforced codes would have made a material improvement in building performance. Of course, wood-frame homes built to the most recent code cannot resist an EF4 or EF5 tornado, but most tornadoes, even during larger events, are EF3 and below. Therefore, if homes are built to a modern code, and have safe rooms built to Federal Emergency Management Agency (FEMA) P-320/361 or storm shelters constructed to meet the International Code Council/National Storm Shelter Association 500 standard, we could save lives and homes.

This idea is the premise of the “Dual-Objective-Based Tornado Design Philosophy” first proposed by Dr. John van de Lindt, Dr. David O. Prevatt and others following engineering investigations of deadly tornado outbreaks.

Louisiana Downgrades Flood Protection in the Bayou State

Another example is Louisiana. In 2005, after Hurricane Katrina, the legislature enacted their first statewide residential building code, yet last year the legislatively-created building commission adopted the latest model code version *without* the minimum one-foot flood elevation (freeboard) requirement. The building commission did so despite recent experience with the 2016 East Baton Rouge flooding—an event that presented a billion-dollar case for preserving the minimum requirement.

Prior to adopting the downgraded minimum code, a review of Louisiana’s 350 at-risk flood communities revealed that less than ten percent (33 jurisdictions) required the beneficial minimum one-foot or greater freeboard requirement. Adoption of the new 2015 version of the International Residential Code intact, without weakening the requirement, would have raised the standards for the remaining 317 at-risk communities, bringing new homes to a higher standard. Homeowners would have qualified for annual, flood insurance premium discounts; local officials would have retained the authority to exceed the minimal requirement if so desired; and taxpayers would have been protected from avoidable future disaster costs.

Moreover, according to the U.S. Department of Housing and Urban Development (HUD) data, more than 24,000 of the homes affected in the East Baton Rouge event endured flooding of one foot or less. Arguably, if these homes had been constructed under the new proposed freeboard requirement, 24,000 families would have avoided costly, disruptive, and life-altering damage and recovery time.

Despite this timely evidence, the Louisiana State Uniform Construction Code Council dropped the freeboard minimum. As a result, Louisiana homes flooded in the future will lack elevation protection unless they are in one of the 33 jurisdictions that implement elevation requirements.

Florida Reverses Twenty-Five Year Code Leadership Legacy

Another example of the eroding commitment to resilience policy is in Florida, where state leaders last year upended the state’s nationally-acclaimed building code system.

Now, instead of mandatory, on-time updates every three years, the Florida Building Commission will use an approach that is certain to fall behind the minimum standards. Instead of using the model building code as the foundation upon which Florida-specific amendments are made, the system has been flipped. Now, we will have a patchwork of random, piecemeal updates that could undermine safety for all structures where we live, work, and play in the highly populated, and highly disaster-prone State of Florida.

The net effect is that Florida has a strong code, for the moment, but Floridians can no longer count on the certainty of a “latest and greatest” building code that addresses normal, as well as disaster-related practices. New science and innovation will be left behind. The only updates to the new model codes that are guaranteed to be included in the Florida Building Code will be those to maintain eligibility for federal funding and discounts from the National Flood Insurance Program (NFIP), FEMA, and HUD; however, no clear process has been established to facilitate this outcome.

There can be material financial costs to this policy as well. States with enhanced mitigation plans that include modern, model codes that are current and consistently enforced qualify for more federal disaster relief dollars. Typically, such states or tribal governments receive Hazard Mitigation Grant Program funds based on 20% of the total estimated eligible Stafford Act disaster assistance, versus 15% for those with non-enhanced mitigation plans.^x

Flood Insurance Sales Rise Then Fall as Memories Fade

We see many examples of this cyclical pattern in public policy, as well as public behavior. Consider how flood insurance sales spike, level off, and drop after disaster memories fade as they did following the “Great” Missouri and Mississippi River Floods in 1993, Tropical Storm Allison in 2001, Hurricane Ike in 2008, and so many more. Will the pattern persist after Hurricane Harvey as well?

It may take decades for families affected by Harvey to forget the case for flood insurance, if ever. But the overall evidence is clear. According to FEMA, only 25% of those that need flood insurance have a policy in force today.

Beyond the Building Code – Behavior

While we believe resilience is impossible without building codes, there are additional critical drivers. Levels of individual and family preparedness in disaster zones can either strengthen or weaken disaster resilience, and as trusted voices, leaders provide an important impetus for individual action.

When inspired to do so, individuals will prepare at home, evacuate when ordered, and buy earthquake or flood insurance as the best hedge against financial ruin. But are we inspiring the public to drive resilience or just instructing them?

Human Biases – Barriers or Boosts to Resilience?

What can explain the above cases where facts and experience clearly show that we need to change how we prepare to respond, survive, and recover from disaster, yet resilience policy isn’t embraced? Is there a more effective way to communicate risk and support the behaviors that drive resilience? Through the cross-disciplinary body of literature and research on disaster resilience and social science, a powerful insight is provided by an examination of the role of biases.

In 2017, *The Ostrich Paradox* by Robert Meyer and Howard Kunreuther^{xi} identified six core biases that affect disaster preparedness. We applaud the authors for their clear presentation of the information, and we suggest it can serve as a powerful risk communication primer. The authors provide information about the biases, insight on how to conduct a behavioral risk audit to understand the psychological biases that inhibit adoption, and then propose policies that work with, not against, natural psychologies.

Here are the six core biases identified in *The Ostrich Paradox* alongside the suggested approaches the authors offer to overcome same:

1. Myopia: a tendency to focus on overly short future time horizons when appraising immediate costs and the potential benefits of protective investments;
 - *Remedy: tactics and incentives that lower the short-term costs of preparation*
2. Amnesia: a tendency to base decisions on most recent experiences, overlooking lessons of the past;
 - *Remedy: communication tactics that correct distorted memories of the past*
3. Optimism: a tendency to underestimate the likelihood of personal harm;
 - *Remedy: communication tactics that enhance beliefs about hazard likelihoods and impacts*
4. Inertia: a tendency to maintain the status quo or adopt a default option when there is uncertainty about the potential benefits of investing in alternative protective measures;
 - *Remedy: policies that make safer actions the default in each setting*
5. Simplification: a tendency to process only limited subsets of information; and,
 - *Remedy: policies that simplify the set of preparedness choices faced by individuals*
6. Herding: a tendency to make decisions by social imitation.
 - *Remedy: tactics designed to foster stronger social norms of safety*

The authors make a compelling case for factors to consider in communicating with the public in harm's way. Their approach resonated with us particularly well as our nonprofit organization was formed twenty years ago to drive a "social value" for disaster safety. Our strategies and tactics confront and leverage the bias they label "herding." Others label it "milling." In our efforts, we call it "social norming."

Prior to the return of frequent, land-falling major hurricanes striking the U.S. in 2016, raising public awareness and promoting leadership action on hurricane preparedness and mitigation policy was becoming difficult.

Some states decided to skip building code update cycles, and others defunded public awareness programs. Many retailers stopped hosting hurricane expositions, and the consensus inside stakeholder circles was that “Hurricane Amnesia” had set in.

To address the problem, FLASH brought together representatives from academia, big data organizations, broadcast meteorology, FEMA, NOAA, insurance companies, product manufacturers, news organizations, and risk communication groups to identify potential solutions.

Together, we created the “National Hurricane Resilience Initiative” as an open-source, umbrella effort to align messaging and timing and get everyone on the “same page” with five common, key messages to promote and elevate hurricane resilience.

