

# Natural Hazards Observer



Volume XXXIX • Number 1

September 2014



Let's all play together

## The role of risk perception in natural disasters

An invited comment by Ross Corotis

**I**N AN OLD STORY, SIX BLIND MEN each feel different parts of an elephant, then are asked to describe the animal. The one who touches the leg says it like a pillar. The one who feels the tail says it is like a rope. And so on.

When social scientists and engineers “feel” natural disasters, they often come up with descriptions as different as the blind men’s. Social scientists build normative understanding of behavior from observing and modeling individual and collective actions. Engineers assume away human behavior and build dams, base isolation systems, and main wind force-resisting systems.

As the losses from natural hazards mount, what’s missing from our message? What’s needed to get social scientists, engineers and policy makers to describe the same elephant?

Well, okay, it’s not that simple. Nor are the differences quite that bad.

Allow me to introduce myself. I am a reformed engineer. The Natural Hazards Center’s Dennis Mileti called me that once, adding that some of his best friends were reformed engineers. In a 40-year career as a structural engineering professor, I’ve conducted research on the modeling of safety and reliability for structural systems, including the determination

of natural- and human-originated forces on structures. I came to the realization that—for some reason—people do not automatically accept and adopt whatever we engineers tell them is best for them. Imagine that.

The traditional quantitative engineering approach to hazards and risk is to compute the probability of occurrence of various events, assess the exposure of aspects of our constructed environment, calculate the vulnerability (usually with the aid of fragility curves), and evaluate the consequences—preferably reduced to a single integrable metric, like money. Nice, neat, and with enough uncertainties, subtleties, and complexities to keep us busy for a career. But “they” still don’t listen to us!

The realities of life, messy as they may be, are critically important for the comprehension, acceptance and implementation of natural hazard strategies. Cognitive science tells us that people react to what they perceive. But don’t they perceive facts? This is when the awakening came. The sensitivity to uncertainty, the fear of the unknown, the complacency with normality, the perception of danger—these phrases are not in the lexicon of most engineers. Yet they are part of everyday decision making. Should I buy flight insurance? What does the special flood hazard area have to do with that delightful

*(Please see “Risk,” page six)*

### INSIDE ...

Joplin tornado

page ten

Letters

page two

Epidemic disease

page three

Public-private partnerships

page five



THE MISSION OF THE NATURAL HAZARDS CENTER is to advance and communicate knowledge on hazards mitigation and disaster preparedness, response, and recovery. Using an all-hazards and interdisciplinary framework, the Center fosters information sharing and integration of activities among researchers, practitioners, and policy makers from around the world; supports and conducts research; and provides educational opportunities for the next generation of hazards scholars and professionals. The Natural Hazards Center is funded through a National Science Foundation grant and supplemented by contributions from a consortium of federal agencies and nonprofit organizations dedicated to reducing vulnerability to disasters.

### Staff

Jolie Breeden.....Program Associate  
 Nnenia Campbell.....Research Assistant  
 Aria Dellepiane.....Library Assistant  
 Sienna Dellepiane.....Library Assistant  
 Courtney Farnham.....Professional Research Assistant  
 RoseMarie Perez Foster.....Senior Research Associate  
 Wanda Headley.....Library Manager  
 Kaitlin Hergenrider.....Library Assistant  
 Ed Hill..... Technical Svcs & Web Development Librarian  
 Wee-Kiat Lim.....Research Assistant  
 Victor Vera Morales .....Library Assistant  
 Ginni Mulder .....Library Assistant  
 Amir Qadri.....Library Assistant  
 Liesel A. Ritchie.....Asst. Director for Research  
 Diane Smith.....Office Manager  
 Kathleen Tierney.....Director  
 Jamie Vickery.....Research Assistant  
 Courtney Welton-Mitchell.....Research Associate  
 Dan Whipple.....Editor

### Research Affiliates

Dennis S. Milet.....Rancho Mirage, CA  
 Lori Peek.....Colorado State University  
 Deborah Thomas.....University of Colorado at Denver

*Observer* cartoons are drawn by Rob Pudim.

Send items of interest to the Natural Hazards Center, University of Colorado at Boulder, 483 UCB, Boulder, CO 80309-0483; (303) 492-6818, (303) 492-2151 (fax); hazctr@colorado.edu. The deadline for the next *Observer* is **September 31, 2014**.

# Letters

*Editor,*

In his note in the most recent *Natural Hazards Observer*, Joseph Scanlon touched briefly on the difficulty of predicting behavior from one or a few case studies. The example he used—an extremely important one—is the behavior of health care workers in a pandemic or, more generally, role abandonment. As he points out, there are cases that point to an altruistic “we’ll do our duty to our patients” response on the part of health care workers, as well as a more selfish “take care of our families and selves first” approach.

He mentioned that the altruism displayed during the pandemic of 1918-19 might be due to it being wartime. However, I’d like to point out other potential causes that have been too little considered.

- **Leadership.** Researchers at Howard University interviewed police officers in New Orleans who stayed on the job during Katrina. They found that a primary cause for the positive behavior was effective leadership at the precinct level. In other words, these precinct leaders established a culture that led these officers to do their duty.

- **Generational context.** Neil Howe and coworkers have developed an interesting approach on America’s evolution based on the idea of four generations. Essentially, their hypothesis is that a generation lasts about 20 years, with a regular progression of four generations every 80 years. They dub these generational archetypes Prophet, Nomad, Hero and Artist.

While Howe’s hypothesis is certainly open to question, it can be used to explain many facets of American history. Its real importance in this context is that it emphasizes the idea of cultural norms. In other words, predictions of general behavior (e.g., health care workers in a pandemic) need to consider the cultural context in which these workers are operating. As an aside, Howe et al. predict great things of the Millennials.

*M. John Plodinec  
 Community and Regional Resilience Institute  
 Oak Ridge, Tennessee*

*Editor,*

Thank you so much for the opportunity to visit the cradle of natural hazards research [the Natural Hazards Workshop was held in Broomfield, Colorado from June 22-25, 2014] with the support of the Mary Fran Myers Scholarship. In many ways it felt like coming to a long sought interdisciplinary and intergenerational home for applied, solution-focused researchers. The Canadian twin event, the Canadian Risks and Hazards Network Symposium, was created based on the Natural Hazards Workshop model. I am deeply grateful for having the opportunity to experience firsthand the original.

The sky is beautiful in Colorado. There is uncertainty in the sky that serves as a daily reminder of the center’s relevance in your region. It was particularly insightful

to be present at this Workshop following the 2013 floods. Witnessing through presentations the ongoing recovery process Boulder and Lyons was a truly remarkable opportunity. The importance of practice and theory interface that the center holds dear to its values was very evident in these sessions.

The content of the Workshop was thoughtful and thought provoking. It catered to practitioners, emerging scholars and veterans in the field. I thoroughly enjoyed five days of a sophisticated form of intellectual tourism and backdoor tours of how federal, regional, and local governments work (and sometimes don't).

It was wonderful to see senior government officials and senior academics in this field speak. Even more inspiring was the great representation of students and newly

appointed associate professors in the field from across the country. The new generation of hazards researchers were actively present at the meeting. Clearly, Bill Anderson's legacy and the "Enabling the Next Generation of Hazards Researchers" program lives on.

The importance of this scientific community for practice is the biggest take away from my visit. The example of Gilbert F. White regularly visiting the city hall to engage with hazards issues is inspiring. It is a reminder that in addition to enabling citizen-scientists, it is very important to be scientist-citizens, especially given the privilege of working in an applied, rapidly expanding field.

Lilia Yumagulova  
Vancouver, Canada

## On the Line

It's not about Ebola, but ...

# There's some good news on the disease front

---

Child deaths from malaria are down more than 30 percent since 2004

---

Since the world has been focused on the bad news about the Ebola

outbreak in West Africa, you can be forgiven for missing some good news about epidemic diseases. The British medical journal *Lancet* reports that new HIV infections have dropped by one-third from their epidemic peak; sub-Saharan Africa has seen a 31 percent decline in children's deaths from malaria; and tuberculosis deaths declined by 3.7 percent since 2000.

By far the most prevalent disease is malaria—as usual. "Globally, malaria cases and deaths grew rapidly from 1990 reaching a peak of 232 million cases in 2003 and 1.2 million deaths in 2004. Since 2004, child deaths from malaria in sub-Saharan Africa have decreased by 31.5 percent. Outside of Africa, malaria mortality has been steadily decreasing since 1990," write the authors.

Around the world, the authors report 1.8 million new cases of HIV infection, with 1.3 million deaths from the disease. "At the peak of the epidemic in 2005, HIV caused 1.7 million deaths," the report says. Nearly 30 million people around the world still live with the disease.

Tuberculosis occurs in 7.5 million people and there were 1.4 million deaths in 2013.

"Our estimates of the number of people living with HIV are 18.7 percent smaller than UNAIDS's estimates in 2012. The number of people living with malaria is larger than estimated by WHO [World Health Organization]. The number of people



living with HIV, tuberculosis, or malaria have all decreased since 2000. At the global level, upward trends for malaria and HIV deaths have been reversed and declines in tuberculosis deaths have accelerated. 101 countries (74 of which are developing) still have increasing HIV incidence. Substantial progress since the Millennium Declaration is an encouraging sign of the effect of global action," the authors say.

Most malaria cases occur in sub-Saharan Africa. Even there, the problem is concentrated in two countries—Nigeria and the Democratic Republic of Congo. Outside of Africa, "Malaria mortality has been steadily declining since 1990 as well, but Yemen, India, Myanmar, and Papua New Guinea all have malaria death rates over 7.5 per 100,000. By contrast, certain countries in Southeast Asia (Thailand and Malaysia) have achieved very low death rates," says a release about the study.

"Great progress has been made in reducing malaria deaths and infections, but we need more success stories

throughout Africa in particular for us to eliminate malaria," said Corine Karema, of the Malaria & Other Parasitic Diseases Division, Ministry of Health Rwanda, and a co-author. "Malaria is notoriously difficult to early diagnose, treat promptly using efficacious drugs, and track, and part of the strategy in fighting it is to invest in gathering better evidence through a robust surveillance system."

A malaria vaccine has been shown to reduce the disease in infant and children, and reduce cases in areas of high malaria transmission, according to a report in *PLoS Medicine*. The effect of the vaccine diminishes over time, but provides protection for at least 18 months.

For TB, death rates declined mostly among people who are HIV-negative. "Men and boys make up the majority of TB cases among people who are HIV-negative and die at higher rates (64.7 percent) than HIV-negative women and girls with

TB. In 2013, 83.2 percent of cases and 58.8 percent of deaths in HIV-negative people with TB occurred under age 60," says the release.

"As the world's population grows older, tuberculosis will remain a major health threat," said Nobhojit Roy of the BARC Hospital in India.

Dealing with the global HIV epidemic has been notably successful. Antiretroviral therapy, prevention of mother-to-child transmission, and prophylaxis have all slowed the disease. "Researchers note that the comparatively low price per year of life saved is one of the major achievements in global health in the past decade. Comparison of the total amount invested in HIV prevention and treatment to the years of life saved during 2000–2011 yields in developing countries a ratio of \$4,498 per life-year saved. In 2011, all donors combined spent \$7.7 billion on HIV/AIDS," the report says.

