



A Reset for U.S.
Natural Hazards
Policy? Lessons
from Harvey, Irma,
and Maria

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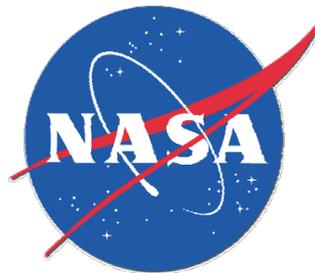
A Reset for U.S. Natural Hazards Policy? Lessons from Harvey, Irma, and Maria

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About the AMS Policy Program

The AMS Policy Program has three primary goals. The first is ensuring that policy choices take full advantage of information and services relating to weather, water, and climate. The second is making sure that policy makers understand how much the broader society's welfare depends on information and services relating to weather, water, and climate. The third is to facilitate collaborations relating to Earth observation, science, and service that advance public interest.

Meeting these three goals will help ensure that the scientific community receives the support and resources it needs to be able to make critical information and services available and, most importantly, will help the nation, and the world, avoid risks and realize opportunities related to the Earth system.

The Policy Program uses three primary approaches to help meet these goals.

- We develop capacity within the AMS community for effective and constructive engagement with the broader society.
- We inform policy makers directly on established scientific understanding and the latest policy-relevant research.
- We help expand the knowledge base needed for incorporating scientific understanding into the policy process through research and analysis.

Through these activities, we create new ways to reduce society's vulnerability to weather and climate events by sharing our resources and information with policy makers and the public.

Executive Summary

The 2017 Atlantic hurricane season inflicted heavy casualties and loss of life. At the same time, events in Texas, Florida, and Puerto Rico highlighted opportunities for improving U.S. natural hazards policy. In short, these involve building community-level resilience nationally and correspondingly reducing reliance on forecast-based emergency evacuations. Progress is needed in several respects: a more integrated approach toward economic development and hazard risk management; more effective and strategic public-private collaboration in risk management; a focus on reducing risk versus mere redistribution of risk; rigorous learning from experience versus rebuilding as before; and shouldering responsibility versus relying on federal bailouts. Ultimately, resilience in the face of hazards cannot be accomplished by a few. Instead it will require embrace as a shared public value.

1. Introduction & Context

The 2017 Atlantic hurricane season has proven costly indeed. Hundreds (by some reckonings *thousands*) of lives were lost. Months after the storms had passed, estimates of property damage and economic disruption continued to mount, totaling 300 billion dollars. The lives of some three million people in the United States and its territories remained on hold as power, safe drinking water, and other basic necessities had yet to be restored; as housing remained uninhabitable; and as insurers, lenders, and federal, state, and local governments wrangled over the sources and beneficiaries of what financial aid would be available.¹ United States social fabric and standing in the world were damaged as well. America's poor, elderly, and other underrepresented groups disproportionately and publicly bore the brunt of the disruption. A watching world saw the United States struggling to take care of its own, from Houston to Puerto Rico and the U.S. Virgin Islands, while providing only minimal aid to the recovery across the rest of the Caribbean.

It's tempting to see the 2017 calamity as the result of an unusual and unfortunate alignment of storm tracks. Certainly such great losses don't occur every year. Historically, only a minority of past hurricane seasons have delivered comparable destruction. But the reality is that while extremes such as hurricanes are nature's way of doing business, destruction such as seen in 2017 is more fundamentally a result of how individuals, and institutions and society more broadly, make decisions and act, as shaped in large part by natural hazards policy.

What does that policy look like? To oversimplify, current U.S. hazards policy (1) pays minimal attention to preventive or mitigation measures such as land use and building codes, (2) focuses instead primarily on *saving lives*, primarily through forecast-based evacuation, and (3) accomplishes *recovery* through funding from a combination of private and federal insurance, supplemented by *ad hoc* local-, state-, and federal-government outlays, as well as by non-profits and foundations.

Each element of these policies can and should be improved. The time horizon and accuracy of current weather forecasts can be extended. The management of evacuations could be accomplished and coordinated more effectively.

¹ By way of simple numerical comparison, it's perhaps worth noting that this impact on the U.S. economy and lives is roughly comparable to the deadly opioid-addiction crisis; together these events total 5% of U.S. GDP for the year

Participation in the National Flood Insurance Program could be enlarged and that program put on a financially sound, more sustainable footing. Executive branches and legislatures of government at all levels could take steps to make appropriations for disaster relief less reactive, more disciplined, and timely.

But incremental improvements in present policy tools and their use will be inadequate to the need. And unfortunately, this incremental approach (especially when applied only intermittently, in the immediate aftermath of major disasters) is how much of hazards policy is made.

Discussions throughout the duration of this American Meteorological Society policy study repeatedly pointed to the necessity for an expanded view of natural hazards policy. More fundamental changes, amounting to a reset, are required. For starters, the reliance on evacuation and recovery is misplaced. Policies need to be rebalanced in favor of better land use, stricter building codes, and more attention to the resilience and uninterrupted operation of critical infrastructure. Evacuation and recovery would then become tools to manage residual risk rather than the central risk management effort.

We examine five basic changes that could constitute a reset in hazards policy. Taken together, these would shift the focus toward building resiliency and avoiding loss and suffering. This reset involves moving policies:

- Toward integrated treatment of economic development and hazard risk management.
- From “rely-on-government” to “work-through-“public-private partnership,” extending to strategic planning and coordination,
- From “*redistribute-risk*” to “*reduce-risk*”
- From “rebuild-as-before” (or “return-to-prior-condition”) to “learn-from-experience”
- From “rely-on-post-disaster bailout” to “shoulder-pre-disaster responsibility,” individually, and institutionally, at all levels.

It would be hard to accomplish such a paradigm shift using only the resources and capabilities of the past. But the advance of science and technology – new observing instruments and platforms, and emerging capabilities for data analysis – offers new means for early detection of vulnerability buildup, which could motivate and guide local, regional, and national efforts to build resilience. This

American Meteorological Society policy study puts forward the case for such changes.

2. Why now? And Why the American Meteorological Society?

Why now? Because the hazards challenge is dire. Statistics show that worldwide, disaster losses are increasing, at a pace comparable to if not exceeding that of inflation. By themselves, the 2017 hurricane losses amount to 2-3% of US GDP, comparable to US economic growth for the year. Much of that disruption stems from vulnerability of aging critical infrastructure – the electrical grid, transportation, water supply etc. – elements in need of upgrade anyway, according to the American Society of Civil Engineers.² The incremental funds needed to build-in resilience to hazards, if made now, at the time of renovation, will more than repay the investment in terms of reduced societal disruption in coming years.

These broad trends were made manifest this past fall in several ways. In Houston, hard-hit by floods from much weaker events (10-20” of rainfall) over the past few years, residents saw Harvey’s flooding as the last straw. Interest in buyouts has increased. In Florida, flooding occurred in unanticipated locations throughout the state. In Puerto Rico, already venturing into bankruptcy under the weight of \$75 B in pre-existing debt, and relying on fragile, aging infrastructure, vulnerability was particularly acute. Congress struggled to maintain a tradition of helping distressed populations in the face of political partisanship and the high costs involved. As of mid-January 2018, following the brief government shutdown, the third and largest tranche of supplemental funding for disaster relief still remained unappropriated – held captive by partisan debate over continuing resolutions and government shutdowns until final passage in early February. The wrangling didn’t just delay recovery; it added to and extended the misery of everyone impacted by the storms.