1. Personal Safety - *Know your evacuation zone and shelter*
2. Financial Security - *Have an insurance check-up*
3. Family Preparedness - *Build a disaster supply kit*
4. Damage Prevention - *Strengthen your home*
5. Community Service - *Help your neighbor*

The timing alignment included moving the annual NOAA Hurricane Awareness Tour (HAT) to line up with the White House declaration of “National Hurricane Preparedness Week.” The initiative also included creation of a new national event and social media campaign entitled [#HurricaneStrong](#).

Now in its third year, the campaign has reached millions, including governors, mayors, corporate leaders, celebrities, and citizens. Through participation, they learned that to be *#HurricaneStrong*, you must start with the five key steps listed above.

Since the launch in May of 2016, the *#HurricaneStrong* campaign has created a simple, common language and “call to arms” to drive buy-in. It has drawn tens of thousands of

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leaders and citizens to events and reached millions more through traditional news and social media outreach.

The initiative inspired *The Weather Channel* to sign on as the national media partner and offer free Public Service Announcements aired during prime hurricane season slots. One home improvement store offered workshops in 700 stores, simultaneously, on a single day during the official “week,” and it successfully ignited creative spinoff volunteer events from San Antonio to Norfolk at Walmart stores, minor league baseball games, festivals, and more.

Our experience shows that organizing our collective messaging “act” is only the first step of many more that we need to take to get ahead of the audience’s needs.

1. **Personal Safety** – *Know your evacuation zone and shelter*
2. **Financial Security** – *Have an insurance check-up*
3. **Family Preparedness** – *Build a disaster supply kit*
4. **Damage Prevention** – *Strengthen your home*
5. **Community Service** – *Help your neighbor*

III. Reviewing the 2017 Disaster Season

As we review the major 2017 disasters, we will comment on the potential presence of the six biases detailed in *The Ostrich Paradox*. We will also identify potential strategic options to help overcome some that can increase resilience during the disaster recovery underway from California to the Caribbean.

Our current disaster management system is correctly rooted in the local nature of such events, but the decentralized approach has slowed wider-scale resilience reforms. That said, we believe that, like the volume created by the [#HurricaneStrong](#) campaign, the sheer breadth and legacy of last year’s events can help overcome the Build-Destroy-Rebuild cycle.

Here’s why.

Last year, in just under 60 days, the United States experienced the shock of multiple billion-dollar disasters at the total cost of more than \$300 billion. The shock isn’t just quantitative, it’s qualitative too. We had epic, some say biblical, flooding; major hurricanes (it’s the first time two Atlantic category 4 U.S. landfalls have occurred in the same year^{xii}); and the deadliest spate of wildfires in California history.

Many have tried to describe and differentiate it—tipping point, paradigm shift, sea change, new world order. These are all ways to say that natural disasters cannot remain only local concerns that garner momentary national attention. We live in an anytime, all-hazard world, and the only way to adequately protect our communities is to embrace resilience across the board with no exceptions, no seasons, and no compromises.

We must overcome the bias of myopia, or nearsightedness. We need to accept that investing in, and prioritizing, safety isn't negotiable. It is the obligation of all levels of government to protect its citizens. Moreover, embracing basic safety standards for construction and other disaster preparations saves lives, saves money, and spares communities inevitable decades of disruption.

\$300Billion
2017DisasterSeason
Maria
Harvey
Wildfires
Irma

The following will look to each disaster and explore what we knew, what we learned, and how we can move forward to improve disaster resilience in the future.

a. Hurricane Harvey

On August 25, 2017, Hurricane Harvey made landfall near Rockport, Texas.^{xiii} Rockport and the surrounding areas endured a category 4 hurricane, but this was just the beginning. After the devastating wind damage, Harvey generated extraordinary levels of flooding. As of August 31, 2017, an estimated 70 percent of Harris County was flooded by at least 1.5 feet of water, with an estimated 136,000 flooded structures in the county alone.

According to Jeff Lindner of Harris County Flood Control District, government personnel completed 60,049 water rescues with an additional estimate of 20,000 to 30,000 performed by civilians.

What We Knew

We understood ahead of time that a direct hit from a category 4 hurricane would cause the type of wind damage that devastated Rockport and Port Aransas because we have had decades of insights from wind science and engineering testing. As a result, we understand how buildings perform or fail in hurricane force winds.

Modern building codes incorporate these insights and high-performing building methods and materials, but Texas does not have a uniformly adopted and enforced system of building codes. That is why the benefits were not uniformly realized. NOAA's latest damage estimate from Harvey is \$125 billion, and engineering investigations will eventually establish the degree of avoidable loss suffered due to the absence of minimum building codes, enforcement, or effective floodplain regulations.

We also knew that catastrophic flooding in Harris County was likely given the rainfall predictions, although Harvey exceeded what was already expected to be an historic event. In fact, the National Hurricane Center found that Harvey was the most significant tropical cyclone rainfall event in U.S. history.^{xiv} To wit, the highest storm total rainfall report from Harvey was 60.58 inches.^{xv} Furthermore, during Harvey, eighteen values over 48 inches were recorded across southeastern Texas.^{xvi} This is one of the rare occasions that using the description of "biblical" flooding levels is not hyperbolic.

We knew that flood insurance market penetration was lacking. In the end, only an estimated one-fifth of Harvey victims were insured for flood risk.^{xvii}

We knew modern technology could help post-disaster, but we underestimated the potential, as well as the speed of deployment and adaptation.

What We Learned

Technologies deployed in Harvey swiftly evolved and later became tools for those in Irma's path. One example is "GasBuddy." The mobile app helped Harvey evacuees identify which gas stations had run out of fuel or lost electricity.^{xviii}

The expanded version of the app emerged after a run on Texas gas stations post-Harvey convinced the company's CEO that GasBuddy needed to re-engineer their mobile app overnight to help Irma evacuees from the app's usual purpose to price gasoline, to also help find available gasoline.^{xix} GasBuddy did so quickly, and it was downloaded a total of 1.8 million times between August 26 and September 11.^{xx}

*What We Knew
What We Learned
How We are Moving Forward*

Zello, a modernized two-way radio, is an app that uses Wi-Fi or cellular connection to link users around the world.^{xxi} The app was used when Harvey hit Houston to help coordinate search and rescue missions, including by those in the so-called "Cajun Navy", a group of Louisiana (and Texas) boat owners who conducted search-and-rescue missions.^{xxii} Zello connects victims and rescuers instantly, allowing both to post voice messages to specific channels.^{xxiii} To gain a better understanding of how Zello was used during Harvey, read the *Houston Chronicle's* article, "[I downloaded an app, and suddenly, was part of the Cajun Navy.](#)" As Irma headed for Florida, the Zello app took the top spot on Apple's store.^{xxiv}

The role of drones in disaster recovery after Harvey, and then Irma, is also noteworthy. Drones, or Unmanned Ariel Vehicles (UAV), are vehicles that fly without an on-board pilot.^{xxv} After Harvey's landfall, drone operators responded to the area to support rescue and recovery efforts.^{xxvi}

After Harvey, the American Red Cross tested the use of drones to speed up damage assessment and recovery.^{xxvii} Additionally, telecom companies [Verizon and AT&T used drones](#) to assess equipment damage, and [some insurers have deployed drones](#) to more quickly view and assess damaged areas.^{xxviii} We are aware of many insurers who used drones to swiftly adjust California wildfire claims as well.