## They Said It ...



"We wanted to abandon this village."—**Sheku Jaya, village teacher in Njala Ngiema, Sierra Leone, where 61 people out of a population of 500 have died from Ebola. Quoted in the *New York Times*, August 11, 2014.**

"The very essence of our nation is at stake."—**Sierra Leone President Ernest Bai Koroma about the Ebola epidemic in West Africa, quoted in the *New York Times*, August 4, 2104.**

"Patient Zero in the Ebola outbreak, researchers suspect, was a two-year-old boy who died on Dec. 6, just a few days after falling ill in a village in Guéckédou, in southeastern Guinea. Bordering Sierra Leone and Liberia, Guéckédou is at the intersection of three nations, where the disease found an easy entry point to the region."—**The *New York Times*, August 9, 2014.**

"The epidemic is very big, very dispersed. It seems logical that the country is reacting. I do understand that the central government has to do something. Cases are now being reported in more southern regions. There is a geographical spread. We do see that it is several districts that are hit now."—**Dr. Hilde de Clerck, the interim emergency coordinator in Sierra Leone for Doctors Without Borders. Quoted in the *New York Times*, July 31, 2014.**

"Ebola virus disease has three species of human significance: Zaire, Sudan, and Bundibugyo. The West Africa outbreak is form a new strain of the Zaire species, with a reported case-fatality rate of 55 percent. Infection can

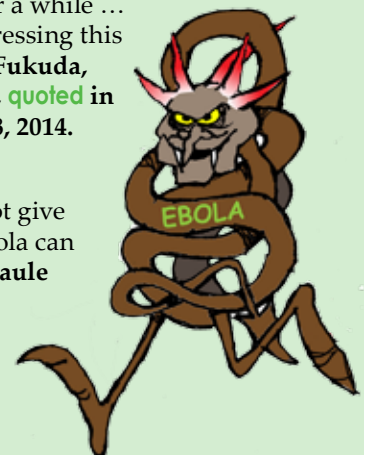
cause fever, vomiting, diarrhea, and generalized bleedings as well as death. Fruit bats likely carry Ebola virus, with humans infected by close contact with infected body fluids and 'bushmeat' of primates, forest antelope, wild pigs, and bats. Human-to-human transmission occurs only by close contact with infected body fluids."—**Lawrence Gostin, Daniel Lucey, and Alexandra Phelan, in the *Journal of the American Medical Association*, published online August 11, 2014.**

"The whole thing has been very incompetently handled. If the government had quarantined this area, they could have contained it. Instead they opened a treatment center in Kenema, a major population center."—**Lansana Gberie, Sierra Leone historian, quoted in the *New York Times* on July 31, 2014.**

"I am declaring the current outbreak of the Ebola virus disease a public health emergency of international concern. Countries affected to date simply don't have the capacity to manage an outbreak on this scale on their own."—**Dr. Margaret Chan, director general of the World Health Organization, quoted in the *New York Times*, August 8, 2014.**

"Things will get worse for a while ... we are fully prepared for addressing this for some months."—**Dr. Keiji Fukuda, WHO head of health security, quoted in the *New York Times*, August 8, 2014.**

"It is very important to not give false hope to anybody that Ebola can be treated now."—**Dr. Marie-Paule Kiény, assistant director of the WHO, quoted in the *New York Times*, August 12, 2014.**



# The uneasiness of public-private partnerships

---

We're all in this together. But what does that mean, exactly?

---

"Public-private partnerships are not easy. Everyone brings their own baggage to the table. One of the reasons they fail is that they talk a good game, but when the rubber meets the road and it's about action, that's when they fall apart," says Gerald McSwiggan, director of the U.S. Chamber of Commerce Foundation Corporate Citizenship Center Issue Network.

McSwiggan spoke at a plenary session at the 39th Annual Natural Hazards Research and Applications Workshop, held June 22-25, 2014 in Broomfield, Colorado about an issue that is becoming more important as the burdens of preparing for and responding to disasters are becoming more onerous. The issue of public-private partnerships is coming to the forefront of disaster risk reduction.

Emily Tibbott of The Nature Conservancy told the Workshop, "In terms of the partnership theme, there's too much to be done, and the needs are so great that we can't go it alone. The problems are so complex, there is no single actor that can solve it on their own."

In a meeting in Geneva in July—the Intergovernmental Preparatory Committee of the Third UN World Conference on Disaster Risk Reduction—attendees heard that "future progress to reduce disaster risk rests, in large part, on expanded and stronger public-private sector partnerships."

Gary Lawrence, vice president and chief sustainability officer of AECOM Technology Corporation, said in Geneva that solutions and actions within the context of such partnership must be: technically feasible; economically viable; and politically acceptable. "These variables will be in constant flux. Given uncertainties and the need to balance risk-sharing, public-private partnerships must be founded on conditions of trust and regulatory clarity," Lawrence told said.

But these partnerships don't come without controversy. In their book *Public Private Partnerships for Sustainable Development*, Philipp Pattberg and fellow editors say, "The role and relevance of these partnerships remains contested. Some observers view the new emphasis on public-private partnerships ... as problematic, since voluntary public private governance arrangements might privilege more powerful actors, in



particular 'the North' and 'big business' and consolidate the privatization of governance and dominant neo-liberal modes of globalization."

McSwiggan points out that the issue of resilient business is a two-way street. Businesses spend a lot of money to protect themselves from disasters and to be able to keep functioning during and afterwards. But businesses also need customers, who may themselves be disrupted by the disaster without the resources that a business can bring to bear. "A lot of businesses have started to realize that there are major supply chain issues," he said. After the Tuhoku earthquake in Japan, many U.S. businesses found that they couldn't get the inputs they needed from suppliers. "Communities and supply chains are only as strong as their weakest link," he said.

"We were charged by the president to create a system of national preparedness—not of federal government preparedness or government preparedness or inter government preparedness—but national preparedness. And that breaks all those lines down," said the Federal Emergency Management Agency's Deputy Administrator Tim Manning at the Natural Hazards Center's Workshop. "So beyond the sloganeering of the 'whole community' concept ... what we mean by that is it doesn't matter whose doing what, or why, we're all in this together."

In May 2013 at the launch of the Global Assessment Report on Disaster Risk Reduction, UN Secretary-General Ban Ki-Moon said, "Economic losses from disasters are out of control and can only be reduced in partnership with the private sector which is responsible for 70 percent to 85 percent of all investment worldwide in new buildings, industry and small-to medium-sized enterprises."

# Risk ...

(Continued from page one)

stream? Will first responders really be first, do they know what they are doing, and will I ever be a first responder? Could that person the media is relentlessly covering ever really be me? Do we have the social network to be a resilient community?

Engineers have a great deal of technical knowledge to offer the hazards community. But effective solutions must incorporate the behavioral aspects of the community along with the technical solutions (Mileti and Peek 2002; Bonstrom et al 2012). Engineers employ assumptions and safety factors to compensate for aspects they don't fully understand. Social scientists can't assume away complexities of actual behavior. Flooding, hurricane and wind affect more people in the United States in a typical year than earthquakes, tornadoes and lightning. They kill more, do more crop and infrastructure damage, injure more, and cause more indirect or induced economic damage (Hazards and Vulnerability Research Institute 2009; Hammel and Corotis 2010). Yet the focus is on earthquakes. For seismic research and investigation we have the National Earthquake Hazard Reduction Program. For wind and hurricane we have an unfunded National Windstorm Impact Reduction Program. And for flooding we're often content to offer after-the-fact compensation through the National Flood Insurance Program.

Of course, not everyone agrees that perceptions of risk should be taken into account in decision making. An interesting debate concerning this comprised an entire issue of the journal *Reliability Engineering and System Safety* (1998), in which 16 articles were evenly divided on whether to use perceived risk for decision-making.

More recently Beck and Kewell (2014) wrote, "In addition to early concerns over the potentially exclusive or hegemonic nature of decision analytic expert discourses, academics of the 1970s and 1980s formulated a number of refinements to the application of these methodologies to public policy decisions. Amongst the less fruitful approaches were perhaps the writing of a number of U.S. psychologists who argued that individual perceptions of risk differed, for various reasons, from actual levels of risk."

They go on to say, "Identifying differences between public perceptions of risks and actual or measured risk levels provides us at best with ambiguous normative implications. Thus, supposedly 'irrational'

individual preferences such as the dread effect ... could be taken to support a number of normative positions."

But studies have shown that sociological aspects of the population affected are extremely important. Examples include the extensive work of Susan Cutter and her associates (Cutter et al. 2003) on social vulnerability, Kathleen Tierney's research on societal actions (Tierney et al. 2006), and focused studies of different consequences to earthquakes (Liel et al. 2013; Nguyen and Corotis 2013). Assuming that in the long run, effective decisions can only be made with the advice and consent of the people affected, and that knowledge of how people perceive risks enables risk professionals to better tailor their messages, we will proceed to discuss some ideas for graphical presentation of consequences for different natural hazards.

Engineers and social scientists have to learn together which part of the elephant the at-risk public is feeling.

## Natural hazards—fact and perception

THE NATURAL HAZARD EVENTS USED IN THE STUDIES reported here come from the Hazards and Vulnerability Research Institute (2009) at the University of South Carolina, the Spatial Hazard Events and Losses Database for the United States, or SHELDUS. It provides comprehensive records of natural hazard events for 18 different types of hazards from 1960, and the results here are for events through 2009.

The characteristics of the consequences included in our studies are fatalities, injuries and economic losses. This last is direct economic loss only, combing the property and crop damage categories presented in SHELDUS. While it is possible to assign value to a statistical life, this often obfuscates the outcome and dominates discussion. We chose not to convert fatalities to a monetary value, but for more discussion the work of Viscusi and Aldy (2003) is very informative, and leads

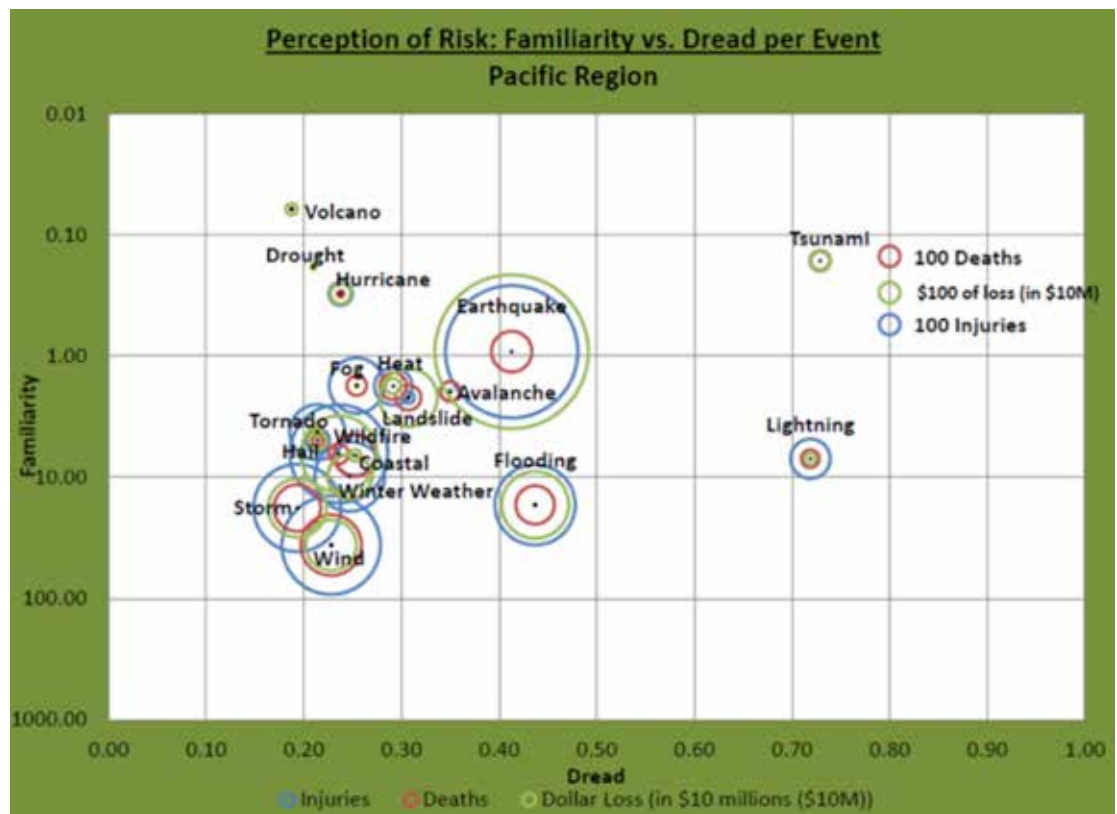


Figure 1. Risk graph for the Pacific US Region (Hurley and Corotis, 2014, *International Journal of Risk Assessment and Management*).

in the United States to a current number around \$9 million.

The importance of risk perception with respect to natural hazards is based on the work of Twigg (2003), who concludes, "Events relating to hazards interact with a variety of social, psychological, institutional and cultural processes in ways that can heighten or attenuate perceptions of risk and thereby shape risk behavior." It then uses the work of Slovic (2000), who analyzed 90 everyday activities, substances and technologies that lead to risks and benefits, described in terms of 18 risk characteristics. Using statistical factor analysis, Slovic determined five orthogonal factors that accounted for most of the variance among the hazards. The factor providing the highest explained variance was one he labeled "dread," having high statistical loadings with hazard characteristics described by the words control, dread, catastrophic potential, fatal consequences, and inequitable distribution of risks and benefits.

The second most significant factor in risk perception he labeled "unknown risk." It correlated to characteristics of unobservable, unknown, new, and delayed harm. Other factors of significance were "number of people exposed," "degree of voluntariness," and "technological stigma." The first of these was combined with dread for the hazard studies discussed here, and the other two were deemed not important delineators for natural hazards. Our first framework of putting these together was reported in Hammel and Corotis (2010), where we also looked into maximum estimated potential loss for credible future events.

