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Lessons from Australia's Black Saturday

Fighting wildfires with evidence rather than opinion

An invited comment by Philip Gibbons

When a big wildfire hits a community resulting in loss of life and property you can be sure emotions will run high in the aftermath. You can also be sure a range of strongly held opinions will be expressed on what should be done in the future to prevent such disasters happening again. What you rarely see, however, is a long, hard examination of the evidence.

Do strongly argued opinions on appropriate land management fit with the available evidence on the loss of houses during wildfires? This was the question we sought to answer when we examined evidence left in the aftermath of the worst wildfire disaster in Australia's history.

The 2009 Black Saturday fires in southern Australia resulted in 173 deaths and the loss of 2,133 houses. In the aftermath there were strident calls from some quarters demanding more prescribed burning, a rethinking of the way we manage national parks, calls for greater logging of native forests, and more relaxed land clearing laws.

However, hard evidence that these treatments mitigate impacts on communities from wildfires remains extremely limited.

What's at stake?

What's at stake is the very security of our peri-urban communities, both in Australia where I live, and in other fire-prone regions such as North America. Communities in fire-prone regions everywhere are at increasing risk from wildfires because of population growth and climate change. The potential consequences of these factors were illustrated by recent major wildfires in California (26 deaths, 3,361 houses lost), Russia (54 deaths, around 2,000 houses lost) and, of course, the Black Saturday event in Australia.

The behavior of wildfires is primarily determined by three things: weather, terrain, and fuel. Of these, fuel load (in terms of the surrounding vegetation) is usually the easiest to manipulate. So, the typical response by authorities to major wildfires is to increase the area of fuel reduction in the landscape. Common fuel-reduction treatments employed are clearing, prescribed burning, grazing, and mechanical removal of biomass (e.g., thinning). These treatments are often undertaken at broad scales and quite a distance from peri-urban communities.

Fuel reduction can be expensive, it can have undesirable environmental impacts and it can undermine the aesthetics

Please see "Australian fires," page ten

Tipping points ahead!

Climate and weather in the American mind

Americans have noticed the heat and floods and such

People who follow these things closely are careful to separate the short-term events—weather—from the long-term trends—climate. But most Americans are not so careful.

While climate scientists are reluctant to attribute any single extreme weather event to climate change, the average American doesn't hesitate. According to *Extreme Weather, Climate and Preparedness in the American Mind*, a **report** from the Yale Project on Climate Change Communication and George Mason University, "A large majority of Americans believe that global warming made several high profile extreme weather events worse, including the unusually warm winter of December 2011 and January 2012 (72 percent), record high summer temperatures in the United States. in 2011 (70 percent), the drought in Texas and Oklahoma in 2011 (69 percent), record snowfall in the United States in 2010 and 2011 (61 percent), the Mississippi River floods in the spring of 2011 (63 percent), and Hurricane Irene (59 percent)."

That's the good news—if that's the phrase we want. But other results in the survey indicate that Americans take a Homer Simpson approach to learning from experience. Although fully 82 percent of Americans say they personally experienced extreme weather or a natural disaster in the last year, "only 36 percent have a disaster emergency plan that all members of their family know about and an emergency supply kit in their home."

And half of Americans believe that extreme weather will cause a natural disaster in their own community in the next year.

About half of Americans say that heat waves, droughts, and heavy rainfall have become more common in their communities over the past decades. This accords with some recent scientific research indicating that global water cycles have intensified in the past 50 years. A **paper** in the April 27, 2012 journal *Science* (subscription required) by Paul Durack of the Centre for Australian Weather and Climate Research and colleagues found "robust evidence of an intensified global water cycle in response to warmer global temperatures. Fundamental thermodynamics and climate models suggest that dry regions will become drier and wet regions will become wetter in response to warming," they write.

Several scientists also **wrote** in the June 7, 2012 *Nature*, (subscription required) that the Earth is close to a major "tipping point"—perhaps as soon as 2025—which will result in widespread destruction of natural ecosystems. "It really will be a new world, biologically, at that point," warns Anthony Barnosky from the University of California, Berkeley. "The data suggests that there will be a reduction in biodiversity and severe impacts on much of what we depend on to sustain our quality of life, including, for example,

fisheries, agriculture, forest products and clean water. This could happen within just a few generations."

These "tipping points" have occurred quite rapidly in the past, most recently from 14,300 to about 11,300 years ago when the climate made a rapid warm-cold-warm fluctuation wiping out half of the species of large-bodied animals, several species of large birds, and causing a significant loss of biodiversity.

The planet shifted quickly from significant glaciation to more-or-less the current climate conditions that have allowed humans to prosper so enthusiastically. The signals of the coming tipping point, the authors write, are the rapid increase in human population, habitat transformation, energy consumption, and climate change. Humans are using between 20 and 40 percent of global "net primary productivity."

"All of these far exceed, in both rate and magnitude, the forcings evident at the most recent global-scale state shift, the last glacial–interglacial transition, which is a particularly relevant benchmark for comparison given that the two global-scale forcings at that time—climate change and human population growth are also primary forcings today."

With these kinds of changes under way, it may not be enough to have an emergency supply kit. It might not hold enough bandages.

They Said It ...

"Lower income people often do not have a choice as to whether they will live in an area of climate hazard. They are the most vulnerable people to climate impacts. They don't have the economic conditions that allow them to be resilient to the hazards."—**Neenah Estrella-Luna, urban planning profesor at Northeastern University, quoted by** *Climate Central*.

"You know, hundred pound loads, not out of the ordinary. Riding around the city, not out of the ordinary. Lifting bike over rocks—I can't say I haven't done that before!"—**Joel Metz, bicycle freight delivery man, on plans to incorporate cargo bikes in emergency planning, quoted in** OPB News.

"We were surprised to see just how many people remain unaware of the alerting systems in their area, and even more disconcerting, how many are apathetic in their response to emergency scenarios and communications."—**Len Pagano, president and CEO, Safe America Foundation, quoted in** JEMSmobile.

"There were just an amazing diversity of species that we have never seen before. And the massiveness of this thing—it's about 100 tons of stuff. And it really does have millions of organisms and maybe hundreds of species."—**Marine biologist John Chapman on the sea life attached to to a dock that was ripped free by the Japanese tsunami, floated across the Pacific intact, then came aground in Oregon, quoted by** *NPR*.

"After a period of rapid ice loss through the first half of June, sea ice extent is now slightly below 2010 levels, the previous record low at this time of year. Sea level pressure patterns have been favorable for the retreat of sea ice for much of the past month."—**National Snow and Ice Data Center, in a press** release.

Out of the frying pan and into the ...

Fire funding on the budget block

Fire losses up, firefighter funding down

The hot fire season collided with the hot political season in the United States this year as President Barack Obama said the nation needs more firefighters, and the Republican presidential nominee said it doesn't.

A writer for the online magazine *Slate* weighed in with a mild defense of Romney's position, arguing that fire deaths are showing a declining trend in the nation since 2004. The fire death rate dropped from 13.6 per million people in 2004 to 12.0 per million in 2008.

But by other indicators, the fire problem has been holding steady or getting worse. Residential building fires peaked in 2006 with a total of 392,700. Dollar loss, however, peaked in 2008, with $8.1 billion in direct losses—all according to U.S. Fire Administration fire estimates. A 2011 report for the National Fire Protection Association estimated the total direct and indirect cost of fires in the United States for 2008 to be $362 billion.

Several significant fires raged in the West in mid-June, including the 59 square mile Little Bear fire near Ruidoso, New Mexico, and the 73 square mile High Park fire near Fort Collins, Colorado. With fires already burning in Arizona, Utah, Wyoming, and new ones cropping up daily, resources are in high demand. The incursion of people into the urban-wildland interface is a serious issue. In 2009, there were about 79,000 wildfires tallied by the USFA, a slight drop from the previous three years, but higher than most years in the last decade.

The NFPA's *Third Needs Assessment of the U.S. Fire Service* says, "Fire service needs are extensive across the board, and in nearly every area of need, the smaller the community protected, the greater the need." While there has been progress is some areas—especially personal protection and firefighting equipment as a result of the Assistance to Firefighters program and Staffing for Adequate Fire and Emergency Response Act (SAFER), other areas have not shown much improvement, especially training.

The *Needs Assessment* says that 46 percent of fire departments responsible for structural firefighting have not fully trained their personnel. This figure is down from 55 percent in 2001.

The report also says that 68 percent of fire departments responsible for wildland firefighting have not trained all of their personnel, down from 75 percent in 2001.

The modest success of the training program is consistent with the modest scale of the Assistance to Firefighters program, says USFA. "The grants must continue and grow if the large remaining need is to be addressed as well," the *Needs Assessment* says.

The federal budget for both the AFG and SAFER programs is essentially flat—stuck at about $670 million—between 2012 and 2013. In a Congressional Research Service report on the SAFER program, analyst Lennard Kruger wrote, "In support of SAFER, fire-service advocates cited and continue to cite studies performed by the U.S. Fire Administration and the National Fire Protection Association, the *Boston Globe*, and the National Institute for Occupational Safety and Health which concluded that many fire departments fall below minimum standards for personnel levels. According to these studies, the result of this shortfall can lead to inadequate response to different types of emergency incidents, substandard response times, and an increased risk of firefighter fatalities.

"On the other hand, those opposed to SAFER grants contend that funding for basic local government functions—such as paying for firefighter salaries—should not be assumed by the federal government, particularly at a time of high budget deficits. Also, some SAFER opponents disagree that below-standard levels in firefighting personnel are necessarily problematic, and point to statistics indicating that the number of structural fires in the United States has continued to decline over the past 20 years," he wrote.

The budget of the U.S. Fire Administration, an agency within the Department of Homeland Security, is taking a bigger hit, declining 3.4 percent in 2013 from 2012 levels. "Debate over the USFA budget has focused on whether the USFA is receiving an appropriate level of funding to accomplish its mission, given that appropriations for USFA have consistently been well below the agency's authorized level. An ongoing issue is the viability and status of the USFA and the National Fire Academy within the Department of Homeland Security," Kruger wrote in a separate CRS report.

Meanwhile, the *National Cohesive Wildland Fire Management Strategy: Phase II National Report* has been released, focusing on three overarching goals: restoring and maintaining landscapes; creating fire-adapted communities; and implementing effective wildfire response.