There are still issues to address regarding the use of drones after a disaster for search and recovery. This includes FAA temporary flight restrictions on private drones after Harvey that were criticized as overlooking opportunities to increase rescue and recovery efforts.^{xxix}

Another lesson learned from the Harvey experience is that we should reexamine how we communicate risk. A *Huffington Post* article, "[Hurricane Harvey Is Testing Our Ability To Communicate Natural Disaster Risks](#)," discusses how meteorologists were unsurprised by the extent of Harvey's destruction, but effectively communicating it to the public was a real challenge.^{xxx} A risk communication consultant was quoted, "We can describe a burrito and a pizza as 'epic,' but when we are trying to describe rainfall as 'epic,' and we're truly meaning this is epic—we've never seen anything like this in this country—it's not necessarily resonating."^{xxxi}

While Harvey was a catastrophic and historic event, flooding, even on much smaller scales, is a major source of disaster damage. A Pew Charitable Trusts report found that flooding events prompted 73% of federal disaster declarations between 2008 and 2017.^{xxxii} The report also noted that major flooding in landlocked states was more frequent than flooding along the coasts, as eight of 10 states with the most flood-related disaster declarations were inland states.^{xxxiii}

How We Are Moving Forward

There is mounting evidence that Harvey may have led to a reduction in myopia among the building industry for disaster resilience.^{xxxiv} The benefits of resilient building, especially for resilience against flooding, may be realized by more in the industry and perhaps homeowners as well.

Harvey has served for many a reminder of the risks of catastrophic flooding, arguably overcoming an amnesia bias for many in other locations in advance of Hurricane Irma and the other storms post-Harvey.

*What We Knew
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It seems that Texans are now well-aware of their risk of flooding. Still, we can't discount the influence of a famously independent culture on not evacuating or preparing, even in the face of a high likelihood of disaster. Optimism bias must be considered. And furthermore, this culture of self-reliance and resistance to outside influence feeds a herding bias. But the herd can move in positive ways too.

If building codes and floodplain regulations require elevated homes in special flood hazard areas, then it becomes a default. Communities embed safety for their citizens when they make disaster-resilient building codes, including added provisions needed for their location. That overcomes an inertia bias, and it also simplifies what individuals and families need to do to prepare for disaster, in this case flooding, as critical building practices are already mandatory. This makes sense as homeowners have a fair expectation of community leaders to implement policies that make them safe and protect their property. Further, as stated above, homeowners are not typically present when the building standards are chosen or set.

There has been a lot of discussion around Houston's limited building regulations and what has been called an "unchecked building explosion", and the role of flood maps and regulations.^{xxxv} While Houston is famous for its lack of zoning regulations, we're more interested in how strong its buildings are required to be built, i.e., their building code, and their floodplain regulations. And not just in cities, but in unincorporated areas too. The unincorporated areas of Harris County have added close to one million people since 2000.^{xxxvi}

After Harvey, the Harris County Commissioners Court unanimously approved more stringent regulations for development in the floodplain, including requirements for higher elevations, up to 8 feet higher in some areas, and that some new homes use pier-and-beam construction and be built to withstand high winds.^{xxxvii} Beginning on January 1, 2018, all new buildings must be at least 24 inches above the 500-year floodplain.^{xxxviii} These regulations have been identified as the first major change in Harris County's floodplain regulations in almost 20 years.^{xxxix}

Now Houston is following suit. Houston Mayor Sylvester Turner has championed the effort, and on April 4, 2018 the City Council approved a rule for new homes and other buildings in the city's 100-year and 500-year floodplain that requires them to be built two feet above ground or above the projected water level in a 500-year flood.^{xl}

This leadership in Harris County, and now Houston, post-Harvey is part of a larger movement. Resilience-minded leaders from all sectors have been working pre-Harvey to increase the level of U.S. disaster resilience through a continuum of steady, meaningful improvements and innovation. New FEMA policies, legislative initiatives by public-private coalitions, e.g., *BuildStrong*, and supportive federal legislation incentivize use of modern building codes to spare lives, save homes, and conserve taxpayer money.

Additionally, many new efforts capture the economics of resilience to equip decision-makers with economic data validating investments now to save more later. Examples of the growing body of evidence to demonstrate the value of codes and mitigation includes FEMA's Loss Avoidance Studies and www.floodeconomics.com by the *Economist Intelligence Unit*. Additionally, studies like *Mitigation Saves 2.0* that demonstrate a \$6 to \$1 return on mitigation investments are helping make the economic and societal case for resilience.

This type of economic data supports leadership decision-making in favor of sound resilience policies, and it is our hope that Texas Governor Abbot's "Commission to Rebuild Texas" will evaluate and consider the information as it formulates recommendations and the strategy to not just build back, but build back better as it undertakes recovery from Harvey.

But this new awareness is up against the rapidly-changing landscape and character of many of the flooded-out neighborhoods in Houston as investors move in and owner-

occupied homes give way to rental communities.^{xii} While the new owners/landlords are buying flood insurance as a means of financial mitigation, there is little evidence of consumer disclosures or physical mitigation efforts on the previously-flooded rental homes. This trend may compromise progress in consumer awareness of flooding risk and is evidence of the continuing need for public outreach and education.

In 2012, we created the Texas State Collaborative (TSC), a private-public collaboration convened to address the most pressing issues affecting the Texas built environment. TSC is a volunteer group of academics, building code officials, consumer advocates, design and building professionals, emergency managers, home builders, leading insurers, meteorologists, nonprofits, product manufacturers, regulators, and government officials.

At the outset of the TSC formation, most agreed that Texas is without a consistent and high-quality building code system across the disaster-prone state, and transparency is lacking. Through the coalition, we performed hyper-local analyses of cities and counties across the state to identify building code presence or absence as well as amendments affecting potential disaster resilience of the structure.

The National Weather Service added hyper-local analyses of weather risks, and we collected the code and weather data into *Leadership Toolkits*. The Building Officials Association of Texas distributed the toolkits to the jurisdictions, and the inventory is showcased online at www.texasstatecollaborative.org.

The toolkits raise awareness of the top three weather perils in key Texas cities and counties, and they identify residential building code amendments that affect the relative resilience of that jurisdiction in the context of the weather perils present. The toolkits include recommendations and information about ISO's Building Code Effectiveness Grading Schedule (BCEGS) for the jurisdiction, available mitigation incentives, and frequently asked questions about building codes.

Sharing hyperlocal building code data with the jurisdictions through the lens of disaster safety and resilience brought attention to the issue of disparity between city and county residential building codes. Specifically, counties interpreted Texas law as a barrier to residential building code enforcement authority. As a result, while builders had to have inspections on residential structures in counties that adopted such regulations, they were not required to pass the inspections. It is important to note that this situation only applied to those counties that chose to adopt a residential building code, and many counties do not.

The Texas Legislature learned of this disparity through the TSC education and outreach effort. TSC members with advocacy teams worked with the Legislature, and they enacted H.B. 2040 in 2017 to remedy the situation. As a result, counties now have the authority to require builders to pass inspections, however, the county leaders still must

adopt and choose to enforce a building code for this change to improve resilience in Texas counties.

We hope that the members of the “Commission to Rebuild Texas” identify the law change in H.B. 2040 as an opportunity to extend much-needed residential building codes into counties as a critical means to increase Texas’ resilience.

