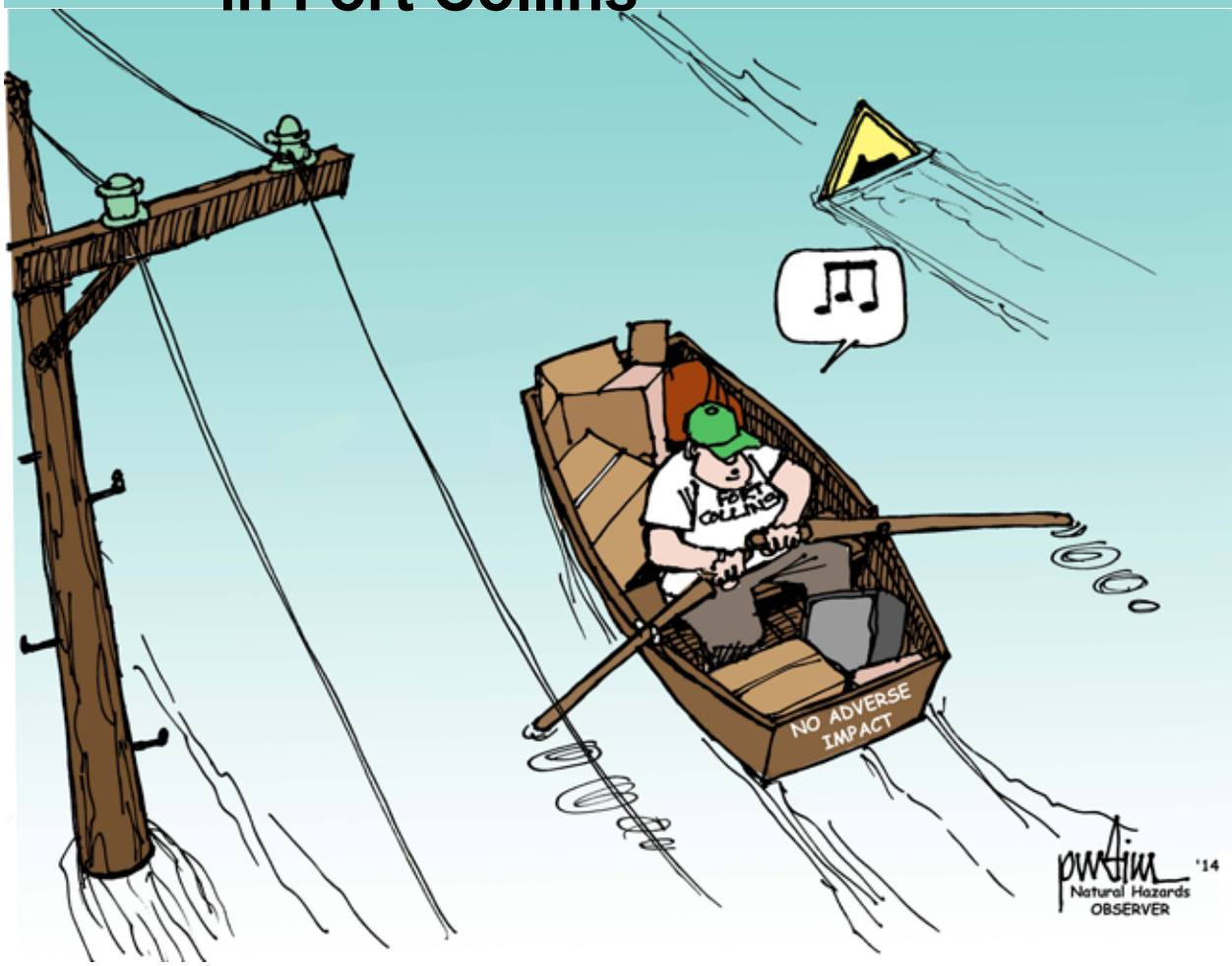
Natural Hazards Observer

Volume XXXVIII · Number 6 July 2014

No adverse impact floodplain management in Fort Collins

An invited comment by Brian Varrella and Terri Turner



The Rocky Mountains of Colorado have a long and often dramatic history of flooding. Many of the population centers in the state are located at the eastern foot of this monolithic chain of snowcapped peaks, lush green valleys, and deep canyons.

These areas are commonly known as the Front Range, where annual precipitation is around 15 inches per year and residents enjoy 300 days of sunshine annually.

The Front Range is also known to be one of the most hazardous areas of the country for short-duration, high-intensity storms that generate flash floods and concentrated rainfall flood events. In Fort Collins, a town of about 150,000 people on the Cache la Poudre River, the dramatic and unpredictable nature of Front Range weather would be rediscovered on September 12, 2013.

Fort Collins is often rated as one of the best cities in the United States to raise a family, to retire, and to live and work.

The history of the town begins with a flood. Established in 1864 as a military outpost on the banks of the Poudre River, the original encampment was destroyed the same year when the river flooded. The outpost was moved to higher adjacent ground that became the Old Town area of Fort Collins of today. The Poudre River is now respected as the city's greatest environmental asset. The community has worked diligently

(Please see "No adverse impact," page four)

INSIDE ...

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. Mileti.....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 **July 31, 2014**.

News and Notes

Our time around the Natural Hazards Center for the last couple of months has focused on preparing for our annual Natural Hazards Workshop, which is just beginning as this issue of the *Observer* went to press. The Workshop is, as usual, a diverse event. Many topics are covered by many people with many points of view. There were 355 people registered this year, from at least 12 countries.

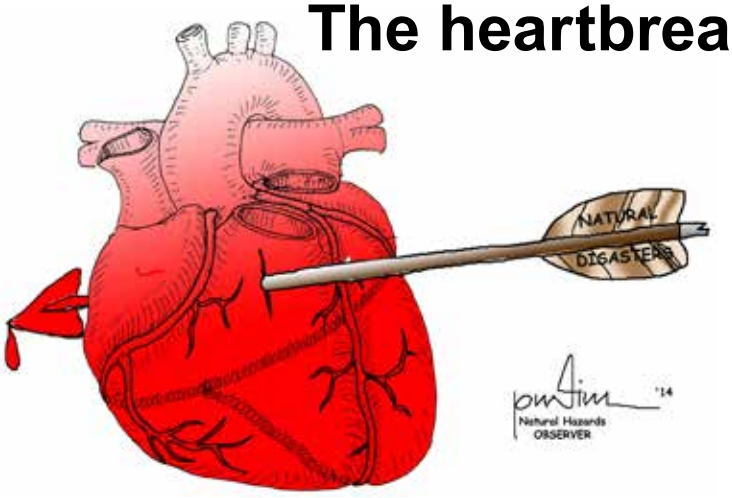
Among all this diversity, it is hard to pick out a single theme. But because of our location and our own experience, it's hard not to focus on the floods that hit Colorado's Front Range communities in September of 2013.

Most of us here at the Hazards Center had a personal experience in this disaster, to a greater or lesser extent. So while it may not have been 2013's biggest disaster globally, it looms large in our vision. Several sessions are addressing the lessons learned—and yet to be learned—from the flood.

In his opening keynote address, Dennis Mileti told the audience how Boulder's warning system was in place because of the tenacious efforts of Natural Hazards Center founder Gilbert White, who regularly attended Boulder City Council meetings to drive home the point that preparations needed to be made for the inevitable flood that would hit the city.

As Mileti noted, the Workshop is a place where people can communicate about what they know, and what they need to know. This knowledge transfer is both a personal and professional interest to us this year as we share at the Workshop.

The heartbreak of disasters—literally



Missouri and Vermont show spikes of disease after disasters

Major disasters in two states caused dramatic spikes in cases of Takotsubo cardiomyopathy—also called broken heart syndrome.

Takotsubo cardiomyopathy "is a disorder characterized by a temporary enlargement and weakening of the heart muscle, which is often triggered by extreme physical or emotional stress – for example, being in a car accident or losing a child or spouse. Previous international studies have also linked broken heart syndrome to natural disasters, including the 2004 earthquake in Japan. This is the first U.S. study to examine the geographic distribution of the condition in relation to such catastrophes," according to a release from the American College of Cardiology.

Researchers from the University of Arkansas identified 21,748 people with broken heart syndrome in 2011. They mapped the cases state by state, finding that Vermont and Missouri had the highest rates of cases. Vermont had 380 cases per million residents, and Missouri 169 per million. Most states had fewer than 150 cases per million residents.

The rate in Vermont was nearly double that of most other states in the same year—2011—in which it was hit by Tropical Storm Irene, which caused the most damage since the Great Flood of 1927.

Missouri experience the Joplin tornado the same year, which killed 158 people.

"Despite the seemingly increasing number of natural disasters we have, there is limited data about how it might affect the heart," said Sadip Pant of the University of Arkansas, and lead investigator of the study. "Our findings suggest two disasters, one in Vermont and one in Missouri, might have been possible triggers for the clustering of Takotsubo cardiomyopathy cases in these regions."

Patients with broken heart syndrome often complain of chest pain and shortness of breath, symptoms that mimic those of a heart attack, which can delay diagnosis. In addition, biomarkers in the blood and changes on electrocardiogram can raise suspicions of possible heart attack. While broken heart syndrome typically resolves within a month or two, in the acute scenario it can result in serious complications such as heart failure, life-threatening arrhythmias, and stroke. Previous studies found that as many as one in four patients with broken heart syndrome have some form of arrhythmia and 1 to 7 percent suffer cardiac arrest. Many patients are diagnosed when doctors see there are no blockages in the artery, or imaging reveals changes in the shape of the heart that are characteristic of broken heart syndrome.

Takotsubo cardiomyopathy got its name because the abnormal shape of the heart resembles a Japanese octopus fishing pot (tako=octopus, tsubo=pot).

Wildfires heat up

Wildfire in the western United States have become later and more frequent since 1984—"a trend that could continue as climate change causes temperatures to rise and drought to become more severe in the coming decades," according to research from the American Geophysical Union.

At the same time, people in the country have greater dread of earthquakes and landslides, even though the danger form fires is much greater, says Maura Knutson and Ross Corotis of the University of Colorado Boulder.