Further complicating fire management as people move into the urban-wildland interface is the fact that wildfires are an important factor in ecosystem health. A 2008 article from PubMed found, "Severely burned forest conditions have probably occurred naturally across a broad range of forest types for millennia. These findings highlight the fact that severe fire provides an important ecological backdrop for fire specialists like the black-backed woodpecker, and that the presence and importance of severe fire may be much broader than commonly appreciated."

Big volcanoes may give little warning

A Yellowstone blow may be closer than we think

Catastrophic volcanoes have shaped Earth since its beginning, but we've always taken a little comfort that they give some warning before blowing. It has been believed that the giant pools of magma that cause volcanic super-eruptions bubbled for as much as 200,000 years before erupting. But recent work indicates they may exist for only a few thousand—or maybe only a few hundred—before the big blow.

Vanderbilt University's Guilherme Gualda and colleagues studied California's Bishop Tuff, a super-eruption that occurred in California 760,000 years ago. They looked at the crystallization rates of quartz to gather information about the lifespan of the magma bodies. Several lines of evidence indicate that the formation time "took less that 10,000 years and most likely between 500 to 3,000 years before the eruption," according to a news release.

"The fact that the process of magma body formation occurs in historical time, instead of geological time, completely changes the nature of the problem," said Gualda. Instead of concluding that there is virtually no risk of another super-eruption for the foreseeable future because there are no suitable magma bodies, geologists need to regularly monitor areas where super-eruptions are likely, to provide advanced warning if such a magma body begins to form.

Super-eruptions may be the ultimate low probability, high impact event. The Toba eruption in Indonesia, about 63,000 years ago, may have been responsible for reducing the population of the emerging human race to as few as 1,000 breeding pairs. The eruption probably plunged the Earth into a thousand years of cooler climate.

Yellowstone National Park sits in a vast caldera that was formed by a super-eruption about 600,000 years ago. The caldera has seen such super-eruptions about every 600,000 years for the last two million years. Researchers at Washington State University and the Scottish Universities Environmental Research Center say that the eruption two million years ago that created the Huckleberry Ridge deposit was actually two eruptions occurring about 6,000 years apart. So Yellowstone eruptions may be slightly less massive and slightly more frequent than previously believed.

No eruption in historical times compares with Toba or Yellowstone. The 1980 Mt. St. Helens eruption ejected 0.3 cubic kilometers of rock and ash into the atmosphere. The last Yellowstone super-eruption—Lava Creek Caldera about 600,000 years ago—ejected 1,000 cubic kilometers of material, or about 33,000 times as much. The larger of the Huckleberry Ridge explosions threw out 2,200 cubic kilometers of material. Toba is estimated to have ejected about 2,800 cubic kilometers. It deposited a layer of ash six inches deep over all of South Asia.

"The Yellowstone volcano's previous behavior is the best guide of what it will do in the future," says Ben Ellis, co-author and postdoctoral researcher at Washington State University's School of the Environment. "This research suggests explosive volcanism from Yellowstone is more frequent than previously thought."

The Natural Hazards Center is pleased to announce the winners of the 2012 Hazards and Disasters Student Paper Competition.

The graduate student winner is: Eric Best, University of Delaware, *Collective Models of Disaster: Making a Case for Using Collective Mobile Phone Location Data in Disaster Science*

The undergraduate student winner is: Audrey Matusich, Colorado State University, *Vulnerable Victims: Media Constructions of Children After the BP Oil Spill*

Because of an oversight on the part of the, ahem, editor of the *Observer*, we never announced the names of the 2011 winners, which were: **Graduate student** Jennifer Tobin-Gurley, Colorado State University, *Downward Mobility: Displaced Single Mothers in the Aftermath of Hurricane Katrina.*

Undergraduate student Julie Broderick, Mount Royal University, *The Biopolitics of Desire: Exploring the Axis of Sexuality during the 2004 Indian Ocean Tsunami in Thailand*.

First-place winners each receive $100, publication on the Natural Hazards Center Web site, and an invitation to the 2012 Annual Natural Hazards Research and Applications Workshop in Broomfield, Colorado.

Creating recovery in New York after 9/11

A conversation between David Mammen and Haruo Hayashi

David Mammen *served for a decade as president of the Institute of Public Administration, a New York-based nonprofit. He also headed the International Division of the American Planning Association. His book* ***Creating Recovery: Values and Approaches in New York after 9/11*** *was published by Fuji Technology Press in August 2011. Throughout his research and writing, Mammen worked closely with* **Haruo Hayashi**, *professor at the Research Center for Disaster Reduction Systems at Kyoto University. Hayashi is a frequent contributor to the Natural Hazards Center's Annual Research and Applications Workshop. The* ***Observer*** *asked Mammen and Hayashi to talk about Mammen's book, especially regarding recovery lessons that might be relevant in both Japan and New York.*

Mammen: Haruo, you made your annual visit to New York City a few months ago. I had a chance to spend the day talking with you and your students about recovery efforts and looking around Lower Manhattan together. To me, this year's visit felt fundamentally different from previous ones, perhaps because the book we had been working on for so long had finally been published. Your students had brought copies for me to sign—which was charming—but also made me feel like the story about 9/11 recovery efforts is becoming history. For so many years, our work had felt like current events. I was often sending you notes about new developments, and several times when I thought we could bring the narrative to some kind of conclusion, a new aspect of the story would begin to unfold. But your current students were young children in 2001, and just from their reaction to our discussions, I could feel the passage of time.

Hayashi: Yes, seeing the physical reconstruction of Ground Zero—delayed for so many years but now far along—makes a great difference in our perception of recovery efforts. Because your book tells the story of recovery efforts in such detail, students and others will be able to learn what happened 10 and 20 years from now.

As a social psychologist, and as a friend and colleague who has watched you working on this research for many

years, permit me this observation: I think that after finishing your book, the relationship between you and 9/11 recovery became very stable. That is, you could finish your book because you came to fully understand what happened during 9/11 recovery.

Mammen: The research got started when you came to New York in December 2001, along with our friend Ken Topping, to talk about how we could document recovery efforts as they would unfold, and learn from New York's experience. You organized a study tour of government officials and leading academics, which grew to more than 40 people by March 2002.

Hayashi: Our group at Kyoto University is interested in social resilience from large-scale disasters of all kinds. It was 10 p.m. on September 11 in Japan when I watched what happened live in New York, and there was no doubt in my mind that we should study this event. In the case of 9/11, since we were foreigners, I thought it would be essential to have a New York-based research partner who could be our eyes and ears. I immediately thought of you because of my fond memory from our first encounter in 1998, when you were a co-chair of the international conference commemorating the fiftieth anniversary of the Fukui earthquake. I recall you led a panel discussion with mayors from cities around the world that had experienced disasters and recovery.

Mammen: Staffing the March 2002 study tour helped me begin to understand the breadth and depth of interest in New York's recovery efforts. I'll never forget the afternoon when the entire group went to Fresh Kills landfill on Staten Island, where debris from Ground Zero was being searched for remains. It was a profoundly moving experience for me to observe the operation being carried out by the police, FBI, and U.S. Army Corps of Engineers.

Hayashi: I also remember it very clearly. The workers all wore white paper clothing to search very minute debris for human remains. It was difficult work because everything at the World Trade Center was shattered into pieces. It also made us so sad to find a tomb of so many destroyed fire engines, ambulances, and police cars showing us the tremendous impact of the Twin Towers collapse.

Mammen: Over the years, you were able to include our research in some of your projects that were sponsored by Japan's government. Our small team was able to meet together occasionally, in the United States and Japan (sometimes at the annual Hazards Workshops in Boulder), to ask questions about recovery efforts in New York and to hear updates from me. I'm trained as an urban planner, and worked in the field of public administration for many years, so I was naturally drawn to those aspects of the recovery story. But you always encouraged me to also study the economic and social dimensions of the disaster as well.

Hayashi: Maybe that's because I'm trained as a social psychologist. In addition, the Kobe recovery study taught us the importance of economic recovery and what we call "life recovery"—or "social dimensions" in your terms—in addition to physical recovery as the goals for long-term disaster recovery. I think that disaster recovery will be complete when all of the three goals are achieved. This is why I refer to economic and social dimensions so often.

Mammen: From year to year, we would have opportunities to present our research at conferences. I found myself trying to move away from the chronology and complex details toward a few key observations. Aided by the benefit of hindsight and many drafts, I ended up with four main points that I wanted people to understand about the recovery efforts in New York.

First, I thought it important to highlight the variety and complexity of intergovernmental relations as it relates to the New York recovery effort. While the central government in Japan has great power and authority, recovery in New York has been created by strong intergovernmental relations involving the federal, state, and city governments. The federal government's main role has been to provide money, and to allow the money to be spent in rather flexible ways. The state government has handled most of the operations of recovery, through a number of established agencies and some new ones set up after 9/11. And while the agencies of New York City government have played only a very small formal role in recovery, the mayor of New York City has provided the strongest and most consistent vision of what recovery should achieve.

Hayashi: Intergovernmental relations are one of the most interesting parts of your book. I learned a lot from your analysis. In talking with you about intergovernmental relations, I began to distinguish between "funding agencies" and "operating agencies." Funding agencies are straightforward: they provide money. Operating agencies take care of the implementation of projects. In looking at the 9/11 recovery effort, I am impressed by the variety as well as the quality of those operating agencies in both public and private sectors.

Mammen: My second main point has to do with public participation in shaping the recovery efforts. In Japan, public participation in planning and development issues is relatively weak, although growing in importance. But public participation has been instrumental in New York. Through civic and professional groups, community-based organizations, and nonprofits of many kinds, individuals have played crucial roles in shaping physical, economic and social recovery efforts.

Hayashi: I like this point, too. I've written that citizen participation is one of the most indispensable factors for successful recovery plans. Disaster victims themselves

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— Haruo Hayashi

become operating agencies for recovery.

Mammen: I'm a big fan of the writer Haruki Murakami. While he's best known for his fiction, I also enjoyed his non-fiction book *Underground*, a fascinating account of the March 1995 sarin gas attack on the Tokyo subway system. I happened to be in Tokyo on the day of the gas attack, and the only reason I wasn't on the subway system at the time was because a meeting had been moved to my hotel. I re-read this book a few times while I was writing my book, and took inspiration from some of Murakami's observations. He quoted a victim of the attack who said, "There was no reaction whatsoever from anyone to my turning around to open the windows. No one said a thing, everyone was so quiet. No response, no communication. I lived in America for a year, and believe me, if the same thing had happened in America, there would have been a real scene."