The Harvey experience demonstrated that we must overcome existing biases and much, much more. Changes in technology and the advent of social media platforms have revolutionized how we get information to the public. Disaster preparedness and resilience remain some of the toughest sells for policymakers, however, we remain focused on identifying gaps and educating on the need for proven resilience policies and creative communication tactics as fundamental for success.

b. Hurricane Irma

Irma made initial landfall in the Florida Keys on September 10, and then moved north up Florida’s Gulf Coast. Models showed that the storm was headed directly for Miami but it took a turn to the west that helped it avoid a direct hit.^{xlii} Irma was almost as large as the state of Texas, and both Florida coasts felt hurricane-force winds.^{xliii} Irma destroyed an estimated 95% of buildings in parts of St. Martin, and devastated parts of St. Barts and the Virgin Islands.^{xliv} The Florida Keys and the southwestern Florida coastline experienced damage, and flooding occurred in already oversaturated parts of Florida and southern Georgia.^{xlv} Irma’s eyewall passed north of Puerto Rico knocking out power in an eerie foreshadowing of the direct hit by Maria later the same month.

Irma had a widespread impact on the power grid, resulting in 16 million people across the southeastern U.S., mostly in Florida, losing power.^{xlvi}

What We Knew

We knew the need to prepare for power outages, including the critical messages surrounding safe operation of generators to avoid carbon monoxide poisoning. Tragically, carbon monoxide deaths occurred, and deaths from heat exhaustion occurred as well. The most shocking cases included the deaths of twelve residents of a South Florida nursing home located across the street from a hospital.

***What We Knew
What We Learned
How We are Moving Forward***

We knew that homes in Florida could be subjected to hurricane winds, even inland. In 2004, Hurricane Charley cut across the middle of the state to wreak havoc on Central Florida, toppling

10,000 trees in Orlando alone. However, Irma was unique in how it covered the state in forecast projections. The omnipresent storm threat made it extremely difficult for families to make evacuation judgments and plan their routes, especially as the forecast track shifted.

Regardless of the typical difficulty brought by a shifting track, evacuation in areas subject to storm surge should be automatic, no questions asked. “Run from the water” is the adage. Anticipating wind damage makes the evacuation calculus a little trickier.

During Irma, many families were unsure if their home was strong enough to endure the potential category 3, 4, or 5 storm. Those with homes built since the new Florida Building Code, March 2002 and after, were more confident. However, forecasters have a challenging time pinpointing the exact location where a hurricane will make landfall until it is generally too late to evacuate. Further, many people do not know when their home was built or to what standard. We believe this was part of why thousands of Floridians evacuated. And, as the entire state was in the shadow of the potential Irma landfall, most headed north and found themselves in heavy traffic.

Charley, Irma, and many other hurricanes have repeatedly proven that storms can affect *any* area of Florida. That is why we believe that all Florida homes should be built to withstand hurricanes. Imagine the confidence and ease that thousands of families would have enjoyed if they knew, with certainty, how their home would perform under high-wind conditions. Moreover, imagine the reduction in community upheaval that the confident, in situ population would enjoy.

The current Florida Building Code is strong, and it appears that buildings built to meet the Florida Building Code performed well. The Florida Keys may have experienced a test of the code by experiencing nearly the design level (the highest wind speeds that the building code is designed to withstand), but most of Florida did not experience design-level wind speeds.

Nonetheless, newer homes performed better as they were without the roof degradation caused by the Florida sun and heat, and the materials were less worn overall.

This makes the building code story in Florida very ironic. The newspapers celebrated the strong homes that survived, crediting the strong Florida building codes. Fast-forward five years or more, and this success may not be replicated due to the legislative change made in 2017 and described above. Florida is now statutorily-destined to steadfastly fall behind and miss out on innovations that could help lessen damage in years to come.

This policy outcome was a clear case of myopia. The short-sighted focus on the minor administrative costs of maintaining an updated building code won out against the long-term safety benefits. And amnesia. Florida had gone a long time without experiencing a severe hurricane threat.

Irma brought devastation to the Florida Keys, but we cannot forget the devastation Irma brought to the Caribbean.^{xlvii} These outcomes should serve as a reminder to the rest of Florida and the U.S., that Irma’s impact could have been so much worse if early predictive models had come to fruition.

How We Are Moving Forward

Hurricane Matthew in 2016 and Hurricane Irma in 2017 had the potential to bring wide scale, utter devastation to Florida. Fortunately, neither storm lived up to its full forecast potential, even though there were disastrous and catastrophic impacts for many who suffered death, injury, anxiety, fear, flooding, damaging winds, and power outages.

As such, we must work harder and more creatively to convey the risk at any level to individuals, families, businesses, and leaders while we simultaneously convey the simple and economical things that can be done to protect both people and buildings.

As discussed in the Hurricane Harvey review above, the most powerful and economical thing to do to protect people and buildings is to adopt minimum building standards through use of a modern building code. Minimum codes should be uniformly in place in every community as they deliver premier consumer protection against natural disasters losses and a means to ensure everyday safety and durability as well.

Transparency is one of the strongest tools for improved consumer fairness. We believe that is exactly what is needed in the building code policy arena. Earlier, we referenced survey findings that identified a gap between consumer understanding of building performance in disasters and building codes. In the same survey, we also identified high consumer expectations of builders and leaders regarding disaster resilience. What this tells us is that while consumers may not always understand the direct correlation between building codes and improved building performance in disasters, they do have a strong expectation of their leaders to keep them safe. Perhaps we can close the gap between consumer expectations and resilience policy leadership by adding these insights to the growing body of powerful economic studies that demonstrate the return on investment of mitigation.

*What We Knew
What We Learned
How We are Moving Forward*

Many local leaders already understand their community's expectations as well as the economic case, and some are acting by preventing further degradation of sound building code policies.

In 2018, while Florida leaders did not reverse the negative building code legislation that weakened the system in 2017, they did reject H.B. 299, a measure proposed by the homebuilding industry that would have weakened the quality and integrity of the Florida Building Commission. The unsuccessful measure proposed to shrink the body by eliminating many of the seats for relevant specialty professions that currently serve.

Additionally, the Florida Legislature passed legislation requiring every nursing home and assisted living facility in Florida to have emergency generators.^{xlviii}

In the Florida Keys where Irma's high winds did the most damage, local leaders in Monroe County have pushed for a new regulation to require all roofs be constructed

using wind-resistant metal. The Monroe County Board of County Commissioners discussed this issue during its January 17, 2018 meeting.

Another positive trend is that flood insurance sales are increasing and private flood insurance offerings are growing, albeit at a very modest pace. This is only possible due to law changes that allow for private companies to participate.

Perhaps the best model of resilience leadership is in North Florida where Leon County experienced damage and extensive power outages from Hurricane Hermine in 2016. In 2017, the North Florida county was briefly predicted to endure a direct hit from Hurricane Irma.

Following those experiences, Leon County Government leaders identified the desire to advance resilience and partnered with FLASH to explore available programs and initiatives to accomplish same. Through the collaboration, we identified the opportunity to prototype a *#HurricaneStrong* community by benchmarking against existing, objective and subjective criteria of various resilience elements, including the following:

- Engaged Leadership (Elected Officials, Staff)
- NOAA/NWS *StormReady* Designation
- Current, model building codes adopted/enforced Excellent BCEGS rating (1-4)
- Excellent Floodplain Management/CRS Rating
- Widespread Community Awareness/Outreach (multiple programs)
- Resilient Businesses/Organizations
- Resilient School Systems

Through the initiative, Leon County Government has expanded public outreach programming, invested in the *Ready Business* workshop effort, and is serving as an ambassador to other communities to raise awareness and provide support to engage community leaders across the state and country.

We announced this initiative in March at the National Hurricane Conference, and nearly a dozen additional communities came forward to pursue the honorary designation. On May 31, we announced that Miami-Dade County, Florida had achieved the designation as well and is now the second *#HurricaneStrong* community in the United States. This is critical given South Florida's importance as a global economic gateway and high hurricane risk profile.

