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In This Issue

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International Association for Wind Engineering

The Autumn Issue: Infrastructure & Climate Change

In this issue we highlight testimony before the US Senate Congressional Committee on Banking, Housing and Urban Affairs regarding infrastructure and climate change. Dr. Shafieezadeh of Ohio State University is well-known for his research into electric power delivery systems under extreme winds such as hurricanes. Dr. Roger Pielke, Jr. of University of Colorado, Boulder is a professor in the Environmental Studies Program. Before joining the faculty of the University of Colorado, from 1993 to 2001 Pielke was a Scientist at the National Center for Atmospheric Research. His testimony reminds us of the uncertainties involved in climate change assessment and impacts.

Congressional Testimony
21st Century Communities: Climate Change, Resilience, and Reinsurance

Testimony before
The Committee on Banking, Housing, and Urban Affairs
The United States Senate
July 20, 2021

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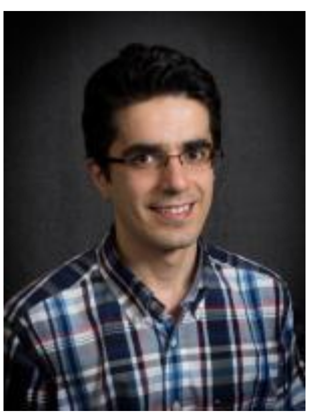
Chairman Brown, Ranking Member Toomey, and Members of the Committee on Banking,Housing, and Urban Affairs,



My name is Abdollah Shafieezadeh. I am the Lichtenstein Associate Professor of Civil, Environmental and Geodetic Engineering at The Ohio State University (OSU). I am also the director of Risk Assessment and Management of Structural and Infrastructure Systems lab at OSU. It is my great honor to share with the committee my insights on the state of the nation's critical infrastructure, current and future risks, especially those that are imparted by climate and weather hazards, and some of the ways we can pursue to improve the resilience of our infrastructure and communities.

The Significance of the Nation's Infrastructure

The daily life of Americans, the long-term economic prosperity of the nation and the national security of the United States depend on the continued functioning of a large set of infrastructure systems in the country. These systems that form the backbone of our society are complex in terms of their scale, and system operations and interdependencies under normal conditions and when challenged by the stresses of the environment. Attending these risks in a cost-effective manner requires a strategic vision that includes long-term planning with a flexibility included to adapt to uncertain conditions of the future.

The physical and operational scales of our infrastructure are significantly large. As an example, the power grid in the U.S., is widely considered the most complex engineered system in the world. It includes over 8,000 power plants, 600,000 miles of high and extra high voltage transmission lines and millions of miles of distribution lines[1]. At every instant in time, this system balances electricity supply and demand, and delivers power from distant generation units to energy consumers through a web of transmission and distribution networks. We have over 4 million miles of public roadways and over 600,000 bridges across the United States. Together, they facilitated 3.2 trillion vehicle miles traveled in 2019[2]. More than 16,000 wastewater treatment plants in the country and a web of tens to tens of thousands of miles of pipelines under small communities to large cities collect and process over 60 billion gallons of wastewater every day[2]. Similarly, we have other vast interconnected and interdependent systems of telecommunication, water, dam and levees, healthcare and emergency services, among many others, that provide immediate and long-term critical services to the society[3].

Challenges Facing Our Critical Infrastructure

The current state of our critical infrastructure, however, is not good, and for many systems, the state is far from good. According to a nationwide assessment of the state of our critical infrastructure across the nation by the American Society of Civil Engineers (ASCE), which I am a member of, America's infrastructure scores C-[2,4]. A grade of C means that the infrastructure state is mediocre and requires attention, and a grade of D means that the infrastructure is poor and at risk[2].