### Dread

IN THE WORK OF HURLEY AND COROTIS (2014) the factor "dread" was defined for natural hazards in terms of three characteristics: the lead time (or time to react) for the hazard; the number of fatalities per event; and the number of people affected by an event. Lead times vary from none for lightning, to a few seconds for an earthquake, to days for a hurricane, to months for drought.

Flooding lead times can vary from minutes for mountain flash floods to days for major riverine flooding. The number of fatalities per event varies widely—one immediately thinks of hurricanes Katrina and Sandy. But on average typical numbers from the SHEL DUS database are 6.3 fatalities per landslide; 4.1 due to extreme heat; 3.4 for drought; 2.1 per hurricane; 1.7 for winter weather, and numbers below 1.0 for all other hazards. The number of people affected by a single event also varies widely, but typical numbers from the International Disaster Database (CRED 2009) vary from 134,000 for flooding to 28,000 for wildfire and 1,900 for earthquake.

The three characteristics chosen to define dread were scaled and transformed to avoid unintended dominance due to scale of one characteristic over the others, and then combined as a weighted sum. For illustration, lead time was given a weighting of 0.5, and the other two terms of 0.25 each.

### Unknown risk

THE FACTOR "UNKNOWN RISK" WAS INTERPRETED in these hazard studies as linked to familiarity. Since memory is one of the strongest drivers of people's actions and emotions, familiarity is defined as the number of times a hazard event has occurred per year in a specific region. Slovic (2000) showed that familiarity with a risk decreases one's perceived fear about it. Therefore, people living in a region where there are few occurrences of a particular type of hazard can be expected to

have a greater fear and perception of that hazard's risks. He also found, "Risk judgments are influenced by the memorability of past events and the imaginability of future events."

### Let's be graphic

USING THE INFORMATION DESCRIBED ABOVE, regional risk graphs were developed for the United States. For one illustration, shown below are the results for the Pacific Region (See figure 1, previous page).

By comparing, for instance, earthquakes and hurricanes in the Pacific region, we get an idea why there is so much research funding in the United States for the former. For each event in that region, there are many more deaths and injuries, as well as dollar loss for an earthquake than for a hurricane (the consequences are proportional to the area contained within each ring). And the dread factor for earthquakes is about twice that for hurricanes (mitigated somewhat by the higher level of earthquake familiarity). This situation of course is quite different in the Southeast region of the United States, which raises the question of where the influence on national policy is greater.

The hazard rings in these graphs are located in the Cartesian coordinates of dread and familiarity, and the rings show deaths, injuries and dollar losses, all per event.

An important aspect not included in this approach is the variation among events. Indeed, results are frequently presented in terms of total consequences over a reference period, or per event. In Jones and Corotis (2012) we developed probabilistic histograms of the numbers of deaths, injuries, property loss and crop loss for each type of hazard by geographical region. The amount of information quickly becomes overwhelming, but the ability to understand the range of con-

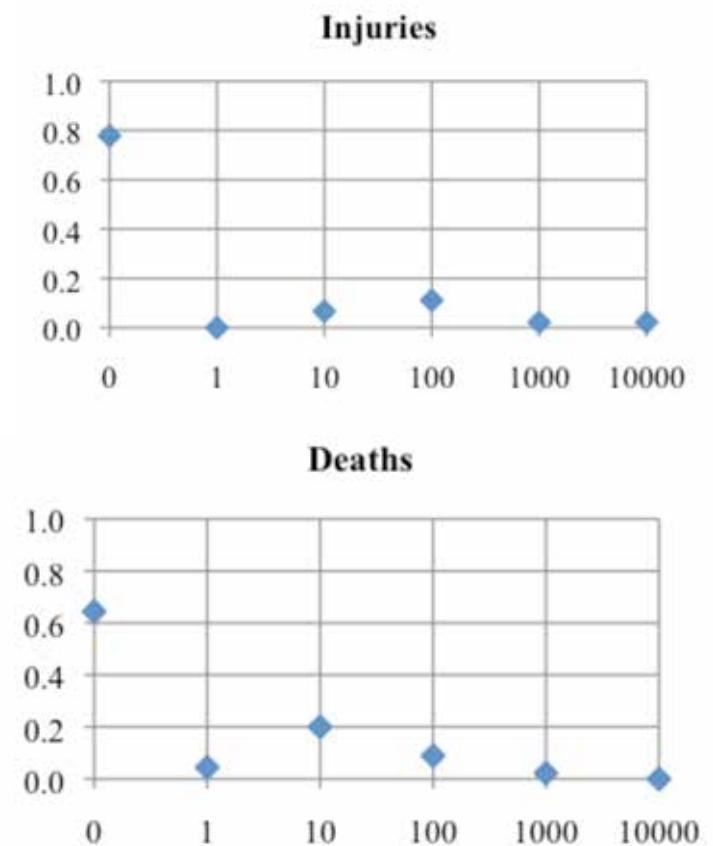


Figure 2. Histograms of earthquake consequences for the Pacific US Region (Jones and Corotis, 2012, *International Journal of Risk Assessment and Management*).

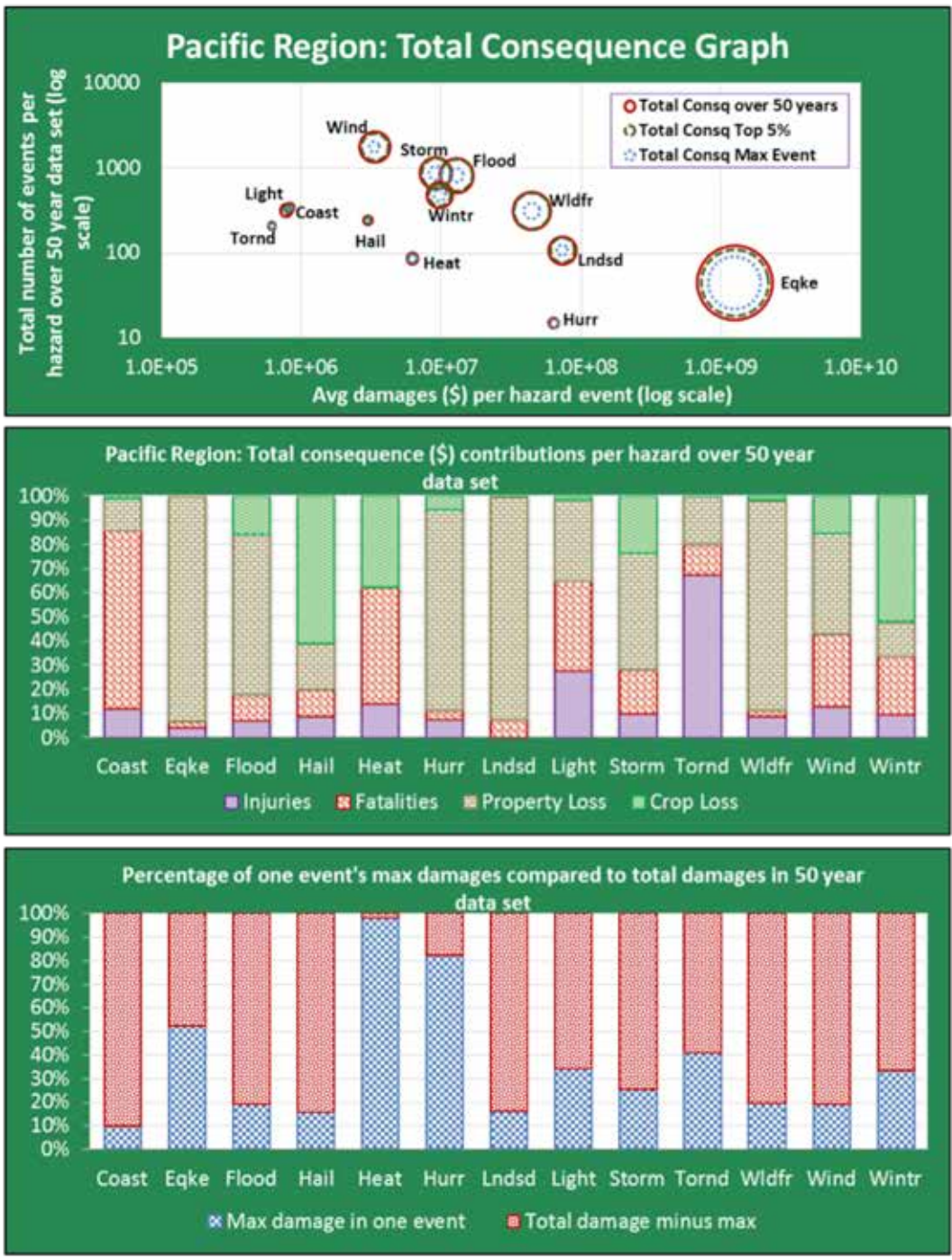


Figure 2. Histograms of Earthquake Consequences for the Pacific US Region (Jones and Corotis, 2012, *International Journal of Risk Assessment and Management*).

sequences for a particular hazard can be very helpful. Shown is a partial set of histograms for earthquakes in the Pacific United States Region (Figure 2, page 7).

This figure shows that there were no injuries in about 80 percent of the Pacific Region earthquakes, and no deaths in more than 60 percent. Public perception of Pacific earthquakes is likely dominated by the approximately one in 10 that injures and kills 100 people. It should be noted that the number 100 represents the range of more than 10, and up to 100.

As a final elaboration on the range of outcomes among events, it is interesting to compare the total consequences among hazards for a region in comparison to the contribution from the largest 5 percent of all events and the maximum event. Shown in Figure 3 is one such chart for the Pacific Region.

Figure 3 is somewhat daunting, but starts with the top graph similar to Figure 2, except that the rings are now in terms of total consequences (assigning monetary value to injuries and deaths), and over the entire 50-year SHELDUS record. Focusing on earthquakes in this Pacific Region, one sees that these are the dominant hazard in terms of consequences, that much of the consequence comes from one earthquake (homework assignment: which one?), and that the total consequences from all earthquakes are almost entirely attributable to the largest 5 percent of the events. It can be seen from the graph that there were about 50 earthquakes in the record. The upper chart visually displays the percentage of total consequence in terms of injuries, fatalities, property loss and crop loss for each hazard category, and the lower chart indicates the percentage of total consequence from the single largest event (50 percent for earthquake).

#### A word on validation

WHILE THE VALUES in these studies have been calibrated through extensive data sets and literature review, they have not been verified. The quantitative measures of risk perception in particular should be calibrated, ideally through a structured survey sample approach with both qualitative and quantitative analysis. Results could also be cross-correlated with surrogate measures, such as media coverage, funding on research for particular types of hazards, local and regional hazard reduction and resiliency plans, and public awareness campaigns.

These graphs were developed with the goal of allowing policy makers to make a more informed decision when creating a hazard mitigation plan, and explaining actions to the public (Corotis 2010). Knowing the basics such as deaths, injuries, and damages is important, but including the way people feel about those hazards is also important. Research by Perry and Lindell supports the need for a visual representation of both "risk as analysis" and "risk as feeling" (2007), and they explain that "Experienced planners know that citizen compliance with protective action recommendations (PARs) is much more likely if those protective actions are designed in a way that complements known human response."



## References

Beck, Matthias and Beth Kewell. 2014. *Risk: A Study of its Origins, History and Politics*. World Scientific Publishing Company, Singapore.

Bonstrom, Holly, Ross Corotis, and Keith Porter. 2012. Overcoming public and political challenges for natural hazard risk investment decisions. *Journal of Integrated Disaster Risk Management* 2(1), 1-23.

Corotis, Ross. 2010. Political issues for sustainable hazards policy. *International Journal of Engineering under Uncertainty: Hazards, Assessment and Mitigation* 2(1), January-June, 1-7.

CRED. 2010. *EM-DAT: The International Disaster Database*. 2009. <http://www.emdat.be/result-country-profile>.

Cutter, Susan L., Bryan J. Boruff, and W. Lynn Shirley. 2003. Social vulnerability to environmental hazards. *Social Science Quarterly* 84(2), June, 242-261.

Hammel, Evan and Ross Corotis. 2010. Multi-attribute aspects for risk assessment of natural hazards. *International Journal of Risk Assessment and Management* 14(6), December, 437-458.

Hazards and Vulnerability Research Institute. 2009. *The Spatial Hazard Events and Losses Database for the United States, Version 7.0* <http://www.sheldus.org>.

Hurley, Maura and Ross Corotis. 2014. Perception of risk of natural hazards: A hazard mitigation plan framework. *International Journal of Risk Assessment and Management* 17(3), 188-211.

