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Risk Management REVIEW



RISK MANAGEMENT AND DECISION PROCESSES CENTER
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Introducing the Wharton Risk Center's Policy Incubator

This fall, the Wharton Risk Center launched a new initiative: the Policy Incubator. The Incubator supports novel approaches for increasing resilience by developing visionary ideas, working with innovative thinkers, and advancing implementable on-the-ground solutions.

As losses from natural disasters escalate around the world, so does the need for creative, cost-effective, and comprehensive solutions. The Policy Incubator will identify and assess potentially transformative strategies for building household and community resilience to extreme events, moving them toward adoption and implementation. The incubator will also serve to bring together innovative thinkers from the private and public sectors to address the challenges of natural disasters and a changing climate.

The structure of the Policy Incubator draws inspiration from business incubators, which help

If you have an interest in being involved with the Policy Incubator, please reach out to Carolyn Kousky at ckousky@wharton.upenn.edu.

launch promising product or business ideas of creative entrepreneurs. In a similar fashion, our Policy Incubator will take an early-stage policy idea and provide the analysis and development needed to see it through to readiness for piloting and implementation.

The Policy Incubator is:

- a thought leader, soliciting and supporting innovative and potentially transformative approaches to building resilience.
- a test kitchen, where promising policies are analyzed and researched, giving support and grounding to visionary ideas.
- an independent convener, bringing together diverse sectors to dissect challenges in order to design new solutions.
- a bridge between disciplines and sectors, combining perspectives, translating across boundaries, and promoting collaboration through evidence-based policy design and analysis.
- a voice for the public good, committed to resilience opportunities that benefit everyone.

The Policy Incubator will begin with a focus on five topic areas:

Closing the disaster insurance gap: helping build approaches for ensuring greater insurance coverage against disasters for families located in risky locations.

Upgrading flood insurance: developing new models for the public and private sector in managing flood risk to expand coverage, promote risk reduction, and improve risk communication.

Linking risk reduction and risk transfer: harnessing risk transfer strategies to help encourage greater investments in hazard mitigation by the private sector and public insurance programs.

Building resilience for everyone: ensuring that disadvantaged communities are not left behind in planning, preparation, risk reduction and recovery.

Creating policies for a dynamic coast: preparing for extreme events while preserving the amenities and economic benefits of water-front communities.

The Importance of Fairness in Designing the National Flood Insurance Program

Congress is now considering the reauthorization of the National Flood Insurance Program (NFIP) that provides flood insurance to most homeowners in hazard-prone areas. I urge Congress to design insurance programs that communicate to Americans their actual risk but also to place the concept of fairness explicitly on the table in determining how much individuals should pay for coverage. In this case, fairness means the impact that a sudden increase in premiums will have on the well-being of the affected individuals.

Empirical research reveals that public perceptions of fairness are likely to lead firms to take into account this factor in their pricing decisions.¹ For the same reason, one would also expect Congress to consider the fairness of their actions when they pass new legislation with respect to how insurance premiums will affect low income residents currently residing in flood prone areas.

When the National Flood Insurance Program (NFIP) was enacted in 1968 there was general consensus in Congress that premiums should reflect the risk of water-related property damage from hurricanes and floods. However, there was also a concern that for those residing along our nation's coasts and rivers who are subject to severe flood losses, high premiums would significantly reduce their property values and that this could become an unfair economic strain.

For this reason, the NFIP specified that homeowners living in high-risk areas at the time the law was enacted would be charged a subsidized premium to maintain the property value of their residences. The program instituted standards for new construction to avoid exacerbating vulnerability to flooding.

NFIP legislation enacted in 2012 and 2014 stipulated that flood insurance

In this case, *fairness* means the impact a sudden increase in premiums will have on the well-being of affected individuals.

premiums should eventually become risk-based. But there was also recognition that risk-based premiums may impose a financial burden on some working-class Americans who do not want to move away from their jobs, families, or communities.

Our elected representatives on both sides of the aisle espouse fairness across a wide range of issues, including trade, tax reform, and jobs. If they truly want to extend that allegiance to the principle of fairness, they might wish to consider offering some form of financial assistance to help low-income families afford flood coverage.

In the case of flood insurance, those subject to water-related damage should receive information on the cost of insurance that reflects their flood risk. If this risk-based premium exceeds a proportion of their income or housing costs, they should be given an insur-

Individuals must be made aware of their risk-based flood insurance premiums for two reasons:

1) risk based premiums communicate to those at risk the severity of the hazard they face and

2) they encourage those at risk to undertake loss reduction measures so their insurance will cost less

ance voucher or tax credit so they could afford insurance. A recent RAND study recommends that those whose total housing costs—including flood insurance premiums—exceed a certain percentage of their income be provided with financial assistance.²

It is important to encourage property owners in flood prone areas to invest in cost-effective loss reduction measures for their well-being and that of the country. Homeowners could be offered a long-term home improvement loan to pay for cost-effective ways to mitigate future losses, such as elevating the house or moving utilities to a higher floor, so that the annual cost of the loan would be less than their savings from the reduced risk-based premium.

This proposal is not only fair, but also encourages property owners to reduce future losses from inevitable disasters now. It also avoids using taxpayer dollars to assist uninsured and unprotected victims from hurricanes and floods who will demand and may receive federal disaster relief.

By considering the issue of fairness as an important criterion in the reauthorization of the NFIP, we will have taken a major step in enabling high-risk individuals to have coverage while at the same time maintaining the basic principles of insurance.

1. Kahneman, D.; Knetsch, J.L.; Thaler, R.H. (1986). "Fairness as a Constraint on Profit Seeking: Entitlements in the Market." *The American Economic Review*, 76(4): 728–741.

2. Dixon, L.; Clancy, N.; Miller, B.; Hoegberg, S.; Lewis, M.M.; Bender, B.; Ebinger, S.; Hodges, M.; Syck, G.M.; Nagy, C.; Choquette, S.R. (2017). *The Cost and Affordability of Flood Insurance in New York City*. Santa Monica, CA: RAND Corporation.

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Decision Science Perspectives on Hurricane Vulnerability

Although there have been great advances in hurricane prediction and response, the economic toll from hurricanes on U.S. communities continues to rise. In a recent article, Kenneth Broad, Kerry Milch, Ben Orlove and I present data from Hurricanes Earl (2010), Irene (2011), Isaac (2012), and Sandy (2012) to show that individual and household decisions contribute to this vulnerability.

Phone surveys of coastal residents conducted as hurricanes Isaac and Sandy approached the U.S. east coast during the 2012 Atlantic hurricane seasons reveal that people were concerned and took the warnings seriously. However, our results indicate that people have difficulty preparing for low-probability/high-impact events, even when accurately forecasted. These findings have implications for other natural hazards such as earthquakes, wildfires, landslides, and tsunamis.

In the case of hurricanes, we found that decisions made during the period spanning pre-season to the approach and landfall of a storm are subject to multiple cognitive biases and other decision making challenges.

We identify five decision biases or obstacles that interfere with resi-

dents' ability to protect themselves and minimize property damage: (1) temporal and spatial myopia, (2) poor mental models of storm risk, (3) gaps between objective and subjective probability estimates, (4) prior storm experience, and (5) social factors.

One approach to dealing with these cognitive and motivational obstacles is to structure the choice set for decisions so that the default option will increase the likelihood of the most beneficial decision being made.¹ In other words, decisions would be set up so that the default is taking some preparatory action, and an individual or household would have to purposefully decide to not take the action, rather than the default be doing nothing and having to consciously decide to take action. This purposeful structuring of information is referred to as *decision architecture* or *choice architecture*.²

Encouraging adoption of emergency preparedness measures will require actions at multiple levels—from individual decision makers to local government to global re-insurance companies. Some preparatory actions may play out years before an actual event, such as investment in hurricane-proof windows

Water is the big threat in hurricanes in most cases, yet all of the signals in warnings focus on wind: the Saffir-Simpson scale is a wind scale, the word “hurricane” connotes “hurricane-force wind” as the next step up from “gale-force,” and people routinely experience wind and therefore can mentally visualize it, but not flooding. Given the proliferation of media information available, one plausible explanation of incomplete or erroneous mental models is that people did not pay sufficient attention to evacuation warnings. That is, because they misunderstood the nature of the threats from hurricanes, residents had trouble interpreting evacuation notices and other warnings. “Near-miss” and “false alarm” storm warning experiences also impact judgments of the likelihood of future events.

This article is based on “Decision Science Perspectives on Hurricane Vulnerability: Evidence from the 2010-2012 Atlantic Hurricane Seasons” by Kenneth Broad, Kerry Milch, Ben Orlove and Robert Meyer. This research was supported by an NSF award (SES-0951516), an NSF-NOAA award (SES-0838650), and the Wharton Risk Management and Decision Processes Center.

and doors and, most importantly, home location choices.

Given the relatively short-term time frame of home ownership, people may be understandably reluctant to invest thousands of dollars in protections such as storm-proof windows and elevating structures. Thus, it is up to policymakers to incentivize citizens, through subsidies, code changes, or other insurance related mechanisms.³

1. Johnson, E.J.; Shu, S.B.; Dellaert, B.G.C.; Fox, C.; Goldstein, D.G.; Häubl, G.; Larrick, R.P.; Payne, J.W.; Peters, E.; Schkade, D.; et al. Beyond nudges: Tools of a choice architecture. *Marketing Letters* 2012, 23, 487–504, doi: 10.1007/s11002-012-9186-1.
2. Thaler, R.H.; Sunstein, C.R. *Nudge: Improving Decisions About Health, Wealth, and Happiness*, 1st ed.; Yale University Press: New Haven, U.S., 2008; ISBN 9780300122237.
3. Meyer, R.; Kunreuther, H. *The Ostrich Paradox: Why We Underprepare for Disasters*, 1st ed.; Wharton Digital Press: Philadelphia, PA, 2017; ISBN 978-1-61363-080-8.

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Demonstrating the Economic Value of Strong Statewide Building Codes

Twenty-five years ago (August 1992) Hurricane Andrew devastated south Florida becoming the costliest disaster in U.S. history at the time. Andrew revealed that construction practices and code enforcement in Florida for the 20 years prior had deteriorated, needlessly increasing damage when the hurricane struck. In response, the state of Florida created the Florida Building Code (FBC), fully enacted in 2001, as the strongest statewide building code in the United States. The FBC was based on national model codes developed by the International Code Council, heavily emphasizing wind engineering principles.

These new code changes increased construction costs, but had the potential of reducing future damages from wind storms in a state highly vulnerable to hurricanes. As increased costs of construction are often the fundamental argument against more stringent codes, a key question is whether the reduction in damage from hurricanes exceeded the increased cost to comply with the FBC.

To answer this question, working with colleagues from Austin College and the National Center for Atmospheric Research, we conducted a study of the difference in realized damage between homes built before and after enactment of the FBC from the wind storms that struck Florida in the 10 years after enactment.

During this time, Florida experienced seven land falling hurricanes, four of which reached category 3 or higher on the Saffir-Simpson scale. This created an ideal test of the 2001 enacted code. In our analysis, we first quantified the reduction of residential property wind damage due to the implementation of the FBC utilizing realized insurance policy, claim, and paid insured loss data across the entire state of Florida spanning the years 2001 to 2010 provided to us by

	BCA 53% Reduction	BCA 72% Reduction
ISO Sample	3.50	4.75
With Deductibles	5.84	7.93
All Florida	2.67	3.63
With Deductibles	4.46	6.06

Table 1. ISO Sample = Florida property/casualty insurance industry data from 2001-2010. **All Florida** = results from a catastrophe model designed for the state of Florida which estimated an average annual wind loss for all residential properties in Florida of \$3.156 billion (\$5.26 billion with deductibles).

the Insurance Services Office (ISO). We found that homes built to the FBC suffered 53% less damage than homes built prior. In addition, homes built to the FBC were less likely to file a claim than older homes. When this is taken into account, the full reduction in damage to new versus older homes is a 72% reduction in damage.