Our infrastructure, for a long time, has been a source of pride for the nation. The vast power grid, highway systems, water and wastewater networks, among our other infrastructure systems have changed the way of life, created jobs and provided many opportunities for growth for rural and urban communities. These systems that expanded to a significant degree shortly after World War II, have been challenged by a large set of factors including, among others, aging and deterioration; natural hazards, primarily climate and weather extremes; cyber and physical attacks; and shifting, and in some parts, increasing demands for infrastructure services, partly, because of increasing urbanization. The infrastructure needs have been increasing with systems and components reaching or passing their intended design lifetime, as this transition increases the rate of failure, and subsequently, the required replacement or costly maintenance and rehabilitation actions[5]. While local, state, and federal governments and public and private sectors have been investing in infrastructure, the needs have consistently exceeded investments, leading to a growing gap in infrastructure investments[2].

[1] U.S. DOE, "Dynamic Line Rating Report to Congress," June 2019, https://www.energy.gov/sites/default/files/2021/03/f83/DLR%20Report%20-%20June%202019%20final%20-%20FOR%20PUBLIC%20USE.pdf.

[2] American Society of Civil Engineers, "2021 Report Card for America's Infrastructure" (Reston, VA), accessed July 14, 2021, https://infrastructurereportcard.org/wp-content/uploads/2020/12/National_IRC_2021-report.pdf.

[3] DHS, "Critical Infrastructure Sectors | CISA," accessed July 13, 2021, https://www.cisa.gov/critical-infrastructure-sectors.

[4] The scoring is based on regular assessment of the state of the infrastructure and considers multiple factors including capacity, condition, funding, future need, operation and maintenance, public safety, resilience, and innovation. See ASCE Infrastructure Report Card 2021 for more details.

[5] Yousef Mohammadi Darestani et al., "Life Cycle Resilience Quantification and Enhancement of Power Distribution Systems: A Risk-Based Approach," *Structural Safety* 90 (2021): 102075.

[6] PJM Regional Transmission Operator (RTO), "2019 Regional Transmission Expansion Plan (RTEP)," 2020, https://www.pjm.com/library/reports-notices/rtep-documents.aspx.

The nation's infrastructure was built long ago. As an example, parts of the power grid were built about a century ago, but a major expansion of the grid happened in 1950s and 1960s, with components and systems that had the design lifetime of about 50 years. Inspection of facilities built in 1960s and earlier have shown significant deterioration[6]. The traffic volume on bridges and roadways has increased by 18% from 2000 to 2019[2]. The increasing service demands along with aging have resulted in accelerated deterioration, which among other factors, have left 43% of our public roadways in poor or mediocre conditions and 7.5% of bridges (over 46,000 bridges) in the nation in poor conditions[2]. In many cities, there are considerable portions of underground wastewater collection pipelines that are a century old. Infiltration, exfiltration and leakage are becoming more frequent, as these systems are aging and as traffic loads on our roadways are increasing, posing risks to public health and safety[7,8].

Resilience concerns of our increasingly deteriorating – yet increasingly vital – critical infrastructure are further compounded by climate and weather extremes. The built environment in the U.S. is exposed to a broad range of climate and weather hazards. Since 1980, the country has sustained 298 billion-dollar weather and climate disasters[9,10] with the total cost of these events exceeding $1.975 trillion. The observed trends in these losses are concerning. The number of billion-dollar weather and climate disasters has increased from 2.9 events per year in1980s to 12.3 events per year in 2010s. In the same period, the average annual loss by such events has increased by a factor of 4.6 to $84.5 billion. In 2020, the number of billion-dollar disasters reached 22 incurring $98.9 billion in losses. Impacts of climate and weather extremes on our infrastructure have been significant. Historical data indicate that extreme weather events are the leading cause of power grid outages[11]. In the period of 1980 to 2012, the nation observed an alarming tenfold increase in the number of outages[12]. The compounding effects of aging and deterioration and stresses from extreme events can substantially increase grid failures[13,14]. The number of major power outages has remained high since 2012[15,16]. Power outages inflicted an annual average loss on the US economy of between $40 and $55 billion[17]. The lasting outages have also had detrimental impacts on public health especially for vulnerable populations[18,19]. Similarly, the impacts of climate and weather extremes on the transportation infrastructure have been significant. Over 57% of 1948

[7] Soroush Zamanian, Jieun Hur, and Abdollah Shafieezadeh, "Significant Variables for Leakage and Collapse of Buried Concrete Sewer Pipes: A Global Sensitivity Analysis via Bayesian Additive Regression Trees and Sobol'indices," *Structure and Infrastructure Engineering*, 2020, 1–13.

