STRONGER CLIMATE RESILIENCE WITH INSURANCE

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On the connection between climate change and insurance, Evan Mills wrote in *Science* that “insurance is a form of adaptive capacity” (Mills 2005). Well-functioning insurance markets price risk appropriately, and thereby encourage risk reduction. And so, a natural question to ask is this: to what extent can the insurance industry further promote climate adaptation? To address this question, researchers representing the climate science, insurance, and climate adaptation communities gathered at the Nexus of Climate Data, Insurance, and Adaptive Capacity, in November 2018. The goal was to look specifically at the intersection of these three research communities and identify new research paths for how insurance can lead to greater climate change adaptation.

The concept for the workshop grew out of the one-year research program on the Mathematical and Statistical Methods for Climate and Earth System organized in 2017–18 by the Statistical and Applied

THE NEXUS OF CLIMATE DATA, INSURANCE, AND ADAPTIVE CAPACITY

WHAT: Fifty-seven active researchers from climate science, insurance and reinsurance, and climate change adaptation discussed the intersection of these three research communities and developed actionable research paths forward for the insurance industry to lead climate adaptation.

WHEN: 8–9 November 2018

WHERE: Asheville, North Carolina

Mathematical Sciences Institute (SAMSI) in Research Triangle Park, North Carolina. Authors Erhardt, Bell, Blanton, and Smith were members of the program working group on risk and coastal hazards, which was formed to address active scientific questions in the measurement of climate risk, with particular attention to flooding. Those research discussions led to the idea of an interdisciplinary workshop exploring the connections between climate change and the ways in which the insurance industry could promote or better facilitate adaptation and resilience through well-designed insurance products and markets. The organizers added Frank Nutter, president of the Reinsurance Association of America, and Megan Robinson, chief operating officer of The Collider, a global innovation center for climate entrepreneurs in Asheville, North Carolina (<https://thecollider.org/>), to gain better perspective from the insurance and climate adaptation communities. The organizers then identified and invited prominent speakers from across the research areas in roughly equal proportion. A central consideration was to identify those who could speak to all of the varied audiences present.

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THE INVITED SPEAKERS. Three of the speakers were from government agencies. Derek Arndt, chief of climate monitoring at National Oceanic and Atmospheric Administration (NOAA)/National Centers for Environmental Information (NCEI), spoke about freely available sources of climate data and information and introduced the supporting role NOAA/NCEI can play. Jennifer Jurado, chief resilience officer of Broward County, Florida, described efforts to fuse scientific projections with the government approval process for flood control in Florida, going well beyond standards and maps set by the Federal Emergency Management Agency (FEMA). Finally, Adam Smith, from NOAA/NCEI, described the billion-dollar weather and climate disasters database and the increasing trends in these disasters since 1980 (www.ncdc.noaa.gov/billions/).

Five of the speakers were academics. Doug Nychka, professor of statistics at Colorado School of Mines and former institute director at the National Center for Atmospheric Research, spoke about climate model projections and their use in statistical analyses. Dan Cooley, professor of statistics at Colorado State University, spoke about the statistics of modeling extreme events as opposed to “typical” events, relying on extreme value theory with attention to paired extreme events. Mitch Roznik, graduate student in agricultural economics at the University of Manitoba, described changes to crop risk and crop insurance in Canada owing to a changing climate. Mathieu Boudreault, associate professor of actuarial science at the Université du Québec à Montréal (UQAM), described a hierarchical modeling approach that fused climate model projections, hydrology, and hydraulics models to study flood risk along a river in Canada. Finally, Jeremy Hess, associate professor of emergency medicine at the University of Washington, described estimating the human health impact of climate change with attention to health and life insurance.

Three speakers represented industry. Roy Wright, president and CEO of the Insurance Institute for Business and Home Safety, former deputy administrator of FEMA, and former director of the National Flood Insurance Program, discussed the use of regulation and building codes to encourage greater climate resilience. Raghuveer Vinukollu, natural catastrophe solutions manager at Munich Re, discussed public-private partnerships to manage flood risk. Steve Kolk, of the Casualty Actuarial Society, introduced the audience to the actuaries’ climate index and the actuaries’ climate risk index.

The workshop itself followed an established organizing strategy from SAMSI. We began with the

plenary talks and then self-selected into breakout discussion groups to address different topics raised in the talks. The chosen topics were 1) how to build a better flood map, 2) the use of climate model projections for insurance, 3) climate mitigation and adaptation, and 4) high-impact possibilities that was warmly named “What keeps you up at night?” Brief summaries of each discussion are included, with extended material on each topic available in the online supplement to this summary (see <https://doi.org/10.1175/BAMS-D-19-0073.2>).

HOW TO BUILD A BETTER FLOOD MAP.