Jones, Jenni and Ross Corotis. 2012. The regional consequences of individual natural hazard events. *International Journal of Risk Assessment and Management* 16(1/2/3), 78-111.

Liel, Abbie, Ross Corotis, Jeannette Sutton, Guido Camata, Enrico Spacone, and Rose Bricker-Ford. 2013. Perceptions of decision-making roles and priorities affecting rebuilding after disaster: The example of L'Aquila, Italy. *Earthquake Spectra* 29(3), August, 843-868.

Mileti, Dennis and Lori Peek. 2002. Understanding individual and social characteristics in the promotion of household disaster preparedness. *New Tools for Environmental Protection: Education, Information and Voluntary Measures* 125-139.

Nguyen, Lan and Ross Corotis. 2013. Seismic risk and society development indicators: Examination of three countries. *Natural Hazards Review ASCE*, 14(2), May, 122-133.

Perry, Ronald and Michael Lindell. 2007. *Emergency Planning*. John Wiley & Sons, Inc.

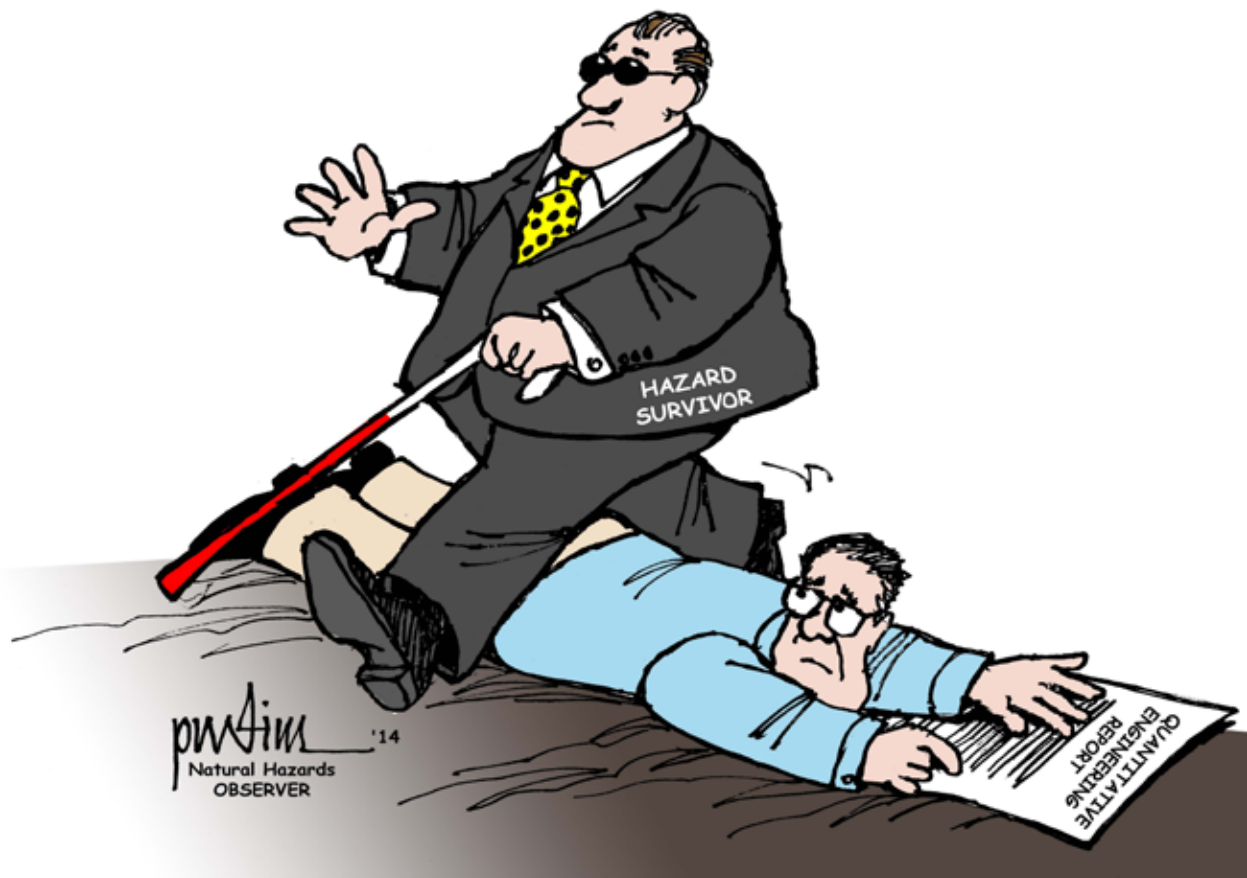
*Reliability Engineering and System Safety* (1998). Special issue: Risk perception versus risk analysis. David Okrent and Nick Pidgeon, Eds. 59(1), January, Elsevier, Oxford, England.

Slovic, Paul. 2000. *The Perception of Risk*. London: Earthscan Publications Ltd.

Tierney, Kathleen, Christine Bevc, and Erica Kuligowski. 2006. Metaphors matter: Disaster myths, media frames, and their consequences in Hurricane Katrina. *The ANNALS of the American Academy of Political and Social Science* 604(1), 57-81.

Twigg, John. 2003. The human factor in early warnings: risk perception and the appropriate communications. Zschau, Jochen and Andreas Koppers. *Early Warning Systems for Natural Disaster Reduction*. Berlin: Springer. 20.

Viscusi, W. Kip and Joseph E. Aldy. 2003. The value of a statistical life: A critical review of market estimates throughout the world. *The Journal of Risk and Uncertainty* 27(1), 5-76.



# Lessons from the 2011 Joplin tornado



An invited comment by Erica Kuligowski, Franklin Lombardo, Long Phan, and David Jorgensen

**E**VEN WITH 17 MINUTES OF WARNING LEAD TIME—three minutes longer than the national average tornado warning time—161 lives were lost and over 1,000 people injured by the powerful tornado that struck Joplin, Missouri on the evening of Sunday, May 22, 2011.

Days after the tornado, the National Institute of Standards and Technology, in cooperation with the National Oceanic and Atmospheric Administration, dispatched a team of researchers with expertise in structural, fire, and wind engineering, disaster sociology (human behavior and emergency communication and response), meteorology, and severe storm predictions and warnings to conduct a technical investigation of the event under the National Construction Safety Team Act (see Kuligowski et al. 2014).

One of the objectives of the NIST investigation was to understand how the public responded to the National Weather Service's and the city of Joplin's emergency warnings and communications during that fateful event. In turn, we wanted to identify the patterns, locations, and causes of deaths and injuries due to the tornado. Data were collected and analyzed on the following: (1) the damage to the built environment and vegetation; (2) building design and construction; (3) the emergency communication protocol and procedures in place before

the storm hit; and (4) the response of the public to the emergency communications and the storm itself.

This study provided an approximation of the environmental conditions that existed during the storm (via wind speed estimates), an evaluation of the performance of buildings in the affected area, and an understanding of the consequences of the tornado for the people who were in its path. As with any NCST investigation, the ultimate goal was to develop findings and recommendations for improvements to codes, standards, and practices for buildings and emergency communication procedures that will lead to improved safety in tornadoes.

## Buildings don't protect occupants

ONE UNIQUE ASPECT OF THE JOPLIN TORNADO was the broad range of building systems it affected. While most buildings damaged by tornadoes are typically low-rise, marginally or non-engineered buildings like manufactured homes, the Joplin tornado damaged non-engineered and engineered buildings alike. Most notable were the east and west towers of the St. John's Regional Medical Center, which were both a critical facility and the tallest buildings in the immediate region.

BUILDING	EST. WIND SPEED (MPH)	STRUCTURAL SYSTEM	DEGREE OF DAMAGE	BASEMENT (YES/NO)	DEATHS	CIRCUMSTANCES OF DEATH
AT&T store	160	Metal frame walls with brick facade	Unrated	No	1	Crushed in back office (refuge)
Elks Lodge	170	Wood frame	Demolished	No	4	Attempting to run to cooler (refuge)
Full Gospel Church	150	Wood frame	Demolished	No	4	Nursery (refuge)
Harmony Heights Baptist Church	160	Concrete masonry unit/wood frame walls with wood roof trusses	Demolished	No	3	Located in nursery and library (refuge)
Meadows Healthcare facility	100	Wood frame	Heavy	No	2	(Not known)
Pizza Hut	170	Wood frame	Demolished	No	5	Thrown from cooler (refuge)
Stained Glass Theater	170	Unreinforced masonry walls with brick facade	Demolished	Yes	3	Above-ground theater area (survivors in basement)
Walmart	165	Box-type system with concrete masonry perimeter walls, metal roof diaphragm	Demolished (southern half)	No	3	(Not known)
Home Depot	170	Box-type system with tilt-up reinforced concrete perimeter walls and metal roof diaphragm	Demolished	No	8	Structural collapse toward front of the store (lumber area)
St. John's Regional Medical Center	170	West tower: 7-story cast-in-place reinforced concrete frame; East tower: 9-story steel frame	Significant damage to envelope	No	12	Four patients in ICU, one additional on 3rd floor; others (unknown locations)
Greenbriar Nursing home	170	Unreinforced masonry with wood roof trusses	Demolished	No	19	Located in hallway (refuge)
Single-family homes	>136	Wood frame	Heavy/ totaled to demolished	56 none, 3 partial	59	All above ground when storm hit; 20 known to take internal refuge (all others unknown)
Apartments	>136	Wood frame	Demolished	No	12	All above ground when storm hit; 2 known to take internal refuge

While these towers did not collapse, they sustained significant damage to their envelopes due to the combination of high wind pressure and wind-borne debris impact. Regardless of construction type, neither these towers, nor other affected residential and nonresidential buildings, were able to provide protection for their occupants, as evidenced by the high death toll of occupants in the buildings (135 of the 161 deaths, or 83.8 percent of all fatalities). Details of the 135 fatalities that occurred within buildings, and the circumstances surrounding these deaths, are shown in Table 1.

Virtually all of the buildings in which there were fatalities experienced maximum wind speeds (i.e., 136 mph and above) in excess of the code-level design wind speed for these building types. In fact, these buildings were subjected to wind speeds close to or above the speeds that would be expected to cause collapse of or major damage to structures designed to the non-tornadic wind design building code requirements. While it is recognized that conventional buildings in the United States are not required to be designed for tornado hazards and there are no building code requirements for tornado-resistant design currently, the high death and injury toll, in a city with long history of timely code adoption, points to serious failure of buildings to provide life-safety and gives rise to an important question: Can building safety in tornadoes be enhanced?

To begin to answer this question, we first looked at the fatalities that occurred within designated tornado refuge areas. Many nonresidential facilities, including high-occupancy commercial and critical facilities surveyed by NIST, did not have tornado-resistant community shelters or safe rooms. Instead, they had designated refuge areas. For the Pizza Hut

restaurant, for example, shown in Table 1, the cooler was specified as the refuge area for shelter from tornadoes. However, these areas are typically best-available refuge areas within the facilities. They're not specifically designed for tornado resistance. During the Joplin tornado, NIST found that several of these designated refuge areas suffered severe structural damage. There was no evidence that these areas saved lives.

At the time of the tornado, neither Joplin nor Jasper County operated community shelters or safe rooms. With 82 percent of the homes in Joplin lacking basements, only a few residential buildings with some type of above-ground storm shelters, and a few nonresidential buildings with underground locations (e.g., basements, like in the Stained Glass Theater), the option for safe sheltering for many in the affected area was limited.

### Impact of Emergency Communication

THE NEXT STEP IN THE PROCESS was to study the Joplin tornado fatalities that were located outside of designated refuge areas when the storm hit. In some cases, people were attempting to reach a designated refuge area within a building (e.g., the deaths that occurred in the Elks Lodge or those attempting to reach the basement level in the Stained Glass theater; See Table 1). In other cases, deaths occurred while people were located outdoors or in vehicles. It is important to understand, given the relatively generous tornado warning lead time, the reasons why people did not seek some form of shelter before the tornado hit.

We were unable to ascertain what emergency information the deceased had received and the subsequent motives or perspectives that guided their actions. However, it was possible

## The Natural Hazards Observer is back in print! Back by popular demand!

Many people have asked us how to get a print copy of the *Observer*. They've even said that they'd be willing to pay a little for the privilege.

For **only \$15 a year**, you can get a hard copy of the bimonthly *Observer* conveniently delivered by First Class mail.

The *Observer* is still available for free online. You can sign up for pay or free versions at [ibs.colorado.edu/hazards/subscribe](http://ibs.colorado.edu/hazards/subscribe).