[8] Soroush Zamanian, Mehrzad Rahimi, and Abdollah Shafieezadeh, "Resilience of Sewer Networks to Extreme Weather Hazards: Past Experiences and an Assessment Framework," in *Pipelines 2020* (American Society of Civil Engineers Reston, VA, 2020), 50–59.

[9] A billion-dollar disaster refers to an event with the total incurred loss across all impacted areas exceeding $1billion.

[10] NOAA National Centers for Environmental Information (NCEI), "U.S. Billion-Dollar Weather and Climate Disasters," 2021, DOI: 10.25921/stkw-7w73, https://www.ncdc.noaa.gov/billions/.

[11] Executive Office of the President., "Economic Benefits of Increasing Electric Grid Resilience to Weather Outages" (IEEE USA Books and eBooks, p29., 2013).

[12] Alyson Kenward and Urooj Raja, "Blackout: Extreme Weather, Climate Change and Power Outages," *Climate Central* 10 (2014): 1–23.

[13] Abdollah Shafieezadeh et al., "Age-Dependent Fragility Models of Utility Wood Poles in Power Distribution Networks against Extreme Wind Hazards," *IEEE Transactions on Power Delivery* 29, no. 1 (2013): 131–39.

[14] Yousef Mohammadi Darestani and Abdollah Shafieezadeh, "Multi-Dimensional Wind Fragility Functions for Wood Utility Poles," *Engineering Structures* 183 (2019): 937–48.

[15] Sayanti Mukherjee, Roshanak Nateghi, and Makarand Hastak, "A Multi-Hazard Approach to Assess Severe Weather-Induced Major Power Outage Risks in the Us," *Reliability Engineering & System Safety* 175 (2018): 283– 305.

[16] Stephen A. Shield et al., "Major Impacts of Weather Events on the Electrical Power Delivery System in the United States," *Energy* 218 (2021): 119434.

[17] Richard J. Campbell and Sean Lowry, "Weather-Related Power Outages and Electric System Resiliency"(Congressional Research Service, Library of Congress Washington, DC, 2012).

[18] Joan A. Casey et al., "Trends from 2008–2018 in Electricity-Dependent Durable Medical Equipment Rentals and Sociodemographic Disparities," *Epidemiology (Cambridge, Mass.)* 32, no. 3 (2021): 327.

[19] Wangjian Zhang et al., "Power Outage: An Ignored Risk Factor for COPD Exacerbations," *Chest* 158, no. 6 (2020): 2346–57.

recorded bridge collapses in the U.S.until 2014 have been linked to hydraulic causes, e.g., flooding[20].

We are in a highly uncertain and increasingly volatile environment because of the changes in climate patterns, especially climate and weather extremes. We are not only concerned about single hazard types becoming more extreme, we are also concerned about the increasing likelihood of compound weather and climate events[21], where combinations of multiple climate drivers or hazards can lead to significant losses[22]. Climate change is anticipated to impact many hazards to the built environment. Projections indicate that the relative sea level along the coasts of the U.S. may rise by over 14 inches by 2080 under a low global mean sea level rise scenario[23]. This scenario is very likely to be exceeded under various climate change projections. This small rise in relative sea level will increase the annual frequency of damaging flood events by 25 times[23], which will have devastating impacts on buildings, energy and transportation infrastructure and other critical built and natural systems in coastal regions, and will extend the reach of coastal flooding to areas further inland. While there are differences in the projected impacts, studies generally indicate that stresses to the built environment in the United States will increase, and in some parts of the country the increase will be substantial[24].

Infrastructure design codes and standards have traditionally relied on statistical analysis of historical data to determine design loads for the intended service life of the systems. This approach would work well if the environment remains stationary meaning that there are no long-term temporal trends in loads. However, we are currently at a stage where we are observing trends that are changing loads. In addition, modern design codes for structures with new design philosophies and procedures were developed in late 1990s and early 2000s based on the lessons learned from past failures and research on the performance of structures[25]. Many structures in the nation's built environment, however, were designed and constructed long before modern standards and based on codes that are no longer considered adequate. In addition, changes in the characteristics of the environment over time, e.g., land use and its impacts, can result in conditions that significantly differ from those assumed during the design of infrastructure, therefore, posing risks that were not accounted for in the design process.