New York's recovery efforts as described in my book do indeed portray "a real scene." Murakami also wrote, "Keeping quiet is a bad Japanese habit." As you know, New Yorkers don't share this bad habit. (We have others!) There were tens of thousands of voices, opinions, and ideas about how to create recovery after 9/11.

Hayashi: Please don't make the Japanese sound so enigmatic! Personally I think the silence of those impacted by a disaster is a universal phenomenon, followed by an enormous amount of communication. Mr. Murakami may have spent a year in the U.S. without facing a big disaster.

I am very much impressed by the management of such occasions as Listening to the City, which was a workshop held in July 2002 with 5,000 people with socio-demographic representation of the New York population. That workshop led to fundamental changes in how government agencies and the private sector approached the recovery effort.

Mammen: My third main observation has to do with using recovery as an opportunity to make improvements. In Japan, disaster recovery has usually meant rebuilding only what was there before. In contrast, recovery from the World Trade Center disaster has included many extensive improvements and investment in major projects that serve the entire metropolitan region, not just the World Trade Center site. This has been facilitated by the ability to use federal funds in flexible and non-standard ways. Also, strong public participation has helped support and build consensus for such improvements.

The investments in new transportation projects illustrate this point. Local officials argued that Lower Manhattan's recovery required new and improved transportation systems in order to make downtown a vital commercial and residential center and to accommodate the millions of visitors expected each year at Ground Zero after the site was redeveloped and a memorial was built. Other improvements included parks, schools, cultural facilities, and tourism initiatives throughout Lower Manhattan, not just at Ground Zero.

Hayashi: Using recovery as an opportunity to make improvements is really an important lesson for the Japanese to learn. The current Japanese disaster management system is designed based on floods and landslide due to heavy rains where recovery to the *status quo ante* is important. The Kobe earthquake in 1995 was the first major disaster in Japan to take into account how we should design long-term recovery. Those who worked on the Kobe recovery were pursuing recovery as an opportunity to make improvements. Some succeeded and some failed because of resistance from the existing system. I think we can view this aspect of the 9/11 recovery effort as a best practice—using recovery as an opportunity to make improvements in social systems.

Mammen: My fourth observation concerns recovery adapting over time. The co-founder of the September 11th Fund, a charitable organization which raised more than $500 million from two million donors worldwide, wisely noted that not everything that needs to be done is obvious on day one. For example, World Trade Center disaster-associated physical and mental health issues have come into focus only slowly over the past ten years, and proper responses to these recovery needs are still being formulated. Recovery efforts in New York have had to adapt to new knowledge and understanding over time. All of these attributes led me to characterize New York's recovery as being created, not simply administered.

Hayashi: The fourth point is profound. At the conclusion of our first study tour in March 2002, you arranged for leaders of our team to make presentations about our observations at a symposium held at the Japan Society. At that time, I said, "Do not rush," because recovery needs a long time. In coming back to New York every year since then, I thought New York was not in a rush, because there was little apparent progress at Ground Zero. However, it was revealed that there were serious health issues among workers who cleaned debris and for those who lived and worked around Ground Zero. Even in New York, people were in a rush for recovery. It is a point I will never forget.

Mammen: You invited me to spend a year as visiting professor at Kyoto University in 2006-2007, which gave me time to compile my notes and begin writing the book. I asked you, "Who should I have in mind when I am writing?"

Hayashi: Yes, I remember answering, "For the governor of Tokyo; for office workers and students; for a housewife taking care of her family; for my mother living in the suburb of Tokyo." I wanted to encourage you to tell all aspects of the recovery story as thoroughly as you could, with sufficient context so that readers unfamiliar with New York institutions and personalities would be able to understand what

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had happened and draw their own lessons.

Mammen: I'm glad you gave me that guidance, and I've been pleased that the few reviews I've seen have characterized the book as "an easily read narrative full of facts and figures with a minimum of attitude" (*Planning*) and "a thorough and clear description of the recovery, blessedly free of hysteria" (*Natural Hazards Observer*). I did try to write for a general audience.

I've also been asked from time to time, but have not felt qualified to comment on how the 9/11 recovery story relates or compares to subsequent disaster recovery efforts that we have witnessed since 2001—Hurricane Katrina, the Indian Ocean tsunami, and of course the Great East Japan earthquake and tsunami. But I know you think a great deal about learning across disasters. I also know that you have studied the prospect of a near field earthquake disaster occurring in the Tokyo metropolitan area, and put the probability of such an event at 70 percent within the next 30 years.

Hayashi: Even in the case of a Tokyo Metropolitan Earthquake with a M_w 7.3, the central business district of Tokyo will be not so damaged physically. However, the impact of such an earthquake will be great economically as well as socially.

Mammen: Going back to your recent visit that I mentioned at the beginning of this conversation, the other big difference from previous visits was that this time we could actually go onto the Ground Zero site, and visit the 9/11 Memorial which is now open to the public. Walking around Ground Zero brought a flood of emotions to me.

I was immediately struck by the size of the voids that comprise the Memorial, on the footprints where the Twin Towers had stood. In my memory of the towers, their footprints seemed much smaller. The waterfalls cascading into the two voids made a very loud sound, which I thought made it difficult to sit quietly and reflect.

I also have to confess that I had a reaction I often feel at sights around New York. I wanted to find a spot away from tourists, but that was hard to do. I also wondered how those who had lost family members could visit and grieve amidst the tourism.

I was also struck by the wide-open skies above—other than Central Park and the waterfront, it is hard to find places in Manhattan where you can enjoy the sky, but the vista from Ground Zero was huge.

Last but not least, the mirrored skin on One World Trade Center, still under construction, was a beautiful sight. But it was also disturbing to see the reflection of planes against the building.

Hayashi: It took ten years since 9/11 before we could go onto Ground Zero for the first time. Standing on Ground Zero, watching the new construction, and looking into the voids of the memorial made me feel the passage of time, as you mentioned earlier.

Mammen: Ten years ago, I was searching for a way I could help in the days and weeks after 9/11, and it was frankly difficult to find something that I felt I could do or contribute that wasn't already being done. I'm so grateful to you for helping me understand that I could help by explaining New York's recovery efforts. And it is remarkable that you were able to sustain your support and guidance over the ten years covered by the book. Thank you. I hope you will still come to visit each year with your students, even though they can stay at home and read the book!

Hayashi: I would like to continue my annual visit to New York because recovery is not fully completed. And I would like to thank you for compiling a concise but thorough account of ten years of 9/11 recovery efforts. I respect your patience and commitment to this project as a New Yorker who was a witness to these significant events.

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Australian fires ...

(Continued from page one)

that attract residents and tourists to the outskirts of our cities and smaller towns. And fuel reduction is not without risk, something amply illustrated recently by the loss of 40 houses in Western Australia due to an escaped prescribed burn. So, given that these treatments are expensive, damaging and risky, you'd think there would be compelling evidence demonstrating their effectiveness. In fact, such evidence remains extremely limited.

There are many reasons why the evidence is scarce. Wildfires are a difficult phenomenon to study. Large, destructive fires cannot be lit experimentally. House loss during wildfires is often aggregated, preventing statistical examination of landscape-scale variables influencing house loss, and adequate pre- and post-fire data are not always available.

But this is where Australia's Black Saturday fires provided us a rare opportunity to examine and compare the many factors at play. This event destroyed a large population of houses in landscapes with a mix of housing densities, tenures, terrains and fuel types, occurred during some of the most extreme fire weather ever recorded, and occurred in landscapes where there were adequate pre- and post-fire data. Thus, although a tragic event, Black Saturday also represented an unprecedented opportunity to learn about wildfire.

Opinion vs. evidence

In the days after Black Saturday, commentators, experts, and politicians offered their opinions to the media on who, or what, was to blame for the 173 lives lost and 2,133 houses destroyed. Opinions on tragedies like Black Saturday get a good run in the media. For example, a comment that Australian authorities were "arsonists" for not undertaking enough prescribed burning was widely reported, despite this particular commentator having no expertise in land management or fire science. These opinions came at a time when people wanted answers and politicians wanted to act, so were influential in shaping public debate. However, opinion should not be confused with evidence, which is much harder to assemble.

The evidence my colleagues and I—a collaboration of 10 fire, landscape, and statistical scientists from Australia and California—have collected was recently published in the international journal *PLoS ONE*. It took nearly three years to collect and analyze, and then undergo peer review. It's based on 12,000 measurements at 499 houses.

The envelope, please

So, what does the evidence show? Our analysis suggests six factors have the potential to make a big difference to houses during wildfires. They are, in order of importance: (1) the cover of trees and shrubs within 40 meters (131 feet) of houses; (2) whether trees and shrubs within 40 meters of houses are predominantly remnant native vegetation or planted vegetation; (3) the upwind distance from houses to groups of trees or shrubs; (4) the upwind distance from houses to public forested land (irrespective of whether it is managed for nature conservation or logging); (5) the upwind distance from houses to prescribed burning within 5 years; and (6) the number of buildings or structures within 40 meters of houses.

All fuel treatments were more effective if undertaken closer to houses. For example, 15 percent fewer houses were destroyed if prescribed burning occurred at the observed minimum distance from houses (0.5 kilometer or 0.3 miles) rather than the observed average distance from houses (8.5 km or 5.25 miles). That fuel treatments are more effective closer to houses is consistent with the fact that the three mechanisms that destroy houses during wildfires—ember attack, ra-

diant heat, and direct flame contact—all are at their maximum closer to the fuel source.

After Black Saturday the debate in Australia focused on prescribed burning. A Royal Commission after Black Saturday recommended that the area of prescribed burning should be tripled. However, our results indicate that the proximity of prescribed burning to houses is more important than the total area of prescribed burning in the landscape, suggesting recommendations like this are based on a flawed logic. Overall, clearing vegetation within 40 meters of houses was twice as effective as prescribed burning on Black Saturday, so our results also suggest that a focus on prescribed burning is misguided.

Another area of controversy after Black Saturday was the practice of "locking up" forests in national parks. However, we found that on Black Saturday houses were at similar risk whether they were adjacent to National Park or forest that was managed for wood production.