Yes! Send me a one year subscription to the *Observer* for only 15 bucks.

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_ STATE/ZIP \_\_\_\_\_

EMAIL \_\_\_\_\_

to determine the factors that influenced survivors to decide against protective action, especially since many decided against protective action at some point in their decision making process. Qualitative interview data from 140 survivors<sup>1</sup> from the Joplin tornado—particularly those who were responsible for their own protective decision making, for example, a head of household or someone alone in a car—were analyzed to develop a conceptual model of decision-making (Kuligowski et al. 2014). This model was developed to identify the reasons why protective actions were or were not taken. In turn, it identifies improvements to the emergency communication system and protocols, if warranted.

Qualitative analysis determined that responses to the approaching tornado among members of the public, in many cases (and even among those who survived the incident without injury), were delayed or incomplete. Two factors were found to have contributed to the delayed or incomplete public response to the Joplin tornado. The first was a lack of awareness of the approaching tornado. The second factor was an inability to perceive personal risk due to one or more of the following: receipt of conflicting or uncertain information about the tornado; pre-existing beliefs about Joplin's immunity to direct tornado strikes; and distrust of or confusion about Joplin's emergency communications system.



### Lack of Awareness

IN THE FIRST CASE, INDIVIDUALS WHO DID NOT RECEIVE tornado alert or warning cues on May 22, 2011—i.e., who were unaware that a tornado was happening—did not formulate any general risk associated with the event, so they didn't protect themselves. Of the 140 survivors included in this analysis, 16 percent were unaware that a tornado was taking place until a family member or friend called or the tornado was upon them. The 16 percent of decision makers who fell into this category were distributed among three different awareness states that made the receipt of warning information difficult: asleep, awake with impaired hearing, and awake but disconnected from emergency communications.

For example, a couple in their late 80s was watching television before the storm hit, and do not recall receiving any information on the impending tornado. They were both hard of hearing, making it difficult for them to hear outdoor sirens (which others claimed they could hear from indoors) as well as information provided via the television programming that they were already watching. Extended family members who would normally call and alert them of bad weather were out of town on the evening of May 22. That evening, the wife had noticed that it was getting dark outside. So she went to light candles near the front of the house when the following happened, according to the couple's daughter:

"It just hit right then, and everything started flying, and [the husband] threw her [his wife] down in the hallway and just jumped on top of her and held onto the carpet as best he could, and the floorboards. He said when it was over this whole part of the roof was off." (NIST Interview 20)

1. 140 out of 168 survivors interviewed by NIST (Kuligowski et al. 2014)

This couple was caught completely off guard by this storm, but suffered only minor injuries from being thrown around the house.

For those disconnected from tornado-related emergency communications, individuals were out-of-range from the city-wide tornado siren system, or simply did not hear the sirens from inside their homes. Even though the siren system was meant to alert individuals located outside of structures only, there was a general sense among the interviewees that Joplin-area residents located indoors (especially at home) relied on this technology to alert them as well. These decision makers were also disconnected from other forms of tornado-related emergency communication, such as NOAA weather radios or opt-in subscription services that provide messages to mobile phones in the Joplin area.

### No personal risk perceived

IN THE SECOND CASE, INDIVIDUALS WHO WERE UNABLE TO confirm the existence of a tornado, either due to the receipt of conflicting or uncertain information and/or their pre-existing perspectives on tornadoes in general, did not perceive any personal risk as a result of the weather that day. Of the 140 survivors, a majority of the sample (61 percent) were unable to confirm the existence of a tornado until they encountered direct visual or audible evidence of it.

When initial information was given to decision makers on May 22, 2011, around 5:09 p.m., including the sirens that sounded at 5:11 p.m., there was little available to confirm the risk of a tornado threatening Joplin. The tornado touched down around 5:38 p.m. Any warning information provided to individuals around 5:09 p.m. (until 5:17 p.m.) related to a storm that the NWS weather forecasters were tracking to the

north of Joplin. A Joplin native remembered:

“The announcer and the weatherman that came on the TV seemed to say the track was, you know, mainly north of town. It wasn’t going to be a bother for where I was at towards the south part of town. So, I continued to sit there on the front porch and enjoy the cool air that was, you know, for the day.” (NIST Interview 58)

After hearing this information and based upon the perceived tendency for storms to track toward the northeast only, interviewees assumed that they were not at risk.

Around this same time (5:09 PM), individuals were offered very little in the way of environmental cues of an impending storm, also making it difficult to confirm the tornado risk. People looked outside, to the sky, for clues that a tornado was coming and saw only clouds that did not look as menacing as what would normally accompany a tornado. An interviewee recalled his actions at home that evening:

“The tornado sirens went off once, we walked outside and you couldn’t really, didn’t really see nothing then, and we went back in and finished eating.” (NIST Interview 108)

The decision had become as simple as that—if there was nothing in the sky to worry about, then it was appropriate to return to your previous pursuits until something caught your attention. Some people continued to monitor weather reports, while others resumed activities unrelated to the weather.

Even after the first set of sirens stopped and time progressed, interviewees who continued to monitor the weather via television or radio (or Internet sources) still did not perceive firm confirmation of an impending storm likely to affect them. First, the NWS issued a tornado warning at 5:17 p.m. for the storm that eventually hit Joplin. However, the outdoor siren system was not reactivated at 5:17 p.m. Additionally, interviewees who had been tuned into the news outlets at 5:17 p.m. primarily reported that the media continued to discuss a storm that was to the north of Joplin.

During this time, the inability to confirm personal risk in a timely manner on May 22, 2011, was exacerbated by Joplin-area residents’ perspectives on tornadoes in general. When asked about their views on the possibility of severe storms in Joplin, decision makers in the 140-person sample (and even other NIST interviewees) generally did not believe that tornadoes in Joplin were something that they would witness during their lifetimes.

One factor behind these views was a public perception—pervasive among the decision makers—that severe storm false

alarms were common in Joplin. This false perception was also exacerbated by the tendency of NWS forecasters to over-warn tornado hazards. Indeed, official NWS verification statistics showed a 78 percent false alarm rate for the southern Missouri area (i.e., over three-quarters of all official tornado warnings did not have a verified tornado report). One individual described his perspective on storm warnings as follows:

“I grew up in Arkansas and spent a lot of time in Oklahoma, and then Missouri in this area. So, tornado watches are common. But, tornadoes don’t always strike, and they’re usually small. So, the chances of it truthfully hitting are pretty slim.” (NIST Interview 10)

Decision makers seemed to blame the outdoor siren system for over-warning as well, even though the sirens sounded only once per year, on average, for wind-related events.

Even if a tornado did materialize, most interviewees erroneously believed that they would be safe inside the city limits of Joplin. Residents were confident that they would be protected from severe storms and tornado damage, and believed that “it cannot happen to us” based upon tornado tracking beliefs or myths. For example, interviewees believed that severe storms always went around Joplin to the north or the south, creating a mythical “bubble” around their city that protected them from harm.

Finally, some interviewees expressed their confusion regarding the tornado siren protocol. On May 22, 2011, some interviewees were confused about how long the sirens should sound and the reasons why the sirens stopped after three minutes, even though this was Joplin’s emergency communication protocol. However, contrary to protocol, Joplin survivors were unsure why the second siren had been initiated, since this had not happened in the past.

### Protection is deemed necessary

THE MAJORITY OF DECISION MAKERS, who eventually decided that protection was necessary, did so only after receiving intense cues from the environment. Intense cues were those visibly or audibly disseminated by the tornado. Actually seeing the massive debris wall heading straight for them or hearing the sound of a freight train caused Joplin survivors to perceive risk and that they were potentially in trouble. High-intensity cues also included seeing large trees swirling or laying down on the ground, seeing cars or other heavy objects lift or fly off of the ground, and hearing information about the tornado in an urgent tone (i.e., the newscaster who urgently prompted people to “Take cover now!”). It was at this point when they realized that protection was necessary if they wanted to escape this tornado unharmed. Seeing or hearing these cues

prompted individuals to take shelter in various locations in buildings, in vehicles, or outdoors. Among these individuals, the intense cues triggered cognitions about risk and danger to themselves, their friends, and family members. In some cases, the cues were so severe that individuals who were already located in their basements (e.g., “early actors”) moved to an internal refuge area (closet or bathroom) within their basement.



Actually seeing the massive debris wall heading straight for them or hearing the sound of a freight train caused Joplin survivors to perceive risk and that they were potentially in trouble.

## Next Steps

AS A RESULT OF THE JOPLIN TORNADO INVESTIGATION, NIST made 16 recommendations for improving how buildings and shelters are designed, constructed, and maintained in tornado-prone regions and for improving emergency communications (see <http://nvlpubs.nist.gov/nistpubs/NCSTAR/NIST.NCSTAR.3.pdf>). The following are three key recommendations where implementation is likely to have the greatest impact on life safety in future disasters:

(1) Develop nationally accepted performance-based standards for tornado-resistant design of buildings and infrastructure, as well as design methods to achieve those standards. Under these standards, specific types of buildings, for example, hospitals, will be designed and constructed to meet specific performance objectives, depending upon the types of tornado intensities expected in certain events.

(2) Install tornado shelters in new and existing multi-family residential buildings, mercantile buildings, schools and buildings with assembly occupancies located in tornado hazard areas. As part of this effort, develop and implement uniform national guidelines that enable communities to create safe and effective public sheltering strategies. The guidelines should address planning for siting, designing, installing, and operating public tornado shelters within the community.

(3) Create national codes and standards and uniform guidance for clear, consistent, recognizable, and accurate emergency communications, encompassing alerts and warnings, to enable safe, effective, and timely responses among individuals, organizations, and communities in the path of storms having the potential to create tornadoes. Additionally, NIST

recommends that emergency managers, the NWS, and the media develop a joint plan and take steps to make sure that accurate and consistent emergency alert and warning information is communicated in a timely manner to enhance the situational awareness of community residents, visitors, and emergency responders affected by an event. This involves improving the NWS information to include forecast uncertainty information in the form of probabilities to reduce over warning as well as utilizing modern “push” communications to personal cell phones and smart phones.

NIST is assigning top priority to work vigorously with key stakeholders, including the building, codes, standards, and other relevant communities, as well as other federal agencies, to assure that there is a complete understanding of the NIST recommendations and to provide technical assistance for implementing these recommendations into standards and codes.

*Erica Kuligowski is a sociologist in the Disaster Resilience Program at the National Institute of Standards and Technology. Long Phan is also at NIST, a research structural engineer in the Materials and Structural Systems Division. David Jorgensen is a meteorologist with the National Severe Storms Laboratory in Norman, Oklahoma. Frank Lombardo is a research assistant professor in the Department of Civil and Environmental Engineering at Rensselaer Polytechnic Institute.*

## References

Kuligowski, Erica, et al. 2014. *Final Report, National Institute of Standards and Technology (NIST) Technical Investigation of the May 22, 2011, Tornado in Joplin, Missouri, available at <http://nvlpubs.nist.gov/nistpubs/NCSTAR/NIST.NCSTAR.3.pdf>*



# Resources

Below are brief descriptions of some of the resources on hazards and disasters that have recently come to the attention of the Natural Hazards Center. Web links are provided for items that are available free online. Other materials can be purchased through the publisher or local and online booksellers.

All of the material listed here is available at the Natural Hazards Center Library. For more information contact librarian Wanda Headley at [wanda.headley@colorado.edu](mailto:wanda.headley@colorado.edu).

## FLOOD

**Climate Change and Flood Risk Management: Adaptation and Extreme Events at the Local Level.** E. Carina H. Keskitalo, ed. 2013. ISBN: 978-1-78100-667-2. 321 pp., \$131. Edward Elgar. <http://bit.ly/1surCgv>.

This book focuses on the flood risks mostly in the northern reaches of the planet—the Saskatchewan River in Canada, the Torne River between Sweden and Denmark, the Carrot River watershed in Saskatchewan, and the like. It deals mostly in case studies of these areas. They find that the flooding in some of these areas can lead to policy changes, even in the face of uncertainty surrounding climate change.

For instance, in their examination of flooding in Saxony in the early part of this century, “The study provides strong empirical evidence that the 2002 flood has functioned as a catalyst for sweeping political actions by decision makers across all government levels. Of special importance is the observation that the severe damage in 2002 raised political awareness not just about flood risk management, but also about the likely impacts of future climate change.”

## NUCLEAR

**Analysis of Cancer Risks in Populations Near Nuclear Facilities: Phase One.** National Research Council of the National Academies. 2012. ISBN: 978-0-309-25571-4. 412 pp., available for download at <http://dels.nas.edu/Report/Analysis-Cancer-Risks-Populations/13388>.