West of the 100th meridian—roughly from Nebraska to California—the number of fires 1,000 acres in size or greater has increased by an average rate of seven a year between 1984 and 2011, according to research by the University of Utah's Philip Dennison. The total area these fires burned increased by 90,000 acres annually.

"Twenty eight years is a pretty short period of record, and yet we are seeing statistically significant trends in different wildfire variables—it is striking," said Max Moritz, a fire specialist at the University of California-Berkeley Cooperative Extension. Moritz and Dennison were two authors of the paper, which appeared in April's *Geophysical Research Letters*.

A research ecologist not connected to the study, Jeremy Littell of the U.S. Geological Survey in Anchorage, AK, said the trends in fire activity reported in the paper resemble what would be expected from rising temperatures caused by climate change. Other factors, including invasion of non-native species and past fire management practices, are also likely contributing to the observed changes in fire activity, according to the study.

Corotis and Knutson, writing in the *International Journal of Risk Assessment and Management*, Suggest a new paradigm for risk assessment so that natural disaster mitigation plans reflect actual risk. "The higher the perceived risk of a natural disaster, the more people want to see that risk reduced and that means seeing their tax dollars spent on mitigation and preparation," according to a release on the study. "For

(Continued on page five)

No adverse impact ...

(Continued from page one)

since 1980 to apply the principles of "no adverse impact floodplain management" to manage the human interface with this hazardous, yet beautiful area.

No adverse impact floodplain management is a managing principle that assures that the actions of one property owner are not allowed to impose adverse flood impacts on other property owners. The adverse impacts can be measured in terms of increased flood peaks, increased flood stages, higher flood velocities, increased erosion and sedimentation, or other adverse impacts the community considers important. The NAI approach not only results in reduced flood damages. Its true strength is seen when proposed development actions that would affect local flooding, or the property rights of others, are permitted only in accordance with a local plan that identifies the negative impacts the community wishes to avoid or mitigate.

Because it is a locally driven initiative, an NAI-based plan promotes local accountability for the land use decision-making process and is supported when the community adopts innovative approaches it considers appropriate for its unique flood-risk situation.

The Fort Collins flood event that started on September 12, 2013, did not dissipate to what would be considered safe levels until four days after it started. The peak discharge along the Poudre River corridor rose to the 2 percent annual chance threshold early the morning of September 13—only 24 hours into the event. All bridges over the river were closed to traffic, schools were closed, a neighborhood was evacuated, and the river was monitored around the clock from the Fort Collins Emergency Operations Center.

Fort Collins is proud to have endured a nearly 50-year storm event with no casualties, no injuries, and only $1 million in damages community-wide. Statewide, damages from Colorado 2013 regional flooding are currently estimated between $1.5 billion to $2 billion. For most Fort Collins residents and businesses however, life returned to normal within a week. Much of the success was attributed to implementation of no adverse impact principles and practices long before this flood event ever happened.

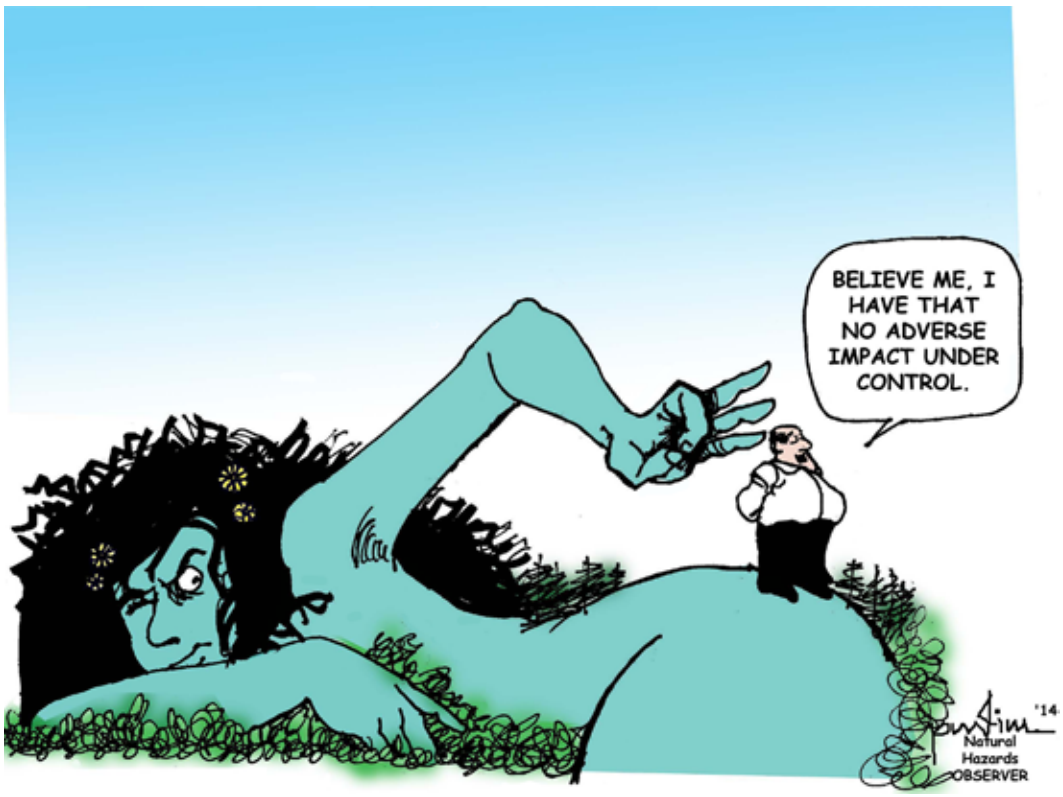
Prior planning

Community resilience against this regional flood disaster of September 2013 was realized through a combination of prior planning activities. The Fort Collins Stormwater Utility utilizes a willing-buyer, willing-seller program that works in conjunction with open space preservation and purchasing of natural areas. The program has purchased two-thirds of the total Special Flood Hazard Area along the Poudre River corridor to reserve 979 acres of floodplain for critical floodwater storage and to preserve the natural and beneficial functions of the river's floodplain. The Stormwater Utility also maintains a two-foot freeboard standard (additional elevation above base flood elevation) for new construction and prohibits new residential construction, floatable and hazardous material storage, and critical facilities construction or expansion in the Poudre River SFHA.

The flood warning system in Fort Collins is the most dense network in Colorado. The flood warning engineer at the Stormwater Utility maintains an updated on-call procedures manual and leads staff in use and practice of the flood warning system during non-flooding periods. New to Fort Collins this year was a strategic social media communication plan that was practiced over the summer of 2013, optimized, then utilized just in time for the September 2013 flood event. The guidelines, practice, and implementation of social media were crucial to sharing accurate and timely information to help public and private individuals make wise decisions in the face of this imminent natural hazard.

No system of planning, mitigation, or flood warning is perfect, and the Fort Collins flood of 2013 provided insight to gaps in the Stormwater Utility flood response and recovery plans. Emergency managers and floodplain managers in Fort Collins learned that the flood warning gauges in their largest river were susceptible to severe damage. So severe, in fact, that some key installations were inactive after the first day or two of the flood event. New locations for data collection were exposed when necessary data was not available during the flood event, leading to the conclusion that a few new strategic gauges were necessary for this next season.

All of the mitigation efforts in recent years have produced a situation in which the present-tense natural response of the Poudre River to severe flooding was outstanding. The river has excellent capacity to safely convey stormwater runoff up to a 2 percent annual chance event—the "fifty-year flood"—



The Fort Collins flood event that started on September 12, 2013, did not dissipate to what would be considered safe levels until four days after it started. The peak discharge along the Poudre River corridor rose to the 2 percent annual chance threshold early the morning of September 13—only 24 hours into the event.

indicating that resources must now be allocated to flash flooding in the 10 other local watersheds in Fort Collins. These basins, subject to short-duration, rapid-response flash flooding would not provide floodplain and emergency managers with hours of lead time, but rather minutes, to respond to a public safety emergency caused by rising water.

Lessons learned

The major lesson the Colorado communities learned from September 2013 flooding is that static flood hazards do not accurately convey flood risks in steep gradient watersheds in the Western United States. Rivers along the urban corridor and adjacent foothills of the Colorado Rocky Mountains experienced severe debris loading, mudslides, lateral migration, aggradation and degradation. Rivers everywhere across the United States are dynamic systems that move up-and-down and side-to-side. In steep areas along Colorado's eastern slope, these movements are rapid and severe.

The standard flood insurance rate map will not show the dynamic hazards visible in the 1,500 square mile area affected by Colorado's 2013 flooding. Erosion hazard zones, or buffer areas, similar to those adopted by Vermont after Hurricane Irene, would more accurately inform the public, local government, and state and regional authorities on the actual risk in rivers and streams in Colorado (and probably elsewhere in the United States). These dynamic hazard areas would allow critical infrastructure to be planned and installed with future resilience in mind, and would allow home and business owners to be able to adequately insure and mitigate their risk against the next flood event.

At the time of writing of this article—mid-March, 2014—the South Platte River watershed, wholly impacted by September 2013 flooding, was experiencing a higher than average snowpack of 145 percent of normal levels. High groundwater and antecedent moisture beneath the snowpack indicate spring runoff could be higher than average. The Colorado Office of Emergency Management is already gathering local entities together to develop emergency management protocols and strategies for anticipated spring flooding.

These proactive efforts may help downstream communities prepare for back-to-back flood events that could potentially occur only 7 or 8 months apart. Fort Collins is ready for what Mother Nature might throw at her both now and in the future. Fort Collins has also learned a very important lesson in analyzing their outcomes from the September 2013 flood event. In fact it is a lesson that could be replicated in communities all across the United States. The lesson is this: For flood-prone communities, like Fort Collins, an ounce of "no adverse impact" mitigation measures may be worth a pound of disaster prevention.