Why the American Meteorological Society? The weather-, water-, and climate professionals comprising the AMS are better positioned than most to know the limitations of forecast skill as a foundation for emergency response and evacuation. Consider, for example, the forecasts for Hurricane Harvey. Days in advance, forecasts pointed to the likelihood of rainfall amounts approaching 50”

² <https://www.infrastructurereportcard.org/>

for the event, larger by factors of 2-3 over previous experience in the Houston area. Those prior events, though far less severe, had caused widespread flooding and damage. But even 4-5 days' notice was insufficient for emergency managers across the area to pre-position the levels of additional gasoline, food, and other services needed to support safely an evacuation of several million people for travel extending hundreds of miles. And evacuation did nothing to limit flooding damage to some 100,000 homes. Hurricane Irma posed a similar challenge for Florida residents and the state's emergency managers. Days in advance, forecasts showed the hurricane track would run virtually the entire north-south extent of the state. The huge size of the storm meant that no coast of the state could promise haven. In the same way, when Maria hit the small territory of Puerto Rico, the island offered no safe destination. *In each case, forecast skill was unprecedented, saving lives and some property. Yet loss of life and suffering remained high; property damage, and business and community disruption were extensive.* For a variety of reasons, then, forecast-based emergency management of evacuations of ever-increasing scope and duration cannot meet society's need. Rather evacuation is best viewed as a tool for handling the residual risk remaining after other strategies such as land use and building codes have been fully brought into play.

Meteorologists across the whole of the Weather Enterprise, spanning government, private-, and academic sectors, want to see energy and attention focused on making home and community the safest place to be in the event of hurricane landfall, and reducing the need for evacuation to the minimum practicable.³

3. The Purpose and Structure of the Study

This AMS policy study was framed to achieve three purposes:

- Advance and deepen knowledge: tease out a broader understanding of the environmental, social, and technological factors that contributed to the hurricane season's impacts. An extensive hazards literature makes it clear that individual events such as Harvey, Irma, and Maria are not just possible but inevitable over time – and, moreover, that vulnerability in Coastal Texas, Florida, and Puerto

³ The attitude is analogous to that of a dentist, whose office sign reads, “You don't have to floss all your teeth – just the ones you want to keep.” Your dentists can handle your dental emergency – but want you to forestall it with simple, inexpensive preventive action.

Rico have been ratcheting up, day by day, and year on year. Why did communities in harm's way not take full advantage of ameliorative measures? What factors contributed to the disastrous consequences? Moreover, these events are merely recent realizations of a larger set of natural hazards scenarios that threaten the United States, each of which is daily one-day-closer to occurring. The disastrous California fires from this past fall come to mind. Earthquakes constitute a similar threat. What can be done to forestall these calamities? Can new technologies make a difference? What policy interventions might help? The United States and its people need answers to such questions.

- Broaden awareness: contribute to and at the same time inform the ongoing national policy dialog on natural hazards policy; share the study content, findings, and recommendations with the scientific community, the private sector, the Executive Branch, and Congress, and a variety of American publics.
- Build capacity: equip study participants, as well as those attending the subsequent briefing(s) and reading this report and/or viewing videos of some of the presentations, to engage in the formulation and implementation of hazards policy more effectively over the long term. It is not enough that a small community of experts better grasps the environmental, sociological, and technical factors that enhance or reduce disaster risk. The critical difference is broad societal uptake of the information.

The Study structure:

Given that meteorology is a natural science, in which not just controlled laboratory experiments but observation of the natural world play a role in advancing knowledge, perhaps it's not surprising that the structure of Weather Enterprise policy studies mimics that of meteorological field experiments. These begin with planning, then enter a preparation phase, followed by the actual work in the field, and finally conclude with analysis and dissemination of findings.

Planning phase

"Life is what happens to you while you're busy making other plans" – John Lennon⁴

In the late summer and early fall, AMS Policy Program staff had been planning a study on water policy that would examine the balancing of public good and private interest. But as the hurricane season progressed, it became obvious that

⁴ But the origin of the sentiment goes back to a 1957 issue of *Readers Digest*, which attributes it to Allen Saunders.

the water policy issue on everyone's minds would be water as hazard, and staff sharpened focus accordingly.

Preparation phase

Workshops have much to commend them in policy study and development; they have much in common with crowdsourcing, with benefits to match. But they suffer from a shortcoming – the human tendency, especially in this multi-tasking, short-attention 21st-century world, to show up for the workshop itself with little advance preparation, and to wing it once there. In an effort to do better, the Policy Program has begun to explore use of platforms such as AAAS' Trellis, and another platform, *Higher Logic*, to conduct dialog prior to the face-to-face workshop proper. That was done in this instance. Upon registering for the November 15-16 workshop, participants were invited to join a conversation of about a month's duration on four topics:

- The Harvey-Irma-Maria disasters were years in the building. Local and national political and business leaders, planners, emergency managers, insurers, various publics – all saw them coming. Why did they happen anyway?
- How big is the U.S. problem? What similar risks does the nation face? What is the cumulative national exposure to similar scenarios and risks across the country that draw closer to reality day by day, year on year?
- What new tools are at hand for managing, reducing such future risk? How might they be harnessed? Subsidiary question: what are the respective public, private sector roles in the needed innovation?
- What policy options show promise for building resilience? And how can we more effectively use the policy tools and programs we already have?⁵

The conversation provided a number of useful insights. On the other hand, productive though it was, the Policy Program staff had the sense that this phase was under-utilized. Some registrants participated with vigor. However, most participants didn't weigh in on the workshop topic until the day of the meeting itself. Perhaps they intended to come to learn, and didn't feel they had much to offer; perhaps the many competing claims on everyone's time posed too great a barrier. It's difficult, however, to escape the nagging feeling we could have provided more incentive and encouragement for people to contribute, and that the resulting study would have been the better for it. In future studies, we will

⁵ And (a question really beyond the scope of this workshop, as constructed): what lessons might we learn from international experience.

continue to explore the use of IT for sharpening workshop participation and improving outcomes.

Field phase: The November 15-16 meeting/workshop itself

The month-long Trellis conversation plus the workshop together attracted some 130 registrants, 80 of whom were able to show up in person for part or all of the workshop, which was held at AAAS headquarters in downtown Washington, DC. An agenda for the workshop is attached as Appendix A. The agenda was structured around talks given by nine extraordinary speakers, from a range of backgrounds that didn't cubbyhole neatly into discrete topics, but instead spanned the wide-ranging facets of the discussion space in a way that allowed speakers and participants to unpack complex questions, pool decades' worth of professional experience, and circle back on key issues over the course of the two days.⁶

Dissemination phase

Immediately following the workshop, eight of the panelists led a briefing for Congressional staff on Capitol Hill. This event provided an opportunity to share – while the collective intellectual momentum was fresh in the panelists' minds – many of the key takeaways from the workshop with policy experts who are well positioned to carry these ideas forward at the federal level.