We see this as another positive indication of leadership intentions regarding resilience, and we look forward to highlighting these leaders and sharing the news as the next *#HurricaneStrong* communities come online.

c. Hurricane Maria^{xlix}

Hurricane Maria hit Puerto Rico as a category 4 storm with 155 mph winds, the strongest to hit Puerto Rico in more than 80 years.^l Puerto Rico is still striving to gain

recovery momentum due to extreme problems with local coordination and persistent power grid weaknesses.

The implications of the power grid failure are hard to understate. One article, [“After Four Months, Much of Puerto Rico Still Dark and Damaged,”](#) illustrated the challenges and status of Puerto Rico.

What We Knew and Learned

Ricardo Alvarez-Diaz, president of the Puerto Rico Builders Association, stated that about 55% of all structures in Puerto Rico haven't been built to code partly because the government lacks an adequate process for code certification during the building process.^{li} Mr. Alvarez-Diaz also said that the approximately 250,000 housing units damaged in the latest hurricane season would have been much less if they had all been built to code.^{liii}

We knew that Puerto Rico was vulnerable to hurricanes and power outages as well as other perils, especially earthquakes. FLASH and FEMA were in Puerto Rico in August 2017 conducting *Ready Business* workshops in San Juan and Mayagüez to help businesses address these very threats through preparedness. The workshops focused on the 2016 power outage^{liiii} and how it affected local businesses and the economy.

What we did not expect was the depth of the building code administration and enforcement challenges in Puerto Rico. One of our team members joined the FEMA-led Mitigation Assessment Team (MAT) in December 2017, bringing his perspective as a general contractor, former building official of a large jurisdiction in Florida, floodplain manager, and seasoned mitigation advocate. The first question on the ground was, “What building codes are used in Puerto Rico?” The consensus is that the code is good and strong, but it lacks consistent administration and enforcement processes. The enforcement gap is also typical in many areas of the United States.

Puerto Rico is an unincorporated territory, but its building code is analogous to other “statewide” building codes, although it should be called territory-wide in Puerto Rico's case. According to those on the ground, the permitting and inspection system in place does not yield consistently inspected structures. This is evidenced by the abundance of “informal construction” in Puerto Rico, or construction in which building codes or permits were not followed. Adding real penalties for work without a permit, hiring local inspectors, and setting up building officials with training in the I-Codes could make a material improvement in building performance both every day as well as disaster resilience.

In 1998, Hurricane Georges (a category 1 hurricane) served as a catalyst for mitigation efforts in Puerto Rico, but early evidence from Maria indicates that some of the efforts didn't go as far as they could have.

Observations on the ground painted a picture of opportunities for improvement. For example, a seven-story municipal building, built in 1992, had substantial wind damage to its roof, as well as water intrusion damage. The site investigation revealed hurricane shutters were placed only on one side of the building, and impact-resistant glass was not used on the windows.

One of the most powerful sets of tools for smart and effective recovery comes from one of our founding and Legacy Partners, the engineers of FEMA Building Science Branch. After major disasters, they lead forensic engineering missions and produce assessment reports, recovery advisories, and provide technical counsel on the ground through temporary deployment to the affected communities.

Reports can include detailed findings regarding building performance, as well as failures, along with recommendations for improvements in minimum standards, materials, and other resilience considerations. FEMA's insights and professional counsel are invaluable and essential to aid hurricane-impacted communities, as well as inform to future models of building codes and standards.

How We Are Moving Forward

We are encouraged by the innovation and ideas under consideration to make Puerto Rico's electric grid more resilient.^{liv}

As Puerto Rico rebuilds, the effort to do so resiliently can be institutionalized by exploring every option to hire additional staff and garner resources to support the inspection and permitting process. Some local resistance has started to evolve with homebuilder interests urging preservation of building code status quo, but we hope that local leaders will steer past the short-term vision to chart a stronger foundation for Puerto Rico's future.

While Puerto Rico received much of the media attention post-Maria, it is critical to remember that the Virgin Islands endured devastating impacts as well. The Virgin Islands suffered what the *New York Times* aptly described as an Irma/Maria "one-two punch".^{lv} The negative affect on tourism was immediate, however, the islands are recovering as swiftly as possible. Tourism is both the livelihood for many Virgin Islanders, as well as a third of the local gross domestic product.^{lvi}

At the time of this writing, USVI leaders had demonstrated widespread acceptance of the opportunity to modernize during recovery and rebuilding. The FEMA-led mission is on the ground there now, and we are optimistic that they will not only rebuild, but they will set a new standard for safe and resilient construction in the Caribbean.

We are encouraged to see the focus in both these communities on building back better and the growing awareness of the essential linkage between codes and disaster survival.

d. California Wildfires

In 2017, there were nearly 9,000 wildfires in California, burning 1.2 million acres of land, killing at least 46 people, and destroying more than 10,800 structures.^{lvii}

The stories of those that survived and perished are horrific.^{lviii} One couple survived in a swimming pool surrounded by flames.^{lix} The stories of evacuations, smoke-filled roads, and no cell phone service all paint a picture of a disaster that we never want to see again.

Let's begin our examination by looking at how these kinds of wildfires start.

We knew that wildfires develop and spread in the wildland urban interface (WUI). Weather conditions combined with development in WUIs (housing and vegetation intermix or are in close proximity of each other) have led to many recent wildfires.^{lx}

The blend of houses and forest on the fringe of metropolitan areas is common, and the Southern Appalachian region is one area of heaviest concentration in the WUI.^{lxi}

Consider these WUI basics:

- More than 46 million homes in 70,000 U.S. communities are at risk of WUI fires.^{lxii}
- Since the 1960s, U.S. residents in the WUI has increased from 25 million to 140 million.^{lxiii}
- From 1940 to 2000, the number of housing units within half a mile of a national forest grew to 1.8 million from 484,000.^{lxiv}
- Sixty percent of houses built between 1990 and 2000 are in wildfire-prone areas.^{lxv}
- A 2002 FEMA report found that 38% of new home construction in the western U.S. was next to or intermixed with WUI areas.^{lxvi}
- Annually, an average of 3,000 structures in the U.S. are destroyed by WUI fires.^{lxvii}
- Since 2000, more than 38,000 homes in the U.S. have been destroyed by WUI fires.^{lxviii}
- The total cost of WUI fires in 2009 was estimated to exceed \$14 billion.^{lxix}
- In 2013, suppression costs alone were estimated to exceed \$4.5 billion.^{lxx}

We knew how to protect homes against wildfires.

Since 2008, California has required that new construction in moderate, high and very high hazard areas comply with regulations in Chapter 7A of California's building code,^{lxxi} including a brush clearance zone within 100 feet of their property; non-combustible materials for roofs, wall sidings, and eaves; attic vents to stop embers from entering houses and double-pane, tempered glass windows.^{lxxii}

Note that areas designated local responsibility, primarily cities and urban counties, are outside of the state requirements discussed here.^{lxxiii}

However, these state requirements only apply to new construction, not existing construction. The *Los Angeles Times* noted that retrofitting ordinances for existing homes have been enacted for other hazards, like earthquakes, but “there has been no push so far, either at the state or local level, to require existing houses in fire zones to be upgraded.”^{lxxiv}

The time has come to address existing construction as well.

Some assert that making wildfire-protected communities would be more effective than controlling flammable growth in the wild land, as is current practice.^{lxxv} Communities, neighborhoods, and individual homeowners can greatly reduce the risk of wildfire spread through landscaping and construction choices guided by reducing ignition sources.