“Finding scientific evidence of whether people who live near nuclear facilities have a greater risk of developing cancer than those who live farther away is a challenge,” says John Burris, chair of the committee that wrote this report. Burris is also president of Burroughs Wellcome Fund in Research Triangle Park, North Carolina. “There are issues of whether scientists can get the information needed to carry out the study. For example, some state cancer registries have only recently attained quality data. Also, data may be insufficient to estimate the amount of radioactive material released from nuclear facilities, especially during early years of operations. This makes it much more difficult to determine risks from decades ago when radiation releases from nuclear facilities were larger.” Burris is quoted on the NRC web site.

This report recommends a pilot study to see if the problems inherent in this kind of research can be solved with enough certainty to warrant a full-scale effort. The committee recommended two approaches to the cancer risk study, which could be carried out by the Research Council as the second phase of its project, should the USNRC decide to proceed. One approach would be to investigate rates of cancer occurrence and cancer deaths in small geographic areas within approximately a 30-mile radius of nuclear facilities. The different geographic areas should represent a range of potential exposures from radioactive material releases from

the facilities, from the highest to essentially no exposure.

Another would be to conduct a record-based, case-control study to assess the association of cancers in children less than 15-years-old in relation to their mothers’ residential proximity to a nuclear facility during pregnancy. Both approaches would have a sub-analysis focusing on leukemia, the cancer associated with radiation exposure in children.

## CLIMATE

**Adaptation to Climate Change in Asia.** Sushil Vachani and Jawed Usmani, eds. 2014. ISBN: 978-1-78195-473-7. 213 pp., \$120 (hardcover). Edward Elgar. <http://bit.ly/1sGuCqj>.

This book focuses on climate change adaptation in eight Asian territories—seven countries and Hong Kong. The countries are Bangladesh, Cambodia, China, India, Nepal, Singapore and South Korea. Together they are home to 2.8 billion people, 40 percent of the globe’s population. The economies of these territories are large and rich, although the large ones aren’t so rich and the rich one’s aren’t so large, at least as measured by per capita gross domestic product.

The economies of these nations vary as well. Hong Kong and Singapore have virtually no agricultural sector. Nepal and Cambodia have little industry, lots of agriculture. China is long on industry, short on ag ... and so on.

So Asia’s a big and varied place. The whole continent faces risks from climate change, but those risks vary. This book looks at each nation and territory in turn to consider what climate might bring, and what might be done about it. “In South Korea,” the authors say, “disasters occurring due to climate anomalies are considered to be the most serious problems that need to be addressed through adaptation. In particular, heavy rainfall, scorching heat and heavy snowfall in urban areas are deemed to be most severe.”

China, which is a major contributor to global CO<sub>2</sub> levels, faces extreme weather events, public health challenges, and resulting ethnic tensions. “Some regions that are most vulnerable to the impacts of climate change in China are already subject to ethnic tensions, including the Tibetan Plateau region. As glaciers melt and inhabitants of the Tibetan Plateau region must deal with more water scarcity, they may migrate toward central or eastern China. A similar phenomenon may occur as Inner Mongolia faces more decertification as a result of climate change. Migration of such ‘climate refugees’ from Tibet and Inner Mongolia into predominantly ethnic Chinese regions could increase ethnic tensions, and even threaten regional stability.”

One of the premises of this book is that “adaptation to climate change” is no longer a taboo topic. It’s been feared that urging adaptation lessens the urgency of reducing the causes of climate change. But as the nations of the globe have missed opportunity after opportunity to deal with this, adaptation has become essential.



# Contracts and Grants

Below are descriptions of some recently awarded contracts and grants related to hazards and disasters.

**Assessing the reliability of levees in changing geologic conditions.** National Science Foundation awards #1400640 and 1362357. [http://www.nsf.gov/awardsearch/showAward?AWD\\_ID=1400640](http://www.nsf.gov/awardsearch/showAward?AWD_ID=1400640). Three years. Two awards. \$204,947 to principal investigator John Rice, Utah State University, john.rice@usu.edu and \$85,000 to principal investigator Christopher Meehan, University of Delaware, cmeehan@udel.edu.

This research will investigate methods of assessing the risk of levee failure as a result of variable geologic conditions along the length of the levee. As levees are loaded during floods, water will begin to seep through both the levee and through the levee foundation. At low flow velocities, the water will pass through the soil matrix without significantly affecting it. However, as the river water rises, the amount of seepage increases and the velocity of the seeping water and/or the pressure of the seeping water increases in response. This increases the potential for erosion of soil from within the levee or its foundation, a phenomenon known as internal erosion. If allowed to continue, internal erosion can lead to instability and eventual failure of the levee.

Current levee evaluation methods assume relatively uniform subsurface conditions for assessing seepage behavior. However, buried geologic structures in the near-surface soils left behind by prehistoric creek or river channels often have a huge effect on the seepage behavior in the levee foundation, often to the point where these structures control the reliability of the levee with respect to internal erosion. This research provides knowledge necessary for the development of a method for assessing the underseepage risk to levee reaches that have variable geologic features in their foundation.

The new assessment procedures takes into account the three-dimensional aspects of the seepage flow into these features and assesses the probability of developing seepage conditions where internal erosion is likely to initiate. By mapping where these features occur along a long levee reach and evaluating the risk each of these features poses to the levee, we can evaluate the reliability of the entire levee reach by combining the risks of the various geologic features located along their alignment. The results of this research will assist engineers in assessing where levees present unacceptable risk to the land they protect. Because there are thousands of miles of levees in the United States needing evaluation and mitigation for underseepage, this methodology has the potential to greatly improve the efficiency at which available funds are spent to increase the reliability of this critical aspect of our nation's infrastructure.

This project transforms the analysis strategy and methodology for assessing risk to linear geotechnical projects constructed over varied geologic conditions. The project is formulated specifically for levees but the methods developed will also be applicable to other linear structures or projects. The analysis framework consists of robust reliability analyses (response surface Monte Carlo analyses) that are applied to individual geomorphic features to estimate the probability of key hydraulic parameters reaching levels where the initiation

of internal erosion is likely. These probabilities will then be combined with the likelihood of other steps in the internal erosion failure process occurring to obtain the probability of failure due to each geomorphic feature along the project alignment. The resulting probabilities will then be statistically combined to obtain the total risk to the project due to the failure mechanisms considered. This methodology provides a robust means for assessing the total risk to linear structures in a way that accounts for length effects and the geologic hazards located along their alignment.

**Physics-based volcano geodesy with application to effusive eruptions at Mount St. Helens.** National Science Foundation award #1358607. [http://www.nsf.gov/awardsearch/showAward?AWD\\_ID=1358607](http://www.nsf.gov/awardsearch/showAward?AWD_ID=1358607). Three years. \$270,594 to principal investigator Paul Segall, Stanford University, segall@stanford.edu.

Non-technical summary: Prior to volcanic eruptions magma accumulates in shallow reservoirs in Earth's crust. As a result, pressure increases in these magma chambers, which deforms or "inflates" the Earth's surface. In contrast, during eruptions, magma leaves these reservoirs, decreasing pressure and causing the Earth's surface to "deflate." Better understanding of these signals could help improve societal responses to volcanic eruptions, such as possible evacuations and changes to airline routes near volcanoes like following the 2010 Icelandic eruption.

This project is developing new physics-based models of volcano deformation, which can be coupled with deformation measurements from the EarthScope Plate Boundary to improve forecasts of the duration of an eruption and the volume of material that may be erupted. The project is investigating a data assimilation approach in which available data are used to develop probabilistic estimates for parameters that describe the state of the magmatic system. These are then used to initialize an ensemble of forward models that predict future behavior, including eruption duration and total erupted volume. Given improved forward models, this approach has the advantage of being consistent with both available data and realistic physics-based eruption models. Physics-based volcano eruption forecasts are similar in concept to numerical weather forecasts that assimilate satellite and other data into sophisticated weather models.

Technical summary: This project employs Markov Chain Monte Carlo inversion of continuous GPS positions, magma efflux, and other data using a physics-based forward model of an effusive eruption. Including a physically consistent eruption model allows the estimation procedure to constrain parameters of interest that are not resolved by traditional approaches, including the volume of the crustal magma chamber and the initial water content of the magma. These parameters influence the size and potential explosive potential of eruptions. Ongoing work is increasing the realism of the forward model by including: (1) equilibrium crystallization of the magma as it ascends and pressure

decreases; (2) explicit consideration of the rheological transition from distributed viscous flow to solid plug flow with slip on bounding faults, based on a Bingham fluid model; and (3) explicit consideration of gas loss (both H<sub>2</sub>O and CO<sub>2</sub>) through both lateral and vertical diffusion. Other goals include better models of the eruption onset and cessation. The method is being applied to the 2004-2008 dome forming eruption of Mount St. Helens, including GPS data from the Plate Boundary Observatory and could be applied to other volcanoes, including Augustine in Alaska, Unzen in Japan, and the Soufriere Hills on Montserrat.

**Extreme weather events and emergency medical services: A discrete optimization modeling framework.**

National Science Foundation grant #1444219. [http://www.nsf.gov/awardsearch/showAward?AWD\\_ID=1444219](http://www.nsf.gov/awardsearch/showAward?AWD_ID=1444219). Three years. \$309,783 to principal investigator Laura McLay, University of Wisconsin-Madison, lamclay@vcu.edu.

This research investigates how to reformulate and reframe important service system models that have considerable social relevance by considering the fundamental decision issues within their social context. This plan is motivated by important, timely resource allocation problems in emergency medical service systems, namely, how to provide a coordinated EMS response to medical emergencies during extreme weather events, thus integrating two types of hazard mitigation problems that have been addressed separately in the literature thus far.

In particular, this research investigates how to optimally dispatch medical units to geographically dispersed patients, as well as how dispatching policies change during normal and extreme weather events. Emergency medical dispatching protocols are typically designed for systems operating under normal weather conditions. In general, little guidance exists for how dispatching protocols may change for systems operating under extreme weather conditions. The central challenges of the research program are to reformulate and reframe new classes of hard discrete optimization problems that capture the social context surrounding service systems and to solve the discrete optimization models by exploring new algorithms and heuristics as well as by characterizing the structural properties of the models. The discrete optimization models developed in this project provide novel formulations that reformulate and reframe new classes of problems by investigating the particular demands of EMS systems.

These new models and algorithms can be used to provide fundamental insights into the design and operation of EMS systems in response to medical emergencies that arise during extreme weather events. Challenging extensions investigate how to simultaneously locate and dispatch medical units and investigate game-theoretic aspects of emergency medical dispatch using principal agent problem models. The central challenges of the educational component are to create a portfolio of teaching and outreach activities that educates public safety leaders through outreach, to create a series of podcasts about applying advanced analytical tools to risk and hazard applications, to use the research as a vehicle for outreach using social networking tools (blogs, FaceBook, and Twitter), to develop a course on mathematical models for homeland security and emergency management, and to mentor students. Integration between the research and educational components will be achieved by including the research models in the outreach and other educational

activities and by using the outreach and educational component to better inform the research models.

**Rolling isolation systems to protect building contents from earthquakes.** National Science Foundation grant #1436015. [http://www.nsf.gov/awardsearch/showAward?AWD\\_ID=1436015](http://www.nsf.gov/awardsearch/showAward?AWD_ID=1436015). Three years. \$240,113 to principal investigator Henri Gavin, Duke University, henri.gavin@duke.edu.

Fragile objects and mission-critical building contents such as hospital equipment may be placed on rolling isolation systems in order to protect them from damage during earthquake event. Rolling isolation systems consist of a matched pair of horizontal rectangular frames with rigid shallow dishes fixed to their corners. The dishes in the lower frame are concave up, and those in the upper frame are concave down. A large steel ball located between these dishes allows the upper frame to roll over the lower frame. The intensity of shaking that rolling isolation systems can protect against is determined largely by the diameter of the steel dishes. Currently one of the limiting factors for rolling systems is that they can protect objects only from horizontal shaking. Further, the best bowl shape and the proper amount of energy-damping for a particular application remain open questions. This award supports research to develop rolling isolation systems that can protect fragile building contents from severe horizontal and vertical motions. The resulting systems will incorporate specialized components for vertical isolation and multiple isolation layers. In developing these systems and assessing their promise for earthquake hazard mitigation, this research will lead to a better understanding of the true three-dimensional aspect of earthquake ground motions and their impact on fragile objects and structures. Ultimately, the proper design and implementation of rolling isolation will ensure that irreplaceable objects, critical hospital and telecommunications equipment, and digital infrastructure will remain operational during and after severe earthquakes, thereby mitigating the costs of these potentially disastrous events.