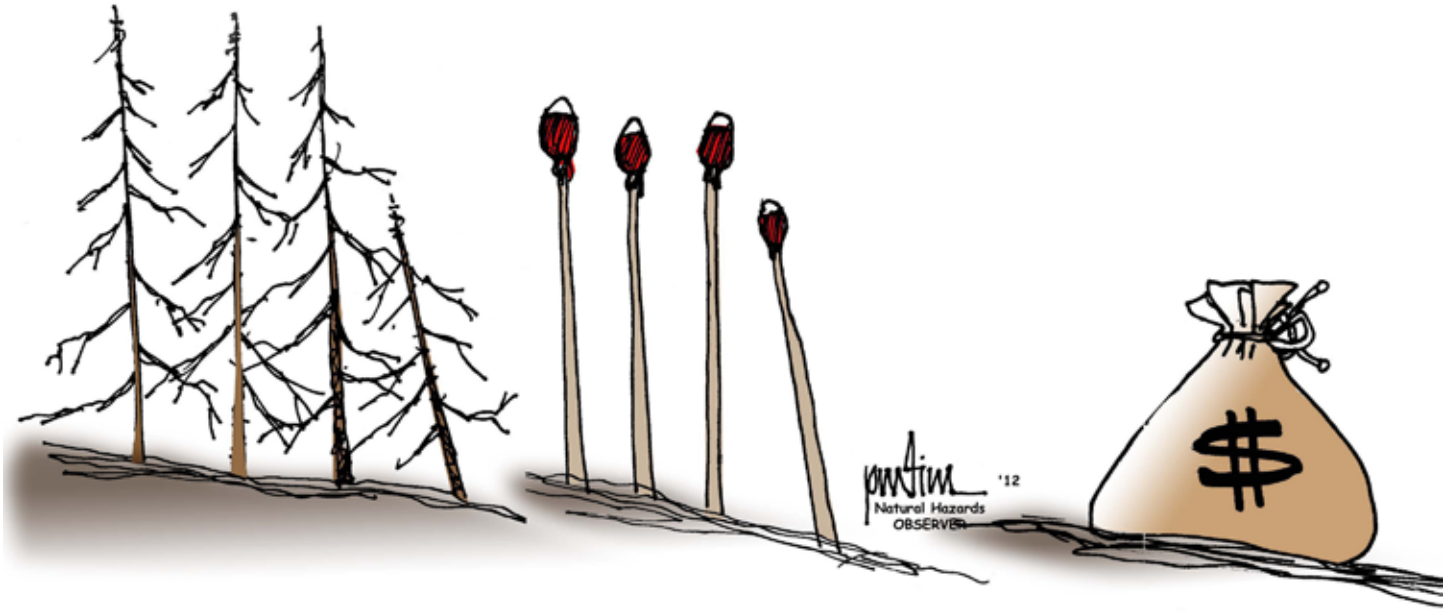
"I know which I'd rather use..."

Our results do show that reducing fuels—particularly those close to houses—plays an important role in saving homes and lives. We predicted that minimizing several fuels could theoretically reduce house loss by between 76 percent and 97 percent, which would translate to considerably fewer wildfire-related deaths. Sixty-nine percent of the deaths on Black Saturday were people in or near houses.

However, to achieve anything near this level of protection, we need a shift in emphasis away from broad-scale fuel-reduction to intensive fuel treatments closer to property—an argument that has also been put forward by Tania Schoennagel and colleagues at the University of Colorado.

Although we found that that fuel reduction—particularly if undertaken close to houses—reduces the likelihood that a house will be destroyed during wildfire, our results also indicate that fuel reduction alone cannot guarantee protection to houses, particularly in extreme fire weather. It is therefore critical that other measures, such as architectural solutions, safer places, and leaving early, are considered by every resident in fire-prone areas in addition to, or instead of, fuel reduction.

Evidence is not as timely as opinion. Evidence is not as entertaining as opinion. Evidence isn't as black and white as opinion. And while opinion is delivered with confidence and certainty, evidence must be presented with caution and uncertainty.



Aerial photos of a house prior to, and immediately after, the Black Saturday Fires in Australia. Fuels within 40 meters (131 feet) of houses were the most critical determinant of house loss during these fires

Photo courtesy of Philip Gibbons

But, I know which I'd rather use to protect my house and my family from wildfires.

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Reference

Gibbons, P., L. van Bommel, A.M. Gill, G.J. Cary, D.A. Driscoll, et al. 2012. Land management practices associated with house loss in wildfires. *PLoS ONE*. Available online at dx.plos.org/10.1371/journal.pone.0029212

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.

Climate change, growth, and the many faces of sustainable development

Climate Change Adaptation and International Development: Making Development Cooperation More Effective. Ryo Fujikura and Masato Kawanishi, eds. 2011. ISBN: 978-1-84971-152-4. 416 pp., $64.95 (softcover). Earthscan. www.routledge.com.

Climate Change and Growth in Asia. Moazzem Hossain and Eliyathamby Selvanathan, eds. 2011. ISBN: 978-1-84844-245-0. 288 pp., $119.40 (hardcover). Edward Elgar Publishing. www.e-elgar.co.uk/.

Climate Change and Arctic Sustainable Development: Scientific, Social, Cultural, and Educational Challenges. 2009. ISBN: 978-9-2310-4139-6. 376 pp., $32. UNESCO Publishing. www.earthprint.com.

The list of things that might go wrong with a warming Earth is long. And the list of things included in a definition of "sustainable development" is just as long. These lists often overlap. Depending on your source of information, areas that climate and development share are agriculture, AIDS, drought, famine, fisheries, floods, governance, health, heat waves, malaria, malnutrition, migration, poverty, rainfall, sea level rise, water … and so on.

What you call "sustainability" depends a great deal on what you want to sustain. It is a value-laden issue. In UNESCO's *Climate Change and Arctic Sustainable Development*, it's pretty clear that what the indigenous populations of the region want first is a seat at table to decide their own definition. It is a commonplace in serious climate circles that the northern latitudes will warm the most under anthropogenic climate change. Since few of us live or travel there, this is one reason that we may not notice some of the strongest physical evidence—scientists call it "data"—about the phenomenon.

Climate Change and Arctic Sustainable Development paints a pretty bleak picture of what is going on in the region. "Arctic sea ice has retreated in summer by almost 50 percent during the last 20 years," writes Jean-Claude Gascard, coordinator of the EU DAMOCLES Project. "In the Arctic, sea ice retreat seems to accelerate the melting of the Greenland ice cap, responsible for a sea level rise of about one millimeter to two mm per year. Arctic sea ice retreat seems also to affect perma-

frost and methane releases aggravating greenhouse gas concentration in the atmosphere."

Sea ice is the highway for Inuit hunters. With thinning and sparser sea ice, the Inuit report increased difficulty in obtaining the big game and sea mammals on which they rely. They are already making substitutions in their diet, consuming more caribou and musk oxen. But, writes Duane Smith, president of the Inuit Circumpolar Council of Canada, "Not one of them said anything to suggest they were giving up on hunting despite the considerable challenges they were facing in getting out on the ice and land."

Sustainable?

I went to a conference many years ago about the infamous northern spotted owl and timber harvesting in the Pacific Northwest. The spotted owl likes old growth forest habitat—indeed, requires it. Old growth forest is also critical habitat for loggers, who require the big trees to sustain their own livelihood. A biologist at this meeting gave a talk, apparently seriously, in which he argued that science could find out what it was that the owls liked about the old growth, transfer those conditions to newer, less economically valuable trees, move the northern spotted owl to this younger habitat, saving the species while allowing the old growth to be cut down.

If you move the northern spotted owl from it's old growth world into a new one, it may survive. But is it still the northern spotted owl?

The same question arises in regard to the far northern residents and their ice. "The natural world provides materially and spiritually for the peoples of the Arctic. The relationship between humans and their environment is deep and multi-faceted," writes Henry P. Huntington, a consultant in Eagle River, Alaska. "Most often in scientific work, we focus on the material connections between people and their environment. Those connections are vital, deep, and fascinating. But the spiritual connections are also vital, deep, and fascinating, even if they are harder to discover, assess, and address."

The marriage of the Western approach to science and the system of indigenous knowledge remains a thorny issue among native populations, who sometimes feel shunted aside in the pursuit of Western-style, data-driven conclusions. At a conference at the National Center for Atmospheric Research in Colorado in 2008, Leroy Little Bear, a Blackfoot and former director of the American Indian Program at Harvard University, said, "There is a very big difference in worldview, in the paradigms from which we operate."

Shannon McNeeley, at the time a National Science Foundation fellow working with native Athabascans, said, "What might be statistically significant to a scientist may not be significant on a human or ecological scale. It's a matter then of changing the assumptions, our paradigm of how we look at these problems."

In 1977, research surveys indicated the population of bowhead whales in Alaska's Beaufort Sea had declined to about 800 individuals. Inuit hunters, claiming superior knowledge of the whales' migratory habits, insisted that the population was closer to 7,000. When the methodological criticisms were incorporated and a more sophisticated survey completed in 1991, the scientists came up with an estimate of 7,000 animals.

Despite some of these successes, the UNESCO volume intimates that the locals are still struggling for a spot at the table. Alexander Pelyasov, director of the Center of Arctic and Northern Economies, Council for Reproductive Forces, Russian Federation, urges "the necessity for Arctic scientists to be highly receptive to the toolbox elaborated by modern social science, that is, concepts of creativity, networks, post-industrial society and knowledge economy."

While the physical impacts of climate change are likely most noticeable in the upper latitudes, there are far more people facing an uncertain future in the lower latitudes. In Asia, for instance. *Climate Change and Growth in Asia* takes on the challenge of seeing what lies in store for the crowded, ambitious, and restless people who live in China, India, Bangladesh, and other parts of the Asia-Pacific region.

You don't need a sophisticated understanding of climate or social science to follow this from M. Adil Khan: "The extent and intensity of negative impacts of climate change will very much depend on a country or community's existing overall socioeconomic and physical/ecological conditions, as well as on the rate and intensity of future global warming. Furthermore, due to their limited coping capacities, poorer nations are likely to be disproportionately exposed and thus be more vulnerable to climate change-induced disasters."

In other words, in disasters and in climate change, as in so many other areas, it's better to be rich than poor. Khan begins his chapter with an ominous quote from the The Independent's Johann Hari, "So if we carry on as we are, Bangladesh will enter its endgame ... The headstone would read, Bangladesh, 1971-2071: born in blood, died in water."

In Bangladesh, "sustainability" is closely linked to sea level rise. In even the conservative scenarios outlined by the Intergovernmental Panel on Climate Change, sea level in 2100 will be about 40 centimeters (16 inches) higher than today. This will flood out an estimated 80 million people from areas in coastal Asia. A one meter (3.3 foot) rise would flood 6,000 square kilometers (2,300 square miles) of India and nearly all of southern Bangladesh.