Although the reduction in damage from homes built to the FBC is striking, the economic public policy litmus test of the statewide code is how this benefit compares to the cost of its implementation. Our claims-based empirical loss estimations enabled us to further assess the economic effectiveness of the FBC through a benefit-cost analysis (BCA). Table 1 shows that for different samples of our loss data our estimated BCA ratios range from a low of 2.67 to a high of 7.93. In other words, comparing the increased construction cost to the expected reduction in windstorm damage across the life of the home provides anywhere from two to eight dollars in expected damage reduction (benefit) for every dollar of increased cost. These results easily pass a benefit to cost test suggesting that the FBC is good public policy from an economic perspective.

Finally, we use our BCA results to calculate a payback period for the

investment of stronger codes. For example, assuming a 72% reduction in loss and including deductibles for all residential property in Florida, the BCA ratio of 6.06 translates to a payback of just over eight years. This payback result is important for gauging political support for the enactment of such a new statewide code. Payback periods that approach the typical mortgage term of 30 years would be likely difficult to garner significant public support and that is not what our analysis indicates for the FBC.

Our research study is pertinent to a current public policy concern in Florida that adherence to the FBC leads to increased costs of construction. Our results indicate, however, that despite the increased costs, the strong code still provides sufficient economic value given the inherent hurricane risk Florida faces.

For more information, see the working paper "Economic Effectiveness of Implementing a Statewide Building Code: The Case of Florida" <http://whr.tn/2h4pr30>.

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Barriers to Catastrophic Risk Insurance: Transportation Infrastructure

The U.S. transportation network is comprised of a wide range of infrastructure systems—both publicly and privately owned—vital to the U.S. economy and way of life. The costs of restoring infrastructure after disasters are now higher due to a huge increase in the value at risk. Seventy-two percent of hurricane disaster relief since 2005 has gone to programs for public facilities, including billions of dollars for restoration of public utilities, roads, and bridges. Following Hurricane Sandy, the federal government paid \$4.2 billion in relief to the New York Metropolitan Transit Authority; only \$800 million in damage was paid by insurance.

The Wharton Risk Center is researching the role of insurance in providing financial protection against infrastructure damage and encouraging investment in loss reduction measures. The project, “Identifying and Reducing Barriers to Infrastructure Insurance” is funded by the **Department of Homeland Security’s Critical Infrastructure Resilience Institute (CIRI)** at the **University of Illinois**. Study efforts include review of relevant technical literature, and interviews with managers from the insurance and infrastructure sectors. This investigation provides insight on barriers and opportunities for improving transportation infrastructure resilience to catastrophic events.

Emerging and non-modeled risks present substantial challenges to insurance firms. Three emerging risks identified in our interviews are climate change, cyber risk, and terrorism.

- ◇ Uncertainty associated with climate change impacts is a significant challenge to insurers who need to quantify risk, and to infrastructure managers who must factor climate change risks into short-term and long-term planning and capital projects.
- ◇ Pivotal cyber events could have far-reaching impacts; insurance companies do not yet have a high enough confidence level to fully insure against cyber-related losses. Infrastructure managers want cyber policies with a broad range of coverage, including areas that may be difficult for insurers to cover currently.
- ◇ Terrorism coverage is offered under the Terrorism Risk Insurance Act (TRIA), but applies only to events that are labeled as terrorism by the federal government. Some infrastructure managers choose not to purchase this coverage due to the limitations on covered events, or choose not to insure for terrorism risk if they believe their location is not a target.

The following have been identified as key needs:

- **More and better data:** Availability of and accessibility to data on insured and uninsured infrastructure losses and effectiveness of resilience measures is needed for predictive analytics to aid infrastructure owners and managers in evaluating and choosing risk management and resilience measures. These data will also guide insurance companies in developing new products such as multi-year insurance contracts for this market and establishing risk-based rates. Governance of data sharing is a related issue.
- **Metrics to measure resilience:** Like data, metrics are important for evaluating resilience measures and for determining necessary or important insurance coverage types and amounts. Metrics to track resilience are needed for risk modeling and in underwriting. Metrics also provide a framework for measuring and improving resilience and in adjusting premiums to reflect risk.
- **Risk engineering:** Risk engineering can help pinpoint cost-effective ways for infrastructure systems to allocate their limited funds for resilience improvements. Insurers can estimate how resilience measures will impact exposure and premiums, and enable infrastructure managers to understand their exposure, undertake loss reduction measures and obtain insurance coverage at an attractive premium.
- **Loans for resilience financing:** With many demands on financial resources for infrastructure systems, loans for financing resilience improvements are key to reducing future losses. Government loans are sometimes available, but these don’t cover all the costs, and infrastructure managers can’t always justify the residual expenses. Tying loans for resilience improvements to insurance premium reductions could justify the costs of these improvements to infrastructure managers.
- **Federal disaster relief funds:** Infrastructure managers and insurers we interviewed believe that the federal government should and will provide assistance in the aftermath of a catastrophic event. Insurers cite limitations in the amount of capital available in the (re)insurance market to provide high policy limits for catastrophic losses. While federal disaster funding is needed after truly catastrophic events, expectation of aid can create a moral hazard, curbing insurance and resiliency of infrastructure.

Our further investigations will study moral hazard in infrastructure risk management and the development of metrics to assess the financial resilience of infrastructure systems.

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Look to Caribbean Risk Insurance Model for U.S. Hurricane Recovery

The first few days after a disaster, as experienced with Hurricanes Harvey and Irma, are about emergency response: making sure people are safe, reuniting families, securing housing, filling necessities and restoring life-lines. Then, as days shift to weeks and then months and even years, the slow process of rebuilding is undertaken. At every step of the way is the question of financing. Are there dollars available for what needs to be done? Who will pay for it? How will the costs be shared?

Government provides critical financing after a disaster in the United States, whereas the Caribbean islands are largely dependent on donors. In both cases, however, aid can be slow to arrive and insufficient. A common challenge is the short-term liquidity constraints faced in the aftermath of a large storm.

To help solve this problem for small island nations, a novel scheme began a decade ago in the Caribbean. Designed to provide financial assistance to countries that wouldn't have the resources to recover on their own, the Caribbean Catastrophe Risk Insurance Facility was the first entity of its kind. The CCRIF, a type of risk pool among countries, was designed to provide payouts when a hurricane or earthquake struck. It has since expanded in both geographic scope, now covering Central American countries, as well

The Caribbean Catastrophe Risk Insurance Facility (CCRIF) is a type of risk pool designed to provide payouts when a hurricane or earthquake strikes.

as perils, having added excess rainfall coverage. Currently, 17 countries are members.

Countries can choose to purchase up to \$100 million in coverage for both hurricanes and earthquakes, paying a premium that is based on their risk. Initial capitalization was funded by donations from agencies and multiple countries. Some of the risk is now transferred to reinsurance and the capital markets. This model allows for much cheaper protection than if a country were to try on their own to purchase such insurance.

Payouts from CCRIF are made within two weeks of a disaster. The reason payouts can be so timely is due to the use of something called a parametric trigger. This means that the payout is based on measurable aspects of the disaster itself, not on damages. This type of policy allows for extremely rapid payment, since no loss assessment processes or loss adjusters are necessary.

For hurricanes, the CCRIF uses data from the National Hurricane Center and for earthquakes, data from the U.S. Geological Survey. This independent and public data is used instead of actual damage estimates as the basis for determining payments.

CCRIF policies are designed to cover short term liquidity needs, not to fully cover all repair and rebuilding costs. For example, after the 2010 earthquake in Haiti, the CCRIF money was the first to flow to the country and was used to pay the salaries of emergency response workers.

Since 2007, the CCRIF has made payouts 22 times for 10 countries totaling \$69 million. The CCRIF has estimated it will now be making payments for Hurricane Irma of \$15.6 million to Antigua and Barbuda,

The benefits of parametric policies are the low cost and rapid payout.

The challenge is that the payout may be more or less than the actual damages sustained.

Anguilla, and St. Kitts and Nevis. Since its creation, entities similar to the CCRIF have been set up in other places around the world, including the Pacific islands and Africa. The concept of parametric insurance is also at the core of microinsurance, used to provide coverage for low-income households in developing countries.

The CCRIF model of an insurance pool based on a parametric trigger to provide fast liquidity post-disaster could be applied in other contexts here in the United States. The benefits of parametric policies are the low cost and rapid payout. The challenge is that the payout may be more or less than the actual damages sustained. Rather than considering parametric policies a substitute to indemnity-based insurance, or to all governmental assistance, however, it may be more useful to consider them an essential tool for certain classes of disaster financing needs that are not well met with our current system.

For instance, state and local governments could use such policies to access relief funds quickly or to fill in gaps in federal assistance. The state of Hawaii is already exploring this possibility. A CCRIF-type model could also be used for more novel

types of coverage, such as community flood insurance, which would provide a base level of assistance to all residents of a flood-prone area.

Parametric products are also already being developed in the United States for households to cover such expenses as emergency repairs or temporary housing. While such policies would not be well-suited to covering the full costs of rebuilding a destroyed home, they could provide more and faster funds than either disaster aid or traditional insurance to meet immediate needs. A parametric product could also be targeted at certain populations that are currently uninsured, such as low-income families that might otherwise face spiraling costs after a disaster. This may require some initial donor assistance, as was the case with the CCRIF.

As disaster losses continue to escalate, novel financing approaches will be needed. The United States could learn from the CCRIF on how risk pooling models, making use of objective and public data, could help improve household and community resiliency. Planning for disaster financing before the event can help ensure needs are met swiftly, reduce uncertainty for victims, and help guarantee that public dollars are deployed to produce the greatest benefits.

This article originally appeared in *The Hill*, September 15, 2017. Reprinted with permission. <http://thehill.com/opinion/energy-environment/350812-look-to-caribbean-risk-insurance-model-for-us-hurricane-recovery>

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Improving Disaster Financing

Resources for the Future and the Wharton Risk Management and Decision Processes Center brought together researchers, policymakers, and private sector experts on the role of government in disaster insurance markets. At the workshop, “*Improving Disaster Financing: Evaluating Policy Interventions in Disaster Insurance Markets*,” scholars presented papers on six governmental disaster insurance programs: the [National Flood Insurance Program](#); the [California Earthquake Authority](#); [Florida’s State Wind Pools](#); the [Terrorism Risk Insurance Program \(TRIA\)](#); the [UK’s New Flood Reinsurance Pool](#); and the potential for [All Hazard Homeowners Insurance](#).

Participants discussed the ideal roles of the public and private sectors in disaster risk financing and evaluated each program against a range of topic areas, such as incentives for risk reduction, take-up rates, how costs are distributed, and the influence on the private market. The series of papers prepared for the conference in November 2016 conference will be published in a special issue of *Risk Management and Insurance Review* with Carolyn Kousky and Howard Kunreuther’s synthesis paper: [Defining the Roles of the Public and Private Sector in Risk Communication, Risk Reduction, and Risk Transfer](#).

We thank the event sponsors: the American Academy of Actuaries; the American Risk and Insurance Association; Risk Management Solutions; the Society of Actuaries; and XL Catlin. For more information on the conference, papers and issue briefs, please visit <http://www.rff.org/research/collection/improving-disaster-financing>.

The Wharton Risk Management and Decision Processes Center is undertaking a study on the private flood insurance market, funded by the **Department of Homeland Security’s Flood Apex** program. The project has three objectives: (1) document the current state and nature of the private flood insurance market across the country; (2) identify and analyze the factors that influence the amount and form of private flood insurance in the U.S.; and (3) develop policy recommendations to promote an effective public-private partnership for closing the flood insurance gap.

Jeffrey Czajkowski and Carolyn Kousky attended the **DHS S&T Homeowner Flood Insurance Roundtable** in Washington DC in March 2017. Discussion at the roundtable, which was in support of the DHS S&T Flood Apex program, focused on challenges facing flood insurance uptake among homeowners, and strategies for increasing the number of flood insured structures including understanding the needs of industry groups that sell flood insurance. For more information, visit [DHS S&T National Conversation on Homeland Security](#).