This report provides a comprehensive synthesis of those ideas in a format that can be widely shared with stakeholders and policymakers from all areas of the Hazards community. Because of the complex and overlapping structure of the information our participants surfaced over the course of the workshop, there were options for how to share the many ideas that our group covered. The four questions that originally framed discussion in the planning phase, however, remained one of the clearest ways to present our findings, which we share in the following sections.

⁶ If anything, the workshop discussions highlighted a need for an even broader array of participants: spanning the governance network, including federal, state, local; non-profits; corporations; insurance officials; emergent group leaders, etc

4. Findings from the Workshop

The Harvey-Irma-Maria disasters were years in the building. Local and national political and business leaders, planners, emergency managers, insurers, various publics – all saw them coming. Why did they happen anyway?

Workshop participants concluded there are many things that all stakeholders involved – city and regional planners, home buyers, developers, NFIP administrators, Congressional policymakers – might have done to reduce the impact these storms had on Houston, Puerto Rico, and Florida. In his keynote talk, Gerry Galloway, one of the nation’s foremost experts on water resources policy, made a comment that applies especially to Hurricane Harvey: we put ourselves in nature’s path.

The Houston area occupies an enormous floodplain, comprising four contiguous river basins. However, resilience to hazards is only one of several competing goals governing land use. For decades, the prevailing view of city leaders has been that real estate development should be allowed to take place unencumbered: Houston is the only major US city without a zoning code. It’s been argued that such freedom from regulation fosters economic growth. Certainly this was one of the factors that allowed Harris County (where Houston is located) to add more people than any other US County from 2009 to 2016 (when it slipped to second place).⁷

Data from the US Geological Survey shows that, as a result of Harris County’s growth, the amount of rain-impervious surface area in the metropolitan Houston area increased 32 percent between 2001 and 2011. While flood control officials responded by increasing the capacity of local infrastructure to handle stormwater, Hurricane Harvey’s 50 inches of rain exceeded the design parameters. While Hurricane Harvey was immense – the first storm to flood all four of Houston’s river basins – smaller storms have borne out the same conclusion: in May 2015, the “Memorial Day” flood dropped 28 inches of rain on the city. During the “Tax Day” flood in April of 2016, 16 inches of rain fell. National Public Radio memorably captured the successive effect these floods have had on local residents in its reporting on Houston resident Bill Pennington,

⁷ <https://www.bloomberg.com/news/features/2017-08-31/a-hard-rain-and-a-hard-lesson-for-houston>

whose home will now have been rebuilt three times courtesy of funds provided by the National Flood Insurance Program (NFIP).⁸

Bill Pennington's story highlights the Gordian knot of challenges that characterize the NFIP, whose policies have historically been provided at discounted rates in an attempt to grow participation to a level that would allow the NFIP to afford the enormous cost of events like Harvey. However those reduced rates fail to reflect the flood risk that properties like Pennington's are vulnerable to, which creates a downward spiral of unacknowledged liabilities. Also, there are currently only limited options for handling coverage on properties that flood repeatedly: despite the existence of buy-out programs, more than 25 percent of NFIP payouts go to 1 percent of the houses that NFIP insures. None of this is helped by the fact that Texas, which does not collect income tax, relies heavily on property tax to fund the State programs and local public schools, and accounting for flood risk would put substantial downward pressure on property values throughout the Houston area. But one can also make the argument that careful urban planning with land use patterns and infrastructure investments that avoid floodplain development won't necessarily lead to economic decline – in fact, such practices can and should have the opposite impact.

Galloway also shared a saying from the Dutch, who remain at the vanguard of flood prevention and mitigation: You need room for the river. In Houston, not only was there very little room to begin with, but the built environment wound up working against the local residents: with such enormous rainfall, water rose in front of the dams and also backed up behind the dams in ways that compromised the effectiveness of business-as-usual dam operations. Newspapers printed memorable photos of highways that filled with water to become rivers of their own: this was in large part because of the highways' sound walls, which both enclosed water along the highways and increased flooding around the property behind the sound walls.

The main factor that magnified Hurricane Irma and Maria's destruction across Puerto Rico was poorly maintained and aging infrastructure – one of the challenges that the US faces more broadly. The Puerto Rico Electric Power Authority (PREPA) had been struggling with operational and budgetary issues for years before the 2017 hurricane season. As of July 2017, PREPA was \$8 billion in debt and had filed for bankruptcy. Attrition among PREPA's senior staff was especially high and resulted in substantial shortfalls in grid maintenance, as indicated in reports that PREPA commissioned in 2015 and 2016 by the

⁸ <https://www.npr.org/sections/money/2017/09/29/554603161/episode-797-flood-money>

consultancy Synapse Energy Associates. According to reporting by Reuters, “[t]he deferred upkeep, according to a PREPA assessment in April, led to a ‘degraded and unsafe’ grid that needed at least \$4 billion for modernization of an ‘isolated system, in challenging terrain’ that is ‘subject to natural atmospheric events.’”⁹

When the hurricanes hit, Puerto Rico’s water infrastructure was also deeply in need of attention: in May 2017, the Natural Resources Defense Council released a study showing that Puerto Rico’s water system had the worst record under the 1974 Safe Drinking Water Act, with 69% of Puerto Ricans living with water that did not meet minimum safety standards. The world saw the impacts of these infrastructure challenges play out in Irma and Maria’s aftermath as, week after week, the huge majority of the island’s population struggled to rebuild without electricity or safe drinking water. As of the end of 2017, about half of the Puerto Rico’s population was still without power.¹⁰

As frustrating as the outcomes were for Houston and Puerto Rico, encouragement for our ability to reduce future hazards risk can be seen in the example of how Florida prepared for Hurricane Irma. Historically, Florida has made a substantial investment in recovery planning compared to other states. Panelist Phil Berke (Professor in the Department of Landscape Architecture and Urban Planning at Texas A&M University and Director of the Institute for Sustainable Communities) and colleagues conducted an eight-state study along the Atlantic and Gulf coasts that included a randomized sample of about 282 local communities¹¹: they found that Florida had high rates of recovery plan adoption relative to other states. Additionally, Florida was the only state in the sample to have state-mandated local recovery plans. In 2011, the Florida legislature rescinded the mandate. While all recovery plans for Berke’s study were adopted prior to 2011 and were not affected by the act to rescind, it is likely that pre-disaster recovery planning has become institutionalized in Florida and as a result is practiced more in Florida than in other states.