In the past, some have asserted that the obstacle to mandatory retrofitting programs is the difficulty of quantifying the cost and benefit of such measures.^{lxxvi} We think 2017 has the potential to change that calculus.

The insurance industry can also provide incentives for wildfire-resistant construction through insurability restrictions and actuarially-sound premium discounts,^{lxxvii} although for a neighborhood to have optimal protection, the entire neighborhood should be built with fire in mind. If you have prepared your home, but your immediate neighbor has not and the fire spreads to their house, the fire may still spread to yours. Keeping fire away from the entire development gives each home the best chance for survival.

Also, why not expand the definition of fire hazard areas in California? The *Los Angeles Times* analysis of California’s maps for the highest-risk fire areas in Southern California revealed about 550,000 residences covered by the zones.^{lxxviii} Adding areas with a lower, but still significant, fire risk would approximately double the number.^{lxxix}

Modeling fire behavior is still in development, as wind and embers are difficult to map.^{lxxx} Current WUI fire hazard maps algorithms account for vegetation, topography, and wind speed, but the *Los Angeles Times* analysis referenced above also found that using a different boundary would add about 450,000 Southern California housing units to the map.^{lxxxi}

Clearly, there is a real opportunity for additional research into mapping wildfire hazards.

We knew that immediate evacuation during wildfires is a life or death decision. But are residents able to evacuate, especially those with disabilities, access, and functional needs? The high percent of older adults who perished in 2017 wildfires present an incontrovertible case for reexamination of our emergency practices, outreach, and education to this population.

We knew that California is known for wildfires, but what about the rest of the U.S.? While California has experienced many wildfires in its history, many other parts of the U.S. are vulnerable as well. According to NFPA's Michele Steinberg, about 70 percent of the nation's wildfires occur outside of the Western U.S.^{lxxxii} We saw this last year in Gatlinburg, Tennessee.

We knew that wildfires make certain locations more susceptible to mudslides, with heavy rainfall on burned hillsides leading to mudslides (USGS [notes](#) that debris flows are sometimes referred to as mudslides, mudflows, among other terms, and that landslides are the larger category of a mass of rock, debris, or earth down a slope.)^{lxxxiii} Land charred by fire and left without vegetation is more susceptible to flooding and debris flows, as burned soil can be as water repellent as pavement.^{lxxxiv} And it may not take much rain to set off a mudslide, with .3 inches of rain in 30 minutes triggering mudslides in Southern California.^{lxxxv}

The U.S. Geological Survey (USGS) warned of potentially devastating landslides in the wake of the Thomas wildfire in the mountainsides around Santa Barbara.^{lxxxvi} The mudslides in Montecito killed at least 21 people and destroyed more than a hundred homes.^{lxxxvii} Several articles discuss the need for better mapping for landslides, including the points that maps either aren't developed (or are exceptionally outdated) or that landslide hazard maps generally don't show predicted run-out zones, rather just where landslides are likely to start.^{lxxxviii}

Yet we cannot overlook the important work the USGS, other federal agencies, and the states are doing. The USGS Landslide Hazards Program creates hazard maps and forecasts and undertakes [real-time monitoring of landslides](#) across disasters, including USGS efforts in Puerto Rico mapping landslide frequency as a result of Hurricane Maria.^{lxxxix} The [National Aeronautics and Space Administration](#) (NASA) Goddard Space Flight Center has created a global map of potential landslide areas taking into account annual precipitation rates.^{xc} Several states or regions have developed landslide inventories in maps or databases, largely the result of Stafford Act mandates.^{xcii}

Unfortunately, as with building codes, fears of hindering development have sometimes taken priority over making citizens safe from landslides. This was seen in North Carolina in 2004, when the legislatively approved program to map landslide hazards was canceled over concerns that the maps would adversely affect development.^{xciii}

Updated national landslide maps are needed. A 2014 article cited that the [last national landslide overview map](#) was produced in 1982, long before computerized mapping tools became commonplace.^{xciiii} The analysis suggests that the 1982 map is poorly defined and referred to as a "cartoon", with officials warning the public not to zoom in too closely on the map lest they receive bad information. Also, there are multiple types of landslide maps (e.g., landslide-inventory, landslide hazard, landslide-risk, landslide-zone) for the U.S. to update/develop.^{xciv}

One proposed piece of legislation, the National Landslide Loss Reduction Act ([H.R. 4776](#), [H.R.1675](#)) would establish a National Landslide Hazards Reduction Program to identify landslide hazard risks along with other initiatives, directing the USGS to establish the first national landslide hazards inventory for the United States.^{xcv}

Among other things, this legislation focuses on the lack of uniformity in landslide risk assessment and prediction practices in the U.S., including a collective landslide inventory for the U.S. or an agreed upon method of creating one.^{xcvi}

Partnerships for Reducing Landslide Risk: Assessment of the National Landslide Hazards Mitigation Strategy also identifies a national landslide inventory as “an important first step toward an appreciation of the true scope and distribution of landslide hazards,” with an accurate inventory providing “metrics for national policies and would greatly reduce the present uncertainty concerning the magnitude of economic loss and environmental damage caused by landslides.”^{xcvii}

The call for continued investments in mitigating landslide hazards across the U.S. seems clear. This is another issue that would benefit from transparency as homeowners need to know the risks they face when they build or buy their homes. Unfortunately, as Montecito showcased, we want to build in beautiful, albeit risk-prone, places. Mapping and accurately reflecting the hazards would help homeowners understand their potential risk as part of a buying decision as well as inform to mitigation options. California requires disclosure of specified natural hazards for certain types of real estate transfers, including whether the property is in a landslide zone (CAL CIV. §§1103).

Misfires in risk communication lead to confusion (at best) and fatalities (at worst), and this presents a compelling case for continued research and resources to ensure the public is equipped with life-saving information that is available when they need it and in the form they will receive it.

How We Are Moving Forward

Existing, available wildfire preparedness resources from FEMA and Firewise provide individuals and families with useful tools to prepare themselves and their homes for wildfires. [Firewise USA](#) is a program of the National Fire Protection Association, co-sponsored by the USDA Forest Service, the US Department of the Interior, and the National Association of State Foresters. Firewise focuses on a local approach to increase wildfire safety and encourages homeowners to take responsibility for preparation and mitigation. The program teaches ways to adapt and live with wildfire while encouraging neighbors to work together.

Firewise works. In 2007, our organization produced a video documenting successful performance of building and landscaping wildfire strategies entitled, *Tale of Two Homes – Wildfire*^{xcviii}. The video showcases starkly different outcomes for families affected by the Witch Creek fires in San Diego County in October 2007. Santa Ana winds fueled the Witch Creek fires, and they burned nearly 200,000 acres and more than 1,000 homes.

Our video profiled affected homeowners in Rancho Bernardo. The first homeowner, R.J., lost his house when his combustible wooden deck ignited and fueled the inundation and destruction. He barely had time to evacuate his family and drove down a dark canyon road to escape. A local fire chief described the wooden deck and vegetation underneath as “organized kindling.”

The second homeowner, Helena, was the only one on the cul-de-sac of six homes whose house survived. It survived because she took steps before the disaster. She replaced her combustible wooden-shake roof with class A fire-resistive asphalt shingles, placed wire mesh around her deck to keep embers from getting underneath, and she planted fire-resistant landscaping with higher water content to reduce the ignitability of the plant material.

FLASH partners have used the wildfire video, and *Tale of Two Homes* video series, for years, and the stories and messaging help address several of the identified “biases.”