Brian Varrella is the floodplain administrator for Fort Collins, Colorado and the current chair of the Colorado Association of Stormwater and Floodplain Managers. He also serves as Region 8 director for the Association of State Floodplain Managers. Terri Turner is the floodplain manager and hazard mitigation specialist for Augusta, Georgia. She also sits on the board of directors for the Association of State Floodplain Managers.

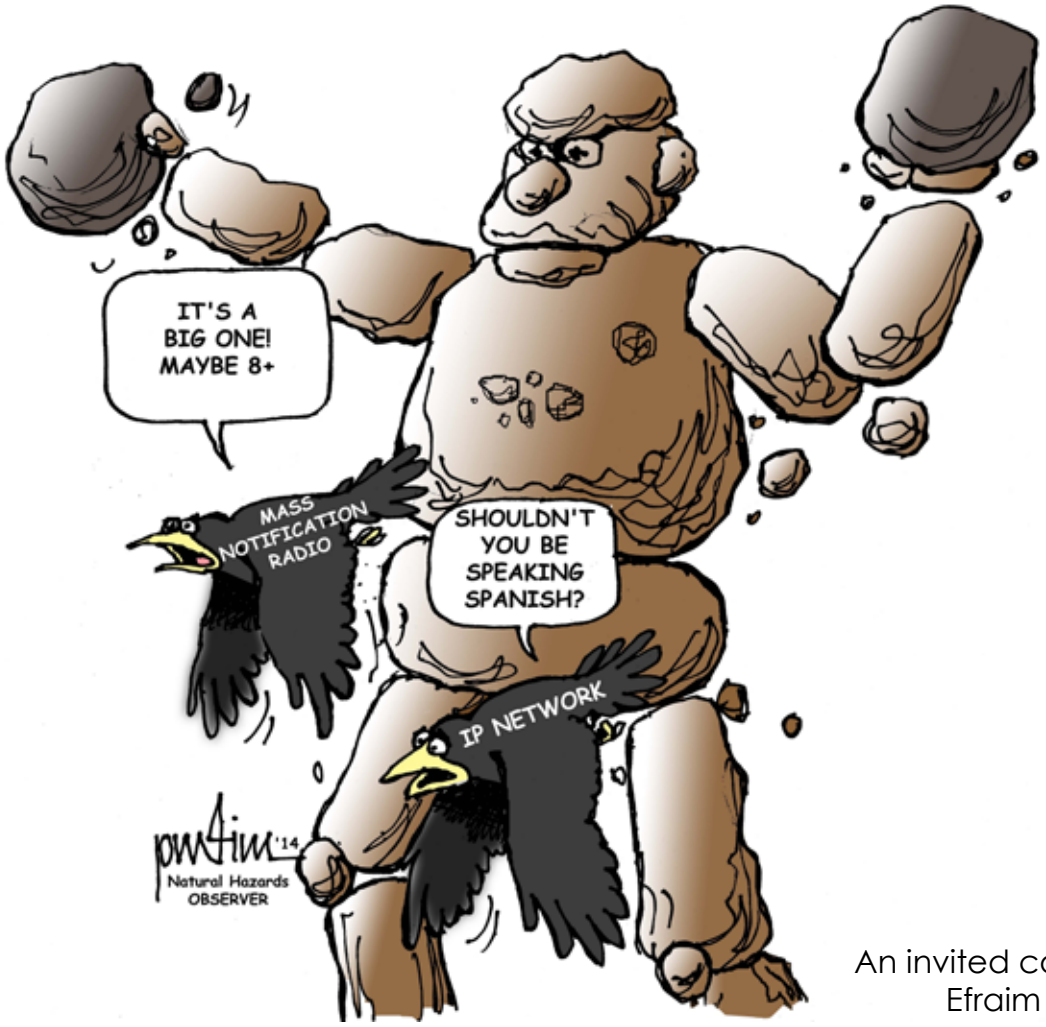
(Continued from page three)

example, far more money is spent on reducing earthquake risk than on reducing the risk from wildfires, perhaps because the perceived risk is much greater, even though both will cause significant losses of life and property. The team's new framework for risk assessment will act as an aid in decision making for these types of situations as well as perhaps even offering a way to give members of the public a clearer understanding of actual risk rather than perceived risk."

Forest fires have also increased melting of Greenland's ice sheet, according to another recent study published in the *Proceedings of the National Academy of Sciences*. Ash from Northern Hemisphere fires has lowered the albedo—the surface's ability to reflect sunlight—causing widespread surface melting in Greenland. In July 2012, 97 percent of the ice sheet experienced surface melt.

"The widespread melting of the Greenland ice sheet required the combination of both of these effects -- lowered snow albedo from ash and unusually warm temperatures -- to push the ice sheet over the threshold," says Kaitlin Keegan, the study's lead author and a Dartmouth doctoral student. "With both the frequency of forest fires and warmer temperatures predicted to increase with climate change, widespread melt events are likely to happen much more frequently in the future."

The presence of a high concentration of ammonium concurrent with the black carbon indicates the ash's source was large boreal forest fires during the summer in Siberia and North America in June and July 2012. Air masses from these two areas arrived at the Greenland ice sheet's summit just before the widespread melt event.



An invited comment by
Efraim Petel

When it comes to earthquakes ...

Where Mexico goes, the United States should follow

On Friday, April 18, 2014, Mexico experienced a 7.2 magnitude earthquake lasting about 30 seconds, originating in the Guerrero state. Millions felt it, but not a single life was lost.

That was not a fluke occurrence or blind luck. Mexican government officials have been working diligently since 1985 to develop an earthquake detection and warning system to better protect the population.

As calls for better earthquake preparedness in the United States increase, some officials are looking to Mexico as an example of what can be done.

In September 1985, Mexico endured an Mw 8.1 earthquake that killed more than 10,000 people and created major damage to the greater Mexico City area—upwards of $4 billion. In response, the Mexican government undertook efforts to develop a warning system for the general population. At first, expectations were minimal, merely hoping for messages disseminated via AM/FM radio stations throughout the Mexico City region.

By 1993, the effort had grown to encompass the outlying states. A joint venture between the Mexican government and local broadcasters was established, developing the basis for a model that emphasized warning as much as the detection of earthquakes. Furthermore, the government took into account tsunamis that also might develop as a result of earthquakes, emphasizing the need for some type of coordinated warning system.

"It was very important to involve the general public and to make them aware of the dual phenomenon," said Juan Espinosa, director of Mexico's Center for Seismic Registry and Instruments. "Success for us was not measured in just detection. What was more important was giving people some kind of warning and getting information to them quickly and in a way that was integrated in their everyday lives. But we had to have the willing participation of the general public. If we raised awareness, we felt that we also increased preparedness."

The Mexican government—under the direction of Espinosa and his team—began to develop a system that would: detect an earthquake; calculate its strength and when and where it started; identify which locations could be affected; estimate

how much time the locations had before the P-wave (primary wave) hit; and provide warning to the general public at each location before they felt the impact.

In 2007 the technology became available for Mexico to have a system in which sensors could be integrated with a network that would instantaneously compute the locations of endangered areas and enable two-way communication between government agencies, emergency response personnel and the public. At the time, the alerts still did not reach all of the endangered population. Espinosa and his team reached out to my team and I at AtHoc. We had developed a mass notification solution in the form of software combined with small radios to receive signals via a network resulting in broadcast sirens and automated messages that would give recipients warning to take cover in advance of an earthquake. A particular emphasis was placed on children and their safety and the first mass deployment of the warning device was the Mexico City schools. The mayor deployed the first radio in the school that was most affected by the 1985 earthquake.

Public participation

By 2010, the effort had expanded to the outlying states. In particular, the state of Chiapas—located in the southeast region of Mexico bordering the Pacific Ocean—is ground zero for many earthquakes that strike Mexico. It has experienced more than 250 earthquakes in 2013 and 2014 alone. In 2010, Chiapas decided to establish annual training exercises involving the general population. During the drill in March 2012, an earthquake struck the Guerrero and Oaxaca states and was felt in Chiapas right in the middle of the exercise.

Mexico's earthquake preparations have grown to the point where this year, when the states of Guerrero and Chiapas conducted their training the week of March 17th, the exercises involved the participation of more than half a million people in Guerrero and more than four million people in Chiapas.

In order for a warning system to be effective, participation of the general public is critical. Businesses, schools, government agencies and individuals must be willing to pay attention and be a part of the drills. Mexico is an excellent example of federal and state agencies working together to improve their earthquake detection and warning system, year in and year out.

Once again, Mexico showed impeccable timing for its earthquake warning drills, given the Mw 7.2 earthquake on April 19th. It hit a month after their exercises in Guerrero and Chiapas. The fact that Mexico City had 74 seconds warning and zero casualties validated the decision to build up its earthquake detection system and combine it with a public warning system.

Mexico has taken into account the fact that not every earthquake warrants the activation of the mass notification system in every town (or at all). Mexico's warning system is calibrated to the strength of the earthquake as measured by the initial sensors so that only government agencies and emergency services are alerted to earthquakes Mw 5.0 or above on the Richter scale. Earthquakes larger than Mw 6.0 activate the mass notification system that alerts the general public and only to those areas that need the warning.

"The SASMEX (Mexican System for Seismic Alerts) function operated in accordance with all of its technological specifications for the April 19th earthquake," said Espinosa. "The strength and range of the earthquake was forecast by the two nearest sensors which initiated the early warning that was propagated by 66 subsequent field stations and issued warnings to vulnerable cities and excluding cities that were not going to be affected. Throughout the process, the warning range was automatically continuously adjusted regarding the distance between the epicenter and the cities to be warned."

Espinosa added that tens of thousands of alerting receivers were in place throughout principal cities within range of the earthquake. "It was also a successful operation of the AM, FM and TV broadcast signals automatically being controlled by the SASMEX warning system in the cities within the earthquake zone."

Anecdotally, evidence of the effectiveness of the system was seen on live TV when a news anchor in Mexico City received word of the imminent earthquake and calmly said he had received warning of an impending shake and needed to take precautions, even though he had yet to feel the earthquake. Contrast that with video of television news anchors in Los Angeles reacting in a panic when an earthquake hit on March 17 because they had no warning whatsoever.