Hari wrote in a **story** in 2008, "Bangladesh is on course to lose 17 per cent of its land and 30 per cent of its food production by 2050. For America, this would be equivalent to California and New York State drowning, and the entire mid-West turning salty and barren."

Salt invasion from the sea into the fresh water table has already caused a loss of rice paddies, forcing some to switch to shrimp farming, which Hari says employs fewer people and is less stable economically.

The rise of the rapidly expanding BRIC countries—Brazil, Russia, India, and China—creates it's own set of issues. Sustainability and climate is intimately linked with population growth in Asia, write Malcolm McIntosh and Tapan Sarker. "Almost everything that we use on a daily basis is in some way connected to China," they write. "This means that population growth must be halted and reversed as this action would see one of the greatest improvements in wellbeing for the vast majority of the world's poorest people, as well as significantly reducing carbon emissions. This policy would not just have application to people in developing countries but to cities in every country in the world. If we are to focus on resilience and community cohesion, this is an issue that political leaders must not shy from."

Climate Change Adaptation and International Development first focuses its spotlight on Asia, then turns to Africa. Not long ago, Africa was considered to be the lost continent, with a bleak future. In only a few years, this assessment has changed. There have been several international reports touting some

African countries as possible engines for economic welfare in the region. Most of the governments have avoided the debt crisis that has engulfed the developed nations, so they may be in a solid financial position to encourage growth. But they are also plagued by poor infrastructure, bad governments, corruption, and unstable institutions.

This book takes a strong disasters perspective in its approach. In a case study of Lesotho, for instance, the authors argue that "in order to understand how climate change will affect people differently, it is critical to view climate stress within the context of many other stressors. They also highlight the dynamic nature of vulnerability, pointing to the dangers of a 'snapshot approach' to vulnerability assessment."

Because of a lack of technical expertise, African nations do not generally apply climate models in their future planning. African economies remain largely agriculturally based, so understanding the effects of climate change on this sector will be critical for adaptation. "Predicting the exact impact of climate change upon the complex systems that constitute agricultural sectors is difficult," write Gina Ziervogel and Anna Taylor. "But in many parts of Africa it seems that warmer climates and changes in precipitation will destabilize agricultural production. While farmers in some regions may benefit from longer growing seasons and higher yields, the general consequences for Africa are expected to be adverse, and particularly adverse for the poor and the marginalized who do not have the means to withstand shocks and changes."

So once again, it is better to be rich than poor when facing disaster.

This book identifies one emerging issue that will likely become a critical destabilizing one in the future: migration. The international community is only now beginning to provide legal structures to deal with environmental migrants. "Climate change expresses itself in two distinct but related ways—slow onset environmental degradation (i.e., slow shifts in average environmental conditions over relatively long periods) and rapid onset or acute extreme events (i.e., extreme weather events due to increased energy within the climate system). Slow onset will affect entire cities. Sana'a, the capital of Yemen, and Quetta, the capital of Pakistan's Baluchistan Province, are cities said to be at particular risk of having to be abandoned within the foreseeable future. A shift to a permanent EI Niño would increase water resource stress across large parts of Asia and South and East Africa, reducing crop productivity, affecting fishing stocks and increasing risks of hunger and malnutrition."

But, say Mohamed Hamza and coauthors in the last essay in this book, because migration is actually an individual decision, it is very difficult to predict how many people will be on the move and where. "People move for a complex set of reasons, of which a changing environment is only one," they write. "Given such levels of uncertainty, it is extremely difficult to make any clear policy recommendations."

These books demonstrate the complexity of the issues in addressing the goal of "sustainability." In Africa, the long decline of infrastructure, the lack of technical capability, existing agricultural practices, and a host of other issues plague sustainability efforts. During the 1950s and 1960s, when most African nations were freed from the colonial yoke, most made little effort to adapt their governing institutions to the African culture. They simply adopted the institutions of the colonial masters in toto, putting Africans in charge. This has had many repercussions. Sometimes these are merely humorous, like the ridiculous 18th century style wigs worn by sitting judges.

But some are more serious. The educational philosophy adopted from the British colonizers, for instance, emphasizes rote memorization rather than innovative thinking and condemns a student's future to her performance on a couple of tests. While the European nations that brought this system to the continent have moved beyond it, it flourishes in many African countries, to their detriment.

While not strictly a climate issue, this presents a considerable barrier to developing the kind of technical expertise needed to create a "sustainable" economy in the face of rapidly changing conditions over which the nations themselves have no control.

—Dan Whipple

CLIMATE CHANGE

Climate Change in Africa. By Camilla Toulmin. 2010. ISBN: 978-1-84813-015-9. 192 pp., $22.95 (softcover). Zed Books. www.zedbooks.co.uk

Preparing for climate change is an exercise in planning under uncertainty. This book outlines the uncertainties facing the vast African continent. They are—as you would expect in a place so large—varied.

"The impacts of climate change on Africa include increased aridity, sea level rise, reduced fresh water availability, cyclones, coastal erosion, deforestation, loss of forest quality, woodland degradation, coral bleaching, the spread of malaria and impacts on food security. Although there remains work to be done in the fine-tuning of models and their results, the scale of the problems that lie ahead necessitates increased investment in building more resilient systems, whether for urban centers, agriculture, energy generation or water supply," writes Toulmin, who is an economist and the director of the International Institute for Environment and Development.

Africa makes a tiny contribution to the problem of greenhouse gas emissions, but will face serious consequences. This is the result of high levels of poverty, bad governments, and other factors. "In many areas, climate change impacts will further exacerbate poverty and render more taxing achievement of the Millennium Development Goals," Toulmin writes. "It is also evident, however, that the impacts of climate change are quite diverse. While many areas will become hotter and drier, a few regions may gain increased rainfall, at least in the short to medium term. Making best use of rainfall and

other water resources will be key to successful adaptation, at the level of the field, village, watershed and river basin."

This variability and uncertainty can be illustrated tidily in the case of the Sahel, the 3,000-mile stretch of Africa south of the Sahara stretching from Senegal in the west to the Horn of Africa in the east. Toulmin writes, "Climate models generate mixed predictions for the future Sahelian climate. Some maintain that the Sahel region will be even drier in the twenty-first century, owing to hotter temperatures and higher levels of evaporation. Whatever rain does fall will therefore evaporate at a faster rate, exacerbating the already arid conditions. Others have a more optimistic view of likely rainfall trends, such that agricultural conditions might improve at least for the next twenty to thirty years."

Reacting effectively to this uncertainty is one definition of resilience. African nations' poverty, poor governments, and vulnerability to things like price spikes in fuel and food mean that they have a lot of catching up to do if what has become a promising new dawn on the continent is to become a fully lit day.

FLOODS

Devastation on the Delaware: Stories and Images of the Deadly Flood of 1955. By Mary A. Shafer. 2010. ISBN: 978-09771329-0-4. 496 pp., $19.95 (softcover). Word Forge Books. wordforgebooks.com

This is an anecdote-filled history of the Delaware River floods of 1955, which occurred in the wake of hurricanes Connie and Diane. The flooding caused substantial loss of life and property damage in Pennsylvania, New Jersey, and New York. Shafer writes, "This disaster did more to change life in the Delaware Valley than almost any other single event in its history."

The book gives life to the stories of individuals who were affected by the flooding. Sometimes in disaster research, we can lose this personal touch as the human toll piles up into statistics.

Shafer also discusses some issues in the flooding aftermath that sound modern more than 55 years later. "The reactive nature of politics touches off a flurry of demands for dams, levees and other structures to be built, with the intent of controlling nature's waterways," she writes. "Rarely considered is something much more readily controlled: the behavior of those who put themselves in harm's way by choosing to build, live and work in the natural floodplain of these waterways.

"Little discussed among those clamoring for the government to 'do something' is many people's unwillingness to acknowledge that the beauty and atmosphere of a life beside the river comes at a price. What really needs to be done is for everyone to acknowledge that trade-off, and make informed and honest choices about what they can and can't put up with.

"Even along the river's tributaries, the choices are the same. Part of the massive destruction along the Brodhead Creek near the Stroudsburgs has been due to a Depression-era WPA [Works Progress Administration] project that had straightened some of the creek's natural curves. At the time it was done, the practice was not only condoned but recommended, based on the mistaken assumption that a straight waterway would be more easily maintained and controlled."

FOR KIDS

Patty Pelican and the Gulf Oil Spill. By Lynda Wurster Deniger, with illustrations by Paulette Ferguson. 2011. ISBN: 978-0-9831744-0-0. 36 pp., $19.95 (hardcover). HIS Publishing Company. www.saltyseasandfriends.com.

Patty Pelican and her friend Sammy Seagull get their wings fouled with crude oil in the aftermath of the Gulf of Mexico's Deepwater Horizon disaster, while Dottie Dolphin swims out of harm's way. The simple story, charmingly illustrated, explains for children the perils faced by wildlife and fishermen in the aftermath of an oil spill.

The book, probably best for younger children, includes a sing-along CD.

Climate Extreme: How Young People Can Respond to Disasters in a Changing World. By Amalia Fawcett. 2012. 28 pp. Plan International and Children in a Changing Climate. Free download at www.childreninachangingclimate.org .

This short publication speaks to children about the essentials of climate change without talking down to them. Refreshingly free of exclamation points, *Climate Extreme* talks about what's likely to happen with the climate and disasters in clear but precise terms. The author isn't afraid to use terms of probability to let kids know how likely they are to face a certain issue.

Heat waves, floods, sea level rise, and health impacts are all discussed in clear, unhysterical terms. This is an excellent tool both for children and for people who work with them in.

Patty Pelican and friend above the spill

Contracts and Grants

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

Subduction Zone Segmentation over Multiple Seismic Cycles, South-Central Chile. National Science Foundation grant #1144537. http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=1144537. Three years. $172,727 to principal investigator Benjamin Horton, University of Pennsylvania, bphorton@sas.upenn.edu.

The possible segmentation of subduction zone faults currently presents one of the most significant questions to the physics and geology of earthquake occurrence and the assessment of future earthquake hazards. How will future large earthquakes be arrayed along a fault? How and why will individual earthquake ruptures stop?

Subduction zone faults form the tectonic plate boundaries that parallel the coastlines of many countries around the world. Advances in instrumentation and modeling in recent decades have produced important insights into fault behavior, yet these measurements span only fractions of the time interval between major earthquakes.