Showcasing Helena’s experience tackles the myopia bias by demonstrating the tangible benefits of her investments in Firewise practices. The video profile tackles the inertia bias by depicting her actions as achievable, even by a woman of 82. It also addresses the optimism bias by depicting everyday people “just like me” that were affected by the fires. This helps people see themselves inside the very real stories of R.J. and Helena.

The lessons learned in Witch Creek and other conflagrations have become policy. The California WUI building codes and local regulations prohibiting of the use of ignitable materials like wood-shake shingles are helping to mitigate wildfire damage to newer homes, but we must address existing homes as well. For starters, older homes should be retrofitted and required to incorporate defensible space recommendations, including up to a 100-foot protective area where feasible.

Additionally, 2017 makes reexamination, perhaps redefinition, of fire hazard zones a sound pursuit. Jurisdictions may need to expand fire hazard zones as discussed in the *Los Angeles Times* article that identifies 550,000 California homes in wildfire zones but points out that they not alone.^{xcix} Weather conditions in California and the west coast e.g., Santa Ana winds in Southern California/Diablo winds in Northern California, make wildfires a risk for more than historically expected.

Evacuation protocols must be reevaluated, communicated, and consistently reinforced so that people are aware and ready go to as the question of “where to go” often remains. This was same quandary for Floridians during Hurricane Irma when the massive hurricane covered the entire state and people weren’t sure if their home could handle such a powerful storm.

Ventura County Fire Chief Mark Lorenzen said that the public seemed more willing to follow mandatory evacuation orders after the Santa Rosa fires.^c Certainly what has happened in California will contribute to overcoming an amnesia bias (distorted view of

past events), as well as herding bias (imbalanced influence on behavior of peers) as neighbors evacuate.

Wildfire science is still exploring the best ways to control the spread of fire in the WUI and beyond. We think creating fire-protected neighborhoods is an achievable goal for every neighborhood prone to wildfires. Leaders and homeowners can come together to create safer communities.

Of all the hazards we work to mitigate, wildfire can be the most affordable as many of the protective measures are inexpensive or even free, especially those focused on landscaping or creating a protective zone without fuel sources around the home.

The first step is to ensure that homeowners understand the most fundamental part of the mitigation opportunity—to reduce or eliminate fuels. Fire needs three ingredients to occur—air, heat, and fuel. We cannot restrict air or heat, but we can reduce and/or eliminate fuels.

That is why we promote wildfire mitigation with a simple statement, “No Fuel – No Fire.” We want to break through the communication clutter and help people understand that the only way to tackle wildfire is to tackle fuels, whether they are building materials like roof shingles or living materials like vegetation or plant debris.

As California continues its long recovery from the fires and mudslides last year, we again return to the fundamental opportunities to break the cycle of “Build-Destroy-Rebuild.” We can reduce wildfire loss of life and property damage through building codes and local regulations for new construction methods and materials, as well as retrofitting and removing ignitable building components like decks, cladding, and roof coverings on existing homes. We can mount more effective risk communication practices regarding protective actions and evacuation and create updated wildfire zone maps that reflect the growing risk in and beyond the WUI.

Across all these solutions, we must prioritize service and support for those with access and functional needs, especially the elderly, to ensure survival for all members of our communities.

IV. Moving Science and Policy into Practice – A Strategy for Success

The 2017 disasters revealed, and in all cases reminded us, that we have tremendous opportunities to mitigate and lessen impacts of disasters. One of the most powerful means of improvement can come through better use of science that is incorporated into policy and practice on a reliably systematic basis. That is why our strategy is to mainstream useful science into use by leaders either as enlightened public policy or for use by all who affect our disaster resilience as improved building practices.

This is the case for collaboration with code officials, design professionals, elected officials, emergency managers, homebuilders, journalists, meteorologists, product manufacturers, and many others. But our most important target audience for sharing empowering information is the one with the most at stake: the consumer.

We focus on knowledge dissemination and application of developed research. We look to existing literature on how individuals perceive their vulnerability to disaster and the adoption of hazard adjustments, looking to research across disciplines, including communication, sociology, anthropology, political science, and psychology.^{ci} We do this by continuously examining and adjusting our risk communication techniques.

This is how we advance understanding to drive change.

Takeaways from 2017 – The Disaster Safety Movement Mandate for Action

Initially, we found the prospect of identifying trends and drawing conclusions out of the 2017 experience overwhelming. However, despite the geographic diversity of hazards from floods and high wind to power outages and wildfires, we have found common themes and a clear mandate for improvement through commitment to these pillars.

1. Modern, model building codes, standards, and floodplain regulations that are adopted on time and effectively enforced are non-negotiable.

Communities in the path of Hurricane Harvey fared better if they were elevated. A photographic array of homes along the coast in Rockport, Texas depicts various levels of damage depending on the vintage of the building code followed. So far, the stark differences in buildings that either failed or performed during Harvey is driving reexamination by responsible Houston and Texas leaders regarding floodplain management. We urge them to embrace more uniformly adopted and enforced residential codes as well, especially for counties without protections in place. Moreover, due to the changing nature of ownership demographics in the impacted areas, we suggest that consumer transparency and flood history disclosure ordinances be considered.

Modern, model building codes, standards, and floodplain regulations that are adopted on time and effectively enforced are non-negotiable.

In the Keys, Hurricane Irma showed that homes built to the excellent Florida building code performed well, even when tested to near design-level winds. This validates our contention that Florida leaders need to reverse their 2017 legislative action and revert to the

proven system to preserve Florida's strong and certain codes. When they do, they can spare the Keys, and the entire hurricane-exposed Florida peninsula, a steady degradation of the best asset to ensure citizen safety and economic vitality after future hurricanes.

Homes built in Puerto Rico using cast-in-place concrete withstood high winds and a great deal of flooding too, but code enforcement should be improved territory-wide to ensure the benefits extend to all the island's communities. Modernization of the building code system in the USVI is underway, and their efforts can serve as a model for leaders in the Caribbean, as well as stateside.

Wildfires in California make the case for evaluation of wildfire potential beyond the WUI, redefinition of at-risk communities, better mapping, investment in updated landslide maps, and expanded prohibition of combustible building materials and components.

Indisputably, building codes, standards, and smart floodplain management are the first and most important lines of defense in disasters of all kinds. If our structures fail, resilience is impossible. These default protections should be put in place to blunt inertia and simplification biases for leaders and to provide protection for communities.

2. The basics are not basic, they are everything. We cannot repeat the core messages enough.

Those in the disaster safety and resilience community have learned and shared the same disaster safety messages repeatedly, but our familiarity should not cloud the need for ordered risk communication coupled with a constant reexamination of the efficacy of our efforts.

The “one size fits all” mass marketing messaging approach is a thing of the past and does not work for diverse audiences. Now is the time to bring our most creative ideas and enthusiasm to messaging the basics of disaster safety against what sometimes seems like the Sisyphean task of reaching everyone. All audiences need to hear essential, key messages that will empower them to become resilient in the face of a single disaster, or multiple, major disasters in rapid succession like in 2017.

The basics are not basic, they are everything. We cannot repeat the core messages enough.

Perhaps our first and most important step is to develop an accepted set of heuristics, or “rules of thumb” to drive improved communication effectiveness. During the last few years, the FEMA Individual and Community Preparedness Division took on this challenge by creating a compendium of multi-hazard protective actions to boost safety in disasters. Now we need to spread this knowledge.

Earlier in this commentary, we outlined the FLASH *#HurricaneStrong* outreach campaign that created a simple, common language and “call to arms” to drive buy-in and preparedness actions before hurricanes. The campaign has not only given trusted voices a way to support five consistent messages, it has evolved into a community designation program that allows leaders to declare and articulate support for resilience.