It begs the question as to why a system in Mexico has not been replicated in the United States. It is not a question of whether or not a unified system of detection and warning is feasible in the United States. The technology is there. Given the advanced communications networks in the United States, there is no reason why an even more robust system of combined detection and warnings should not be available. The existence of next-generation IP-enabled mass notification systems can leverage mobile devices for text and push notifications in much the same manner as what is already used in some parts of the country for inclement weather. LED billboards and roadside signs can also be utilized in the same manner as is used for Amber Alerts.

From a technology perspective, there is no reason why all of these tools cannot be used to provide warning about an earthquake. Mexico has proven successfully that a mass notification system can indeed be combined with an earthquake detection system to provide warning of a minute or more to locations that are hundreds of miles away from the epicenter. Lately, with the seismic expertise developed by scientists with the Cooperative Institute for Research in Environmental Sciences (CIRES), the system is expanding to warn for events happening very close to an affected area—similar to what California and other parts of the United States need.

A news anchor in Mexico City received word of the imminent earthquake and calmly said he had received warning of an impending shake and needed to take precautions, even though he had yet to feel the earthquake. Contrast that with video of television news anchors in Los Angeles reacting in a panic when an earthquake hit on March 17 because they had no warning whatsoever.

More than 100 detection devices

Mexico is a model for the United States to follow with regards to earthquake response. There are more than 100 detection devices along the Mexican Pacific coast that are tested repeatedly. The nearest warning station closest to a Mw 6.8 earthquake off California's northern coast on March 9 was out of order when the earthquake hit.

Ongoing costs for such a system are an issue, as is agency jurisdiction and federal versus state oversight in terms of who would be in charge for developing a combined detection and notification system in the United States. But technology is not an issue. The technology is there to save lives.

For Mexico, the next step is to expand the current system built for earthquakes and grow it into an all-hazards system. In September of 2013, a broad swath of Mexico was hit by three storm systems at the same time. Two hundred people died as a result of the flooding. Mexico's vision for "what's next" also includes examining processes to use text and push notifications to mobile devices and a more expanded use of mass notification tools.

Espinosa said Mexico would also like to expand and make better use of the nearly 100,000 mass notification radios in place throughout the country of Mexico. The devices already include enhancements to accommodate 80 other hazardous scenarios, natural and human-casued. "The improved NOAA [National Oceanic and Atmospheric Administration] Public Alert receivers are useful to communicate other types of alerts without additional investment so that national civil protection authorities can coordinate hazard information to communicate it to the population at risk," he said.

Mexico is using technology developed and available in the United States to expand its vision of a national all-hazards detection and notification system. To do what Mexico has done requires a commitment of resources and time in 10 to 20 year segments where the system is improved incrementally as technology has become available.

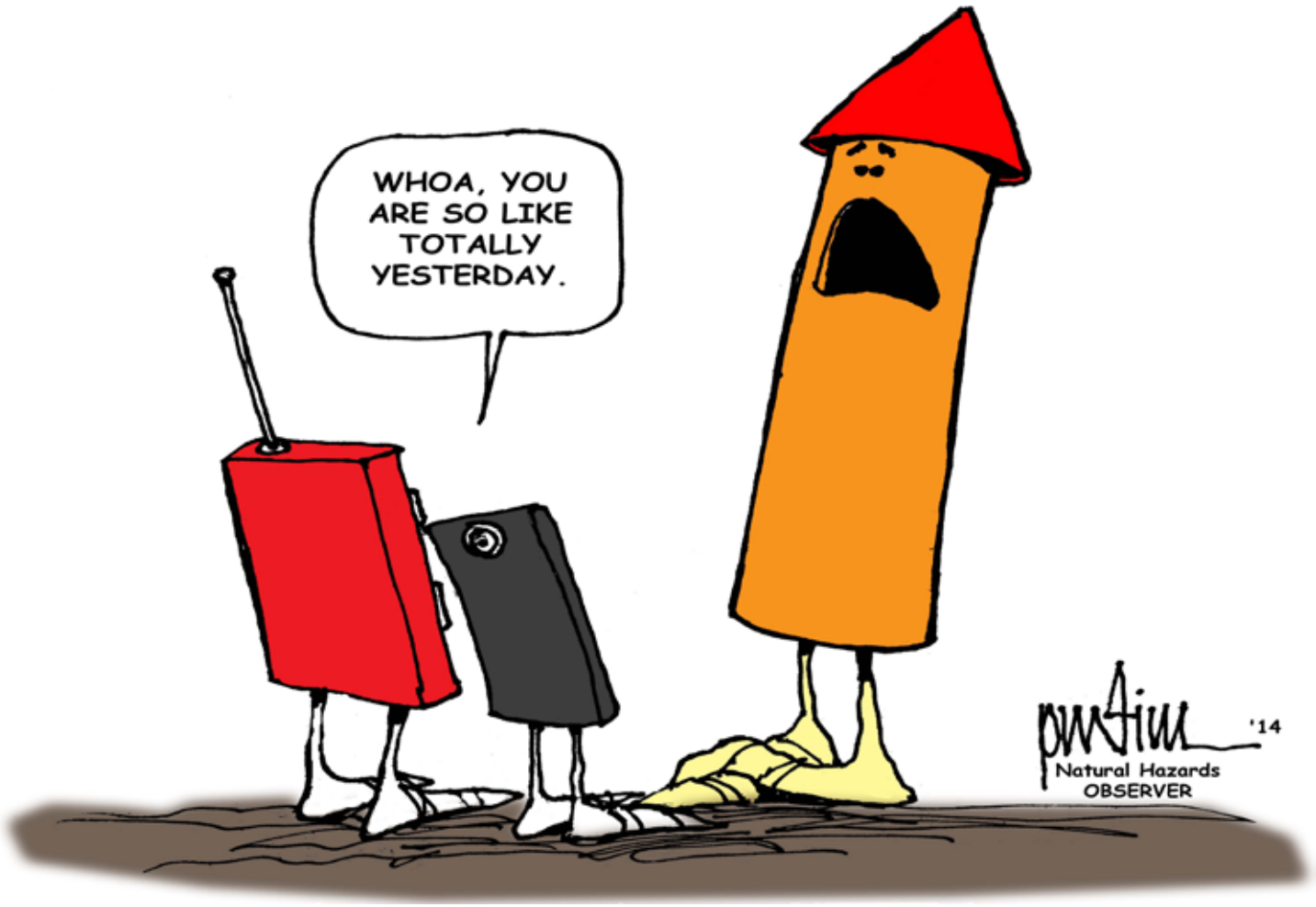
For the United States, the ramifications of combining detection and mass notification systems go far beyond just earthquakes. It extends to tornadoes, wildfires, hurricanes, blizzards, and any number of other potential disasters.

Current mass notification systems, as they operate in the United States, can leverage existing IP networks and have the ability to reach entire populations or targeted groups or key personnel. In an instant, bi-directional communication can be established that can allow for feedback from personnel receiving alerts who can communicate emergency information quickly and immediately to all connected devices.

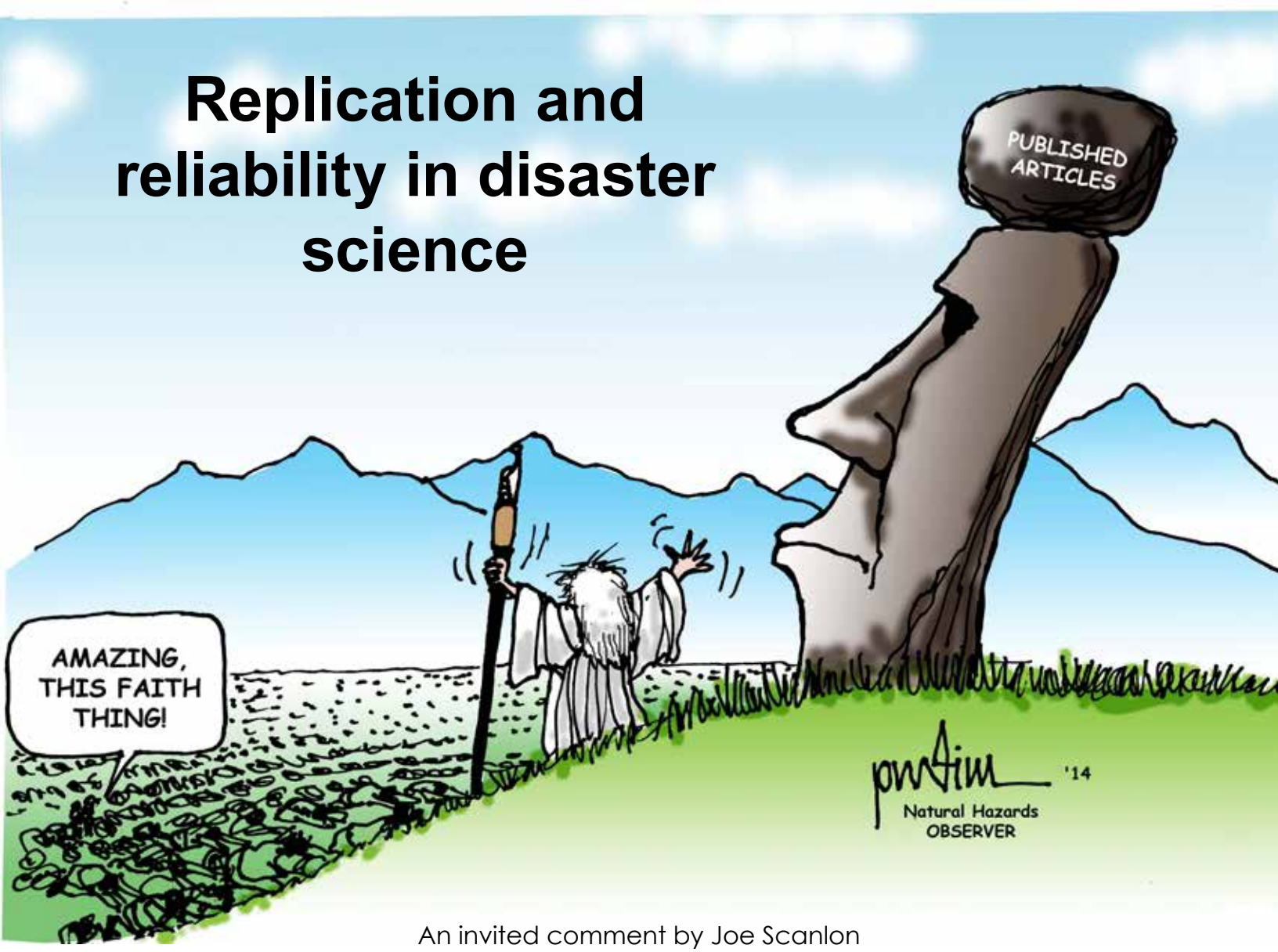
Traditional means such as flashing lights, alarms, and phone calls are still used, but additional methods can be utilized such as texts, push notifications, pop-up alerts on desktops and laptops, along with the exchange of rich data such as images, videos and maps on mobile devices. These features combine to create an effective and interactive mass notification system.