⁹ <https://www.reuters.com/article/us-usa-puertorico-utility-specialreport/special-report-the-bankrupt-utility-behind-puerto-ricos-power-crisis-idUSKBN1C92B5>

¹⁰ <https://www.reuters.com/article/us-usa-puertorico-utility-specialreport/special-report-the-bankrupt-utility-behind-puerto-ricos-power-crisis-idUSKBN1C92B5>

¹¹ Berke, Philip, John Cooper, Meghan Aminto, Shannon Grabich, and Jennifer Horney. 2014. Adaptive planning for disaster recovery and resiliency: An evaluation of 87 local recovery plans in 8 states. *Journal of the American Planning Association* 80(4): 310-323

How big is the U.S. problem? What similar risks does the nation face? What is the cumulative national exposure to similar scenarios and risks across the country that draw closer to reality day by day, year on year?

There are many ways to estimate the size of the national problem, and all of them lead to a daunting outlook. Federal spending for Hurricane Katrina was over \$100 billion; the combined amount of taxpayer money spent to provide relief for Hurricanes Harvey, Irma, and Maria could potentially double that amount. Another way to consider the question is to think about what these events would cost if, over the past decade, we had spent the same amount of money on mitigation. The rule of thumb in the professional flood risk community is that \$1 spent in prevention saves \$4 in expenses after the event takes place.¹² From that point of view, it seems natural that cities and states around the country would be eager to invest in flood mapping, to implement different land-use strategies, and to enforce stronger building codes. Clearly, however, we have focused on other priorities. Why this diffidence about our collective future safety and livelihood?

As participants commented during the workshop, people who may not act rationally by one set of standards usually *are* acting rationally in the context of other conditions that affect their lives. Urban planners in a given city can choose to build on a floodplain – and after the inevitable flood takes place, the money to rebuild will most likely come from the federal government. This results in the lack of any strong incentive to build more safely in the first place. It’s also easy to understand a community’s emotional need to restore what was lost in the wake of natural disaster, even if this places the community right back in harm’s way. Rob Galbraith, a Director in the Property and Casualty (P&C) Property Underwriting area at USAA, described how researchers following up on the 2016 Tennessee wildfires were dismayed that local residents were rebuilding their homes in the same places where those homes had so recently burned down.

Misaligned financial incentives, the human desire to recreate the familiar (thus failing to learn from experience, and repeating mistakes), and a general

¹² [Multihazard Mitigation Council](#), 2005. An important caveat: MMC evaluated post-disaster HMGP projects and found this relationship. This does not, however, capture continued at-risk development in adjacent areas, making it hard to assess effectiveness in terms of risk reduction at larger scales, like a watershed

reluctance to save money in the future by investing in mitigation today: these are all important components of the resilience challenges we face as a nation. In addition, climate change promises to continue to magnify the impacts of weather events across the United States (albeit in ways that will vary from region to region). The most striking recent example comes from California, where the Wine Country fires in the fall of 2017 and the Southern California firestorms at the end of that year pushed the state's wildfire spending to roughly half a billion dollars. According to reporting by the Los Angeles Daily News, as of December 3, 2017, California had about 40 percent more fires over that calendar year than the average for the past five years, and more than twice the average acreage had burned. Impressively, California has succeeded in creating realistic budgets to fight those fires. But what's disconcerting for state finance officials is that year after year, the dollar amounts continue to increase.¹³

Conference participants passionately emphasized that land-use and building-codes together have the potential to greatly improve mitigation efforts nationwide, with respect to diverse hazards. The task isn't simple or straightforward. Land-use strategies are challenging to implement because they require collaboration and integration across a range of local decision-making entities. These entities include agencies that handle land-use regulations; municipal offices that oversee the location and design of local infrastructure; and park and recreation land acquisition programs, just to name a few. As a result, each entity's mitigation efforts will usually be developed in isolation, in response to the needs of different stakeholders and without input from other groups that oversee land use in hazard areas. Because of this "stove-piped" decision making, local mitigation efforts may work against each other, or wind up at the bottom of the priority list, isolated from broader processes of managing land-use change and urbanization.

To address these challenges, policies that encourage development in hazard areas will need significant change. Effective land-use strategies require coordination across multiple federal government programs and policies that currently allow fragmentation and poor coordination to define mitigation efforts at the local level. For example, US DOT requires regional and local transportation plans; FEMA requires local mitigation plans; HUD requires local consolidated plans for affordable housing – however none of these plans are likely to be developed in coordination with each other. Phil Berke and his colleagues have conducted

¹³ <https://www.dailynews.com/2017/12/07/rising-costs-of-fighting-wildfires-is-overwhelming-the-states-firefighting-budget/>

research showing that even in small communities (with populations of 10,000 people or less), three or four such plans (and their associated rules) are in place at a given time. The result is, at best, an absence of mitigation planning – and at worst, development that increasingly puts our most vulnerable populations in the greatest harm’s way.

What new tools are at hand for managing, reducing such future risk? How might they be harnessed? What are the respective public, private sector roles in the needed innovation?

We were fortunate to have several speakers who were experts on some of the most powerful tools that are currently available to help understand and manage risk on broad spatial scales. David Green, Program Manager for Disaster Applications at NASA, spoke about the satellite monitoring that NASA conducts worldwide, in partnership with USGS, NOAA, US military forces, the International Space Station, and other international partner agencies. In situations like Hurricane Harvey or Hurricane Maria, where impacts span huge geographic areas, NASA’s space-based observations can be deployed to provide key information to community leaders, disaster response teams, insurance companies, and other groups. David spoke about how, in the case of Hurricane Maria, insurance companies didn’t have the ability to gather information across all of Puerto Rico. The nighttime satellite photography that NASA provided – which showed how nearly all of the island’s electric grid had been incapacitated – gave insurance firms clear and rapid answers about the extent of the damage. NASA’s ability to show where rainfall is taking place, and what the pre-existing conditions were before a hurricane’s arrival, were also valuable for decision makers who needed to keep tabs on a storm’s impacts in real time: when Hurricane Harvey flooded all four of Houston’s river basins simultaneously, NASA was able to provide critical data on where the water would eventually drain and what the implications were for debris and hazardous substances.¹⁴

¹⁴ an interagency effort underway will offer considerable technological help in future events. NOAA, USGS, and USACE are standing up a National Water Center in Tuscaloosa, Alabama, utilizing and continuing to develop a National Water Model: <http://www.nws.noaa.gov/oh/nwc/>. The effort holds potential for high-resolution prediction of inundation integrating the effects of precipitation, runoff, storm surge, and waves, taking into account effects of the built environment.

While gathering and disseminating space-based observations is something NASA has done for decades, the Disaster Application group is constantly looking for ways that this information can be tailored to meet the needs of communities that are preparing for – and living through – hurricanes and other natural hazards. NASA continues to cultivate relationships with key partners in the hazards community, and is planning future satellite capacity to better meet the needs of decision-makers in places like Puerto Rico and Houston.

Over the past few years, those decision-makers have also turned to the US Census Bureau, which has been developing two tools to help before, during, and after hazard events: OnTheMap for Emergency Management, a web-based mapping tool that tracks real-time events and shows where people live and work, and Business Builder, a similar tool that provides geographic data on people and businesses across all economic sectors. Laura Furgione, who leads the Census Bureau’s Office of Strategic Planning, Innovation and Collaboration, described to workshop participants how important it is for disaster recovery professionals to understand where people live, work and commute. During the Wine Country fires in California, for instance, these Census mapping tools were able to provide block-by-block information on what homes had been wiped out, and how many local workers had become homeless. OnTheMap for Emergency Management was also able to provide disaster response teams with information about the retirement income, supplemental income, and languages spoken by the people affected by the fires – information which would help those teams provide customized, targeted support to the communities in crisis.