The goal of this research project is to use an interdisciplinary array of evidence preserved in coastal landforms and sediments to investigate whether segmentation of subduction zone faults is maintained over multiple earthquake cycles spanning hundreds to thousands of years. The field area, the Arauco Peninsula coast of south-central Chile, crosses the boundary between the rupture zones of two of the largest subduction zone earthquakes in the worldwide historic record, on May 22, 1960 (M_w 9.5) and February 27, 2010 (M_w 8.8).

Prior to 2010, the study area for this project in south-central Chile was one of the most accepted hard fault segment boundaries along the Peru-Chile trench; it was believed to bound several historical ruptures, including the Great Chilean earthquake of 1960. The Chilean earthquake in February 2010 called this hypothesis into question, when the rupture extended south of this boundary and only partially overlapped with the previous earthquake in AD 1835.

The combination of geological evidence of past earthquakes over the last 4,000 years, frequent large subduction zone earthquakes, and an unusually long and comprehensive historic record of earthquakes in south-central Chile makes this region a natural laboratory to address fundamental questions about fault segmentation. This research project will test multiple hypotheses regarding earthquake behavior and coastal response: (1) fault ruptures over multiple earthquake cycles could terminate at fixed (hard), variable (soft), or random boundaries, or could include multiple segments; (2) large subduction zone earthquakes will produce a tsunami deposit simultaneous with an abrupt change in land level; and (3) the Holocene coastal evolution in this region reflects a modest net change in relative sea level in which the vertical uplift or subsidence during large earthquakes is largely reversed during the periods between earthquakes.

We will reconstruct vertical land-level changes and tsunami history associated with multiple earthquake cycles using geomorphic, sedimentological and microfossil analysis. They will characterize the optimal environmental settings for the preservation of land-level changes and tsunami deposits in sedimentary sequences and analyze the impacts of these land-level changes on the coastal landscape.

Ruptures on subduction zone faults have created some of the largest earthquakes and tsunamis in the world, such as the catastrophic earthquake in Japan in 2011 that killed thousands of people and destroyed coastal cities. The practical importance of this investigation for assessing future earthquake hazards in other similar geological settings was underscored by the unforeseen extent of fault ruptures and resulting earthquake magnitudes in the recent devastating earthquakes in Sumatra in 2004, Chile in 2010 and Japan in 2011.

A 21st Century Reconnaissance of Aleutian Arc Inception. National Science Foundation grant #1144499. http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=1144499. Two years. $102,173 to principal investigator Suzanne Kay, Cornell University, smk16@cornell.edu.

The Alaska/Aleutian Arc is the most geologically active region in North America with abundant large earthquakes and eruptions from more than 50 active volcanoes. Determining precisely how and when the Aleutian Arc began to form is one of the key elements for understanding the origin of the Bering Sea-Alaska-North Pacific region as well as how several circum-Pacific volcanic zones are related to one another. Our understanding of how volcanism initiated in the Aleutian Arc is clouded due in large part to the scarcity of data that bear on the ages of the earliest volcanic rocks in the Aleutian Islands.

The proposed reconnaissance investigation of Aleutian Arc inception involves sampling and determining the ages of the oldest records of volcanism. The aim is to define when Aleutian Arc volcanism started and highlight potential linkages with the initiation of volcanism elsewhere in the Pacific and the rapid change in the relative motions of oceanic plates that occurred 52 million years ago. In addition, the proposed research will generate basic information regarding how and why the Aleutian Arc poses significant volcanic and earthquake hazards to the population in Alaska and around the Pacific Rim.

The proposed research will employ state-of-the-art 40Ar/39Ar and U-Pb geochronology, along with geochemical, and isotopic analysis of the dated rocks. The focus is on subaerial outcrops on Amatignak, Ulak, and Kiska islands, which hold the greatest potential for exploration into the early history of the Aleutians. New geochronologic and geochemical data will precisely constrain when the Aleutian Arc inception began, what the compositions of the eruptive products were, and how they evolved through the earliest history of the arc. This information will also be used to evaluate the existing tectonic models of Aleutian Arc inception and Pacific Plate motion during the middle Eocene.

Three-Dimensional Characterization of a Pseudotachylyte-Bearing Fault. National Science Foundation grant #1145238. http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=1145238. Two years. $146,728 to principal investigator Phillip Resor, Wesleyan University, presor@wesleyan.edu.

Fault slip is the dominant mode of deformation in the earth's upper crust. Faults within the crust, however, exhibit a range of behavior, from earthquake-generating stick-slip to aseismic creep.

Laboratory-derived friction laws can explain this spectrum of fault behavior. However, the scaling of these laws to the conditions of natural earthquakes and the interpretation of the laws' physical meanings have proven to be formidable challenges. This research will bridge laboratory and earthquake scales by imaging the three dimensional geometry of pseudotachylyte-bearing faults. Pseudotachylytes, fault rocks formed from frictional melts, are generally considered the only unequivocal evidence of earthquake slip velocities preserved in fault zones.

The solidification of frictional melt "freezes in" earthquake source geometries. But it also precludes the development of extensive fault surface exposures that have enabled previous studies of fault zone geometry.

We have overcome this difficulty by imaging the intact 3D geometry of the fault using high-resolution X-ray computed tomography. In this study we will use CT imagery of natural and experimental fault surfaces to quantify surface roughness, frictional contact area, and pseudotachylyte thickness and will thus determine the evolution of fault roughness with slip and estimate key frictional parameters at earthquake nucleation and propagation scales.

Man-Made Hazard Mitigation of Reservoir Dams: Monte Carlo Simulation with Multiscale Modeling of Concrete and Accurate Fluid-Structure Interaction. National Science Foundation grant #1237920. http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=1237920. One year. $146,591 to principal investigator Gianluca Cusatis, Northwestern University, g-cusatis@northwestern.edu.

The main objective of this project is to study effective computational methods that will allow the failure and reliability analysis of dams subjected to man-made hazards, such as blast and penetration. This requires the accurate modeling of reservoir/dam failure response, which is not handled satisfactorily by available computational tools.

The research approach progresses from the probabilistic modeling of concrete at the length scale of the major material heterogeneities to the formulation of a multi-scale framework for the analysis of large structures. The computational simulation of the dam is then coupled with the simulation of the reservoir water through a novel fluid-structure interaction algorithm. Finally, the developed framework is used to compute the probability of failure associated with projectile penetration and air-blasting.

The successful completion of this research will lead to a significant improvement in the computational tools for dam failure analysis available to practitioners. Engineers will be able to assess accurately the probability of failure of existing dams and dam administrators will be able to use these assessments to prioritize investments and resources.

Decoding and Predicting Antarctic Surface Melt Dynamics with Observations, Regional Atmospheric Modeling and GCMs. National Science Foundation grant #1235231. http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=1235231. Three years. $46,081 to principal investigator David Schneider, University Corporation for Atmospheric Research, dschneid@ucar.edu.

The presence of ice ponds from surface melting of glacial ice can be a significant threshold in assessing the stability of ice sheets, and their overall response to a warming climate. Snow melt has a much reduced albedo, leading to additional seasonal melting from warming insulation. Water run-off not only contributes to the mass loss of ice sheets directly, but meltwater reaching the glacial ice bed may lubricate faster flow of ice sheets towards the ocean. Surficial meltwater may also reach the grounding lines of glacial ice through the wedging open of existing crevasses. The occurrence and amount of meltwater refreeze has even been suggested as a paleo proxy of near-surface atmospheric temperature regimes.

Using contemporary remote sensing (microwave) satellite assessment of surface melt occurrence and extent, the predictive skill of regional meteorological models and reanalyses (e.g. WRF, ERA-Interim) to describe the synoptic conditions favorable to surficial melt is to be investigated. Statistical approaches and pattern recognition techniques are argued to provide a context for projecting future ice sheet change.

Reducing Vibration and Wind Loads in Tall Buildings Using Fluidic-based Aerodynamic Modification (FAM). National Science Foundation grant #1200987. http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=1200987. Two years. $210,787 to principal investigators Chris Letchford, Michael Amitay, Jason Vollen, and Anna Dyson, Rensselaer Polytechnic Institute, letchc@rpl.edu.

This research will develop a revolutionary approach to the shaping of tall buildings to reduce their wind loading. The concept is to use fluidic-based aerodynamic modification (FAM), where wind flow is modified around the building by the injection of fluid flow in strategic locations, to improve the aerodynamic "shape" of a structure.

These fluid interventions will modify the local flow such that the building experiences reduced wind loads. Active flow control is now being widely used in the aeronautical world to improve flow characteristics over airfoils. Its application to bluff bodies, such as buildings, to reduce response is novel.

The research will demonstrate the feasibility of the FAM approach in reducing response; investigate the fundamentals of jet/flow and flow/structure interaction both through their impact on the loading on the building and on the flow patterns around it; and assess the efficiency of steady and periodic forcing of the injected flow in terms of their response reduction and invested energy.

While the development and increased use of lightweight and high-strength materials in the construction of new buildings has provided them with reduced mass, it has increased their susceptibility to dynamic wind load effects. Thus the gains afforded by incorporating these new materials into tall buildings are countered by the need to focus much more attention on their habitability under strong wind conditions. For most tall, slender buildings the design is governed by both the strength and human habitability.

Collaborative Research: Can Low-Angle Normal Faults Produce Earthquakes? A Paleoseismic Perspective. National Science Foundation grant #1237105. http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=1237105. One year. Two grants. $72,217 to principal investigator Laurel Goodwin, University of Wisconsin-Madison, laurel@geology.wisc.edu, and $8,724 to principal investigator, Joshua Feinberg, University of Minnesota-Twin Cities, Feinberg@umn.edu.

The identification of low-angle normal faults, i.e., faults that have dips less than 30 degrees, are problematic with respect to our current understanding of the mechanics by which faults form. According to classic Andersonian fault mechanics, such faults should not form in most geologic settings.

Despite this, they are observed in many geologic settings, but the means by which they form remain controversial. Hypotheses explaining these faults fall into two categories: those that offer explanations (e.g., fault weakness, reduced effective normal stress) for how the faults slip in suboptimal orientations; and those that suggest they move at higher angles before rotating into their current orientations.

A key question is whether or not these faults can generate earthquakes. Of fundamental importance is the observation that low-angle normal faults commonly display an unequivocal—yet poorly studied—record of past seismic activity in the form of pseudotachylyte (frictional melt) veins. The existence of these fossilized earthquakes places an important constraint on structural models that seek to explain the origin of low-angle normal faults: they were clearly seismogenic at some point in their history.