Pricing Storm Surge Risks in Pensacola, Florida

Risk-based insurance premiums, mitigation, and affordability

Pensacola, Florida, located in Escambia County, is the study area for a comprehensive flood risk and insurance analysis by the Wharton Risk Center. About 17% of Florida's National Flood Insurance Program (NFIP) claims are from Escambia County even though the county is home to only 2% of Florida population. Research funded by the **Florida Department of Emergency Management**, involves flood hazard assessment, calculation of risk-based premiums, and the impact of risk-based premiums on the affordability of residential flood insurance in the area.

For our flood hazard assessment we acquired storm surge data (<https://www.u-surge.net/>) that include flood elevations for the 10%, 4%, 2%, 1%, and 0.2% annual chance surge events. The surge data are more granular than the NFIP Digital Flood Insurance Rate Maps (DFIRM) data because DFIRMs show flood elevations for only the 1% annual chance flood zones, known as Special Flood Hazard Areas (SFHAs). Showing only 1% annual chance flood elevations does



not give a complete picture, as there are structures within SFHAs that are at risk to floods with greater probabilities than 1% annual chance of occurrence. Without granular flood risk data, it is impossible to calculate risk-based insurance premiums. Risk-based insurance premiums are an important signal to homeowners about the flood risk they face; if insurance premiums are artificially low, homeowners are often not motivated to mitigate their flood risk.

We calculated risk-based flood insurance premiums for storm surge, and compared these rates with NFIP premiums that we estimated using the NFIP rating manual (October 2016 version). Figure 1 shows the average premiums per \$100 of building and contents coverage for homes in each surge risk zone using both the NFIP and surge data. For the greatest surge risk zones (10% and 4% annual chance), NFIP premiums are lower than surge risk-based premiums. But in the lower surge risk zones (2%, 1%, and 0.2% annual chance), NFIP premiums are greater than surge risk-based premiums.

We investigated whether elevating homes would address affordability of surge risk-based flood insurance. We found that many homes in Pensacola have a concrete slab foundation that is costly to elevate, so the potential savings in premiums did not justify the annual costs of low-interest loans for elevating the houses.

The Wharton Risk Center is continuing this research in Pensacola by examining additional flood risk mitigation actions including, flood barriers, drainage improvement projects, and acquisition and relocation of homes. These efforts will contribute to a comprehensive understanding of cost-effective methods to mitigate flood risks, which is especially important for the resilience of coastal cities like Pensacola that anticipate a future with increased flood risks.

For more information, see Montgomery, M., and Kunreuther, H. (2017). [Pricing storm surge risks in Florida: Implications for determining flood insurance premiums and evaluating mitigation measures.](#)

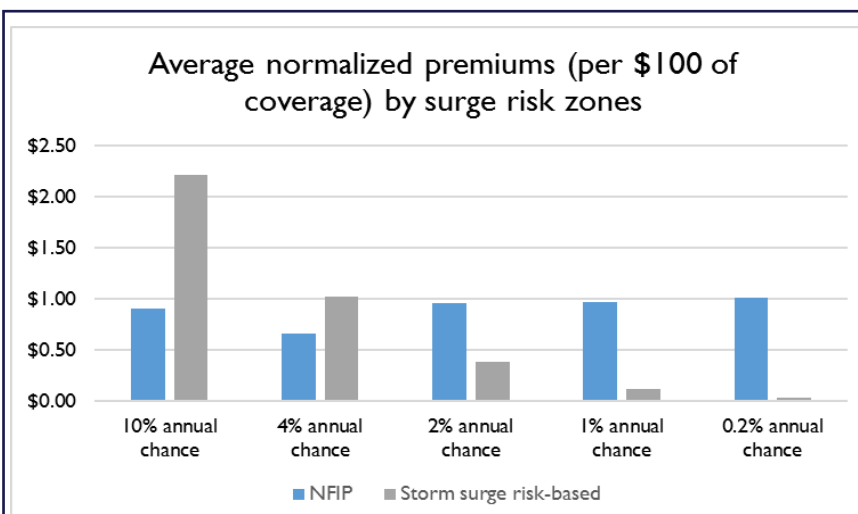


Figure 1. Average normalized NFIP and storm surge risk-based premiums by surge risk zones for Pensacola single-family homes. Premiums are based on \$1,000 deductibles for building and for contents.

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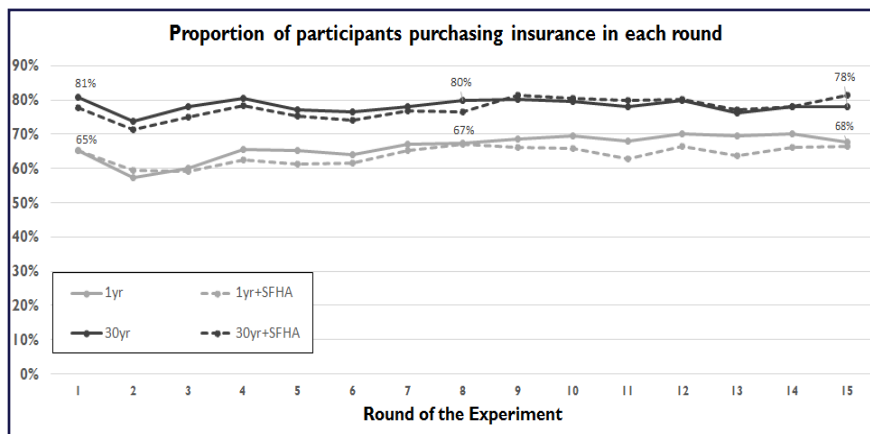
A Better Way to Communicate Flood Risk?

A behavioral science investigation of probability framing on insurance-purchasing behavior

High risk flood zones, known as Special Flood Hazard Areas (SFHA), are defined by FEMA as areas that are in the 100-year flood zone, that is, which have a 1 percent annual chance of experiencing a significant flood. Even though homeowners with a federally insured mortgage in these high risk zones are required to have flood insurance, the insurance penetration rate remains surprisingly low. One reason for the low insurance penetration may be that people do not fully appreciate their risk of flood. Homeowners may be unaware that a risk of 1 percent annually translates into about a 26 percent chance of at least one such flood over a 30-year mortgage.

What if people were presented with the 30-year flood risk instead of the annual flood risk? Would it affect insurance purchasing behavior?

We recruited 2,077 participants to participate in 15 rounds of an incentivized experiment on flood insurance. At the beginning of each round, each participant was endowed with assets worth 95,000 talers (a fictitious currency: 1000 talers = \$1.00), consisting of a house worth 90,000 talers and 5,000 talers in cash. Participants were told that if a flood occurred, their house would experience 45,000 talers in damage. In each round of the experiment, participants were given the option of purchasing flood insurance for 450 talers to protect the value of their house. After deciding whether to purchase flood insurance, participants found out whether they experienced a flood. Participants fell into one of three groups: (1) they did not experience any flood over the course of the experiment, (2) they experienced a flood early in the experiment, during round 4, or (3) they experienced a flood later in the experiment, during round 11.



For the main experimental manipulation, half the participants learned the likelihood of flood occurring as an annual chance (1%); the other half learned the likelihood as a chance over 30 years (26%). We broke these two groups up further: half the people in each condition learned they were in an SFHA, whereas the other half did not.

Results reveal that providing the 30-year likelihood increased insurance uptake by an average of 16.6 percent. Surprisingly, telling people that they lived in an SFHA did not have an impact on purchasing behavior. Though the lab environment may be quite different from the real world, these results suggest that changing the way probabilities are framed may have a larger impact on purchasing behavior than designating zones as “high” or “low” risk.

A second interesting finding was that with respect to flood experience within the experiment, people who experienced a flood (either in round 4 or round 11) were between 0.8 percent and 1.9 percent more likely to purchase insurance for each round that passed since the flood, even though they were told that the likelihood of a flood was the same in each round. As more time passed without

Providing information on the 30-year likelihood increased insurance uptake by an average of 16.6 percent.

Surprisingly, telling people that they lived in an SFHA did not have an impact on purchasing behavior.

experiencing a flood, people acted as if they were “due” for a flood, that is, that a flood was more likely to occur.

These findings provide promising evidence for using cumulative probabilities as a risk communication strategy, although further research is required to assess its impact outside the lab.

For more information, see Chaudhry, SJ, Hand, M, and Kunreuther, H. (2017). An experimental investigation of the effect of presenting cumulative probabilities and risk zone labels on the purchase of flood insurance. Working paper.

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Legacy of Harvey and Irma Turns on FEMA's Post-Disaster Response

Hurricane Harvey destroyed vital roads, public infrastructure, and hundreds of thousands of homes across Houston and southeast Texas. In Florida, Hurricane Irma has left communities reeling with widespread blackouts, severe coastal flooding, and crippled telecommunications systems. When floodwaters finally recede and the debris is cleared, recovery will be long. FEMA will be in these areas for years, and costs will reach well into the billions.

In September, Congress provided an initial \$15 billion to FEMA, HUD, and the Small Business Administration (SBA) for disaster relief. And in October, after wildfires ravaged California and Hurricane Maria tore through the Caribbean, another \$36.5 billion package was approved, with \$18.7 billion allocated to FEMA's disaster relief fund. A third, and even larger, allocation is expected in the coming months as states and local governments seek billions to finance long term recovery efforts. In response to Harvey alone, 792,000 individuals registered for federal assistance and 42,000 were placed in temporary housing.

How will FEMA help the affected communities and families in the coming months and years? And how much federal funding can these areas expect? FEMA's response to previous hurricanes may provide some clues.

FEMA spends more on hurricane recovery than on any other type of disaster. Data from OpenFEMA indicate that of the \$81.1 billion (nominal dollars) of post-disaster aid the agency has distributed from 2005 to 2016, 70% was for hurricane response and recovery. Severe storms and floods accounted for another 25%, and all other disasters just 5%.

FEMA delivers post-disaster assistance through three major

programs: the Public Assistance (PA) Program, the Individuals and Households Program (IHP), and the Hazard Mitigation Grant Program (HMGP).

The PA program provides funds to state and local governments for debris removal, emergency protective measures, and the repair and reconstruction of public facilities. IHP provides two types of assistance: Housing Assistance (HA), which goes toward the repair or replacement of damaged homes or temporary housing needs, and Other Needs Assistance (ONA), which may be used to cover disaster related expenses such as transportation, medical expenses, funeral costs, or replacing personal property.

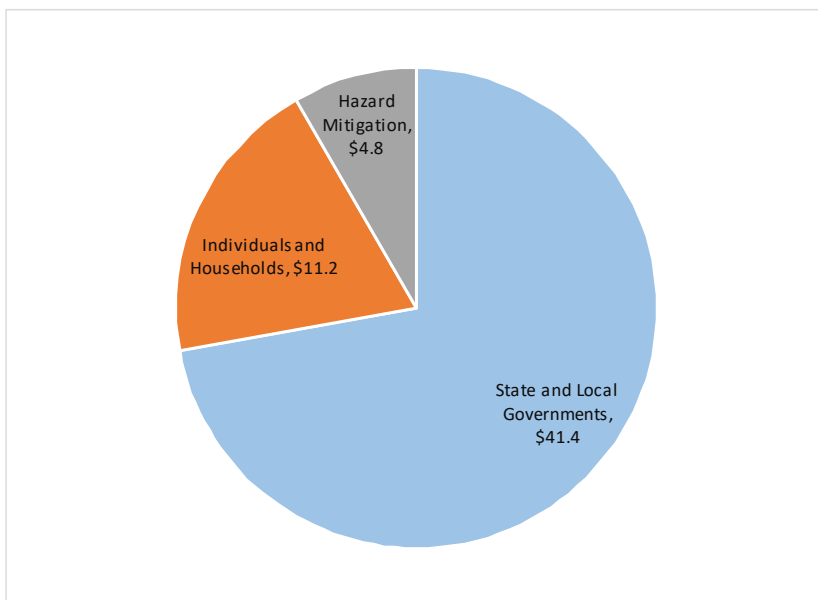
Finally, HMGP provides funds for measures to reduce damages from future disasters. This includes actions like implementing flood control projects, elevating homes, and buying

out high risk properties to preserve as open space.