Business Builder and OnTheMap for Emergency Management were also part of the research that New York City undertook after Hurricane Sandy to better understand how the City’s traffic corridors were used, and to protect them against future storms. In addition to providing these tools, the Census Bureau’s Emergency Preparedness and Response Team (EPRT) plays an active role in the hazards community: EPRT teams regularly collaborate with FEMA’s disaster coordination teams and data analytics teams, providing population statistics that can help assess vulnerability and guide response.

Workshop participants also learned about the mapping products being developed by Descartes Labs, a start-up company co-founded by Steven Brumby. Steven emphasized a perspective that guides the development of Descartes Labs’ products, but which clearly also applies to Laura and David’s work as well: people don’t want remote sensing images so much as they need answers to key

questions, like where is the rain going to fall, and how much will fall on the densest population centers. For example, Descartes Labs has developed capabilities for spotting similarities and differences in satellite images – and merging satellite- with other data sources (such as Census). In principle by such means it should be possible in the future to assess structural and other damage resulting from hurricanes, wildfire, earthquakes, etc., by comparing before- and after images. Such comparisons over time could also be used to assess the buildup of hazard vulnerability at the community or local level prior to events.

One important way of assessing the value of a given tool is the degree to which local people can engage the information the tool provides to create mitigation solutions. Workshop participants expressed the view that, ideally, mitigation solutions that deal with the built environment should be “fine-grained” enough to meet the needs of affected communities. However, participants also commented that in their experience, local governments usually have limited capacity to access and implement new tools to create proactive plans and policies. Even if communities can learn about the latest technological resources, this does not guarantee that they will be able to successfully use those tools to create mitigation solutions. Phil Berke commented that more than 180 cities and counties in the Harvey disaster declaration area in Texas have populations smaller than 20,000 people, and therefore limited capacity to develop strategies to guide recovery: communities like these can benefit from tools with features that engage local people, leverage local knowledge, and enable the creation of solutions that fit the needs and values of individual communities. One tool that is showing promise on this front is the Plan Integration for Resilience Scorecard (PIRS), which the city of Norfolk, VA, used in a recent resilience initiative. Focused on helping communities translate local knowledge into action, PIRS helps stakeholders frame their resilience work with the following questions:

- Where are the community’s hazards?
- What are the different types of vulnerability that exist in those areas?
- Score the community’s development plans: how much are the current plans promoting development in high-risk areas?

The net result is that communities learn how to build back better. In Norfolk, which has been grappling for years with flooding from sea level rise and coastal storms, city staff worked together in self-evaluating multiple city plans including the comprehensive, mitigation, and downtown revitalization plans. As a result of this work, some parts of the city will continue to be developed, but carefully; in

other areas, development will gradually be abated. And building will be encouraged in the parts of the city that are well positioned for increased development.

Norfolk also helped to institutionalize resilience awareness by adopting a point system called the Resilience Quotient. The Resilience Quotient requires every developer to incorporate sea level rise protection measures into building designs. Each proposed development must reach a minimum level of credits to gain project approval, no matter where the development is located. Norfolk's success with these PIRS-led initiatives has not gone unnoticed in the risk prevention community, and PIRS is one of the tools currently being applied in several municipalities in the Harvey impact area.

What policy options show promise for building resilience?

National Programs

The National Flood Insurance Program (NFIP), to a large extent, is the best available option for homeowners in flood-prone areas: it is the resource that helps them to pick up and start life again after events like Harvey, and but it can also be the mechanism that keeps communities locked in costly cycles of repeated rebuilding. Why do we see multiple repetitive losses of the same buildings in communities that participate in the NFIP? There are many complicating factors: for instance, NFIP requires participating communities to elevate buildings once those buildings sustain more than 50% damage – which results in local officials assessing multiple buildings as being 49% damaged. Another consideration in many cases of repeat structural damage is lax enforcement. FEMA almost never penalizes repetitive-loss communities by declaring them ineligible for insurance or downgrading their Community Rating System (CRS) score.¹⁵ In turn, local government officials tend not to enforce their codes: it's difficult to tell homeowners that they must use their own money to elevate their homes, or relocate. (While NFIP policies do provide some funding for mitigation measures,

¹⁵ Implemented in 1990, the National Flood Insurance Program's (NFIP) [Community Rating System \(CRS\)](#) is a voluntary program for recognizing and encouraging community floodplain management activities that exceed the minimum NFIP standards to reduce flood losses, facilitate accurate insurance ratings and promote the awareness of flood insurance.

those funds are currently capped at \$30,000.) Even in NFIP communities, many homeowners do not have insurance but are still required to mitigate against future floods. How can these situations be improved?

Coincidentally, the night before the workshop began, the House of Representatives passed a NFIP reauthorization bill that sought to address these and other challenges. Reporting by Insurance Journal quoted House Financial Services Committee Chairman Jeb Hensarling (R-Tex.), who echoed the perspectives voiced by numerous workshop participants: “We have to realize if we’re going to make this program sustainable we cannot have one percent of the properties causing 25 percent of the losses. Ultimately, if all we do is rebuild the same properties in the same fashion in the same location, that is neither wise nor compassionate.” (Hensarling has also announced that he does not plan to run for re-election.)

In discussing possibilities for NFIP reform, workshop participants spoke about how important it is for poor and disadvantaged communities – the ones who would have the most difficulty starting over after an event like Harvey – to have affordable access to NFIP policies. Similar concerns about the NFIP bill were expressed by Rep. Maxine Waters, (D-Calif.), ranking member of the House Financial Services Committee: “This bill will punish lower- and middle-class Americans with increased premiums, surcharges, and reserve fund assessments. In the wake of a historic hurricane season that devastated so many communities, it is unconscionable that we are considering a bill that would make flood insurance less affordable.”