We will determine the orientations at which low-angle normal faults from the southwestern United States and New Zealand produced earthquakes by using the magnetic remanence preserved in pseudotachylyte to quantify the potential effects of subsequent tilting since seismogenesis. The degree of tilt (if any) will be determined by comparing the magnetic vector of the sample with the expected reference direction for the study area based on well-defined apparent polar wander paths.

The age of pseudotachylite formation (and hence the age of seismogenesis) will be determined using $^{40}Ar/^{39}Ar$ dating using a combination of incremental heating analyses and UV laser-based in situ methods that will target areas of neocrystalline material and avoid the deleterious effects of glass and relict clasts on $^{40}Ar/^{39}Ar$ ages.

This research will contribute to the resolution of a long-standing controversy in the structural geology and tectonics community. If our results show that these faults can only produce earthquakes at higher angles prior to tilting, they will confirm a long-established theory of the mechanics of earthquakes and faulting. If, however, our results show that the pseudotachylites have resulted from faults that formed at angles 30 degrees or less, our current concepts of earthquake mechanics must be either incomplete or flawed, and the data will require a reconsideration of the fundamental controls on earthquake mechanics.

Identifying the Dominant Controls on Strain Localization in the Lower Crust. National Science Foundation grant #1150438. http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=1150438. Five years. $125,000 to principal investigator Christopher Gerbi, University of Maine, Christopher.gerbi@maine.edu.

This project combines a study of crustal rheology with efforts to improve student understanding of the properties controlling the mechanical behavior of Earth materials.

The distribution of rock strength in the crust is a fundamental control on strain and corollary processes such as fluid flow, topographic evolution, and seismicity. Without being able to accurately characterize the strength distribution, we cannot accurately predict how the crust will respond to internal and external driving forces. Despite recent progress constraining the general mechanisms involved in strain-related weakening, we do not know which weakening processes dominate at different levels of the crust.

Using the southwestern Grenville Province of Ontario, Canada, as a natural laboratory, we will combine structural, petrological, and geochronological methods, followed by analytical and numerical modeling sensitivity analysis, to determine the relative importance of different weakening mechanisms during the development of well-exposed shear zones there. We will test the following hypotheses: (1) Reaction and textural weakening are of subequal importance in shear zone development; (2) Grain size reduction is commonly not a major weakening factor at deep crustal levels; (3) Geological evidence does not require shear heating as a component in shear zone formation; and (4) Although initial heterogeneities are important for controlling the stress distribution in the crust, km-scale shear zones form due to a change in constitutive relationships.

Earth's topography and the pattern of rock units exposed at the surface result almost entirely from the combination of erosion and the heterogeneous movement of rocks within the crust and mantle. We focus on identifying what controls patterns of rock movement, or deformation, in the lower portions of continental crust. By identifying the processes that control how rocks change strength during periods of mountain-building, and therefore how the lower crust accommodates the large-scale deformation induced by the movement of tectonic plates, we will improve our ability to predict and explain the evolution of Earth's surface and related processes such as fluid flow and seismicity.

Deep Structure of Three Continental Sutures in Eastern North America. National Science Foundation grant #1147831. http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=1147742. Five years. Two grants. $54,784 to principal investigator Vadim Levin, Rutgers University New Brunswick, vlevin@rcl.rutgers.edu, and $85,779 to principal investigator, William Menke, Columbia University, menke@ldeo.columbia.edu.

Our world's continents have been compared to both icebergs and onions. They are like icebergs in that they consist of a buoyant solid floating on a sea of deeper denser material, and also in that they are mostly unseen, with keels extending down to 250 kilometers (150 miles) beneath the Earth's surface. They are like onions in that they consist of a central core surrounded by a sequence of younger layers that has grown around it.

The process by which continents were formed remains a geologic mystery. Two of the keys to that mystery lie in the structure of the deepest part of the central core (or "craton", to use the geologic term) and of the boundaries between the layers ("sutures" or "terrain boundaries").

Earthscope's Transportable Array (TA) is a tremendous asset to seismologists studying Earth structure, because it provides extremely high-quality data for the entire land area of the United States, a region that includes many important geological features, including plate boundaries, rift zones and hot spots. However, its impact on the "origin of the continents" question is limited, because the core of the continent is not beneath its footprint, but rather lies a little to the north, in Quebec.

We are deploying seismometers in a line stretching from coastal Maine (the edge of the continent) to northern Quebec

(its core). The density of stations is variable, and is highest in the three places where terrain boundaries are crossed. We use earth-imaging techniques to test three significant hypotheses: (1) that the bottom of the continental keel is a distinct interface that deepens towards the cratonic core; (2) that the properties of the continent are regionalized (that is, each layer of the onion has its own recognizable properties), with terrain boundaries having a signature that extends right down to the bottom; and (3) that the part of the Earth below the bottom of the continents (the "asthenosphere") is flowing around the keel (in the same sense that ocean water flows around the keel of an iceberg).

Tectonic and Magmatic Processes during Early-Stage Rifting: an Integrated Study of Northern Lake Malawi, Africa. National Science Foundation grant #1110921. http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=1110921. Five years. Five grants. $282,286 to principal investigators Donna Shillington, Cornella Class, James Gaherty, and Scott Nooner, Columbia University, djs@ldeo.columbia.edu; $84,006 to principal investigator Christopher Scholz, Syracuse University, cascholz@syr.edu; $18,830 to principal investigator Matthew Pritchard, Cornell University, mp337@cornell.edu; $19,435 to principal investigator Cynthia Ebinger, University of Rochester, cebinger@ur.rochester.edu, and $95,433 to principal investigator Andrew Nyblade, ;ennsylvania State University, aan2@psu.edu.

Although the concept that the thick continental lithosphere extends and ultimately ruptures has been accepted for over 50 years, the conditions required for this to occur and the factors that are most important in controlling the style of rifting, the formation and maintenance of tectonic segmentation and the initiation of magmatism remain contentious. This is especially true of the earliest stages of extension, in part because most studies focus on successfully rifted margins and mature rifts, where extensive stretching, syn- and post-rift magmatism, and post-breakup sedimentation overwrite and bury the record of incipient extension. Understanding how, why and when features that are characteristic of mid-ocean ridges and rifts first form and evolve during early rifting is essential for a broader understanding of plate divergence.

The primary scientific goal of this project is to examine the emergence and early evolution of two fundamental features of all divergent plate boundaries: magmatism and segmentation. Magmatism accommodates a significant percentage of plate separation at most mid-ocean ridges and late-stage rifts. Likewise, transform faults demarcate discrete spreading segments in mid-ocean ridges, which are broadly characterized by more robust magmatism at their centers than at their edges. Well-developed magmatic and tectonic segmentation is also observed in late-stage rifts and new ocean basins. However, little is known about the controls on the initiation and development of magmatism and segmentation in young rifts. Specifically, the PIs seek to address the following questions:

When, where and why does magmatism initiate in rifts, and what is its role in accommodating extension?

What controls the development of tectonic segmentation in early-stage rifts? How is it manifested in 4D patterns of magmatism and deformation?

The project consists of an integrated geophysical, geochemical and geological study of the northern Lake Malawi region in the East African Rift System (EARS) to address these questions. This is one of the few places in the world that has all of the ingredients necessary for a comprehensive study of early rifting. Active and passive seismic data and MT data will reveal the 3D structure of the crust and lithosphere at a variety of length scales, from the architecture of border faults and accommodation zones to the distribution of deformation and magma (if present) in the mantle lithosphere. Surface deformation, seismicity, and rift stratigraphy, as well as geochronology, thermobarometry and geochemistry of volcanic rocks, will yield constraints on the origin of magmatism and the evolution of deformation and magmatism at a range of time scales, including possibly variable contributions from sub-lithospheric versus lithospheric sources.

DMS: Disaster Mitigation System. National Science Foundation grant #1236706. http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=1236706. One year. $300,000 to principal investigator Henry McDonald, SimCenter Enterprises, Henry-McDonald@utc.edu.

Energy production, transportation and utilization are ubiquitous in the United States. They encompass nuclear and chemical processes that are subject to a multitude of failure mechanisms that can be the result of poor design, human error or acts of nature or terrorism than can have catastrophic impact of life and property.

The disaster mitigation system being constructed in this activity is a system of systems that provides emergency response staff with both training and planning as well as real time guidance on effective strategies to protect the general public and first responders. The system uses computational fluid dynamics to predict toxic plume evolution and an intelligent agent based model of the impacted population operating within an intelligent traffic management system. Cognitive algorithms are being developed to analyze the output data and dissect it to channel necessary information and guidance to the appropriate people.

These analyses use high performance parallel computing to create the necessary integrated solutions and exploit many of the features of the Global Environment for Network Innovations network. This will result in simulation based information and guidance that can be quickly, and reliably, transmitted to an emergency operations center and first responders in the event of a large toxic material release in an urban area.

A pilot exercise will be performed in collaboration with an urban emergency response team to demonstrate and explore what might be achieved during an emergency to mitigate adverse effects using such emerging advanced computing and networking capabilities and thus encourage their use.

Understanding Dynamic Responses to Hurricane Warnings – Implications for Communication and Research. National Science Foundation grant #1238317. http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=1238317. One year. $28,157 to principal investigator Benjamin Orlove, Columbia University, bso5@columbia.edu.

Recent increases in losses of lives and property from hurricanes in the United States have underscored the need to develop more effective ways to warn residents of approaching storms. Though physical scientists have made great advances in forecasting the movement and strength of storms, we know much less about how residents utilize and interpret the range of forecast products provided to the public, and how these forecasts affect decisions to take protective action. This re-

search will gain this knowledge using a Web-based computer simulation that allows residents to "live through" a hypothetical storm event by watching hypothetical weather broadcasts, and speaking with virtual friends and neighbors about the approaching storm.

This new technique will allow the research team to answer such basic questions as how residents make use of different media (such as television, the Web, and word-of-mouth) over time as a hurricane threat evolves, and which media are most effective in triggering decisions to take protective action. In addition, by varying the content of broadcasts and the nature of the storm threat, the research will enable investigation of factors that could potentially impair preparedness—such as repeated exposure to "false alarms," or forecasts of storms that do not materialize. Armed with such knowledge, the research will hopefully contribute to an understanding of the best way to communicate warnings so as to maximize public preparedness.