Since 2005, 72% of FEMA's hurricane relief funds (\$41.5 billion) have gone to state and local governments through the PA program. Roughly 20% (\$11.2 billion) was provided to individuals and families through IHP, and another 8% (\$4.8 billion) through HMGP.

The largest single share of PA funds (\$15.2 billion) was used to repair public buildings. Another \$7.8 billion was used for emergency protective measures, such as search and rescue operations; \$5.9 billion for public utility repairs; \$5.7 billion for debris removal; and the remainder to repair roads and bridges, water control facilities, and recreational property.

Of the 20% of total funding that went to households, more than half went to rental assistance for



FEMA Disaster Assistance Obligations for Hurricane Recovery 2005-2016
(in billions of nominal dollars)

displaced residents; 21% to help victims make their damaged homes safe and habitable (program requirements stipulate that HA repair funds may only be used to make a home “safe, sanitary, or functional” and are not intended to return a home to its pre-disaster condition); and 26% for ONA. In general, IHP is available only if an applicant cannot secure funds from another source such as insurance, charity, or loans from the SBA. Grants are currently limited to \$33,300 per household, though calculations suggest that the average grant, in 2016 dollars, is for just \$5,500, which is likely not enough to cover a family’s disaster-related expenses.

HMGP, the last major tranche of FEMA assistance, is a function of the total relief FEMA provides under a major disaster declaration. HMGP funds have been used primarily for mitigation reconstruction (19%; building an improved, elevated structure where an existing building and/or foundation has been damaged), property buyouts (13%), and flood control measures (12%). Lesser amounts have been allocated to property elevations (5%) and measures to protect utilities and infrastructure (5%).

Because insurance makes recovery funds available more quickly and enables victims to recover more fully (given sufficient coverage levels), it is a far more effective tool for meeting post-disaster needs. However, only 15% of households in Harris County, Texas have flood insurance. Estimates indicate that total residential flood losses from Harvey will range from \$25 billion to \$37 billion, with 70% uninsured. Given these low coverage levels and FEMA’s expectation that this will be one of the largest housing recovery missions the nation has ever seen, overall IHP spending for Harvey will likely be very high, possibly on par with Hurricanes Sandy (\$1.5 billion) and Katrina (\$6.5 billion).

If history is an indication, the vast majority of FEMA’s resources will be dedicated to rebuilding public facilities and infrastructure.

The aid provided to individuals will focus largely on temporary housing needs. And a smaller share of funds will be used to mitigate damage from future storms.

Thus, if history is any indication, the vast majority of FEMA’s resources will be dedicated to rebuilding public facilities and infrastructure. The aid provided to individuals will focus largely on temporary housing needs. A smaller share of funds will be used to mitigate damage from future storms.

For Houston, an unprecedented storm but familiar impacts

For better or worse, Harris County is well-versed in flood recovery and FEMA’s assistance programs. While certain meteorological characteristics of Hurricane Harvey were unprecedented, setting rainfall records across the affected areas, southeast Texas is no stranger to flood losses. Harvey

is Houston’s third 500-year flood in the past three years. In just the last twelve years, hurricanes, severe storms and floods in Harris County have led to seven major disaster declarations and \$1.1 billion in FEMA assistance.

While some of that money went to mitigation measures such as flood control projects and property buyouts, a larger share was used to rebuild public facilities, infrastructure, and homes. Yet, in many cases, structures are not rebuilt to avoid future flood damages—meaning that when the recovery is complete and FEMA leaves, flood damaged properties may be just as vulnerable as they were on the day Harvey struck.

Both Texas and Florida should use the billions of taxpayer dollars they receive in the coming months to rebuild to higher standards—elevating public facilities and homes well above base flood elevations and buying out or removing repeatedly flooded properties from the floodplain. Yet, as one of the nation’s most thriving and populous cities, and one that has been repeatedly pushed to the brink by catastrophic floods, Houston has an especially unique opportunity to change course and show the country how to rebuild with the future in mind. In doing so, it can become an exemplar of resilience and protect its residents from the damage and devastation they endure today.

This article first appeared in *BRINK: Legacy of Harvey and Irma Turns on FEMA’s Post-Disaster Response*. Sept. 15, 2017.

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The Impact of Waiving Environmental Regulations

Recent PPR seminar examines effects on air quality and fuel prices from waiving environmental regulations

By Bryan C. Williamson | [Penn Program on Regulation](#) | <https://www.theregreview.org/>

Hurricanes have ravaged the nation's coasts over the past twelve years, making Katrina, Sandy, and Harvey household names.

In addition to the damages and economic losses associated with extreme weather events, natural disasters and other catastrophic events can restrict fuel supply by restraining oil refinery operations or impeding the transport of fuel through pipelines and ships. More specifically, these calamities may severely disrupt so-called "boutique" fuel markets, where regulations mandate specialized fuel content unique to a particular state or region. Such disruptions usually necessitate a response from the regulator—often the U.S. Environmental Protection Agency (EPA)—to avoid spikes in fuel costs for both the industry and consumers.

At a recent seminar sponsored by the Penn Program on Regulation (PPR), Joseph Aldy, a professor at Harvard University's John F. Kennedy School of Government, examined government waivers of fuel content regulations and their impact on local air quality and fuel prices. Reflecting on his experience working with fuel regulations in the public and nonprofit sectors, Aldy observed that waivers present an opportunity to assess the social benefits of state and regional fuel regulations.

Aldy focused on boutique fuel regulations under the Clean Air Act. Boutique fuel regulations typically affect specific urban regions with poor air quality that require special treatment of gasoline to reduce emissions of ozone precursors. Aldy noted that although the impact of these regulations on air quality is unclear, they may affect both the costs of fuel refining and the consolidation of market power in the industry. In addition, such standards could well increase

fuel markets' vulnerability to supply shocks resulting from destabilizing events, such as pipeline disruptions or natural disasters.

To address supply shocks, the EPA administrator has the authority to waive boutique fuel regulations. The 2005 Energy Policy Act permits the administrator to waive these regulations under "extreme and unusual" circumstances that could not have reasonably been foreseen or prevented. Waivers must serve the public interest and are granted only after consultation with the U.S. Department of Energy.

EPA decisions to waive fuel content regulations are usually made within a week or two after an event occurs, which results in a supply shock. The waiver process begins when a governor petitions EPA to waive boutique fuel content regulations. Next, EPA consults with the Energy Department, industry leaders, and state officials, and then acquires information about the inventory of local fuel stocks and the breadth of the supply shock. At this point, EPA either approves the waiver for a period of up to twenty days or declines to issue a decision.

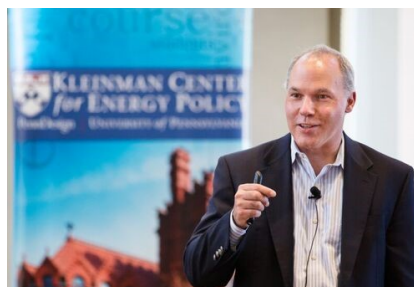
Since EPA first began issuing waivers in 2005, there have been sixty waivers of boutique fuel regulations, with 85 percent of them granted in the wake of hurricanes, according to Aldy.

In an initial analysis, Aldy found a statistically significant increase in ozone concentrations when regulations were waived in areas operating under a boutique standard set by the California Air Resource Board (CARB). However, he did not find any statistically significant impact from waivers on ozone concentration in communities adhering to other, non-CARB standards, known as Reid vapor pressure

and reformulated gasoline standards. According to Aldy, weather explains much of the variation in the data, but waiving CARB fuel content regulations correlates with an increase of about 6 percent in hourly average ozone concentrations and an increase of about 9 percent in eight-hour average ozone concentrations.

To determine the social benefit of these waivers, Aldy plans to compare air quality, fuel prices, and human health outcomes in the aftermath of natural disasters when EPA has waived boutique fuel regulations to those values corresponding with pre-2005 natural disasters that occurred before EPA had waiver authority.

Aldy hopes his research will illuminate the impact of government regulations, not only when they are enforced, but also when they are relaxed in the aftermath of natural disasters.



The seminar was organized by the [Penn Program on Regulation](#) as part of its Risk Regulation Seminar Series, and was jointly sponsored by the Wharton Risk Management and Decision Processes Center and the [Kleinman Center for Energy Policy](#).

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Designing Safety Regulations for High-Hazard Industries

Research on regulatory design by Penn Law professor Cary Coglianese helped shape a report by the **National Academies of Sciences, Engineering, and Medicine** on regulating high-hazard industries, such as pipeline transportation, chemical manufacturing and offshore oil and gas development.

The report, “[Designing Safety Regulations for High-Hazard Industries](#)” examines key factors relevant to government safety regulators when choosing among regulatory design types, particularly for preventing low-frequency, high consequence events. In such contexts, safety regulations are often scrutinized after an incident, but their effectiveness can be inherently difficult to assess when their main purpose is to reduce catastrophic failures that are rare to begin with. One way for regulators to evaluate their work is to identify, track, and analyze data on “incident precursor events” or near misses.

The report was conducted at the request of the **U.S. Department of Transportation’s Pipeline and Hazardous Materials Safety Administration**. Coglianese is one of 14 experts from academia, public policy, and industry serving on the **Committee for a Study of Performance-Based Safety Regulation**, a project of the Academies’ **Transportation Research Board**.

The report can be downloaded at <https://www.nap.edu/catalog/24907/designing-safety-regulations-for-high-hazard-industries>. For more information, see *The Regulatory Review*, <https://www.theregreview.org/2017/10/04/coglianese-menzies-safety-regulations-hazard-industries/>.



Cary Coglianese is the Edward B. Shils Professor of Law and Professor of Political Science at the University of Pennsylvania where he serves as director of the Penn Program on Regulation, and he is a research fellow of the Wharton Risk Center. He specializes in the study of regulation and regulatory processes with an emphasis on the empirical evaluation of alternative regulatory strategies. Email: cary_coglianese@law.upenn.edu.

As climate change advances we can expect more weather related disasters. On the **Kleinman Center for Energy Policy’s** podcast, “*Energy Policy Now*,” Howard Kunreuther, co-director of the Wharton Risk Management and Decision Processes Center, discusses the challenge of balancing support for communities at risk for natural disaster with the economic and political challenges to doing so, and how these issues may be addressed in the future. (Audio) <http://kleinmanenergy.upenn.edu/energy-policy-now/climate-change-and-future-risk>.

UDECIDE (Understanding Decision Climate Interactions on Decadal Scales)

Water resource and flood managers increasingly require predictive climate information to enable appropriate planning and adaptation to future conditions. A relatively new branch of climate science, known as **decadal prediction**, seeks to predict the time-varying trajectory of climate (not just the long-term trend) over the next five to thirty years.

The major goal of this UDECIDE (Understanding Decision Climate Interactions on Decadal Scales) project is to understand the role of decadal climate prediction in water resource and flood management. The Risk Center is focusing on decision experiments to explore how the communication of prediction uncertainty affects decisions, and how this depends on the prediction timescale.

Jeffrey Czajkowski presented research on “Economic Effectiveness of Implementing a Statewide Building Code: The Case of Florida” at **Economic Impact of Codes and Standards: A Workshop on Needs and Resources** in Washington, DC.

The workshop was hosted by the **National Fire Protection Association (NFPA)** and the **International Code Council (ICC)** to review case studies, data, and methodologies measuring economic impacts from various industries and sectors and assess how they can inform similar studies related to codes and standards.