The tension between these two quotes captures the essential challenge of cultivating a flood insurance market that creates incentives for risk reduction while providing meaningful help for the people with limited resources. One approach could be to lower the need for future assistance by devoting more federal resources to risk reduction and mitigation. During the workshop, participants shared concerns over low levels of investment in risk prevention: between 2005 and 2014, the federal government spent on the order of \$275 billion on natural disasters. From that pool of money, only 0.2 percent was allotted to FEMA’s pre-disaster mitigation program. Remarkably, two weeks after the workshop took place, Congressman Lou Barletta (R-Penn.) introduced the Disaster Recovery Reform Act (DRRA) of 2017,¹⁶ a bipartisan bill that aims to prioritize investment in mitigation when communities are recovering from natural disasters, and increases federal support for pre-disaster planning and

¹⁶ <https://transportation.house.gov/uploadedfiles/drra.pdf>

mitigation. Congressman Barletta increased the rule-of-thumb ratio for mitigation spending, arguing that “[e]ven conservative estimates have shown that for every \$1 we spend on mitigation, we can save between \$4 and \$8 in avoided disaster recovery costs. Focusing on mitigation will help disaster prone communities across the nation build better and build smarter. It’s time to stop asking ‘what now?’ right after a catastrophe, and focus on ‘what’s next?’ to prepare for future disasters.”¹⁷

Despite these admirable goals, many within the flood management community were troubled by the bill’s provisions. In a letter to Congressional leadership, the Association of State Floodplain Managers praised the bill’s support for pre-disaster hazard mitigation assistance, but pointed out that the bill would authorize the President to allow disaster assistance funds to be directed to other activities, without any stipulations on the potential risk mitigation benefits of those activities. Another section of the bill would allow hazard mitigation funds to be diverted for building Army Corps of Engineers projects, regardless of how necessary those projects may be for risk mitigation. The letter also noted that the Army Corps’ annual flood control budget is already nearly five times FEMA’s entire Hazard Mitigation Grant Program budget, despite the fact that “FEMA’s non-structural hazard mitigation projects deliver among the highest benefit-cost ratios and reductions of future residual risks of all flood risk reduction techniques available.”

The DRRA wound up becoming part of the disaster assistance package that was passed by the House of Representatives on December 21, 2017; as of the writing of this report, a companion bill has not yet been passed in the Senate.

City and State-level Programs

Over the course of the workshop, participants reiterated the ways in which land-use decisions are almost always made at the local level, and that municipal governments have the biggest impact on the relationship between present-day development choices and future risk mitigation. Participants had high praise for risk mitigation programs that were underway in certain parts of the country, and debated what kinds of motivation would inspire decision-makers in other parts of the US to develop their own resilience initiatives.

¹⁷ <https://barletta.house.gov/media-center/press-releases/barletta-introduces-major-disaster-reform-bill>

One policy that stood out was California’s state law AB 2140, which requires local governments to adopt a safety element in the required local comprehensive plan (called a general plan in California) to guide physical development in ways that reduce risk to hazards. The safety element must be coordinated with other elements (land use, conservation, capital improvements) in the comprehensive plan. Communities, in turn, must adopt regulatory development ordinances consistent with the plans. And, under the federal Disaster Mitigation Act of 2000, each community must develop a local hazard mitigation plan to be eligible for FEMA pre-disaster mitigation grants and post-disaster recovery assistance. The state authorizes local governments to adopt their local hazard mitigation plans as part of their general plans. California further encourages this kind of planning integration through a state post-disaster financial incentive that covers the local share of the 25% non-federal portion of grant-funded post-disaster rebuilding initiatives.

California is also notable in its proactive stance on climate change – a topic that workshop participants repeatedly discussed as a key consideration for future hazard mitigation in all parts of the country. Under the California Environmental Quality Act, municipalities and counties must conduct a greenhouse gas (GHG) emissions inventory and reach GHG emission targets. In 2007, the state successfully sued San Bernadino County, contending that the county’s general plan (a blueprint for the physical development of land until year 2030)¹⁸ did not adequately analyze the effects of development on global warming nor did it identify feasible GHG reduction measures.

Melissa Stults, a sustainability and climate consultant at the University of Michigan, brought up as an example the city of Boston, which is also taking steps to address future risks related to climate change. All Boston developers are responsible for integrating future climate change impacts into their project plans. If the developer fails to take climate impacts into account, then the city is liable for what happens to the people in that building – which gives Boston city officials a strong incentive to put the onus for risk reduction on developers.

Also at the local level is the example of Washington, NC, a small coastal community that is taking a holistic approach to socially equitable vulnerability reduction. The local mitigation plan contains equity policies aimed at floodplain land acquisition and relocation in poor neighborhoods. The land-use plan includes a zoning policy that designates the same acquired floodplain lands as a public park and a greenway corridor that serve a low-income neighborhood. The

¹⁸ <https://oag.ca.gov/news/press-releases/brown-announces-landmark-global-warming-settlement>

work that Washington has done shows the way in which innovative thinking can create multiple benefits for a community's different constituencies, and help lower risk for the community overall.

In terms of flood risk, a significant development among local- and state-level initiatives is the Louisiana Strategic Adaptations for Future Environments, or LA SAFE. Currently reaching the finalization stage after months of community meetings, LA SAFE proposes to relocate thousands of people from areas around the Gulf of Mexico that are most at risk for sea-level rise and flooding. LA SAFE contains a number of provisions, including a moratorium on building in high-risk areas, buyouts for the people currently living in those communities, and higher taxes for residents who insist on staying.¹⁹ LA SAFE is a hugely ambitious piece of legislation, and with so many contentious components, it's hard to predict the likelihood of its implementation. Either way, state officials are hoping that by setting tough benchmarks for lowering future flood risk, LA SAFE may light the way for other states and communities to reevaluate the cost of maintaining the status quo against the possibility a future with greater long-term safety.

Private-Sector Programs and Public-Private Partnerships

The potential for private-sector firms to improve America's hazard mitigation and response practices is enormous. An example of this kind of success was discussed by workshop participants in the context of the National Transportation Safety Board's impact on air travel. The air travel industry realized in the 1960s that they had the safest mode of travel ever, but that they'd be quadrupling their flights in the years to come. This future growth meant that, despite the challenges of diminishing returns, plane manufacturers and airline companies would need to push for even safer equipment and staff training. And built into that ambition was the implicit understanding that if a wing fell off an airplane, no one was going to go back and build the next plane the same way. Perhaps most notably, in their role of providing industry oversight, the National Transportation Safety Board never produced legislation: they only needed to produce findings, and the industry found ways to create safer aircraft in response.²⁰

¹⁹ <https://www.bloomberg.com/news/articles/2017-12-22/louisiana-sinking-fast-prepares-to-empty-out-its-coastal-plain?for-guid=6b37159d-86a4-e711-b65f-90b11c343abd&csp=>

²⁰ Coincidentally, during the preparation of this written report, [To70](#) and the [Aviation Safety Network](#) announced that 2017 had been the safest travel year in aviation history.

Could an analogous process work for firms that handle hazards response? Given the more complex collection of stakeholders involved (government, landowners, developers, insurance providers), the outcome would surely be more varied, but the potential for progress remains. One way in which the private sector is working to meet consumers' risk reduction needs is through the FORTIFIED Home™ program. Introduced by the Insurance Institute for Business & Home Safety in 2010, FORTIFIED Home™ is a voluntary set of uniform standards that homeowners can implement to increase their home's ability to withstand hurricanes, hailstorms, strong winds, and other kinds of extreme weather. Rob Galbraith described how FORTIFIED Home™ has taken hold in Alabama, especially along the coast – in fact, more than half of the FORTIFIED Home™ stock in the US is located in Alabama. Realtors use it as a selling point, and FORTIFIED typically translates into a seven percent increase in property value. However, several states away in Oklahoma – one of the most tornado-prone states in the country – builders struggle to interest home buyers in paying the additional five or six percent for a FORTIFIED Home™, regardless of the resilience benefits.