The non-holonomic constraints inherent to rolling isolation systems result in nonlinear coupling between lateral and rotational dynamics. Uniaxial and linearized models are therefore not sufficient to predict the response of these systems. The objective of this project is therefore to advance the performance and implementation of high-capacity isolation systems for equipment and components subjected to three-dimensional ground-motions. New mathematical models for the nonlinear dynamics of three-dimensional isolation systems will be derived and validated with experiments on a six degree of freedom shake table. These validated models will accelerate the design of new bowl topologies in order to maximize the effective displacement capacities of these systems. New methods of seismic hazard analysis will be developed that recognize the three-dimensional nature of ground motions and the threshold-sensitive behavior of buildings and contents.

**Contested geographies of education: Neighborhood schooling struggles in post-Katrina New Orleans.** National Science Foundation grant #1434330. [http://www.nsf.gov/awardsearch/showAward?AWD\\_ID=1434330](http://www.nsf.gov/awardsearch/showAward?AWD_ID=1434330). Two years. \$14,755 to principal investigator Helga Leitner, University of California-Los Angeles, hleitner@geog.ucla.edu.

Across the United States, cities have become testing

grounds for policies designed to promote market-based solutions to problems in public education. These initiatives commonly rely on the institution of charter schools, which are publicly funded but often privately managed and only minimally accountable to locally elected entities. This research project examines place-based challenges to charter reform through analysis of the attempts of four New Orleans neighborhood-based groups to reopen schools in their communities. With 90 percent of its public school students currently enrolled in charter schools, New Orleans has been a major testing ground market-based reform, and of the ways such reforms might be contested. By focusing on the ability of neighborhood-based groups to address schooling concerns in the public sphere, this project will enrich understanding of place-based social movements, expand the range of concerns commonly addressed in discussions of public education policy, and support ongoing efforts to create more democratic urban spaces through collective inquiry and action. Because schools serve a variety of social, political, and economic purposes, the effects of school reform reach far beyond the school house walls. As they re-work essential aspects of daily life in cities, market-based school reform efforts have provoked intense struggles over the purpose and provision of schooling and the role of community members in influencing urban education policy and practice.

The project will use multiple methods, including document analysis, participant observation, and interviews in order to examine how group members develop, understand, and pursue their schooling agendas under the post-Katrina charter school regime in New Orleans. The specific research questions include: How do neighborhood schooling groups frame their grievances with respect to the effects of neoliberal schooling policies and what counter discourses are advanced in support of neighborhood schooling? What strategies do neighborhood schooling groups use to insert those counter discourses into a larger public sphere and to what effect? How are race, class, and gender implicated in these struggles? What learning is taking place in these place-based efforts to realize particular schooling agendas and what are the democratic implications of both the processes and results of their activities? The proposed research provides: (1) an empirical analysis of the possibilities for producing schooling alternatives to neoliberal policies through collective action initiated at the neighborhood level; (2) a socio-cultural counterpoint to existing political-economic arguments regarding how and why people become involved in such movements, and the ways that place and race inform strategy and the ability to achieve desired goals; and (3) an analysis of how people learn to do democratic work, including identifying and framing common problems, constructing space for social inquiry, negotiating difference, and navigating uneven power relations.

**Enabling the next generation of hazards and disasters researchers.** National Science Foundation grant #1424075. [http://www.nsf.gov/awardsearch/showAward?AWD\\_ID=1424075](http://www.nsf.gov/awardsearch/showAward?AWD_ID=1424075). Two years. \$382,125 to principal investigator Deborah Thomas, University of Colorado Denver, [deborah.thomas@ucdenver.edu](mailto:deborah.thomas@ucdenver.edu).

Every year natural, technological, and human-induced hazards impact millions of people worldwide, resulting in thousands of deaths and billions of dollars of damage. Attracting new scholars to the fields of hazards, risk, and

disasters is vital for advancing knowledge that can lead to disaster loss reduction and overall improvement in the management of emergencies and disasters. The “Enabling the Next Generation of Hazards and Disasters Researchers” program [hereafter the Enabling Program] will support junior faculty at universities in developing research and teaching efforts that inform disaster loss reduction and improve the ways in which hazards and disasters are addressed. The aims of the Enabling Program are to: (1) foster the development of scholars with a career-long commitment to research on hazards, risk, and disasters; (2) contribute to the nation’s future research capacity and infrastructure for reducing disaster loss; and (3) add important original scientific knowledge to the areas of hazards, risk, and disasters to reduce societal vulnerability. Vulnerability and risk reduction require systematic interdisciplinary efforts for improving all phases of disaster management and to the development of resiliency on a broad scale. In addition to incorporating a wide variety of disciplines that inform the challenge of risk reduction, the Enabling Program is also committed to recruiting and mentoring women and members of underrepresented groups.

The Enabling Program is crucial to the advancement of knowledge in the interdisciplinary hazards field, which relies on scholars committed both to their own disciplines and to theoretical and applied aspects of the hazards and disasters field. This is a unique combination, and through the mentoring process, the Enabling Program encourages a distinctive type of scholarly development and builds commitment to the hazards and disasters field. As such, the program offers significant research contributions. First, it continues to help build a cohort of researchers who can understand and address the complex interactions between the social, built, and natural environment associated with hazards. The Enabling Program will build on the success of previous rounds that resulted in an impressive level of scholarly output. Additionally, by continuing a model of explicit encouragement of interdisciplinary education and training around hazards and disasters, the program will assist younger researchers in enhanced research quality and quantity, which benefits every region across the United States.

**Space-based detection of sinkhole activities in Central Florida.** National Science Foundation grant #1417126. [http://www.nsf.gov/awardsearch/showAward?AWD\\_ID=1417126](http://www.nsf.gov/awardsearch/showAward?AWD_ID=1417126). Two years. Two grants. \$90,000 to principal investigator Shimon Wdowinski, University of Miami, [shimonw@rsmas.miami.edu](mailto:shimonw@rsmas.miami.edu), and \$12,000 to principal investigator Sarah Kruse, University of South Florida, [skruse@usf.edu](mailto:skruse@usf.edu).

Over the past year two sinkhole events in central Florida attracted significant media attention. In March 2013, a sinkhole collapsed beneath a house in Seffner and “swallowed” a person from his bedroom. In August 2013, a sinkhole collapse destroyed a resort complex near Disney World.

These dramatic events, however, are just extreme examples that stand out from a steady stream of property damage, which spikes at times of anthropogenic groundwater withdrawals. Detecting incipient sinkhole activity, particularly that which may result in sudden collapse, is a challenging task. However, recent improvements in the detection and resolution capabilities of Synthetic Aperture Radar satellites enable nowadays space-base detection of small movements of the Earth’s surface at the millimeter/year

level. In this project we will use SAR observations acquired over central Florida by German and Italian SAR satellites. Interferometric processing of the data using advanced time series techniques, will provide detailed maps of surface movements and will allow us to detect localized subsiding areas that may be indicative of sinkhole activity. Verification of the space-base sinkhole detection will be conducted using Ground Penetrating Radar surveys. Successful detection of pre-collapse sinkhole activities will serve as very important tool to minimize life and property hazard in central Florida and other sinkhole-prone areas worldwide.

Sinkhole activity in central Florida is a major natural hazard, resulting in severe property damage and occasionally in life loss. We propose to use Interferometric Synthetic Aperture Radar to monitor sinkhole activities in central Florida, in order to detect subsiding sites and resolve possible precursory subsidence prior to sinkhole collapse. We will task the German satellite TerraSAR-X and the Italian satellite constellation Cosmo-SkyMed to acquire high-resolution observations (sub-meter pixel resolution) over selected areas, with repeat acquisition intervals of 10-20 days. Interferometric processing of the data using InSAR time series techniques will provide us high spatial resolution maps of surface movements with 1-2 mm/yr accuracy, which will enable us to detect localized subsidence and better understand activity that may be precursory to sinkhole collapse. We will use the space-based data to select sites for study with sub-meter scale ground-penetrating radar surveys. The purpose of this limited scale project is to provide a proof-of-concept that InSAR observations can be used to detect precursory sinkhole activity in the challenging sub-tropical vegetation-rich environment of central Florida. Successful space-based detection of sinkhole activity will lead to further utilization of InSAR observations for sinkhole hazard mitigation in central Florida and other sinkhole-prone areas worldwide.

**Pacific Rim earthquake engineering mitigation protective technologies international virtual environment.** National Science Foundation grant #1446424. [http://www.nsf.gov/awardsearch/showAward?AWD\\_ID=1446424](http://www.nsf.gov/awardsearch/showAward?AWD_ID=1446424). Two grants. Three years. \$222,711 to principal investigator Erik Johnson, University of Southern California, JohnsonE@usc.edu, and \$170,115 to principal investigator Richard Christenson, University of Connecticut, rchriste@engr.uconn.edu.

Seismic protective systems, such as base isolation, passive energy dissipation, and semi-active and active control, can be applied to new and existing buildings to provide significant reductions in building motion and damage during earthquakes. The objective of this award is to build a community of researchers from Chile, Japan, New Zealand, and the United States, through a virtual institute, to accelerate research on seismic protective systems. This institute will enable U.S. researchers to proactively learn from their foreign counterparts from Pacific Rim countries about the performance of buildings with seismic protective systems during recent major earthquakes in Chile in 2010 and in New Zealand and Japan in 2011, to ensure that seismic protective systems research is directed to better prepare for future hazards. This award will enable the U.S. seismic protective systems community to better anticipate structural damage from future large earthquakes, and avert risk to these events by conducting research now to address the challenges that will facilitate seismic protective systems implementation in

buildings.

The virtual institute will incorporate the following face-to-face and virtual activities: (a) one workshop per year, hosted sequentially in the countries of the foreign partners, to provide direct opportunities for U.S. participants to share research and data and chart future research directions with international collaborators, (b) pairings of early career U.S. faculty participants with foreign counterparts to develop case studies about the effectiveness of seismic protective systems in past earthquakes, thereby building long-term research collaborations, (c) lectures by the foreign counterparts and U.S. senior participants about research on seismic protective systems in their country, (d) an online, directed-study seismic protective systems course that will be used to teach graduate students in the United States and around the world about the state-of-the-art and the state-of-the-research in seismic protective systems, and (e) regular quarterly virtual meetings using online collaboration tools. The virtual institute will bring together researchers on 13 active NSF awards in the areas of seismic protective systems, as well as 20-30 early career participants, to form long-term global research relationships with their international collaborators, who share common research interests and are supported by their respective government research agencies.

**Virtual international institute for seismic performance assessment of structural wall systems.** National Science Foundation grant #14462423. [http://www.nsf.gov/awardsearch/showAward?AWD\\_ID=14462423](http://www.nsf.gov/awardsearch/showAward?AWD_ID=14462423). Three years. \$225,000 to principal investigator John Wallace, University of California-Los Angeles, wallacej@ucla.edu.

Structural walls, which are solid concrete walls commonly used in buildings around stairwells and elevators, are used worldwide because they are economical to construct, efficient to separate spaces, and effective in protecting buildings from strong earthquake ground shaking. Unexpected damage that occurred to structural walls in recent earthquakes, e.g., Chile in 2010 and New Zealand in 2011, as well as damage observed in recent laboratory tests in the United States and Japan, suggest that structural engineers have pushed seismic design limits for structural walls beyond a critical boundary. Despite these observations, engineers are increasingly choosing to use structural walls because, historically, structural wall buildings are less likely to collapse in earthquakes and are more likely to limit heavy damage to building contents. Given recent observations, considerable research on the seismic performance and design of structural walls has been initiated or is planned in the United States and around the world. Many of the research needs identified for structural walls require large-scale laboratory testing to validate and calibrate computational models and to develop and refine seismic design recommendations for building codes. Large-scale testing is expensive; therefore, the ability of any one country to address the breadth of issues that have been identified is limited and progress will be slow.

Given the critical research needs for structural walls and the limited resources available to individual countries, this award will facilitate international research collaborations using both in-person meetings and virtual collaboration tools by creating a virtual international institute for the seismic performance assessment of structural wall systems.



# Conferences and Training

**September 9-12, 2014**

**Learning in Disaster Health Workshop**  
National Center for Disaster Medicine and Public Health  
Fort Meyer, Virginia

Cost: Free

This workshop will focus on disaster health education and training with an emphasis on research, collaboration, and future education needs. Topics include interprofessional disaster education practices, disaster behavioral health, enhancing recovery through learning, expanding the workforce with volunteers, and learning to build resilience at the neighborhood level.