No system is perfect. All of this may not prevent damage or loss of life, but it can mitigate disastrous circumstances and give people at least the chance to survive, if they have enough warning. Ask the people in Mexico.

Efraim Petel is vice president, Global Safety, at AtHoc, Inc.



Replication and reliability in disaster science



An invited comment by Joe Scanlon

In October, 2013, the *Economist* carried the front-page headline "How Science Goes Wrong." Inside was an article describing in detail how many articles published in scholarly journals had proved to be inaccurate and misleading in that they overstated conclusions.

The *Economist* blamed this on a number of things: faulty statistics; sloppy or careless reviewing; too much attention to so-called new findings and too little to experiments that failed; and finally—most important—the absence of replication.

The article was blunt, "Too many of the findings that fill the academic ether are the result of shoddy experiments or poor analysis."

Yet these findings usually remain "significant" because proposals to replicate research are usually turned down.

The article does not mention journals in the disaster field. But the issues it raises need to be addressed. Disaster researchers should be among those who address them.

Thanks to Henry Quarantelli, some progress has already been made. He took a second and third look at his own early writings about looting and modified his views, reporting his findings in an article in the *Natural Hazards Observer* in 2007 (Quarantelli 2007).

Convergence was another topic that needed verification. Fritz and Mathewson argued that untoward incidents generate three kinds of unnecessary response – too many messages, too many people and too much material. They labeled this "convergence," arguing that a media blackout would reduce the amount of unwanted activity. Quarantelli encouraged me to take a look at their seminal paper and that led to the Hazards Center publishing Convergence Revisited, though the research had not been done under the Hazard Center's auspices (Scanlon 1992).

That study was published in 1992. Since then, it has struck me that in the wake of disasters, information, people and material flows not only toward the scene but away from it. There are those who are leaving perhaps of their own volition, perhaps because they have ordered to do so. Those who arrive may do so for related, similar reasons. After Cyclone Tracy struck Darwin, Australia in 1974, for example, two-thirds of the population was evacuated, largely by air. But even as people were leaving, there was a major response by ships of the Royal Australian Navy, bringing many people. After the 1917 Halifax explosion, the injured were removed by trains that came in first from nearby communities then from places further away such as Boston. These trains brought in material and scores of responders, including journalists.

After Hurricane Katrina, many people were leaving but others were arriving to provide assistance. Convergence occurs—but there is also divergence, a two-way flow.

Research is needed to confirm or expand the findings on other trends as well. For one thing we don't know if some of the current widely accepted findings are correct only for a certain time period.

For example when we started doing mass death research, we reviewed the publications by Marvin Hershiser, Sue Blanshan and Quarantelli and by Vanderlyn Pine. Our research found that these studies accurately portrayed the situation as it was when they did the research. But mass death had been handled quite differently prior to the time they did the research. The situation changed in the wake of the Indian Ocean tsunami. For example, what was once done using visual identification and paper files is now done with fingerprints, dental records, and DNA and by high tech systems developed by firms in Denmark and France.

The findings on role abandonment were presented by Meda Miller White, Quarantelli and Russell Dynes as carved in stone. "Role Abandonment" is the idea that persons with emergency responsibilities—nurses, physicians, police, firefighters—may not stay on the job, because of family and other personal concerns. But a few current publications, including some surveys, suggest they are not applicable in pandemics. But in the 1918 pandemic influenza outbreak—so-called Spanish flu—nurses doctors and others responsible for caring for the sick remained on station. But that was wartime. Perhaps that made a difference. Some reports state that during the SARS outbreak, medical personnel refused to treat patients.

On the other hand, some findings suggest role abandonment did take place during the SARS outbreak in Toronto in 2003 and that this may happen again when here is another pandemic. Surveys forecasting behavior can be unreliable. People did not desert their patients during the 1918-19 Spanish flu. But these findings at a minimum suggest the concept of role abandonment needs to be studied.

One problem facing disaster research is that ideas often cannot be tested until an incident occurs. We may not know if role abandonment occurs in pandemics until we have another pandemic. But that doesn't prevent us from noting the research and preparing to test it empirically when the opportunities arise. Perhaps there should be greater willingness by funding agencies to identify topics that need verification so that funds will be immediately available when opportunities arise—even if they have to wait for decades.

One possible solution is to look at what was written about past events and examine documentation of those events. Often the findings are intriguing, as shown by what Russell Dynes has been writing about Voltaire and Rousseau and the Lisbon earthquake. In the March 2000 *International Journal of Mass Emergencies and Disasters*, Dynes reinterpreted the 1755 Lisbon earthquake in the social and cultural context of the time, as seen through the writings of Jean Jacques Rousseau and Voltaire. Dynes showed that Rousseau was one of the first to describe what today we might call vulnerability by arguing that if the residents of Lisbon had better constructed residences and had paid attention to warnings, the death toll would have been much less.

Another solution is, where possible, to revisit data from which earlier scholars drew their inferences. Two graduate

students at the Disaster Research Center—Alex Greer and Lauren Clay—are taking another look at the 1974 Zenia tornado, a tornado which led to some critical research on the long-term emotional impact of such events.

Even if an event has not been studied it may be worthwhile to see if some documents recorded at the time survive. After Russ Dynes asked me to research Samuel Henry Prince I got interested in the 1917 Halifax explosion, the subject of Prince's dissertation. I soon discovered a great deal of untapped material including detailed minutes of the ad hoc Halifax Relief Committee starting two and one half hours after the explosion (Scanlon 1998).

Sometimes it only takes reviewing research from a different perspective. In 1997, in an article for the Australian *Journal of Emergency Management*, I suggested that if all the existing research was reviewed from a gender perspective all of it needed to be re-evaluated (Scanlon 1997). To my knowledge—despite the increased amount of and interest in gender research—no one has systematically revisited the existing literature to see if it is as valid as most of us believe.

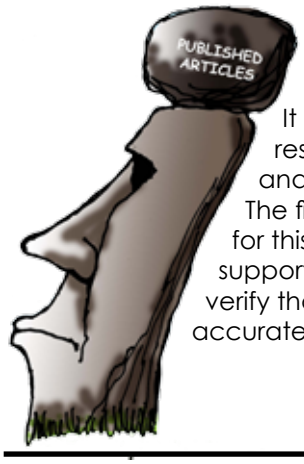
There is also the question whether the research done largely by Americans is applicable in less developed countries—or even in near neighbors like Mexico. Certainly some American scholars have seemed perplexed at some of the responses to death in after the 1985 Mexico City earthquake.

Over the years the Disaster Research Center and the Natural Hazards Center have produced articles on seemingly every conceivable subject. But those articles have rarely replicated earlier research. Se we have accepted on faith the reliability of studies on scapegoating and crowd behavior and panic and convergence and on the way organizations like the Red Cross and the Salvation Army and the military operate.

It is time that those who fund research recognize this failure and start encouraging replication. The first and most obvious reason for this is that it will—if the studies support the original findings—verify that what we teach is indeed accurate.

But there is also the possibility replication will reveal that earlier research has been done with a broad brush and that there are nuances that need to be added or that societal changes mean that what was once true is no longer true or less true. Or—and this is the basic purpose of replication—there may be a flaw in the original research

The key is to test the existing theories. Are they still valid? If not, were they once valid? If not, why were they so widely accepted?



It is time that those who fund research recognize this failure and start encouraging replication. The first and most obvious reason for this is that it will—if the studies support the original findings—verify that what we teach is indeed accurate.

An initial step might be for the Natural Hazards Center to insist that a portion of its quick response proposals must be aimed at testing existing theories.

I was fortunate enough to have enjoyed the friendship and guidance of Gilbert White and to have studied with Dynes and Quarantelli and Dennis Wenger. I have never found anything to quarrel with their research findings. But faith is not a scientific principal. We need to test their ideas with rigorous new research and we need to report both when our findings support what they have written, when new research adds to their findings and when—if this should happen—they do not.

Joseph Scanlon is professor emeritus and director of the Emergency Communications Research Unit at Carleton University in Ottawa, Canada. He has been doing disaster research for more than 40 years. He can be reached at jscanlon@connect.carleton.ca.

References

Scanlon, Joseph. 1988. Disaster's little known pioneer: Canada's Samuel Henry Prince. *International Journal of Mass Emergencies and Disasters,* Vol. 6 No. 3 pp. 213-232

Scanlon, Joseph. 1992. *Convergence Revisited: A New Perspective on a Little Studied Topic.* Boulder: The University of Colorado

Scanlon, Joseph. 1997. Human behaviour in disaster: The relevance of gender. *The Australian Journal of Emergency Management,* Vol. 11 No. 4 Summer 1996-97 pp: 2-7

Quarantelli, E. L. 2007. The myth and the realities: Keeping the looting myth in perspective. *Natural Hazards Observer,* 31(4) (2007): 2-3.

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.