It will be interesting to see the degree to which growing consumer awareness and the likely increase in extreme weather events will lead to changes in these kinds of buying patterns during the coming years. As several workshop participants observed, financial incentives are one of the only proven techniques for influencing behavior. Homeowners and business owners are, arguably, the people with some of the greatest decision-making power about what sustainable development in America can look like. One aspect of this power that interested workshop participants was the way in which real estate websites like Zillow currently provide information on public schools and crime rates near their listed properties. It's entirely possible that Zillow could also provide information on flood risk as well. At what point will home buyers start demanding this kind of disclosure?

Another perspective on the role of public-private partnerships was shared by speaker Samantha Medlock, Senior Vice President at Willis Towers Watson and former lead for the Council on Environmental Quality's work on the Flood Risk Management Standard. One of the topics that Samantha spoke about was the Caribbean Catastrophic Risk Insurance Facility (CCRIF), a non-profit risk pooling entity. CCRIF offers parametric insurance designed to limit the financial impact of catastrophic events on Caribbean governments by providing funds when a hurricane or any similar triggering event occurs. Sixteen Caribbean countries participate in CCRIF, however at the time of the writing of this report, the United States was not one of them, and was therefore unable to benefit from

the assistance that would have been available for Hurricane Maria. Whether the US will join CCRIF in the future is unclear, but the Facility provides a possible template for insurance mechanisms that could work in the US as well.

5. Lessons, takeaways, and recommendations:

- 1. Evacuation is problematic.** Evacuation can indeed save lives; evacuation is and will remain a necessary part of a more comprehensive approach to coping with hazards. However, reliance on evacuation alone shows severe limitations. Evacuations of the scale seen in Texas and Florida overwhelm the resilience of the region (ability to meet demands for fuel, emergency housing, etc.). Return home after the immediate threat had passed proved equally if not more challenging. Displaced populations were not allowed to return until critical infrastructure had been restored, yet in some cases those very populations included many who could have helped with clearing roads, cleaning up, and restoring power. Removal and continued absence of these people, and their skills – and the time required for their return home – slowed post-storm recovery still further. In Puerto Rico, the island offered no safe haven. In short, evacuation saves lives but when schools, hospitals, and workplaces are destroyed as well as homes, those who are displaced and subsequently return often encounter greatly diminished quality of life.
- 2. Mitigation is linked to economic development; that linkage should be reflected in policy.** Our host planet is at one and the same time generous, dangerous, and fragile. Our policies must therefore address economic development, public safety, and environmental protection – not in isolation, but simultaneously. What’s more, equity matters. Public safety ought to be equally available for everyone. The US needs plans that cover not only states but territories as well. We should also think carefully about our country’s place in an international context, and what it means to be a good neighbor both across the Caribbean and beyond. Regardless of the geography, our policies can and should do a better job of accounting for the multiple economic benefits of hazard mitigation, which, arguably, is not incorporated effectively in existing cost-benefit models. Coordination across all levels of government matters here. Although there are signs that we’re making progress, we still have a long way to go. Any

work that can be done within the federal government to better align funding streams, administrative requirements, and planning requirements between multiple agencies would be a substantial improvement. Increased investigation and planning at the local level can also be hugely impactful: the examples (discussed earlier) of Norfolk, VA, and Washington, NC, show the creative and effective ways in which people can design comprehensive risk-mitigation plans that address the needs of their own communities.

- 3. It follows that reliance on the public sector alone should be replaced by public-private sector partnerships.** Just as economic development is a task shared by private enterprise and government at all levels, hazard mitigation is a joint interest of both sectors, and can best be achieved by working in partnership. The private sector currently shares in pre-event mitigation and preparation for hazardous events; in emergency response, and in recovery.

The private sector is also responsible for much critical infrastructure: energy, communications, financial infrastructure, and more. Finding ways to ensure business and community continuity in the face of extreme hazards is the gold standard for infrastructure design, maintenance, and rehabilitation. It's also imperative to understand and account for infrastructure interconnectedness: grid and communications are the vital starting point for everything else. But critical infrastructure extends to schools, hospitals, and other community services. More advance planning is needed to assess how and where infrastructure is placed, as such decisions play a vital role in shaping human settlement patterns. Also, given that it is expensive and often long-lived, siting and design considerations are important as well. For the most part, however, in all this, the private sector currently executes at the direction of the public sector, or serves at best as a junior partner. It would be desirable to extend public-private partnerships in ways that would lead to sharing more equally in strategic planning and direction for business and community continuity in the face of hazards.

- 4. Emphasis should extend from redistribution of risk to reduction of risk.** To start, NFIP policies and implementation can be improved – with a stronger focus on broadening the pool of those insured, but more importantly, taking steps to reduce repetitive loss. The NFIP in its present form can effectively encourage real-estate development in dangerous locations. It would be useful to explore the ways in which the

NFIP can be linked to land-use measures that account for future flood risk (versus unimpeded development) in accordance with Local Flood Damage Prevention Ordinances. Finding ways to make flood insurance more accessible for low-income communities who live in high-risk areas but may have difficulty paying the premiums (much less the cost of rebuilding after a flood event) is also an important goal.

5. Learning from experience vs. repeating mistakes. The record shows that this is difficult to accomplish, but every inch of progress made towards this goal is an enormous achievement. Part of this work is providing policymakers with access to tools like Business Builder and PIRS, which can help communities translate the knowledge they already have about where they live and work into plans for future progress – but the usefulness of these tools depends on a willingness to accept that a community’s future may need to be different than its past. Lessons from hazard-focused cities within the US – and also from other countries, like the Netherlands, that have taken innovative approaches to hazards challenges – have the potential to lead the rest of us in improved directions.

6. Reconnect control with consequences and shoulder responsibility at all levels. Find ways to motivate and support state and municipal policymakers in developing mitigation and recovery solutions that work at the local level, so that federal recovery funds become less central to hazard response. Find ways to encourage the private sector in efficiently designing and marketing products to property owners that can help them be better prepared for the next hazard. While doing this, we need to simultaneously build capacity and awareness and hold communities, states, and others increasingly accountable over time, while providing guidance such as:

- Stronger incentives for better and more integrated local planning and policy
- Graduated federal cost-sharing for structural protection works and graduated post-disaster federal public assistance matching funds
- Encouraging sliding NFIP rates to reward communities that are doing more – one way would be to give more credits under NIFP’s Community Rating System (CRS);

- NFIP should give more attention to holistic approaches that weave mitigation into broader development planning processes, and to reduce the isolation of mitigation efforts that are common at local levels.

Toward all these several policy ends, it is essential to get more information in the hands of people who will be responsible. This has many different elements:

1. Engage the public, especially marginalized groups:

- Recognize local capacities to act.
- Draw on and leverage local knowledge in developing mitigation solutions.
- Engagement is important since changes in land use and building codes, regulations, and public investments must respond to local needs, values, and aspirations for more resilient community building.
- K-12 public education: this may be one of the most powerful pathways for breaking patterns of repetitive loss and accomplishing real change in future generations. Support for initiatives that educate students on the environmental risks they face – and how those risks can be addressed – should be encouraged.