This breakout group broadly addressed current FEMA flood maps in terms of what could be adopted from the commercial sector, including more probabilistic information on flood hazard levels under uncertain environmental conditions. Participants included academic, federal, and industry researchers, with significant input from commercial sector insurance experts. The goal was not to be critical of FEMA practices in map making but rather was more about identifying features of “next generation” flood maps that capture more of the uncertainty of living in or near the floodplain. It was also explicitly recognized that researchers and practitioners have been conducting research and extending applications along these lines, such that improvements to risk characterization vis-a-vis flood maps could be made with relatively little technical effort (as compared to the effort needed to change the federally backed insurance system). The group discussed moving beyond binary measures to probabilistic measures; incorporating land use and projected land use; moving to smoother, finer-scale maps that avoided sharp discontinuities; and how commercial insurance could be the better venue for innovation led by the private sector. These points are each described in further detail in the online supplementary material (<https://doi.org/10.1175/BAMS-D-19-0073.2>).

USE OF CLIMATE MODEL PROJECTIONS IN INSURANCE.

Climate model projections are not widely utilized within the insurance industry, the group acknowledged. Most insurance policies are sufficiently short-term that pricing does not need to consider a changing climate over the policy period. Many insurers lack the technical in-house expertise needed to work with high dimensional climate model output and avoid common misuses of these models. Some regulations, particularly those related to catastrophe models, restrict the use of simulations, projections, or other modeled products (American

Academy of Actuaries 2018). Still, the group found many reasons to view climate model projections as a valuable tool for insurers. Emanuel (2017) stated that the recent Hurricane Harvey rainfall event in Texas has a much higher estimated annual exceedance probability under future climate scenarios than under the past climate. Discussants noted that large scale extreme events like Harvey have tremendous buy-in from the industry, and so restating these risks under future climates is a valuable planning tool. Rerunning observed events under different climate scenarios could allow researchers to quantify the “fraction of attributable risk,” or the fraction of the likelihood of an event that is attributable to a specific causal factor (National Academies of Sciences, Engineering, and Medicine 2016; Lott and Stott 2016). More broadly, the group enumerated nonpricing core functions of insurers that operate on longer time scales, such that a changing climate would impact important decisions. More on this topic can be found in the online supplement (<https://doi.org/10.1175/BAMS-D-19-0073.2>).

CLIMATE MITIGATION AND ADAPTATION.

An early insight of this group was that insurers speak of mitigating losses from climate change, since they are addressing consequences of climate change, but the climate science community often terms their activity adaptation: scientist Mills (2005) termed insurance adaptive capacity, not mitigative capacity. To the climate science community, mitigation is stopping or slowing the climate change itself. This discussion on terminology extended more broadly and suggested the value of jointly authored papers across research communities. The group also spent considerable time considering the costs of action versus the costs of inaction, noting that many of the costs of inaction will ultimately be shouldered by the insurance industry. Among the four breakout discussion groups, this one also addressed most directly the unique role that reinsurance plays, owing to the massive financial resources it has available, the long-term outlook it naturally possesses, and its position as the “insurer of last resort” within private industry. (More on this group can be found in the online supplement at <https://doi.org/10.1175/BAMS-D-19-0073.1>).

WHAT KEEPS YOU UP AT NIGHT? This group was charged with identifying problems that did not fit into any standard category but that could nevertheless be very troublesome in trying to develop a comprehensive approach to climate and insurance risk. The group attracted a wide range of participants,

which immediately shed light on the challenge of translating and disseminating research results and needs across communities. The group suggested that jointly authored papers with authors spanning multiple groups were one strong remedy. Climate model projections again came up in discussion, this time regarding the mismatch in time scales and validation tools used by climate model producers with the desired time scales and validation preferred by potential users within the insurance industry. In short, climate models are produced over long time scales and validated in terms of large-spatial-scale trends, but insurers often need reliable climate projections at a much finer spatial and temporal scale. The group also discussed extreme insurance consequences arising from an interaction of several (possibly nonextreme) causes, with Mora et al. (2017) receiving attention for highlighting the combined causal effects of heat and humidity that lead to extreme heatwaves. The group was particularly interested in questions of attribution of extremes, along with appropriate risk measures for extremes from a financial risk management perspective, and some related papers discussed were Bindoff et al. (2013), Acerbi and Tasche (2002), and Artzner et al. (1999). Each of these topics, along with additional points raised, is further described in the supplement.

MOVING FORWARD. The four groups tackled different questions but came upon similar themes throughout discussion: appropriate databases, best practices, time scales, research priorities, terminology, and government regulation were universally discussed. Each community has a distinct perspective to share, but each also has an opportunity to better incorporate external perspectives into its future research development.

A major takeaway from the workshop was the broad interest in more jointly authored papers combining authors from across different research communities. Not only would this help disseminate results across communities and also clear up misunderstandings in priorities, terminology, limitations, and so forth, but these partnerships would also seed the formation of next generation tools and research. For example, scientific agencies have existing databases such as the Spatial Hazard Events and Losses Database for the United States (SHELDUS); phase 5 of the Coupled Model Intercomparison Project (CMIP5); or the NOAA/NCEI databases, and jointly authored papers can highlight current best practices and data access. But the relationships forged through joint authorship can also inform future development of

next generation data products with respect to the terminology, time scale, priority, and validation needs of this new class of end users. It is easy to imagine how jointly authored papers would lead to greater insights for every research community present at the workshop.

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