ALL HAZARDS

Disasters and the Networked Economy. By J.M. Albala-Bertrand. 2013. ISBN: 978-0-415-66629-9. 196 pp. $125 (hardcover). Routledge. http://www.routledge.com/books/details/9780415666299/

There are inherent difficulties in estimating the economic impact of disasters. Albala-Bertrand is straightforward and thorough in his discussion of these issues, but he soldiers on the draw important conclusions about disasters and economies.

His essential point is that society is a "living organism" whose response to economic upheaval is complex and not easily captured. He lists three failures of quantitative economy studies. "These are," he writes, "(i) the quality of basic data. This is invariably constraining, as a good deal of expedient assumptions implicit or otherwise have to be made to make them usable; (ii) the inherent limitations of any quantitative technique, which more other than not are overcome by means of convenient assumptions to secure tractability at the expense of realism; and (iii) the paramount issue of the interpretation of results , which necessarily frames the quantitative results into some kind of existing theoretical model, normally associated with axiomatic principles, adding to the whole exercise even stinger assumptions."

The economic impact of disasters is hard to pin down. The local effects are indisputable, but whether there is an effect—either temporary or lasting—on the national economy is another matter. It's one that Albala-Bertrand explores in depth.

"Take the case of Chile," he writes, "which is a fairly transparent country. The estimation of economic losses from the 2010 earthquake was set at $30 billion, but a few months later this was challenged by academics who estimated that it actually was between one-third and half of that. The government whoever, kept its figure unchanged."

He's not optimistic about the use of quantitative economic methods to determine the negative impacts of disasters on national economies. "Setting aside the poverty of data,"he writes, "black-box methods are not strong enough to capture sudden shocks like disasters, let alone if the shock fades away soon after the impact."

Deployable Federal Assets Supporting Disaster Response Operations: Summary and Considerations for Congress. By Jared T. Brown. Congressional Research Service. 59 pages. Free. http://www.fas.org/sgp/crs/homesec/R43560.pdf.

I'm not certain that emergency management really needs another term of art for the people who respond to disasters, but this CRS report offers up "deployable federal asset." These are "specially trained federal employees who mission is to provide on-scene assistance to communities by supporting their disaster response."

These assets—which for reasons of propriety we will not call DFA's—include folks like the Federal Emergency Management Agency's incident management assistance teams, Forest Service firefighters, National Guard chemical, radiological, biological hazard responders, and many others. "Deployable federal assets can be described as the federal government's 'first responders' to a disaster," the report says.

The term, the report admits, is not one used in typical emergency management circles, but it may have some considerable use, especially insofar as it focuses some policy issue for Congress. " Congress may wish to consider several policy issues as it evaluates the future authorization and appropriations for deployable federal assets, and as it provides oversight of the assets' response capabilities. There may be theoretical benefits gained by the provision of deployable federal assets, including the pooling of disaster risk across the nation and greater efficiency in the supply of response capabilities. There may also be theoretical disadvantages, including that the provision of deployable federal assets creates a moral hazard resulting in greater disaster risk for the nation, and that federal investment may crowd out the investment of non-federal entities in similar response capabilities. Congress may also assess the various models for staffing these assets, including the benefits and costs of conditional employments, dedicated staffing versus multiuse staffing, and 'federalizing' staff into temporary federal employment for response operations.

"Congress may evaluate whether the provision of deployable federal assets should grant federal officials greater decision-making authority in the management of response operations. Finally, there are a number of challenges that may inhibit congressional oversight, such as the small sample size of incidents available to evaluate the effectiveness of deployable federal assets and the lack of specificity in many of the authorizations and appropriations for these assets."

Natural Disasters and Victorian Empire: Famines, Fevers and the Literary Cultures of South Asia. By Upamanyu Pablo Mukherjee. 2013. ISBN: 978-1-130-00112-2. 221 pp. $85 (hardcover). Palgrave MacMillan. http://bit.ly/1ioZoem

The British Empire has a lot to answer for. This includes the 18th and 19th century famines in India that claimed the lives of millions of people while the warehouses there bulged with grains for export. Mukherjee explores the philosophical and literary cultures that recorded and reflected these events.

"Famines and epidemics, the archetypal 'disaster events' of British South Asia, were at the heart of a number of conflicting material practices and ideological positions within the British elements of the empire," he writes. One

of these is the unfettered belief in the omniscience of the free market. The empire in Asia believed, "Governments should not respond with any welfarist measures to ease the distress of the famine-struck population, since this would be an unnatural interference against the natural laws of the market."

Mukherjee explores the "disaster ideology of empire" in part through the literary contributions of writers in that time and place. The great apologist Rudyard Kipling wrote stories in which "famine is often both a natural disaster and a necessary one … If famine is 'natural' here, then empire is the palliative agent that eases the spins of those who are afflicted by it."

This book takes a little-visited perspective on the history of natural disasters, literature, and the context of the intellectual approaches to the subject.

EARTHQUAKES

Early Earthquakes of the Americas. By Robert L. Kovach. 2004. ISBN: 978-1-107-41049-7. 268 pp., $85 (softcover). Cambridge University Press. http://bit.ly/1u256lf.

Sleuthing out the occurrence of prehistoric earthquakes has a practical value. It provides data about the frequency and intensity of earthquakes along known faults, improving the understanding of the risks there. So it's an area of serious, important academic pursuit. But it's also way cool. And its especially cool when piecing together the prehistoric earthquakes of the Americas which, Robert Kovach points out, are often shrouded in the myth and mystery of the early people here.

For instance, in the *Popul Vuh* manuscript of the sixteenth century Maya, "There was a man called *Vukub-Cakix (*Seven Macaws) who had two sons *Zipacná* and *Cabrakán*. *Zipacná* made the earth by shaping or piling up mountains. *Cabrakán* was the destroyer who could move mountains and the sky at will and make the earth tremble by tapping it with his feet."

And it may be that the Maya adapted their architecture so that buildings could better survive the earthquakes. Kovach says the Maya evolved a building construction known as *bajareque*—a lattice packed on the inside and outside with mud, mixed with straw to form a rein forced adobe wall. "This construction … is very earthquake resistant," he writes, "provided that the wood has not been weakened by rot or termites. The structural resistance comes from strength and flexibility achieved by tying strong wall poles to the horizontal roofing members."

All of this and more is included in this interesting volume that digs deeply into the earthquake history of the Americas over the last five hundred years or so.

HURRICANES

Hurricane Climatology: A Modern Statistical Guide Using R. By James B. Elsner and Thomas H. Jagger. 2013. ISBN: 978-0-19-982763-3. 373 pp., $99 (hardcover). Oxford University Press. http://bit.ly/1pH4ZSu

This is a book that wants to teach you about hurricanes, statistics, and the R programming language all within its modest 373 pages. I have to say that it succeeds brilliantly. It's clear, concise, and sticks to its mission with laser focus.

Hurricane Climatology is a kind of workbook that introduces its key concepts and then provides the examples and steps needed to explore them. The authors use the R programming language because its free, easily available, and broadly useful for statistical applications. "R is really a library of modern statistical tools," the authors say. "It is unmatched in its breadth and scope. A climate scientist whose research requires customized scripting extensive simulation analysis, or state-of-the-art statistical analysis will find R to be a solid foundation."

The two-page scientific description of hurricanes that begins this volume will be hard to surpass. It would be useful to have some acquaintance with fundamental statistical concepts before launching yourself into this book, but the authors actually explain everything at a fairly fundamental level. The next time you're arguing with somebody about climate change's impact on hurricanes—strength, frequency, landfall, whatever—if you've mastered this volume, you'll master the argument.

Surviving Katrina: The Experiences of Low-Income African American Women. By Jessica Warner Pardee. 2014. ISBN: 978-1-62637-044-9. 230 pp., $65 (hardcover). Lynne Rienner Publishers. www.firstforumpress.com

This book opens with a chapter on "theorizing disaster recovery and everyday poverty," but its strength is in story telling. Pardee relates the personal experiences of black women in New Orleans during Katrina in their own voices.

The women relate their tales of violence, displacement, confusion, suffering, often in their own words. Pardee interjects her analysis gently and carefully.

In Pardee's telling, Katrina illustrated truths about the nation that we all know, but usually prefer not to face, especially not in such stark terms as the hurricane offered them.

"The endemic nature of prejudice and racism in the United States was never more on display than in the days following Hurricane Katrina," she writes.

Contracts and Grants

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

Assessment of potential ecological and health impact of coal ash spill in Dan River, North Carolina. National Science Foundation grant #1440764. http://www.nsf.gov/awardsearch/showAward?AWD_ID=1440764. One year. $49,995 to principal investigator April Gu, april@coe.neu.edu, Northeastern University.

This research demonstrates the application of a new, cost-effective toxicity evaluation method for water quality monitoring. The study will encompass the Dan River, site of a recent coal ash spill. The education outreach, public education programs and strategies related to cutting edge water quality monitoring technology, as well as environmental and health implications of coal ash contamination of river water, will bridge the gap between scientific research, field implementation and public health protection.

The study will demonstrate the application of a toxicogenomics-enabled, in vitro assay scheme and methodology platform that can be an effective toxicity evaluation method for timely and informative water quality monitoring. The results will lead to a paradigm shift in water remediation efficacy assessment from methods that suffer from often biased and limited chemical information to a more reliable method that identifies realistic endpoints and better reflects the actual risks to receptors.

Using geochemical signatures to evaluate the impact of a recent coal ash spill on trace elements in water and sediments of the Dan River. National Science Foundation grants #1440099 and #1440067. http://www.nsf.gov/awardsearch/showAward?AWD_ID=1440099. One year. Two grants. $24,499 to principal investigator Louis Derry, lad9@cornell.edu, Cornell University, and $25,499 to principal investigator Madeline Schreiber, mschreib@vt.edu, Virginia Polytechnic Institute.

On February 2, 2014, the third-largest coal ash spill in the nation occurred at Eden, North Carolina, where a drainage pipe under a 27-acre Duke Energy Dan River Steam Plant waste pond collapsed, discharging coal ash and millions of gallons of contaminated water into the Dan River. The Dan River originates in Virginia and flows into North Carolina, then back north into Virginia crossing the state lines eight times. It eventually flows into the Roanoke River, and into Lake Kerr then Lake Gaston and eventually into the Albemarle Sound.