The Zurich Flood Resilience Alliance* is a multi-stakeholder project aimed at measurably enhancing community flood resilience around the world. Our focus is on the development and testing of a comprehensive web-based application to measure resilience, better understanding behavioral barriers that impede adoption of risk reduction and preparedness actions, and reducing the flood insurance protection gap. For more information contact Jeffrey Czajkowski at jczaj@wharton.upenn.edu or visit <https://riskcenter.wharton.upenn.edu/flood-resilience-research-collaboration-zurich-insurance/>.

The Community Flood Resilience Measurement Tool — What we have learned so far

From its inception in 2013, the Zurich Flood Resilience Alliance identified measuring resilience as an integral aspect of our approach to building community flood resilience. From 2013 to 2016 we created a flood resilience measurement framework, which was subsequently operationalized into a web and mobile based tool that allows users (currently, our partner NGOs—MercyCorp International, Concern Worldwide, Plan International, Mexican Red Cross, Practical Action) to collect data on 88 sources of flood resilience. These sources reflect the 5C-4R framework (the five capitals of the Sustainable Livelihoods framework: human, physical, social, natural and financial; and four properties of resilient systems: robustness, redundancy, resourcefulness and rapidity). As of January 2017 when we performed our initial analysis, baseline measurements had been taken in 70 communities across seven countries worldwide. (There are now 104 communities with a baseline measurement and we are starting to analyze the larger dataset.)

The communities in our sample experience floods very frequently, on average, every 1.7 years. These floods are having devastating impacts on communities. On average, households in our sample reported that family members were injured or their property damaged by a flood 3.4 times in the last 10 years. Financial impacts of these events can be felt for months to over a year in many communities.

The data generated consists of more than 500,000 questions on a

household and community level. While the baseline data cannot tell us which sources of resilience are effective (and to what degree and combination) for community flood resilience, we can start to see which sources are highly correlated indicating either a critical relationship or a redundancy, which will be critical for analyzing post flood outcomes.

Data were also collected on self-reports of individuals' perception of their past flood experience and how long it took them to financially recover from the last major flood. These very preliminary results suggest that having a household income continuity strategy was particularly important for recovery. Physical access to food markets was also associated with a faster financial recovery.

In the coming months we will analyze the post event data. The post event studies measure how much loss is sustained and how quickly (and how well) communities recover (that is, actual resilience). We will then begin empirically linking the sources of resilience present in the community before a flood occurs with the actual resilient outcomes after a flood occurs. This will begin to build a body of evidence for what is effective for community flood resilience. Over time and with enough data that is systematically collected in this way, we will be able to empirically validate a measure of flood resilience.

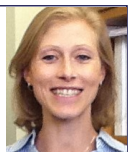
Through qualitative feedback from our partners via interviews and workshops, we were pleased to learn that while the process of measuring resili-

ence requires an investment of time and resources, NGO partners viewed the tool as highly valuable for capacity building for their teams. In particular, the holistic 5C-4R approach encourages practitioners to undertake a deeper analysis of the key strengths and areas of development in the community. NGOs also valued the tool's ability to store and organize a wealth of information in a secure, web-based integrated system. This yields benefits throughout the project cycle from intervention design to reporting.

We hope the tool makes a substantial contribution to others also working to build flood resilience. For additional information about the measurement framework, the Alliance's process and challenges related to measuring flood resilience see Keating, A., Campbell, K., Szoenyi, M., McQuistan, C., Nash, D., Burer, M.: "Development and testing of a community flood resilience measurement tool." *Nat. Hazards Earth Syst. Sci.* (17): 77–101, 2017. <https://www.nat-hazards-earth-syst-sci.net/17/77/2017/nhess-17-77-2017.pdf>.

*The members of the **Zurich Flood Resilience Alliance** are the Federation of the Red Cross and Red Crescent Societies (IFRC), International Institute of Applied Systems Analysis (IIASA), Practical Action, Wharton Risk Management and Decision Processes Center, and the Zurich Insurance Company.

Karen Campbell is a Consulting Principal at IHS Markit and a research fellow at the Wharton Risk Center. karen.campbell@ihsmarkit.com

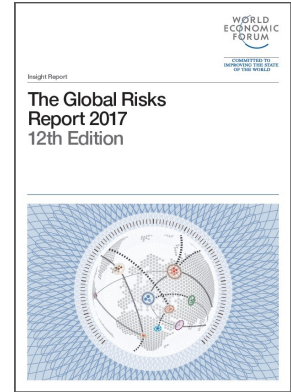


Risk Center Partners with the World Economic Forum on *Global Risks 2017*

Economic inequality, societal polarization and intensifying environmental dangers are the top three trends that will shape global developments over the next ten years, the World Economic Forum’s [Global Risks Report \(GRR\) 2017](#) found. Some 750 experts assessed 30 global risks and 13 underlying trends that could amplify them or alter the inter-connections between them. Three key findings emerged:

- **Rising income and wealth disparity and increasing polarization of societies** ranked first and third, respectively, among the underlying trends that will determine global developments in the next ten years.
- **The environment dominates the global risks landscape.** Climate change was the number two underlying trend this year. For the first time, all five environmental risks in the survey (*extreme weather; failure of climate change mitigation and adaptation; major biodiversity loss; natural disasters, man-made environmental disasters*) were ranked both high-risk and high-likelihood, with [extreme weather events](#) emerging as the single most prominent global risk.
- **Society is not keeping pace with technological change.** Of the 12 emerging technologies examined, experts found [artificial intelligence](#) and [robotics](#) to have the greatest potential benefits, but also the greatest potential negative effects and the greatest need for better governance.

While 2016 saw significant progress in the area of climate change, recent political change puts this progress at risk. The importance of long-term adaptation strategies for addressing the risks associated with sea level rise and coastal flooding cannot be overemphasized. Unless short-term incentives for investing in these measures are provided, they are likely to be given low weight on the policy agenda of communities and countries.



The *Global Risks Report* also provides country-level data on how businesses perceive global risks in their countries and industry sector. An interactive tool, “Global Risks of Highest Concern for Doing Business” is online at <http://reports.weforum.org/global-risks-2017/benchmarking-global-risks-to-businesses-2017/>.

See also *Knowledge@Wharton*, [The Biggest Risks Facing the World in 2017](#). Howard Kunreuther and Erwann Michel-Kerjan discuss the 2017 *Global Risks Report*. The Wharton Risk Center has been an academic partner of the World Economic Forum since 2005.

Top 10 risks in terms of Likelihood

- 1 Extreme weather events
- 2 Large-scale involuntary migration
- 3 Natural disasters
- 4 Terrorist attacks
- 5 Data fraud or theft
- 6 Cyberattacks
- 7 Illicit trade
- 8 Man-made environmental disasters
- 9 Interstate conflict
- 10 Failure of national governance

Top 10 risks in terms of Impact

- 1 Weapons of mass destruction
- 2 Extreme weather events
- 3 Water crises
- 4 Natural disasters
- 5 Failure of climate-change mitigation and adaptation
- 6 Large-scale involuntary migration
- 7 Food crises
- 8 Terrorist attacks
- 9 Interstate conflict
- 10 Unemployment or underemployment

Categories

- Economic
- Environmental
- Geopolitical
- Societal
- Technological

The top 10 risks in terms of likelihood and impact. Source: The World Economic Forum’s *Global Risks Report 2017*.

Involvement in U.S. Policy Decision Making

The full membership of the **ResilientAmerica Roundtable** held its first meeting of the year in February 2017 in Washington, DC. The Roundtable had the opportunity to hear from a variety of federal and non-profit experts about urban flooding, measures of resilience, and seismic hazards.



Roundtable director, Dr. Lauren Alexander Augustine leads a discussion on measures of resilience featuring panelists from **Wharton School**, **The Z Zurich Foundation**, and **The Urban Institute**.

In March 2017, the **ResilientAmerica** team visited Charleston to meet with a small team of local stakeholders to assess the resilience indicators and data collected using the [Zurich Flood Resilience Measurement Framework](#) (see page 14). This assessment process allowed the community to uncover opportunities for resilience-related growth.

Jeffrey Czajkowski and Katherine Greig serve as members of the **National Research Council's Committee on Urban Flooding in the United States**. The committee is exploring causes and extent of urban flooding in several metropolitan areas. Case studies will provide information on questions related to flood control, flood response, recovery, and mitigation both outside and inside the floodplain, and identify commonalities and variances among metropolitan areas on causes, adverse impacts, unexpected problems in recovery, and effective mitigation strategies.

Jeffrey Czajkowski was among the panelists for a session called "[How Do I Know What Works](#)" at [RES/CON – the Global Resilience Summit](#) in New Orleans, Louisiana, in March 2017. The event is RES/CON's annual international conference on the practice of successful resilience and disaster management in an evolving global environment. From innovations in the study of resilience to how emergency responders convey information from the front lines post-disaster, this panel examined how to make sense of the wealth of information. The **Zurich Foundation** was a sponsor of the event. For more information on RES/CON, visit <http://resconnola.com/>



Gregg Ramirez (Army National Guard), Jeff Czajkowski (Wharton Risk Center) and Andrew Whitford (University of Georgia) discuss advancements in resilience activities at RES/CON, The Global Resilience Summit.

The Federal Advisory Committee on Risk-Sharing Mechanisms (ACRSM) invited Howard Kunreuther and other experts to present information on topics related to terrorism risk mechanisms and risk management of other catastrophic risks at a meeting at the Federal Insurance Office, U.S. Department of the Treasury in Washington, DC on June 9, 2017.

The meeting focused on best practices and lessons learned from alternative risk-sharing mechanisms employed in other countries or other catastrophic loss exposures. Julian Enoizi, (Pool Reinsurance Company Limited, U.K.) presented a discussion on “International Terrorism Risk Pools.” Roy Wright (FEMA) presented “Use of Reinsurance by the National Flood Insurance Program.” Howard Kunreuther (Wharton School, University of Pennsylvania) presented “Insuring against Terrorism and Other Extreme Events Linking Intuitive and Deliberative Thinking.”

Meeting materials and video are online at the Committee’s website, <https://www.treasury.gov/initiatives/fio/acrsm/Pages/default.aspx>



Committee members: Wendy Peters (Willis Towers Watson, *Chair*); Jonathan Clark (Guy Carpenter & Company LLC); Kean Driscoll (Validus Reinsurance, Ltd.); Gregory Hendrick (XL Catlin); Edward Ryan (Aon Benfield); Michael Sapnar (Transatlantic Holdings, Inc.); John Seo (Fermat Capital Management LLC); Keith Wolfe (Swiss Re); Steven Seitz (Deputy Director, Federal Insurance Office).

The **NYC Future Conditions Flood Mapping project** is an initiative of the **City of New York** and the **Federal Emergency Management Agency (FEMA)** to revise New York City’s flood maps. The flood map revisions will assist New York City in making coastlines more resilient and climate-ready, while ensuring homeowners are not required to purchase more insurance than their current flood risk requires.

A series of workshops organized by Katherine Greig (in her role with the **NYC Mayor’s Office of Recovery and Resiliency**) and Howard Kunreuther, along with other members of the **New York City Panel on Climate Change** and FEMA, brought together experts and practitioners to discuss current and desired uses and users for a new flood map product that will reflect future conditions flood hazards based on projected climate change and sea level rise impacts. The new maps will be designed to clearly communicate the nature of the flood hazard and will inform building codes, zoning ordinances and land use regulation.

Howard Kunreuther addressed Congressional staffers in June 2017 in connection with proposed legislation concerning the anticipated reauthorization of the NFIP. His talk, “**Insuring High Risks Fairly**” focused on how to deal with fairness and affordability in designing a flood insurance program for the future. There is general agreement that floodplain residents need to know their risk-based insurance premium—and with that information, how to make their homes safer and thus make flood insurance more affordable by investing in cost effective mitigation measures. The seminar was organized by the Penn Wharton Public Policy Initiative (PPI). The PPI works with faculty and research centers across the University to share their expertise to improve federal policymaking on issues impacting business and the economy. See [Insurance against Extreme Events: Pairing Short-Term Incentives with Long-Term Strategies](#).