Hawaii-Fiji Collaboration: Workshop on Social-Ecological Resiliency to Climate Change, Preliminary Data Collection, and Methods Training. National Science Foundation grant #1160830. http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=1160830. One year. $47,148 to principal investigators Tamara Ticktin, Thomas Glambelluca, Alan Friedlander, John Lynham, and Tarcisius Kabataulaka, University of Hawaii, ticktin@hawaii.edu.

People who live on small islands are involved in tight feedback loops that make them acutely aware of how anthropogenic and natural influences affect their resources. Pacific Islanders have developed traditional ecological knowledge and resource management systems to deal with high levels of environmental uncertainty and resource scarcity, and may be able to teach us important lessons about adaptive capacity and resilience in coupled human and natural systems.

A cross-disciplinary team of researchers from the University of Hawaii and the University of the South Pacific will hold a planning workshop, teach a short training course in social-ecological methods and approaches to studying resilience in coupled human natural systems, collect baseline data, and develop a collaboration that has the capacity to test if and under what conditions traditional ecological knowledge and traditional resource management can enhance adaptation and resilience to climate change in the Pacific Islands.

Water Quality and Climate Change Adaptation to Extreme Precipitation Events. National Science Foundation grant #1151358. http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=1151458. Five years. $296,635 to principal investigator Javier Arce, University of Puerto Rico Cayey University College, Javier.arce.@upr.edu.

Given the likelihood that climate change will result in changes to the hydrologic cycle, it is important to understand how extreme precipitation events may affect water systems. This project analyzes how biophysical and socioeconomic elements of the landscape affect water quality and the adaptability of water systems to extreme precipitation events.

Climate change scenarios suggest more frequent extreme precipitation events and extended droughts, increasing the effect of contaminants on streams and underground aquifers. These events may also affect the resilience of social institutions and built structures that are necessary for water quality management and water distribution. This research will specifically address two central questions about changes in precipitation: first, how the spatial distribution and composition of land cover and land use in a watershed affects water quality when a region is exposed to extreme precipitation events; and second, which aspects of water governance promote sustainable, reliable sources of clean water in the region.

The research will be carried out in the La Plata Watershed in Puerto Rico, which has been exposed to large precipitation extremes from multiple hurricanes and displays a diversity of water management systems. By reconstructing the history of land cover change, stream water quality, water governance, and extreme precipitation events in the La Plata Watershed, this project will produce models that explain the primary factors that affect water quality and sustainability.

By demonstrating which social and environmental factors enhance water quality and sustainable access to potable water, these results may impact water policies and help define better water resource management strategies that can adapt to climate change.

Tsunami Run-up and Withdrawal Dynamics on a Sloping Beach with Discontinuous Macro-Roughness. National Science Foundation grant #1206271. http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=1206271. Three years. $658,373 to principal investigators Jennifer Irish and Robert Weiss, Virginia Polytechnic Institute and State University, jirish@vt.edu.

Tsunamis are a leading natural threat to coastal communities, and events such as the 2011 Japan, 2010 Chile, and 2004 Indian Ocean tsunamis caused widespread, crippling damages to coastal infrastructure. Yet, these events also revealed the role of mangroves and other vegetation as sustainable mitigation against tsunami hazard. This research will develop a quantitative understanding of tsunami inundation in regions with coastal forests.

This project combines detailed fluid dynamics modeling with physical experiments to study tsunami inundation in the presence of discontinuous coastal forest. Laboratory experiments will study inundation in discontinuous forest, represented by circular patches of cylinder arrays. Measurements will be used to quantify mean flow and turbulence statistics, the spatial flow field between two forest patches, run-up speed, and large-scale flow structures during withdrawal. Numerical analysis will be integrated with the experimental campaign to expand the parameter set for analysis and to assess the impact of temporal changes in forest characteristics.

Research from this award will lead to better quantification of tsunami hazard reduction, or amplification, as a function of coastal forest density and layout, topographic slope, and tsunami waveform. Ultimately, these advances will lead to more effective evacuation plans, more resilient building and infrastructure design, and more effective design of protective, sustainable forest features. These measures will help to reduce tsunami mortality, community displacement, and economic losses. The broader scientific impacts are in the applicability of the research outcomes to other coastal problems like tsunami wave propagation over coral reefs and storm surge propagation through wetlands, mangroves, and upland forests.

Conferences and Training

July 9-10, 2012
Resilient Communities in North America: Joint Public Advisory Committee Workshop
Commission for Environmental Cooperation
New Orleans, Louisiana
Cost: Not listed

This meeting on the theme of community and ecosystem resilience will be a participatory experience for attendees. Activities include listening to talks and panel discussions, sharing personal stories and experiences, brainstorming ideas and crafting recommendations for CEC Council members.

www.cec.org/Page.asp?PageID=924&SiteNodeID=1182

July 11-13, 2012
SPCC and Stormwater Compliance Workshop
EPA Alliance Training Group
Colorado Springs, Colorado
Cost: $895

This workshop will discuss oil SPCC (Spill, Prevention, Control, and Countermeasure) regulations. Topics include facility inspections, stormwater pollution prevention plan development, SPCC inspections, the Clean Water Act, the Oil Pollution Act of 1990, contingency planning, and minimum control measures and best management practices.

www.epaalliance.com/spcc&stormwaterworkshopjul12.html

July 12-13, 2012
Fourth International Conference on Climate Change
University of Washington
Seattle, Washington
Cost: $350

This conference will examine scientific and political perspectives on climate change. Topics include climate change and disaster management, the impact of climate change on water resources, climate change education for children, climate change vulnerability related to racial and income disparities, and national mitigation strategies.

on-climate.com/conference-2012/

July 23-25, 2012
Pandemics, Bioterrorism, and International Security
George Mason University
Fairfax, Virginia
Cost: $1,500

This course discusses national biodefense and public health challenges. Topics include lessons learned from SARS and the Avian Flu, decision-making lessons from the 1976 Swine Flu Scare, impediments to organizational change, the lack of law enforcement training in the identification of biological agents, the unique features of biological weapons, and political obstacles to developing medical countermeasures for bioterrorist and pandemic threats.

www.ocpe.gmu.edu/programs/health_public_safety/bioterrorism.php

July 24-25, 2012
Gulf Coast Forum
Risk Mitigation Leadership Forum Series
New Orleans, Louisiana
Cost: Free, closes July 6

This forum will help Gulf Coast communities prepare for extreme weather and the upcoming hurricane season. Topics include forecasting, evacuation protocols, land use and building practices, socioeconomic and environmental impacts, mitigation successes, and ways in which the insurance industry can promote effective mitigation.

www.mitigationleadership.com/

August 1-3, 2012
Disaster Interventions, Climate Change, Community Resilience and Humanitarian Aid when Empowering Local Communities
Durham University
Durham, England
Cost: $543

This conference will discuss ways in which humanitarian aid should be delivered. Topics include the appropriateness of postdisaster rebuilding efforts, cultural challenges in partnering with disaster survivors, examples of successful disaster interventions which included regulation and thorough evaluation, and the contribution of local knowledge, values, rituals, and religious belief systems in helping survivors cope with disaster recovery.

www.dur.ac.uk/conference.booking/details/?id=106

August 2-10, 2012
34th International Geological Congress
International Union of Geological Sciences
Brisbane, Australia
Cost: $1,195

The IGC was first held in 1878. This year's theme is "Unearthing Our Past and Future," with an emphasis on the Oceania region's geoscience strengths, innovations, and natural wonders. The scientific program is organized around 37 individual themes, including climate change, geohazards, the dynamic Earth, deep Earth, and many others.

www.34igc.org/

August 19-24, 2012
33rd General Assembly
European Seismological Commission
Moscow, Russia
Cost: $687

This conference will discuss recent significant earthquakes and seismological research. Topics include surface wave tomography for upper mantle studies, human-caused earthquakes, the earthquake history of Europe, earthquake forecasting and prediction, natural seismicity patterns, non-instrumental seismology, and artificial intelligence in geophysical data studies.

www.esc2012-moscow.org/

August 20-24, 2012
Australasian Natural Hazards Management Conference

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Massey University Joint Centre for Disaster Research and GNS Science
Christchurch, New Zealand
Cost: $450

This conference will discuss how to apply new hazards research to emergency management planning processes. Topics include improving postdisaster response and recovery strategies, reducing risk through land use planning, and developing effective warning systems. Pre- and post-conference workshops in the following topics will also be available: emergency management planning for local governments, the role of gender in disasters, rapid evaluation of dangerous buildings, and children, families and disasters

www.hazardseducation.org/conference/2012/2012index.php

August 26-30, 2012
International Disaster and Risk Conference
Global Risk Forum
Davos, Switzerland
Cost: $1,061

This conference discusses integrative risk management approaches for mega-catastrophes, country risk management, environmental and ecological risk, urban risk, societal and political risk, and health risk. Topics include disaster recovery and reconstruction, ecosystem services, land use planning, and critical infrastructure protection.

idrc.info/pages_new.php/IDRC-Davos-2012/831/1/

August 29-31, 2012
Second Nordic International Conference on Climate Change Adaptation
Nordic Climate Change Adaptation Research Network and Nordic Network on Adaptive Management in Relation to Climate Change
Helsinki, Finland
Cost: $325

This conference will discuss adaptation to climate change-related weather events, such as record heat waves, heavy precipitation, and high winds. Topics include severe weather impacts on ecosystem services, regional economic impacts, technical and social adaptation strategies, limits to adaptation and poor adaptation, links between adaptation and mitigation, and the legal, institutional, and financial aspects of adaptation.

www.nordicadaptation2012.net/

September 12-13, 2012
Disaster Risk Reduction
Disaster Management Institute of Southern Africa
Limpopo, South Africa
Cost: $617 before August 6

This conference will discuss natural hazard mitigation and response strategies. Topics include dealing with refugees and internally displaced persons, reducing the risk of fires in vulnerable settlements, addressing the effects of climate change, protecting communities from hazardous materials, educating communities about flood risk reduction and response, and providing humanitarian relief in Somalia and Sudan.

www.disaster.co.za/

October 15-19, 2012
Storm Warning: Water, Energy, and Climate Security in a Changing World
University of British Columbia
Banff, Alberta, Canada
Cost: Not listed

This conference will address six sources of uncertainty affecting water, energy, and climate security. These include unknowns about water availablity; downscaling climate modeling to local and regional areas; the costs of adaptation to climate change; and other topics. The conference is by invitation only, so interested parties should complete an application on the Web site.

www.stormwarning2012.ca/StormWarning2012_Temp_Brochure.pdf

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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.

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