The waters serve as a heavily used recreation system and as a source of drinking water for cities from Danville, Virginia, to as far away as Virginia Beach. The toxic constituents of coal ash include various contaminants from metals such as arsenic, lead, mercury and selenium, along with a suite of organic compounds. While the element concentrations in impoundment water can exceed drinking water criteria and aquatic life water quality criteria, less is known about the fate of trace elements bound to ash in the new biogeochemical environment of the Dan River. Dissolution and changes in speciation can increase metal toxicity thus threaten wildlife and water usability for years to come.

To answer some of these questions a multidisciplinary approach is necessary. This research will provide a clearer picture to environmental agencies and water managers of the extent, transport time scales, and removal processes of coal combustion residue-derived pollutants in this river system.

This project will provide unique insight into the evolution of coal combustion residue-derived contaminants in the basin over longer time and spatial scales, and at levels that may be considered below immediate remediation targets but are still important for the overall biogeochemical function and health of the aquatic ecosystem. The development and application of novel and independent geochemical tracers for coal combustion residue input will help remove some of the ambiguity associated with data on contaminant concentrations, and identify the extent of coal combustion residue inputs even in the absence of action levels of contaminants.

While the initial focus by the state and federal agencies and other organizations has been on identifying the levels of contaminants in the coal combustion residue pond outflow and the river, there are several techniques which allow scientists to trace the response of the system in time and length scales consistent with the transport of coal combustion residue to the Kerr Reservoir. This research will provide tools to track the concentrations of major, minor and trace elements as well as the stable isotope S-34 (sulfur-34) in water and sediments in the Dan River in the post-spill period.

Because germanium (Ge) is enriched in coals and should act as a conservative tracer, we expect Ge to be anomalous and Ge/Si (silicon) ratios to be a unique fingerprint for coal combustion residue input. It is thought that the As/Ge; (chromium) Cr/Ge and other trace element/Ge ratios should be a powerful tools for identifying coal combustion residue-related anomalies in those elements. The stable isotopic analysis of S-34 in dissolved sulfate will act as a second constraint on the coal combustion residue input that can be compared to the Ge/Si and trace element/Ge ratios. This grant provides funds to continue a sampling and analysis program begun in the immediate aftermath of the spill.

The effects of Typhoon Haiyan's storm surge on coastal aquifers. National Science Foundation grant #1439410. http://www.nsf.gov/awardsearch/showAward?AWD_ID=1439410. One year. $49,581 to principal investigator Meinhard Cardenas, cardenas@jsg.utexas.edu, University of Texas at Austin.

Typhoon Haiyan made landfall in the Philippines with sustained winds of 195 miles per hour. The storm surge was several meters high and came and dissipated quickly. The inundation reached one kilometer inland in some places. Thus, there is potential for extensive seawater contamination of coastal groundwater.

Countless rural coastal villages are dependent on coastal aquifers. These villages might have to contend with the long-lasting effects of seawater contamination of groundwater. The team established a 150 meter-long transect perpendicular to shore to investigate the physical and chemical dynamics as-

sociated with infiltration of the seawater through the vadose zone and its fate in the aquifer. Using electrical resistivity tomography, they will track the saline seawater that has now sunk a little bit below the water table and appears to be following postulated groundwater flow paths towards the sea. The scientific objective is to improve our understanding of the physical and chemical processes occurring in coastal aquifers after inundation by seawater due to storm surges.

Assessment of a coal-ash spill in Dan River on water resources downstream using numerical modeling. National Science Foundation grant #1438582. http://www.nsf.gov/awardsearch/showAward?AWD_ID=1438582. One year. $49,999 to principal investigator Mustafa Altinakar, altinakar@ncche.olemiss.edu, University of Mississippi.

This work provides a unique first opportunity to study a major coal-ash spill event while it is still happening, with the added benefits of guiding data collection efforts and immediately interpreting data to gain a better understanding of the consequences of coal ash spills on river-reservoir system, and developing mitigation strategies. Although coal ash spills have occurred many times in the past with disastrous consequences for humans, water resources, and the ecosystem, this will be the first time a complete investigation based on coupled one and two-dimensional modeling of unsteady hydrodynamics, sediment transport and morphodynamics and contaminant transport and fate can be undertaken. The models established for the research will also serve for long term monitoring and development of remediation approaches.

The research team has already published one- and two-dimensional models in the lower reaches of the Dan River/Roanoke River system, downstream from the proposed research site. The results of this research can serve to bridge engineering and policy making by providing fundamental information of the hydraulic flow in the river systems.

Tag team Hurricane Haiyan wind and storm evaluations in the Philippines. National Science Foundation grant #1433262. http://www.nsf.gov/awardsearch/showAward?AWD_ID=1433262. One year. $29,902 to principal investigator Shen-en Chen, schen12@uncc.edu, University of North Carolina at Charlotte.

This project establishes an interactive web site for the data obtained by field team documenting damage from Typhoon Haiyan that made landfall in Philippines. Haiyan may have been the strongest land falling tropical cyclone in recorded history. The damage caused by wind, wave, surge, and debris are characteristics of the storm and not highly dependent on the structures. This project will permit deposition of data at one central web site and allow other designated specialists in the United States to view the data, make comments, and pursue analysis in real time. The advantage of a single web site is that the data will be preserved at one location.

Because Haiyan was probably the strongest recorded land falling storm in history, it represents one end of the envelope for design purposes. For this reason, ascertaining both the hazard and damage levels will give a good estimate of the types and quantities of damage, and failure mechanisms that might occur in the United States. We will establish a web site on a dedicated server to provide interactive connections to field investigators as well as to specialists in the United States. A protocol will be developed for data uploading and sharing. The specialists in the U.S. can provide analysis and comments on the data. The field team will document damage data on two-story residential structures, churches, airport, bridges, docks and government buildings. The damage data, comments and analysis will be transferred to a national repository when available within three years.

Characterization, modeling and uncertainty analysis of tornado wind and its effects on buildings. National Science Foundation grants #1400251 and #1400224. http://www.nsf.gov/awardsearch/showAward?AWD_ID=1400251. Three years. Two grants. $250,000 to principal investigator Partha Sarkar, ppsarkar@iastate.edu, Iowa State University, and $250,000 to Daan Liang daan.liang@ttu.edu, Texas Tech University.

The devastation from recent tornadoes in Joplin, Missouri, and Tuscaloosa, Alabama, in 2011 and in Moore, Oklahoma, in 2013 highlight the national vulnerability to these windstorms. Direct measurement of tornado wind speed near the ground level is difficult to obtain because of its unpredictable nature and destructive force. Current practice is to estimate wind speed based on observed damage to structures and non-structures using the Enhanced Fujita Scale, which is widely accepted in climatological study, risk analysis, and design of critical facilities. However, such damage-based methods have a great degree of uncertainty.

Critical knowledge gaps exist about spatial and temporal distributions of wind flow near the ground level and how wind flow interacts with the terrain and structures. To address these knowledge gaps, this research will characterize, model, and analyze uncertainties in tornado wind and its effects on buildings. This research will lead to better understanding of the effects of tornado and terrain parameters on near-ground wind field structures, the transient aerodynamic force of tornado wind on building designs, and the uncertainties in building performance subject to tornado wind. This knowledge will contribute toward the foundation for developing performance-based building code provisions to mitigate the impact of tornado wind loads on buildings.

This research aims to make the following three knowledge advances. First, knowledge for understanding the tornado wind field will be advanced through a systematic study of the effects of tornado and terrain parameters. This study will fill an important gap between a tornado's structure aloft and ground level damages and will provide the physics-based evidence critically needed for updating the EF Scale. Fragility functions will be developed to recalibrate the expected, upper bound, and lower bound wind speeds for Degree of Damage in the EF Scale.

Second, understanding of pressure and load effects of non-synoptic winds, including tornadoes and thunderstorms, will be advanced with the development of transient aerodynamic force models. These models will not only enable better characterization of load effects under a non-stationary vortex but also will build a bridge to results accumulated from decades of research in stationary boundary layer wind.

Third, a new framework for characterizing and quantifying uncertainties of the tornado wind load chain on buildings will be developed and validated with finite element models and post-storm damage surveys. This framework will permit the integration of uncertainties, including those of building properties and construction quality, in assessing building vulnerability, laying the foundation for performance-based building code provisions for tornadoes. This research is enabled by a confluence of latest advances in tornado simulation,

data acquisition and modeling capabilities, full-scale studies of the tornado vortex, near-ground measurements of tornado wind, and theories in non-stationarity, many of which were not available a few years ago.

Project Smart-Recon: Smart device-enabled reconnaissance after earthquakes. National Science Foundation grants #1362547 and #1362458. http://www.nsf.gov/awardsearch/showAward?AWD_ID=1362547. There years. Two grants. $220,876 to principal investigator Sherif El-Tawil, eltawil@umich.edu, University of Michigan, and $227,958 to principal investigator Ahmed Eltawil, aeltawil@uci.edu, University of California-Irvine.

Whenever a catastrophic event occurs, reconnaissance teams are deployed in the affected areas to conduct visual inspections of buildings. The teams tag the buildings red, yellow, or green to indicate their probable condition and permitted use. This often takes weeks. The central premise of this work is that widespread citizen ownership of smartphones and devices can be leveraged to automate and significantly accelerate this first reconnaissance effort.

This research will demonstrate how to integrate measurements performed by sensors that are typically part of most modern smart devices (e.g. accelerometers, gyroscopes, etc.) to infer information about their motion during a seismic event. By increasing the speed and accuracy with which building damage may be assessed in the aftermath of natural disasters, the proposed reconnaissance technology will reduce potential hazards and hardships to citizens and will provide enormous cost savings. Knowing this information will also enable first responders to optimize their response and physical inspection teams to prioritize their efforts, thereby minimizing confusion in the aftermath of a disaster.