New Faces at the Risk Center



Dr. Carolyn Kousky has joined the Risk Center as Director of Policy Research and Engagement. Previously a Fellow with Resources for the Future in Washington DC. Carolyn is an expert on issues relating to natural disaster

insurance markets, the functioning of the National Flood Insurance Program, the incentive effects of disaster aid, and policy responses to potential changes in extreme events with climate change. She is the recipient of the 2013 Tartufari International Prize from the Accademia Nazionale dei Lincei. Carolyn was a member of the National Research Council Committee on Analysis of Costs and Benefits of Reforms to the National Flood Insurance Program and is a university Fellow at Resources for the Future. At the Risk Center, a focus of her work will be launching the Center's Policy Incubator (see page 1). Carolyn has a B.S. in Earth Systems from Stanford University and a Ph.D. in Public Policy from Harvard University.



Brett Lingle is Senior Research Coordinator at the Wharton Risk Management and Decision Processes Center. His work focuses on disaster risk financing and the role of public policy in hazard mitigation and

disaster recovery. Before joining the Risk Center, he worked with Resources for the Future's Rethinking Risk Initiative to analyze various aspects of the National Flood Insurance Program, FEMA's disaster assistance and mitigation efforts, and federal policy's influence on household and community resilience. Brett has a B.A. in Politics from Pomona College and an M.A. in Environmental Policy from American University.



Katherine Greig is a Senior Fellow & Strategic Advisor at the Wharton Risk Center. She joins the Center from the NYC Mayor's Office of Recovery and Resiliency where she focused on climate change information, insurance research and

outreach, and building mitigation. She worked on similar issues for the Hurricane Sandy Rebuilding Task Force under Secretary for Housing and Urban Development, Shaun Donovan. Prior to the Task Force, Katherine worked at the Boston Consulting Group and the Federal Reserve Bank of New York. She has a MALD (Masters of Law and Diplomacy) from the Fletcher School of Law and Diplomacy, an MBA from Dartmouth's Tuck School of Business, and a B.A. from Stanford. At the Risk Center, Katherine will provide guidance on research and outreach to enhance the Center's stakeholder impact and implementation. She will also develop a communication strategy to policy makers and enhance collaboration with other research centers at Wharton.



Dr. Russell Richie is a post-doctoral research fellow in the Marketing Department of the Wharton School at the University of Pennsylvania. He is interested in language dynamics (how people process language over milliseconds, and

create language over decades) as well as automated analysis of text for insight into psychological and behavioral questions. He uses behavioral experiments, corpus analysis, and computational modeling in his research. At Wharton, Russell is involved with a joint project to extract behavioral insight from textual data. Russell received his Ph.D. in Psychological Sciences at the University of Connecticut.



Dr. Jeffrey Czajkowski has been promoted to Managing Director. During his tenure with the Risk Center since 2011, he has served in the roles of Director of Sponsored Research and Senior Fellow for the Willis Research Network, conducting research on economic and risk-related issues of natural hazards. In his new role, Jeff oversees grant-supported sponsored research and corporate sponsorships, as well as ensuring that ongoing and proposed research efforts align with the Risk Center's strategic direction. Jeff continues to conduct research on various economic and risk-related issues of natural hazards, as well as environmental economics. He has served on three committees of the National Research Council of the National Academy of Sciences as well as the Department of Homeland Security's Flood Apex research review board. He holds a B.S. from Carnegie Mellon University, an M.S. in environmental and urban systems from Florida International University, and a Ph.D. in economics from Florida International University.



Brad Bitterly is the recipient of the *Paul R. Kleindorfer Scholar Award*. The Operations, Information and Decisions (OID) department of the Wharton School established the *Paul R. Kleindorfer Memorial Fund* to honor the memory of Emeritus

Professor Paul Kleindorfer, a former department chair and a co-director of the Wharton Risk Center. The award recognizes the OID doctoral student who is making the most outstanding progress towards the completion of his or her dissertation. It provides \$4,000 of research support.

Brad's dissertation focuses on the benefits and risks of humor. In his research, Brad has found that humor is pervasive in organizations and can profoundly shape both interpersonal perceptions and behavior.

Contributions to the Paul R. Kleindorfer Memorial Fund may be sent to the attention of Alison Matejczyk, Wharton School, University of Pennsylvania, 344 Vance Hall, 3733 Spruce Street, Philadelphia, PA 19104. Please make checks payable to the Trustees of the University of Pennsylvania, with "Kleindorfer Fund" in the memo field.

The Risk Center has a new address!

Suite 130, St. Leonard's Court, 3819 Chestnut Street, University of Pennsylvania, Philadelphia, PA 19104



We bid adieu to Erwann Michel-Kerjan

After more than fourteen years at the Wharton Risk Center, Erwann Michel-Kerjan joined McKinsey as a partner of the firm in February 2017. At a farewell, Risk Center



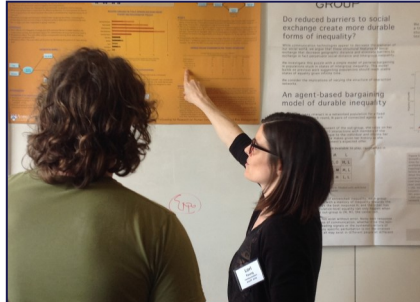
co-director Howard Kunreuther presented Erwann with a representation of a special gift from the Center. Erwann was instrumental in the Center's growth in advancing knowledge on extreme events. "Wharton is a unique place and I'm delighted to see the impact we have had working closely with our partners over the years, both in the U.S. and internationally. And I'm confident more is to come," says Erwann.

Russell Ackoff Doctoral Student Fellowship Awards 2017

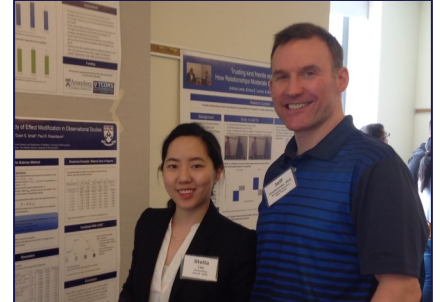
The Wharton Risk Center is pleased to announce the recipients of its 2017 Russell Ackoff Doctoral Student Fellowships. Prof. Emeritus Russell Ackoff's (1919-2009) work was dedicated to furthering understanding of human behavior in organizations. The fellowships are funded by an endowment provided to the Wharton School by the Anheuser-Busch Charitable Trust that also funded a chair held by the late Prof. Emeritus Paul Kleindorfer, formerly a co-director of the Wharton Risk Center. The awards fund data collection, conference fees and other research expenses for studies in human decision making by doctoral students in Wharton and other schools at the University of Pennsylvania. See <http://riskcenter.wharton.upenn.edu/russell-ackoff-doctoral-student-fellowships/>.



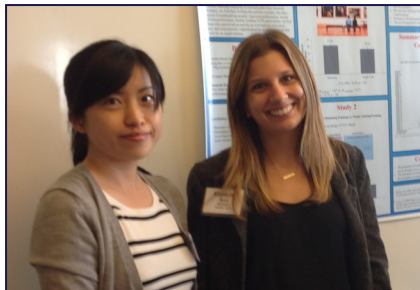
Risk Center Co-Directors Bob Meyer and Howard Kunreuther with Cecilia Gaertig (OID)



Lori Young (Annenberg School for Communication) presents [The Influence of Poverty Discourse on Low-Income Citizens](#)

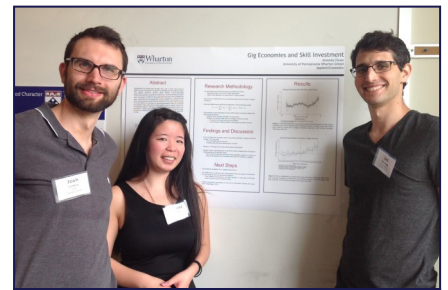


Stella Lee (Annenberg School for Communication) and Dr. Jeffrey Czakowski (Risk Center Managing Director)



Yupeng Chen (Marketing) and Shalena Srna (Marketing)

An important component of the Ackoff program is the opportunity for doctoral students and faculty involved in decision research to connect with each other. Recipients of the 2016 Doctoral Student Fellowships presented their research at the annual Ackoff luncheon. The event coincided with the announcement of the 2017 award recipients. This year, fellowships were awarded to 20 doctoral students at Penn.




Josh Lewis (OID), Amanda Chua (BEPP), and Uri Barnea (Marketing)



RECIPIENT	DEPARTMENT	PROPOSAL TITLE
Uri Barnea	Marketing	The effects of message ephemerality on communicators
Joshua Becker	Annenberg School for Communications	Can social influence improve financial forecasting?
T. Bradford Bitterly	OID	Humorous deflection
Edward Chang	OID	Testing an online intervention to reduce gender bias in the workplace
Yupeng Chen	Marketing	Can films improve the performance of referral programs by inducing reciprocity from customers? Evidence from a field experiment
Amanda Chuan	Business Economics and Public Policy	Labor Market Outcomes and the Reverse Gender Gap in College Enrollment
Youran Fu	Business Economics & Public Policy	Using social data to inform color inventory decision making
Celia Gaertig	OID	The wisdom of the inner crowd
Qing Gong	Economics	Physician learning and decision making: evidence from treatment choices for brain aneurysms
Zheng Huang	Applied Economics	Motivated Beliefs and Transaction Utility: Effects of Pricing Format on Willingness to Pay
Polly Kang	Management	The Effect of Shared Experiences of Anger
Brooke Kelly	Marketing	Prosocial conflicts of interest
Elissa Kranzler	Annenberg School for Communication	Harnessing the power of a 'neural focus group' to predict population-level anti-smoking message effects on risky decisions among adolescents
Joshua Lewis	OID	Extremeness aversion in estimation
Robert Mislavsky	OID	Integrating non-quantitative quality and outcome judgments
Sam Skowronek	OID	The impact of reminders on prescription pickup
Shalena Srna	Marketing	When modesty pays
Esther Uduehi	Marketing	Obesity identity labeling: outside looking in, inside looking forward
Vanitha Virudachalam	OID	Optimizing performance pay in K-12 education
Ozge Yapar	OID	Bayesian bandits for sequential clinical trials of multiple technologies

Wharton Risk Center Issue Briefs

The Wharton Risk Center's issue briefs are short, non-technical summaries distilling the Center's new research findings and the team's best thinking on how the findings can be applied to the management of catastrophic risks.



ISSUE BRIEF Summer 2017

INFORMED DECISIONS ON CATASTROPHE RISK

Characteristics and Protective Behaviors of Hazard Insurance Purchasers

We study the relationship between disaster risk reduction and insurance coverage to assess the presence of moral hazard for two different natural hazards with survey data from Germany and the United States. The results show that moral hazard is absent. Nevertheless, adverse risk selection may be present. This has significant policy relevance such as opportunities for strengthening the link between insurance and risk reduction measures and the use of risk-based insurance premiums.

To determine the existence of moral hazard and whether insurance and risk reduction measures are substitutes, we looked at the confluence of having insurance and the homeowners' undertaking long-term risk reduction activities and short-term emergency preparedness measures.

ABSENCE OF MORAL HAZARD
Moral hazard is not present in the investigated markets. In fact, there is slight evidence for a higher tendency toward self-protection across insured individuals.

DEDUCTIBLE
Insurers offset their concern about policyholders' moral hazard through the use of a deductible. Unfortunately for insurers, the deductible has a very minor influence on risk reduction measures taken, unless the deductible is very high.

We find that decisions to mitigate disaster risks, including insurance purchase, are mainly driven by individuals' internal characteristics rather than external incentives.