2. Improve quality and accessibility of data and metrics:

- Encourage leadership at the national level for setting baselines of risk, monitoring changes in risk, adapting plans to respond to uncertainties, and improving plan performance.
- Expand the range of databases to assess multiple types of vulnerability (physical, social, environmental, business).

3. Develop new tools to build local capacity:

- Research is needed for the creation, testing, and validation of new tools that can
 - maximize the use of scientific and technical information systems;
 - foster engagement, communication and coordination among local agencies, affected stakeholders, and the public; and
 - develop better and more integrated plans that improve resilience.

6. Postscript and Suggestions for Future Work:

AMS was grateful for the opportunity to convene the panelists and all the participants who contributed so richly to this workshop. Their dialogue was inspiring, and an important reminder of the high levels of dedication that characterizes the careers and viewpoints of so many members of the risk mitigation community. While this report has captured the main points of discussion, several topics were touched on that we hope to explore in greater detail in AMS's future policy work. These areas for continued research include:

- A companion tool to PIRS called CHARM (Community Health and Resource Management), which helps stakeholders in the planning community to map local-level hazards, analyze the vulnerability of alternative growth scenarios, and receive real-time feedback.
- The effectiveness with which private insurance policies in Puerto Rico have helped local residents cope with the aftermath of Hurricane Maria. Private flood insurance is more widely deployed in Puerto Rico than in other parts of the US, and may provide answers on the ways in which the private insurance market can play a larger role in hazard mitigation.
- Land-use policies in Sacramento, which was cited several times over the course of the workshop as an example of a city with substantial flood risk, but where the potential to make improvements before a serious hazard occurs still remains.

Appendix: Workshop Program

A Reset for U.S. Natural Hazards Policy: What might it look like? How might it be accomplished?

When: November 15th-16th, 2017

Where: 1200 New York Avenue NW, Washington, DC 20009

Background

Hurricanes Harvey and Irma subjected the United States (and its *de facto* natural hazards policy) to an unexpected and unwelcome stress test (similar from the kind of stress test cardiologists use to evaluate their patients, or the Federal Reserve uses to evaluate the financial health of U.S. banks). Fatalities were low (totaling some 100, versus, say, the 2000 who died in Hurricane Katrina) but were still too high. Thousands of homes were totally lost due to extensive flooding and high winds. Many more were partially damaged. Hundreds of thousands of cars were damaged. According to some estimates, together the two storms may reduce U.S. GDP by as much as 0.8%, or about \$150B. Figures for property loss and economic disruption are still being aggregated but look to total in the \$200-300B range.

The events point to considerable room for improvement in U.S. natural hazards policy and/or its implementation:

- Homes and businesses in the hurricane paths could not be defended; virtually all were under mandatory evacuation.
- Evacuations were an extended ordeal unto themselves; for many people that ordeal continued weeks after the storms had come and gone.
- Weather forecasts revealed extraordinary improvements in meteorological skill over prior years. However, in Harvey and Irma the scale of the evacuations was extensive and involved large numbers and long logistical lead times. Weather guidance, good though it was, struggled to keep pace with the needs of federal, state, and local emergency managers.
- Flooding caused most of the damage. Private insurers, who covered only wind hazard, suffered minimal losses. By contrast, the National Flood

Insurance Program found itself once again strapped for funds. Since something like 80% of those who suffered flood loss had failed to buy flood insurance, hardly anyone affected was made whole.

- The Congress continues to struggle to appropriate off-budget supplemental funds to cover the losses.
- The urgencies and pressures of the moment offer little opportunity for social or technological innovation. Current policies favoring rebuild-as-before will condemn area residents and the Nation as a whole to repetitive loss, extending many decades into the future.
- Public-private-sector coordination was effective, but limited primarily to emergency response and early stages of recovery.

Hurricanes Harvey and Irma suggest that virtually the whole of the U.S. coastline is similarly vulnerable, and that vulnerability is increasing. But opportunities for building resilience – some new, and some that have been on the table for some time, are numerous. They include, but are not limited to, federal, state, and local policy options that promote:

- More effective land use.
- More rigorous building codes.
- More resilient critical infrastructure.
- No-adverse-impact limits on new projects.
- Modifications to National Flood Insurance Program, now up for reauthorization.
- Replacing rebuild-as-before with learn-from-experience approaches, perhaps establishing an agency analogous to the National Transportation Safety Board, to help communities and states minimize repetitive loss.
- Innovation. Harnessing new observing instruments and platforms, and exascale computers scheduled to come on line over the next few years, to improve weather guidance. Using results from social-science research to improve risk communication and emergency response in the face of weather hazards – and improve uptake of pre-event mitigation opportunities. Applying big data, data analytics, and cognitive computing to assess community vulnerability, build resiliency, and guide planning, emergency response and recovery.

- Public-private-sector sustained, strategic-level collaboration with respect to planning for and building community-level disaster resilience.

The Study and the Workshop will be built around four questions.

- **Question 1:** The Harvey-Irma disasters were years in the building. Local and national political and business leaders, planners, emergency managers, insurers, various publics – all saw them coming. Why did they happen anyway? Subsidiary question: Were public/private-sector goals on the same page on how to approach these risks? Where are public and private interests congruent? Where do they diverge?
- **Question 2:** How big is the problem? What similar risks does the United States face? What is the cumulative exposure to similar scenarios and risks that draw closer to reality day by day, year on year?
- **Question 3:** What new tools are at hand for managing, reducing such future risk? How might they be harnessed? Subsidiary question: what are the respective public, private sector roles in the needed innovation?
- **Question 4:** What are the most promising place-based and federal policy options for reducing future U.S. risk (emphasis on local options with secondary attention to federal role)? How might they be further explored or implemented? Subsidiary question: To what extent can these options be expanded, or their effectiveness improved, through strengthening public-private partnerships?

Workshop Agenda

Wednesday morning, November 15

8:00 Registration & breakfast

8:30 Quick overview of workshop goals and outcomes

8:45 Question 1: Why did this happen? Lead discussant: Gerry Galloway

10:15 Break

10:45 Question 2: What is the scope of the national challenge? Facilitated discussion.

12:15 Lunch

Wednesday afternoon

1:15 Question 3: What new tools are at hand? Lead discussants: Steven Brumby, Laura Furgione, David Green

3:00 Break

3:30 Question 4: What are the most promising policy options? Lead discussant: Samantha Medlock

4:00 Wrap-up

Thursday morning, November 16

8:00 Breakfast

8:30 Quick review of previous day and plan for the morning

9:00 Question 4 continued: What are the most promising policy options?
Lead discussants: Larry Larson, Phil Berke, Laura Lightbody, Gavin Smith

10:30 Break

11:00 Extended discussion: Identification of policy options and next steps

12:15 Wrap-up

12:30 Adjourn

Thursday afternoon

2-3:30 Hill briefing, U.S. Senate Building, Room S-115