<http://bit.ly/1hs1Ekg>

**September 10-12, 2014**

**World Reconstruction Conference 2**  
Global Facility for Disaster Reduction and Recovery  
Washington, D.C.

Cost: Free

The second World Reconstruction Conference will build upon the success and outcomes of the first WRC held at Geneva in May, 2011 and will build consensus on resilient recovery as an imperative to sustainable development and poverty reduction. WRC 2 will focus on: the link between recovery and poverty; empowering communities for recovery that is inclusive and participatory; good practice for recovery in fragile and conflict situations; and, country experiences in post-disaster recovery and reconstruction.

<https://www.gfdr.org/wrc2>

**September 21-25, 2014**

**Dam Safety 2014**  
Association of State Dam Safety Officials  
San Diego, California

Cost: \$900

This conference address issues related to dam safety and technology transfer. Topics include California's water supply system, runoff prediction, rapid drawdown analyses, dam failure, inundation modeling, dam removal, the 2013 Colorado Floods, federal guidelines for dam safety risk management, dam repair and improvements, seismic performance of levees, and seepage monitoring and instrumentation.

[www.damsafety.org](http://www.damsafety.org)

**September 21-26, 2014**

**Cochrane Colloquium**  
Cochrane South Asia  
Hyderabad, India

Cost: \$1000

This colloquium will focus on the opportunities and challenges of evidence informed public health, including delivering public health globally and crafting public health policies. Topics include population health, health inequality in South Asia, capacity building, research impacts on national policy, and healthcare communication.

<https://colloquium.cochrane.org/>

**September 23, 2014**  
**Climate Summit 2014**

United Nations  
New York, New York

Cost: Free

As part of a global effort to mobilize action and ambition on climate change, United Nations Secretary-General Ban Ki-moon is inviting Heads of State and Government along with business, finance, civil society and local leaders to a Climate Summit in New York. This meeting hopes to catalyze action by governments, business, finance, industry, and civil society in areas for new commitments and substantial, scalable and replicable contributions to the summit that will help the world shift toward a low-carbon economy.

<http://www.un.org/climatechange/summit/>

**October 6-8, 2014**

**South Africa Society for Disaster Reduction Conference**  
South Africa Society for Disaster Reduction  
Windhoek, Namibia

Cost: \$370

This conference will discuss the context and drivers of risk in the Southern African Development Community Region with an emphasis on best practices and recent disaster risk research. Topics include disaster risk in the Namibian context, humanitarian relief, the future of the Hyogo Framework for Action, gender and disaster risk, and Africa's changing risk profile.

<http://www.sasdir.org/>

**October 8, 2014**

**Northeast Risk & Resilience Leadership Forum**  
RenaissanceRe Risk Sciences Foundation, Inc.  
Stamford, Connecticut

Cost: Free

The cost is free, but space is limited at this one-day forum to look at the impact of severe weather in the Northeast United States. The 10th annual forum brings together "leading experts from areas in weather sciences, risk analysis, insurance, community planning, government, urban engineering and disaster prevention to look at the northeast region in light of events like Sandy and other severe weather systems."

<http://www.mitigationleadership.com/>

**October 21-22, 2014**

**Pacific Northwest Advanced Flood Warning System Workshop**  
National Hydrologic Warning Council  
Grand Mound, Washington

Cost: See website

Flood warning systems save lives, help protect property and they can even help reduce flood insurance rates. Flood warning systems are credited with saving hundreds of lives during the devastating floods in

Colorado in September 2013. A growing number of similar systems are currently operating in the Pacific Northwest. This meeting will build on recent flood warning system successes. Day one will feature flood warning system experts at local, state, and national levels. Day two features interactive panel discussions and table top flood warning exercises.

<http://bit.ly/1pvxgKp>

**October 30-November 1, 2014**  
**5th Conference of the International Society for Integrated Disaster Risk Management**  
**Integrated Disaster Risk Management Society**  
**London, Ontario**

Cost: \$452

The conference builds on opportunities through science and technology, political will and behavior change to address current crises and reduce risks for future generations. While knowledge about the nature and context of disasters has proliferated, many potential actions for integrated disaster reduction remain far from realized. It will address opportunities for action through varied state of the art contributions from the worlds of disaster science, technology, policy and practice. It is also open to expertise less conventionally recognized within this field. It will stimulate a next generation of ideas and actions for disaster reduction.

<http://www.has.uwo.ca/cs/idrim/>

**November 5-7, 2014**  
**Conference on the Gender Dimensions of Weather and Climate Services**

**World Meteorological Organization**  
**Geneva, Switzerland**

Cost: Invitation only, see website

This conference will examine the gender nuances of climate variability and climate change adaptation and seek to develop climate and weather services that build climate resilience. Topics include food security, water management, health, and disaster risk reduction. Conference outcomes will inform the post-2015 development agenda and the Global Framework for Climate Services.

<http://www.wmo.int/genderconference/about>

**November 12-14, 2014**  
**III International conference on ENSO**  
**Instituto Nacional de Meteorología en Hidrología, International Research Centre on El Niño)**

**Guayaquil, Ecuador**

Cost: \$300

The theme of this conference is "bridging the gaps between global ENSO science and regional processes, extremes and impacts." There has been significant progress in the ability to observe, understand and predict ENSO because of the application of new theoretical approaches, significant advances on physical parameterizations of subgrid-scale processes, and a further strengthening of the technological processes. The conference will synthesize progress on ENSO research with a detailed view of the climate-society relationship, and to share experiences in vulnerability assessment methodologies used by the climate impact studies community.

<http://www.ciifen.org/>

**November 13, 2014**  
**Annual Conference on Fire-Related Research and Developments**

**The Institution of Fire Engineers**  
**Gloucester, United Kingdom**

Cost: \$300

This conference will look at fire-related research and practice from a variety of disciplinary perspectives and international viewpoints. Topics include wildfire threat analysis, optimizing communication, large industrial fires, community fire safety, firefighter resilience and family support, and addressing arson.

<http://www.ife.org.uk/Home>

**November 20-21, 2014**  
**Global Crisis Communications Conference 2014**  
**Intelectasia**

**Kuala Lumpur, Malaysia**

Cost: \$1,100

With participation of more than 750 public relations professionals, policy makers, academicians, key thought leaders in the areas of crisis communications, top management/c-suite executives from the Asia Pacific, USA, Europe and Australasia region, GC3 promotes broad global exchange of tried and tested crisis communications strategies through a case-study approach and various panel sessions. The recent MH370 incident has underscored the importance of a good crisis communications strategy whether it's for an organization or a country. Malaysia was at the centre of global attention. As the crisis was unfolding, many quarters questioned the country's capability in managing the crisis. It is important to note that now the country is taking a step forward. GC3 is indeed very timely and serves as a unique platform for us to share our experiences and to learn from others.

<http://www.gc3.intelectasia.com>

**November 28-29, 2014**  
**Reframing Disaster**  
**Arts and Humanities Research Council**

**Leeds, England**

Cost: Not posted

This year marks the 30th anniversary of Bhopal disaster in India, the 20th anniversary of the Rwandan genocide, and the 10th anniversary of the South Asian tsunami. While much attention is being paid to the centenary of World War I, we would like to counterpoint this by considering the politics of remembering, commemorating, and supporting long-term recovery in relation to a range of compound catastrophes that have deep colonial roots. Given that Bhopal, Rwanda, and the tsunami have all generated significant media interest alongside diverse forms of creative response (from art to social activism), this conference will explore how these and other postcolonial disasters have been defined and represented following the initial event. It will examine the particular challenges posed by different forms of disaster (industrial, environmental, social), and connect these with aid and reconstruction work across multiple sectors.

<http://postcolonialdisaster.com/conference/>

The *Observer* is available free online. A print subscription to the *Observer* is \$15 a year to subscribers within the United States. Back issues of the *Observer* are available for \$4.00 each, plus shipping and handling. Orders must be prepaid. Checks should be payable to the University of Colorado. Visa, MasterCard, and American Express cards are also accepted.

Subscribe to the *Observer* and the Natural Hazard Center's electronic newsletter, *DR-Disaster Research News You Can Use*, at:

<http://ibs.colorado.edu/hazards/subscribe>

**December 4-12, 2014**

**Disaster and Hazards Mapping Summit 2014  
Resource Recovery Movement**

**Manila, Philippines**

*Cost: Not posted*

The Disaster and Hazards Mapping Summit 2014 will develop better approaches to mapping risks and dangers to communities in the Philippines and other countries with tropical climates. The databasing, mapping and full coordination of efforts towards use and sharing of a full function GIS on hazards, volcanoes, water, flood, forests in the Philippines and Asia, vulnerability areas, liquefaction potential, crisis and hot spots is long due because of the long-running phenomenon of climate change in the planet. This is also significant in that the Philippines, among other countries, lies in the Pacific Rim of Fire where a large number of earthquake faults lie.

<http://summit.hazmapping.org/>

**January 14-16, 2015**

**Tokyo Conference on International Study for Disaster  
Risk Reduction and Resilience  
Science Council of Japan**

**Tokyo, Japan**

*Cost: Not posted*

We will make proposals, as a product of the conference, for establishing close coordination between sustainable development and disaster risk reduction at all aspects of policy-making, planning and programming of infrastructure and social systems, human resources mobilization, and for creation of structures and mechanisms to implement disaster risk reduction at all levels of society, and for incubating innovative science and technology that would guide us in all phases of disaster management cycle. Organizers invite world leaders and top scientists to our Tokyo conference prior to the Third UN World Conference on Disaster Risk Reduction to discuss and formulate how the science and technology could help in disaster risk reduction and hence fostering sustainable development.

[http://monsoon.t.u-tokyo.ac.jp/AWCI/TokyoISDRRR\\_](http://monsoon.t.u-tokyo.ac.jp/AWCI/TokyoISDRRR_Jan2014/index.htm)

[Jan2014/index.htm](http://monsoon.t.u-tokyo.ac.jp/AWCI/TokyoISDRRR_Jan2014/index.htm)

**March 14-18, 2015**

**3rd World Conference on Disaster Risk Reduction  
UNISDR**

**Sendai City, Japan**

*Cost: Not posted*

This conference is the major venue for international disaster risk reduction to complete the assessment and review of the implementation of the Hyogo Framework for Action and to review the experience obtained in regional and national programs. The conference will adopt a post-2015 disaster risk reduction framework.

<http://www.preventionweb.net/wcdr/>

**June 24-25, 2015**

**Critical Infrastructure Protection and Resilience Asia  
KNM Media LLP and Torch Marketing**

**Bangkok, Thailand**

*Cost: Not posted*

Southeast Asia has seen a rise in insurgency-related attacks and terrorist activities, creating uncertainty and insecurity on critical national infrastructure. Climate change has also seen more extreme weather patterns, creating additional hazardous, unseasonal and unpredictable conditions and a severe strain on infrastructure. Cyber security is also becoming more important. Critical Infrastructure Protection and Resilience Asia will bring together leading stakeholders from industry, operators, agencies and governments to collaborate on securing Asia. The conference will look at developing existing national or international legal and technical frameworks, integrating good risk management, strategic planning and implementation.

<http://cip-asia.com/>



Natural Hazards Center  
Institute of Behavioral Science  
University of Colorado at Boulder  
483 UCB  
Boulder, Colorado 80309-0483  
Change Service Requested

Non-Profit Org.  
U.S. Postage  
PAID  
Boulder, CO 80309  
Permit No. 156

Printed on recycled paper

## Support the Natural Hazards Center

**T**HE SUCCESS OF THE NATURAL HAZARDS CENTER relies on the ongoing support and engagement of the entire hazards and disasters community. The Center welcomes and greatly appreciates all financial contributions. There are several ways you can help:

**Support Center Operations**—Provide support for core Center activities such as the *DR* e-newsletter, Annual Workshop, library, and the *Natural Hazards Observer*.

**Build the Center Endowment**—Leave a charitable legacy for future generations.

**Help the Gilbert F. White Endowed Graduate Research Fellowship in Hazards Mitigation**—Ensure that mitigation remains a central concern of academic scholarship.

**Boost the Mary Fran Myers Scholarship Fund**—Enable representatives from all sectors of the hazards community to attend the Center's Annual Workshop.

To find out more about these and other opportunities for giving, visit: [www.colorado.edu/hazards/about/contribute.html](http://www.colorado.edu/hazards/about/contribute.html)

Or call (303) 492-2149 to discuss making a gift.

---

A U.S.-based organization, the Natural Hazards Center is a nonprofit, tax-exempt corporation under Section 501(c)(3) of the Internal Revenue Code.