Personality traits of flood insurance purchasers
Strong private value of preparing for floods
Internal locus of control
Peace of mind

Conditions that predict purchase of flood insurance
Prior flood damage
Received disaster assistance previously
Income level
Risk reduction measures undertaken

- Findings in this brief are the result of two separate studies using a variety of statistical methods on the flood insurance market in Germany, and flood and windstorm insurance markets in the United States.
- Moral hazard occurs when insured individuals undertake fewer risk-reduction measures than they would if uninsured. In this case, insurance and risk reduction measures could be considered substitutes.
- 42 percent of flood insurance purchasers in New York City undertook long-term mitigation measures such as elevating utility and electricity installations, versus 30 percent of non-purchasers.
- Emergency preparations during an imminent threat do not significantly differ between flood insurance purchasers and non-purchasers in New York City.
- In Germany, individuals with flood insurance more proactively informed themselves about the risk.
- Our survey data suggest that homeowners are not aware of their deductible amount, or if they are aware, believe it to be relatively low. 62% of our respondents with homeowners insurance in the U.S. did not know the amount of their deductible.

Positive indicators:

- Flood insurance demand is related to a strong private value of being well-prepared for flooding.
- Households purchase flood insurance to get peace of mind.

Negative indicators:

- Households that received federal disaster assistance in the past are less likely to carry insurance.
- Low-income homeowners had significantly lower demand for flood insurance. Thus, there is a need for solutions to overcome the affordability challenge.

Wharton Center for Risk Management and Decision Processes – Three decades of catastrophe management research
3730 Walnut Street, Suite 500, Philadelphia, PA 19104 ~ <http://riskcenter.wharton.upenn.edu>

The 2016-2017 series includes:

- Findings from a study to identify barriers to and opportunities for infrastructure insurance and resilience for catastrophic events.
- An examination of the NFIP's Increased Cost of Compliance (ICC) coverage and proposed reforms.
- A study of the relationship between disaster risk reduction and insurance coverage to assess the presence of moral hazard.

Issue briefs are available on the Center's website, <http://riskcenter.wharton.upenn.edu/issue-briefs/>. To request hard copies, please contact Carol Heller, hellerc@wharton.upenn.edu.

Identifying and Reducing Barriers to Infrastructure Catastrophic Risk Insurance: Transportation Infrastructure Systems

The Wharton Risk Center is undertaking a study funded by the Department of Homeland Security's Critical Infrastructure Resilience Institute (CIRI). The purpose of the project is to identify barriers and opportunities for improving infrastructure insurance and resilience for catastrophic events and disruptions. This brief summarizes the key findings and recommendations upon completion of the first two phases of the project

Increased Cost of Compliance (ICC) Coverage

In connection with the National Flood Insurance Program (NFIP)'s anticipated reauthorization in 2017, Congress is considering several proposals that address the program's Increased Cost of Compliance (ICC) coverage, that would expand its eligible uses and give policyholders more funds to implement qualifying risk-reduction measures. We examine ICC claims for single-family homes from 1997 to 2014 and report on our findings from conversations with floodplain managers in several states, highlighting key reasons the program is not more widely used. We also compare the proposals under consideration and discuss the implications of proposed reforms.

Characteristics and Protective Behaviors of Hazard Insurance Purchasers

We study the relationship between disaster risk reduction and insurance coverage to assess the presence of moral hazard for two different natural hazards with survey data from Germany and the United States. The results show that moral hazard is absent. Nevertheless, adverse risk selection may be present. This has significant policy relevance such as opportunities for strengthening the link between insurance and risk reduction measures and the use of risk-based insurance premiums.

TMAC / Proof of Concept

In 2014 FEMA established the Technical Mapping Advisory Council (TMAC) as mandated by Congress under the Biggert-Waters Flood Insurance Reform Act of 2012 to review and recommend improvements to the National Flood Mapping Program and assess projected future conditions as they relate to flooding. A set of TMAC members—John Dorman, Scott Edelman, Chris Jones and Howard Kunreuther, with research assistance from Marilyn Montgomery and John Sperger—undertook a study to compare current NFIP premiums with risk-based premium based on an Average Annual Loss (AAL) approach for individual structures in three North Carolina counties. The study demonstrated the ability to specify risk-based flood insurance premiums using state-of-the-art technology, such as LIDAR (Light Detection and Ranging) and advanced engineering to determine the likely damage to different structures from potential floods. Using the same sources to estimate Base Flood Elevation (BFE) and First Floor Elevation (FFE) in the premium comparisons, most of the homes in the three North Carolina counties have AAL premiums that are significantly less than current NFIP premiums.

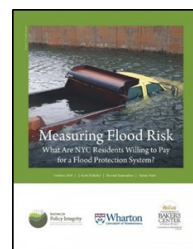
These findings were somewhat surprising, and efforts are underway to determine why the significant difference exists. The cases where the AAL is greater than the NFIP premium often occur where buildings are predicted to suffer damage in the higher frequency floods that are not considered in NFIP calculations. The working paper “Structure Specific Flood Risk Based Insurance Proof of Concept and Preliminary Analysis” is available at: <http://opim.wharton.upenn.edu/risk/library/WP201709-Structure-Specific-Flood-Risk-Based-Insurance.pdf>.

Researchers from Princeton University, the Wharton Risk Center, MIT, and NOAA Geophysical Fluid Dynamic Laboratory are undertaking a multi-year collaborative National Science Foundation project on hurricane hazards, climate science and risk management. The risk management component of this project focuses on options for consideration by the National Flood Insurance Program coupled with engineering designs for cost-effective coastal flood adaptation strategies. FEMA recommends that property in coastal flood zones be elevated to at least 1 foot above the base flood elevation. However, this guideline ignores the design and characteristics of houses that affect their vulnerability to hurricanes.

Joint research by Princeton and the Wharton Risk Center determined an economically optimal elevation level (OEL) that minimizes the combined cost of elevation and cumulative insurance premiums over the lifespan of the house. Elevating to the OELs significantly reduces government spending to address fairness and affordability issues through a program that combines an insurance voucher with a low-interest loan to mitigate the flood risk to the property. Insurance premiums that reflect the true and potentially increasing risk inform homeowners as to potential losses to their property, and thus can incentivize investments in cost-effective loss reduction measures.

Measuring Flood Risk: What Are NYC Residents Willing to Pay for a Flood Protection System?

A policy brief by the **Institute for Policy Integrity, New York University School of Law** evaluates how willingness to pay (WTP) for a flood protection system varies with exposure to flood risk, using detailed flood maps and parcel-level data to identify households within and just beyond the 100-year flood plain in New York City. A survey of single-family homeowners living in the 100- and 500-year flood plains in New York City found that while the majority of residents living in the 100-year flood plain were willing to pay up to \$10 a month to contribute to the cost of a seawall, the majority of residents living in the 500-year flood plain, an area that has a 0.2% risk of flooding in any given year, were willing to pay only up to \$7 a month. These results are consistent with other studies demonstrating that risk—actual or perceived—plays a large role in individuals’ WTP for protection from floods.



By J. Scott Holladay, Howard Kunreuther, and Valerie Stahl
<http://policyintegrity.org/publications/detail/measuring-flood-risk>

Research for this brief was supported in part by a grant from the Alfred P. Sloan Foundation.

New Books

The Ostrich Paradox: Why We Underprepare for Disasters

By Robert Meyer and Howard Kunreuther

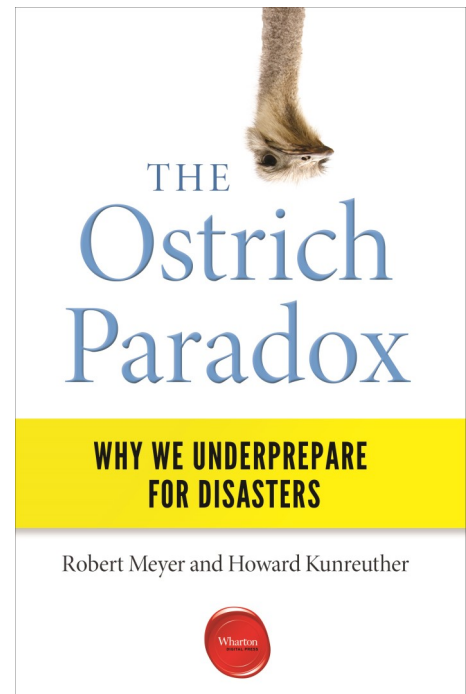
We fail to evacuate when advised. We rebuild in flood zones. We don't wear helmets. We put off purchasing insurance. We would rather avoid the risk of "crying wolf" than sound an alarm.

Our ability to foresee and protect against natural catastrophes has never been greater, yet we consistently fail to heed the warnings and protect ourselves and our communities. What explains the contradiction? How do people make decisions when confronted with high-consequence, low-probability events, and why do these decisions go awry?

Private and public leaders, planners, and policy-makers who want to build more prepared communities must take into account six behavioral biases:

1. Myopia—the tendency to focus on overly short future time horizons when appraising immediate costs and the potential benefits of protective investments.
2. Amnesia—the tendency to forget too quickly the lessons of past disasters.
3. Optimism—the tendency to underestimate the likelihood that losses will occur from future hazards.
4. Inertia—the tendency to maintain the status quo or adopt a default option when there is uncertainty about the potential benefits of investing in alternative protective measures.
5. Simplification—the tendency to selectively attend to only a subset of the relevant facts to consider when making choices involving risk.
6. Herding—the tendency to base choices on the observed actions of others.

Wharton professors Robert Meyer and Howard Kunreuther draw on years of research to develop the Behavioral Risk Audit, a systematic approach for improving preparedness by recognizing these biases and designing strategies that anticipate them. While we may not be able to alter how we think, utilizing this systematic framework to design more effective strategies and enact policies that work with, rather than against, our natural psychologies.



Total pages: 130

Date Published: Feb 7, 2017

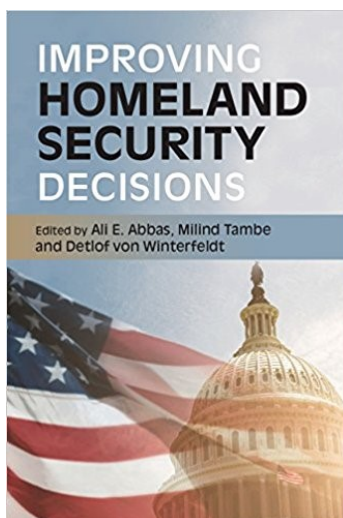
ISBN-13: 9781613630792

Language: English

Format: Ebook and Paperback

For more information and a preview, please visit Wharton Digital Press.

For bulk purchase, please contact wharton-digitalpress@wharton.upenn.edu.



What are the risks of terrorism and what are their consequences and economic impacts? Are we safer from terrorism today than before 9/11? Does the government spend our homeland security funds well? These questions motivated a twelve-year research program of the **National Center for Risk and Economic Analysis of Terrorism Events (CREATE)** at the University of Southern California, funded by the **Department of Homeland Security**.

Improving Homeland Security Decisions showcases some of the most important results of this research and offers key insights on how to address the most important security problems of our time. Written for homeland security researchers and practitioners, this book covers a wide range of methodologies and real-world examples of how to reduce terrorism risks, increase the efficient use of homeland security resources, and thereby make better decisions overall.