A *#HurricaneStrong* community meets established objective and subjective criteria that drive improvement in safety, the built environment, economic resilience, and overall

public engagement of hurricane-prone communities. Leaders following proven steps to safeguard their citizens will be now recognized for doing so.

3. We must improve messaging to individuals, families, and community leaders before, during, and after disasters. Then, we must make the conversation two-way.

The *Ostrich Paradox* describes two cognitive systems. System one is for automated and instinctive thoughts, and system two is for more controlled thoughts. The authors describe late evacuations during Superstorm Sandy in a storm surge area as an example of a lack of knowledge of the hazard (storm surge) combined with an impulse to act from the first cognitive system (fear).

The biases at work here may include myopia (evacuating is more difficult/expensive than the short-term comfort of staying in my home); amnesia (the last hurricane wasn't that bad); optimism (it won't happen to me; forecasts change); inertia and simplification (there are so many things to do to evacuate, so I'll just stay home); and herding (none of my neighbors are evacuating; a culture of we don't leave our houses/we'll be fine).

At the time of this writing, we do not have complete analysis of the precise patterns of decision-making that led to evacuation action or inactions in 2017, but we see a clear need for new collaborative research regarding evacuation behavior for storm surge, high winds, and wildfires. Additionally, we need more research-informed messaging insights to address the low percentage of flood insurance purchases, especially by those with economic means who reside in the high hazard areas.

We need to understand the message disconnect between perceived need and necessary behavioral change, and we need to accomplish this soon. It is our understanding that only 20% of the more than 136,000 homes flooded by Hurricane Harvey were insured for flood damage.^{cii} According to FEMA, these families will qualify for an average of only \$9,000 of assistance to rebuild under the programs currently in place. In many cases, the assistance is a loan that must be repaid.

We must improve messaging to individuals, families, and community leaders before, during, and after disasters. Then, we must make the conversation two-way.

How can we convey these harsh realities ahead of the next storm? Moreover, as we hone our message to improve effectiveness, how do we devise systems that allow for two-way communication as well?

Beyond traditional audiences who bring challenges as described above, it is our conviction that citizens with disabilities, access, and functional needs deserve and require more intense, individualized attention and messaging as well.

We must prioritize them, and that leads us to our next and final pillar.

4. Inclusive disaster-resilience planning and practice is not mainstream.

Harvey, Irma, and the California wildfires reminded us to ensure our disaster preparations are tailored to our family's needs, yet those with disabilities, access, and functional needs require extra preparations and assistance.

The nation watched in shock as Harvey-induced flooding left elderly residents of one Texas nursing home sitting in rising waters. Hurricane Irma generated power outages in South Florida, and twelve residents in one nursing home died after they succumbed to the unbearable, excessive heat. The California Wildfires resulted in the deaths of many older adults^{ciii}, highlighting that limited mobility and unreliable cellphone service must be considered when preparing this population.^{civ}

Inclusive disaster-resilience planning and practice is not mainstream.

These outcomes should remain the focus of our most intense efforts at improvement. These citizens deserve our highest order of care.

To ensure we never forget, we need to accept, embrace, and advance the adage that those who can get ready without assistance have the responsibility to do so. Once we prepare, we can stand aside and allow the finite available resources to focus on those that need them.

The 2017 events demonstrate that we have a great deal more work to do to fulfill our potential and obligation to serve this population in our communities.

V. Conclusion

All Disasters Are Local, But That Decentralization Should Not Dilute Resilience.

As a disaster safety community of citizens, policymakers, practitioners, and scientists, we must focus on catastrophes one at a time. We handle them as they occur, responding generously with resources and national empathy. But we often lose the momentum of public support too swiftly to affect sweeping policy changes. Lessons are learned and sometimes preserved locally, but we run out of momentum to create or sustain change beyond the affected area.

Unfortunately, this approach has created a hodgepodge system of different resilience levels across the country depending on where you live. States like California have not only embraced minimum seismic building codes, but they are now looking to performance-based codes that will go beyond life safety to preserve property too. Contrast that with those counties in Texas that either do not adopt or do not enforce residential building codes.

This local approach is rational in a world where resources are finite, and disasters are an uncertainty. But it sustains a costly cycle of "Build-Destroy-Rebuild" because leaders

sometimes have little incentive to create resilience through building code adoption and enforcement or other “DisasterSmart” policies.

Again, it is understandable. Why act differently so long as communities can expect generous post-disaster relief dollars with few strings attached?

One might counter these observations with the fact that states and local governments have self-determination. That is true. But self-determination without self-funding is inequitable. First, it is unfair to the affected homeowners who bear the cost of insurance deductibles and loss of quality of life during extended, disruptive recovery periods. Additionally, it is unfair to taxpayers beyond the disaster zone who pay through billion-dollar relief grants and subsidized programs like flood insurance.

The cost of disasters can be mitigated by implementing resilience tools like building codes and research-informed risk communication. That is why we are calling for local and state leaders to put strong, modern building codes and communication plans in place before disasters strike. The current system of incomplete resilience leaves U.S. communities on a roller coaster of life safety threats and economic whiplash driven by weather and earth movement, but we can blunt those extremes when we commit to best practices and proven policies.

After the 2017 experience, we see a legacy taking shape. We are moving beyond only a defined community of disaster safety stakeholders who understand and support the policies and practices necessary to affect change. We are moving on to a

new and growing public where everyone values and understands that every city, county, township, tribe, and village can innovate and become resilient through leadership and resolve.

This brings us back to the wisdom of one of the world’s greatest leaders during times of crisis, Winston Churchill, who stated, “Success is not final, failure is not fatal: it is the courage to continue that counts.”

We are committed to continuing, together, until we break the build-destroy-rebuild cycle once and for all.

“Success is not final, failure is not fatal: it is the courage to continue that counts.” – Winston Churchill

Figure 1

1980-2017 Billion-Dollar Weather Events (Over \$10 Billion) Modified from NOAA Billion-Dollar Weather and Climate Disasters: Table of Events - https://www.ncdc.noaa.gov/billions/events/US/1980-2017		
Hurricane Hugo	Sept. 1989	\$18.3
Hurricane Andrew	Aug. 1992	\$48.1
Midwest Flooding	Summer 1993	\$36.1
Tropical Storm Allison	June 2001	\$11.9
Hurricane Charley	Aug. 2004	\$21.3
Hurricane Frances	Sept. 2004	\$13.0
Hurricane Ivan	Sept. 2004	\$27.3
Hurricane Jeanne	Sept. 2004	\$10
Hurricane Katrina	Aug. 2005	\$161.3
Hurricane Rita	Sept. 2005	\$23.9
Hurricane Wilma	Oct. 2005	\$24.5
Midwest Flooding	Summer 2008	\$11.6
Hurricane Ike	Sept. 2008	\$34.8
Southeast/Ohio Valley/Midwest Tornadoes	Apr. 25-28, 2011	\$11.3
Midwest/Southeast Tornadoes	May 22-27, 2011	\$10.1
Hurricane Irene	Aug. 2011	\$15
Hurricane Sandy	Oct. 2012	\$70.2
Louisiana Flooding	Aug. 2016	\$10.4
Hurricane Matthew	Oct. 2016	\$10.4
Western Wildfires, California Firestorm	June 2017 – Dec. 2017	\$18
Hurricane Harvey	Aug. 2017	\$125
Hurricane Irma	Sept. 2017	\$50
Hurricane Maria	Sept. 2017	\$90

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