To attain the project's objectives, new algorithms will be developed to permit smart devices to sense (or learn) the type of surface they are on and use that knowledge to infer information about their motion during a seismic event. Since the motion of each device may be contaminated by secondary motion, e.g. sliding on a surface, signal processing techniques will be employed to investigate how ensemble observations across multiple sensors that experience correlated motion can be used to yield highly accurate estimates of floor motion. Studies will also be conducted to explore the necessary level of accuracy required for device location within a building and device-measured parameters to ensure a meaningful assessment of seismic structural demands. The automated first reconnaissance effort will be enabled through computation of interstory drift ratios and comparing those ratios to known damage limits. It is possible to electronically tag buildings for their level of damage within minutes of a seismic event.

Time-dependent creep model of the central creeping section of the San Andreas Fault from 21 years of InSAR, GPS and repeating earthquakes. National Science Foundation grant #1357079. http://www.nsf.gov/awardsearch/showAward?AWD_ID=1357079. Two years. $100,607 to principal investigator Manoochehr Shirzaei, Arizona State University, Shirzaei@asu.edu.

This work will address the advanced analysis, full integration, and careful interpretation of space-geodetic and seismic data over the central creeping section of the San Andreas. To this end, three time series of the surface deformation, using C-Band, L-Band and X-band SAR data and spanning period 1992-2013, will be generated. The SAR images are acquired by ERS1, 2, Envisat and ALOS and Cosmo-SkyMed satellites, which will be jointly explored with a dense network of GPS data and catalogue of repeating earthquakes, through a time-dependent inverse modeling scheme. This modeling scheme allows resolving the 4-dimensional distribution of slip in the upper crust. It also enables us to conduct a systematic and detailed study of the spatial and temporal association of the aseismic slip pulses and events. This project, in particular, is focused on exploring the nature of interactions between seismic and aseismic deformation processes that occur in the fault zone and characterizing the kinematic models of creep pulses along the Central San Andreas Fault. Characteristic repeating earthquakes will provide unique information on transient activity in the Earth's crust. Fault slip is tied to the mechanical properties of the fault zone rocks and adjoining crustal blocks and the proposed activity can also evaluate the first order changes of crustal properties. The time-dependent kinematic model of transient slip will also allow investigating the possible relationships between long-term, and short-term transient behavior.

An improved understanding of the spatially and temporally varying deformation field of fault zones to great depth is critically important for understanding active tectonics, fault-fault interaction and the occurrence of large earthquakes. The results will allow us to assess the role of aseismic fault slip transients in earthquake occurrence and clustering. We anticipate long-term societal benefits from improved understanding of aseismic slip transients, their relation to regional strain anomalies, and improved models of the earthquake cycle that should improve earthquake forecasts and intermediate to longer-term predictions.

GPS observations of co- and post-seismic deformation in the Argentine Puna from the 1 April 2014, Mw 8.2, Pisagua, Chile, earthquake sequence. National Science Foundation grants #1444233 and #1443410. http://www.nsf.gov/awardsearch/showAward?AWD_ID=1444233. One year. $33,880 to principal investigator Robert Smalley, University of Memphis, rsmalley@memphis.edu and $24,807 to principal investigator Richard Allmendinger, Cornell University, RWAI1@cornell.edu.

An unusual sequence of earthquakes began in the northern Chile subduction zone on March 16, 2014 with a 10-day-long swarm of earthquakes that migrated to the north. This pattern is similar to the swarm of earthquakes that presaged the 2011 magnitude 9.0 Tohoku Japan earthquake. The Japan experience provoked concern in Chile because this megathrust zone last failed in a magnitude 8.8 earthquake in 1877. It is thought capable of producing a magnitude 9.0 earthquake again.

So far, the largest event in the sequence is the April 1, 2014 magnitude 8.2 Pisagua, Chile earthquake. The ground deformation caused by this large earthquake will persist long after the quake and decay over a period of years. Measurements of the surface deformation during and after the event can provide important information about the properties of the Earth in the region, improve understanding of deformation processes, and aid in determining regions with a high likelihood of producing large aftershocks.

Large dense GPS networks installed by U.S., German, French, Peruvian, and Chilean groups in Chile will record this deformation close to the earthquake epicenter. Significant deformation is expected farther away in northwest Argentina.

This project will install new GPS networks and collect data from existing GPS stations in the Argentine Puna Plateau to fully capture the ground motion associated with this event. These data will contribute to understanding the physics and hazard potential of large megathrust earthquakes in Chile and elsewhere, such as Cascadia, Alaska, and Japan.

The April 1, 2014 Mw 8.2 Pisagua, Chile earthquake was the largest event in an unusual sequence of earthquakes, which began in the northern Chile subduction zone on March 16, 2014. Based on the USGS preliminary teleseismic and surface wave inversion, slip occurred along a 250 kilometer along-strike and about 150 km down-dip section of the Chile megathrust that last failed in an M 8.8 earthquake in 1877. U.S., Chilean, Peruvian, German, and the French groups have built relatively dense continuously operating GPS and survey mode GPS station networks in this region, thus the near-field inter-, co- and post-seismic transient signals will be well observed in northern Chile. However, there will be significant co-seismic and post-seismic transient motion up to 700 km from the main event, incorporating nearly all of the Altiplano and at least much of eastern Cordillera in Bolivia, and the Puna of northwestern Argentina. Measuring the mid- and far-field co- and post-seismic signals in the Altiplano and beyond will be critical to any geodynamic modeling effort. In rapid response to the April 1, 2014 Mw 8.2 Pisagua, Chile earthquake, this project will install 4 new CGPS stations and retrieve data from 10 CGPS stations in the Argentine Puna Plateau. Data will be made immediately available to the international earth science community through the UNAVCO Facility Archive. These geodetic data could be important in determining regions with a high likelihood of producing large aftershocks and for hazard mitigation efforts because the largest aftershock (M 7.7 on April 3) was larger than expected, potentially indicating continued unusual activity with the neighboring segments thought to retain a large slip deficit.

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. 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.

Modeled export of ancient, thick sea ice from the Arctic, and its role in abrupt climate change. National Science Foundation grant #1417667. http://www.nsf.gov/awardsearch/showAward?AWD_ID=1417667. Three years. $595,992 to principal investigator Alan Condron. acondron@geo.umass.edu, University of Massachusetts Amherst.

This research addresses fundamental questions regarding both paleoclimate and paleocirculation of the ocean by identifying what may have triggered past abrupt climate change. In the late nineteenth century, Sir George Nares came across 15- to 18-meter thick, immobile, ice extending 480 kilometers off the northern Ellesmere coast. The characteristics of the ice were very different from the 2- to 3-m thick ice now circulating the Arctic Ocean.

Similar accounts from other arctic explorers from this time provided insight into what must surely have been a far thicker and more persistent ice cover over the Arctic Ocean during full glacial conditions than we see today. Indeed, low biological productivity and extremely low, or absent, sediment deposition in the Arctic during glacial periods suggest that parts of the central and western Arctic Ocean were covered by very thick, perennial ice.

This research will explore how such ice could have covered much of the Arctic Ocean during glacial periods, how thick it could have been, and whether its eventual mobilization and demise could have produced freshwater output to the North Atlantic large enough to weaken the deep water formation and trigger abrupt climate cooling. Using a suite of sophisticated, high-resolution, coupled numerical model experiments, this group will address these questions and highlight the connection between changes in the Arctic hydrological cycle and global climate.

Conferences and Training

July 1-2, 2014
Emergency Management Conference
Emergency Services Foundation
Melbourne, Australia
Cost: $588

The Emergency Management Conference is the annual conference presented by the Emergency Services Foundation to provide a forum for the exchange of the valuable information gained by emergency services workers in the line of duty, and in research. Along with emergency management, this year conference will cover topics of disaster risk management, including communicating and public information, responses in natural hazards,community recovery and resilience.

http://www.esf.com.au/

July 21-25, 2014
National Conference on Earthquake Engineering
Earthquake Engineering Research Institute
Anchorage, Alaska
Cost: $975

The conference will address the many aspects of earthquakes and their impact on society. Topics include the 1964 Alaska Earthquake and Tsunami, megadisasters, the Network for Earthquake Engineering Simulation, resilient communities, planning for recovery, tsunami engineering, and subduction megaquakes.

http://10ncee.org/

July 22, 2014
Disaster Preparedness Forum 2014
CSR Asia, Prudence Foundation
Manila, Philippines
Cost: $100

Rapidly increasing damages and losses from recurrent natural disasters in the Asia-Pacific region require greater collaboration for sustainable recovery. With many of the region's countries exposed to typhoons, floods, earthquakes and volcano eruptions there is a need to integrate disaster risk reduction into recovery and reconstruction efforts and build capacity for enhanced responses to future disasters. The business sector has much to contribute in helping improve the speed and effectiveness of disaster recovery and building more resilient communities, small businesses and local economies. At the same time the forum will also shed light on business opportunities offered through such engagements.

http://www.csr-asia.com/dpforum2014/index.php

August 16-21, 2014
World Weather Open Science Conference
World Meteorological Organization, International Council for Science, and others
Montreal, Canada
Cost: $550

This conference will examine societal vulnerability to extreme weather and assess breakthroughs in weather science. Topics include weather prediction, earth systems, communication, data assimilation, interactions between subsystems, weather-related hazards, hydrology, and radar observation.

http://wwosc2014.org/welcome_e.shtml

August 28-24, 2014
International Disaster and Risk Conference
Global Risk Forum Davos
Davos, Switzerland
Cost: $1085

This conference will approach risk management issues from a multidisciplinary, multisectoral perspective and present models for sustainable public-private partnerships. Topics include urban risks, country-level risk management, megacatastrophes, environmental risk, and gender and inequality.

http://idrc.info/home/

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.gfdrr.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,

Natural Hazards Observer
ISSN 0737-5425
Printed in the USA.
Published bimonthly.

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

seismic performance of levees, and seepage monitoring and instrumentation.
www.damsafety.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 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 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. Whilst 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 12-14, 2014
III International conference on ENSO
Instituto Nacional de Meteorología en Hidrología
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/

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 data basing, 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/

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

The 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

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.