Edited by Ali E. Abbas, Milind Tambe, and Detlof von Winterfeldt

Format: Hardback ISBN: 9781107161887

<http://www.cambridge.org/us/academic/subjects/statistics-probability/optimization-or-and-risk/improving-homeland-security-decisions#I2UKcovmLsEPS97x.97>

SELECTED PUBLICATIONS

<http://riskcenter.wharton.upenn.edu/publications/>

- Atreya, Ajita, Warren Kriesel, & Jeffrey Mullen. [Valuing Open Space in a Marshland Environment: Development Alternatives for Coastal Georgia](#). *Journal of Agricultural and Applied Economics* 48(4): 383-402 (2016).
- Collier, Benjamin, Andrew Haughwout, Howard Kunreuther, Erwann Michel-Kerjan, & Michael Stewart. [Firms' Management of Infrequent Shocks](#). NBER Working Paper No. 22612 (2017).
- Czajkowski, Jeffrey, Gabriele Villarini, Marilyn Montgomery, Erwann Michel-Kerjan, & Radoslaw Goska. [Assessing Current and Future Freshwater Flood Risk from North Atlantic Tropical Cyclones via Insurance Claims](#). *Nature Scientific Reports* 7: 41609 (2017).
- Done, James, Kevin Simmons, & Jeffrey Czajkowski. [The Relationship between Residential Losses and Hurricane Winds: The Role of the Florida Building Code](#). *Journal of Risk and Uncertainty in Engineering Systems, Part A: Civil Engineering*
- Grineski, Sara, Timothy Collins, Jayajit Chakraborty, & Marilyn Montgomery. [Hazard Characteristics and Patterns of Environmental Injustice: Household-level Determinants of Environmental Risk in Miami, Florida](#). *Risk Analysis* 37: 1419-1434 (2017).
- Hudson, Paul, Wouter Botzen, Jeffrey Czajkowski, & Heidi Kreibich. [Moral Hazard in Natural Disaster Insurance Markets: Empirical evidence from Germany and the United States](#). *Land Economics* 93(2): 179-208 (2017).
- Kousky, Carolyn, & Leonard Shabman. [Federal Funding for Flood Risk Reduction in the US: Pre- or Post-Disaster?](#) *Water Economics and Policy*, 3(1) (2017).
- Kunreuther, Howard, & Rosemary Lyster. [The Role of Public and Private Insurance in Reducing Losses from Extreme Weather Events and Disasters](#). *Asia Pacific Journal of Environmental Law* 19: 29-54 (2016).
- Kunreuther, Howard, & Mark Pauly. [Insurance decision-making for rare events: the role of emotions](#). *Geneva Pap Risk Insur Issues Pract* (2017). <https://doi.org/10.1057/s41288-017-0068-x>
- Reilly, Allison, Gina Tonn, Chengwei Zhai, & Seth Guikema. [Hurricanes and Power System Reliability—The Effects of Individual Decisions and System-Level Hardening](#). *Proceedings of the IEEE* 105(7) 2017.
- Xian, Siyuan, Ning Lin, & Howard Kunreuther. [Optimal house elevation for reducing flood-related losses](#). *Journal of Hydrology* 548: 63-74 (2017).
- Broad, Kenneth, Kerry Milch, Ben Orlove, & Robert Meyer. [Decision Science Perspectives on Hurricane Vulnerability](#). *Global Environmental Change*.

IN THE MEDIA

<http://riskcenter.wharton.upenn.edu/faculty-news/>

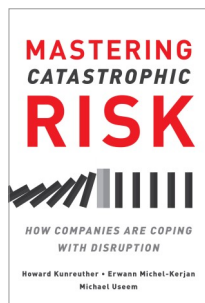
- October 10, 2017.** *The Wall Street Journal*. [Small Businesses Say Federal-Disaster Aid Needs Strengthening](#). Article cites research from the Wharton Risk Center: After Sandy hit the northeast in 2012, 8 percent of firms affected by the storm borrowed money from the agency's disaster-lending program.
- September 21, 2017.** *PBS NewsHour*. [After Harvey and Irma, what's the future of flood insurance?](#) (Podcast and transcript) Interview with John Miller (Risk Center affiliate) on repetitive loss properties along the Passaic River.
- September 8, 2017.** *Mother Jones*. [Here's Why Florida Is so Much More Vulnerable to a Hurricane Like Irma Right Now](#). Article quotes Howard Kunreuther: "People generally feel that disasters will not happen to them."
- September 6, 2017.** *Fortune*. [How We Can Protect Irma and Harvey Victims From Getting Screwed](#). Op-ed by Carolyn Kousky: "Too few victims have the financial support of insurance."
- September 5, 2017.** *The New York Times*. [Opinion – How Houston's Growth Created the Perfect Flood Conditions](#). Article quotes Howard Kunreuther: "It gives people a feeling of complacency if they are not required to buy insurance."
- August 28, 2017.** *Harvard Business Review*. [How the Insurance Industry Can Push Us to Prepare for Climate Change](#). In "The Ostrich Paradox: Why We Underprepare for Disasters," Robert Meyer and Howard Kunreuther point to several personal traits that expose us to greater risk from natural disasters.
- August 25, 2017.** *Scientific American*. [Trump Faces First Big Disaster Test: Hurricane Harvey could be particularly threatening](#). Article quotes Robert Meyer: "If you're just starting to think about it, you're kind of too late."
- August 18, 2017.** *Financial Times*. [Mental bias leaves us unprepared for disaster](#). Review of *The Ostrich Paradox: Why We Underprepare for Disasters* by Robert Meyer and Howard Kunreuther.
- July 5, 2017.** *The Hill*. [How to reform flood insurance to keep more Americans afloat](#). Op-ed by Carolyn Kousky explores increased cost of compliance (ICC) of proposed NFIP reform bills.
- February 10, 2017.** *VICE News*. [How Miami's real estate market is benefitting from rising sea levels](#). (Video) Robert Meyer: "We don't want to scare people who want to move to Florida, because the money to fix the problems associated with climate change comes from real estate taxes."
- February 9, 2017.** *Psychology Today*. [Why We are Underprepared for Disasters](#). Op-ed by Robert Meyer and Howard Kunreuther outlines six behavioral biases.
- January 18, 2017.** *Scientific American*. [The Future of Global Risk: A View From Davos](#). Op-ed by Erwann Michel-Kerjan: "While not a crystal ball, the report has yielded some startling results."
- January 18, 2017.** *This Morning (Seoul Korea)*. [Podcast: 2017 Global Risks Report](#). Radio interview with Howard Kunreuther on environmental risks highlighted in the 2017 *Global Risks Report*.

MASTERING CATASTROPHIC RISKS: HOW COMPANIES ARE COPING WITH DISRUPTION

Executives and their governing boards face ever-more-challenging disruptions. Whether physical, financial or reputational, catastrophic risks threaten a firm's performance and even its existence. Often, the catastrophic disruptions are industry-wide: toxic subprime mortgages proved fatal to dozens of financial institutions in 2008–2009. Sometimes the hazards are a product of global interdependencies: the shutdown of auto-parts makers near the Fukushima nuclear reactors in 2011 forced car factories around the world to close temporarily.

With support from the **Travelers Foundation**, the Wharton Risk Management and Decision Processes Center and the Wharton Leadership Center's joint project, "Effective Corporate Leadership in Catastrophic Risk Management" sought to further our understanding of how large companies are dealing with adverse events. Personal interviews were conducted with directors, executives, and managers of more than a hundred companies in the Standard & Poor's 500.

These leaders candidly shared their experiences in coping with and learning from disruptions, and how their operations have prepared for future calamities. The interviews were supplemented with information from company disclosures, risk surveys, government reports, and analysis of stock price drops in response to catastrophic events. Research from the social sciences adds an important component on the behavioral biases that decision makers must overcome to ensure deliberative thinking and effective risk management practices.



Managing Catastrophic Risks: How Companies Are Coping with Disruption by Howard Kunreuther, Erwann Michel-Kerjan and Michael Useem. Oxford University Press, forthcoming 2018. <https://global.oup.com/academic/product/mastering-catastrophic-risk-9780190499402?>

U.S. Tropical Cyclone Flood Insurance Claims: Storm Surge vs. Freshwater

Funding by the **Willis Research Network** extends research on freshwater flood risk of tropical cyclones (TC). An analysis was undertaken using NFIP claim data from 28 tropical cyclones that affected the U.S. from 2001 to 2014—roughly 465,000 TC residential flood claims for storm-surge and freshwater flooding. Study results illustrate that freshwater claims from tropical cyclones frequently exceed storm surge claims in number and amount. This detailed analysis identified variation in claims and damage by state, storm, and designated flood hazard zones, and provides a better understanding of claim characteristics for underwriting, accumulation, and risk-financing purposes, and providing input for developing risk-based premiums and addressing issues of affordability.

Czajkowski, Jeffrey, Gabriele Villarini, Marilyn Montgomery, Erwann Michel-Kerjan, Radoslaw Goska. [Assessing Current and Future Freshwater Flood Risk from North Atlantic Tropical Cyclones via Insurance Claims](#). *Nature Scientific Reports* 7: 41609 (2017).

Initiative for Global Environmental Leadership (IGEL)

11th Annual Conference

The End of the World as We Know It? The Consequences of Extreme Climatic Disruption for Business and Democracy

April 18, 2018

Co-sponsored with:

Risk Management and Decision Processes Center
Zicklin Center for Business Ethics Research
Andrea Mitchell Center for the Study of Democracy

Hurricanes in the Atlantic Ocean, devastating wildfires in the western United States, and record-breaking monsoons in Asia... In the wake of extreme weather events that are likely to have been caused by or made more severe by climatic disruption, this conference will gather experts from academia, business, the military, and national intelligence services to assess the risks and their consequences for business enterprise and democratic government, and propose strategies to deal with increasing expected frequency of extreme weather events. The conference is open to the public. For more information, please contact Joanne Spigonardo, spigonaj@wharton.upenn.edu.

Research Sponsors and Corporate Associates are a vital part of the Wharton Risk Center's operations.

In addition to providing crucial support for the Risk Center's operations, **Corporate Associates** participate in roundtable discussions and offer insight into the value, direction and timing of research projects. **Research Sponsors** provide funding for specific research initiatives of mutual interest and regularly interact with Risk Center directors, faculty and fellows to discuss these projects. Associates and Sponsors attend our workshops and conferences at no cost. These meetings offer an opportunity to consult with experts and policy makers from research institutions, industry and government agencies from the U.S. and abroad.

The Risk Center is inviting interested organizations to become **Strategic Partners**. With a multi-year commitment, Strategic Partners play a key role in the Center's future research, which can enable these companies and organizations to impact the future of their industry and society. Strategic Partners also benefit from greater visibility and customized relationships across the Wharton School through membership in the Wharton Partnership, Wharton's primary vehicle for fostering industry-academic collaboration.

Corporate Associate, Research Sponsorship, and Strategic Partnership contributions to the Risk Management and Decision Processes Center of the Wharton School are tax-deductible.

We thank our Corporate Associates, Research Sponsors and Strategic Partners for their support and involvement.

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Munich Re

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of America

Renaissance Re

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TransRe

Travelers Companies, Inc.*

Willis Re

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Over the past three decades, the Risk Management and Decision Processes Center at the Wharton School has been at the forefront of basic and applied research to promote effective corporate and public policies for low-probability events with potentially catastrophic consequences. The Wharton Risk Center has focused on natural and technological hazards through the integration of risk assessment and risk perception with risk management strategies. After the attacks of September 11, 2001, research activities were extended to include national security issues (e.g., terrorism risk insurance, protection of critical infrastructure).

Building on the disciplines of economics, finance, insurance, marketing, psychology and decision sciences, the Center's research program is oriented around descriptive and prescriptive analyses. Descriptive research focuses on how individuals and organizations interact and make decisions regarding the management of risk under existing institutional arrangements. Prescriptive analyses propose ways that individuals and organizations, both private and governmental, can make better decisions regarding risk. The Center supports and undertakes field and experimental studies of risk and uncertainty to better understand the linkage between descriptive and prescriptive approaches under various regulatory and market conditions.

In the past several years, the Center has significantly increased its size to now include 70 faculty, research fellows, students and visiting scholars to undertake large-scale initiatives in the United States and around the world..

Providing expertise and a neutral environment for discussion, the Center is also concerned with training decision makers and promoting a dialogue among industry, government, interest groups and academics through its research and policy publications and through sponsored seminars, roundtables and forums. Our newsletter and issue briefs provide updates of Center activities and publications.

**Risk Management Review is a publication of the Center for Risk Management and Decision Processes
Wharton School, University of Pennsylvania**

<http://riskcenter.wharton.upenn.edu>

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