Projected Costs for Improving the Resilience of Critical Infrastructure

Proactive management of risks is substantially more effective than reactive strategies; however, insufficient resources have prevented infrastructure owners and operators from applying proactive measures in many cases. Instead actions are taken when failures occur or when the state of the infrastructure reaches a critical condition. The American Society of Civil Engineers has estimated that the investment gap in the nation's critical infrastructure has grown from $2.06 trillion for the period of 2016-2025[26] to $2.59 trillion for 2020-2029[2] period. More detailed assessments of investment gaps by infrastructure type are available in ASCE's Report Card for America's Infrastructure[2]. These estimates of investments are primarily to address current and immediate future needs and to comply with current regulations. The investment needs will grow ,if these systems are to be prepared for the anticipated stresses and expected service demands of the future. As an example, depending on the emissions scenario, 66,000 to 117,000 of the nation's bridges are estimated to be vulnerable to increased peak flow risks because of climate change[27]. The total cost for adapting to these increased risks alone ranges from $140 to $250 billion[28].

[20] Madeleine M. Flint et al., "Historical Analysis of Hydraulic Bridge Collapses in the Continental United States," *Journal of Infrastructure Systems* 23, no. 3 (2017): 04017005.
[21] Omid Mazdiyasni and Amir AghaKouchak, "Substantial Increase in Concurrent Droughts and Heatwaves in the United States," *Proceedings of the National Academy of Sciences* 112, no. 37 (2015): 11484–89.
[22] Jakob Zscheischler et al., "A Typology of Compound Weather and Climate Events," *Nature Reviews Earth &Environment* 1, no. 7 (2020): 333–47.
[23] William Sweet et al., "Global and Regional Sea Level Rise Scenarios for the United States," 2017.
[24] Donald J. Wuebbles et al., "Climate Science Special Report: Fourth National Climate Assessment (NCA4), Volume I," 2017.
[25] Jim Rossberg and Roberto T. Leon, "Evolution of Codes in the USA," *ASCE.< Https://Www. Nehrp. Gov/Pdf/UJNR_2013_Rossberg_Manuscript. Pdf>(Sept. 29, 2019)*, 2013.

Solutions to Infrastructure Challenges

The nation's infrastructure plays a critical role for many activities of the society, in supporting the economy and serving the public safety and national security. As elaborated earlier, these systems, however, face a wide spectrum of near-term and long-term challenges in an environment that is highly uncertain and increasingly volatile. In order to prepare our infrastructure for such environments, I recommend the following solutions.

Strategic investments in our infrastructure

We are in an environment where risks to our infrastructure are not static but dynamic, the needs are evolving, and the environment is uncertain. In response, we need a long-term national vision for the resilience of our infrastructure with sustained investment plans for adaptive, robust strategies. Mitigation of hazard risks to buildings and other infrastructure systems are among the most effective ways to reduce losses and enhance the resilience of the built environment.

Cost-benefit studies of such investments have shown high benefit to cost ratios in the order of 11 to 1 for adopting the latest building codes, 4 to 1 for above-code design of buildings, and 4 to 1 for applying common and practical retrofit measures to our existing building stock[28]. Every dollar spent on resilience investments for businesses has reduced business interruption losses under major hazards by over $4.5. Retrofitting bridges and hardening the power grid are shown to yield significant benefits over the life of these systems[29,30,31]. To maximize gains, the mitigation investments must consider strategies that improve infrastructure resilience against multi-hazard risks[30,32]. Moreover, early application of climate adaptation measures to deficient infrastructure can substantially reduce adaptation costs[28]. A critical point to note here is that infrastructure stakeholders including owners, operators, and users may not be able to afford the upfront costs of resilience projects, even for cases where the benefit to cost ratio is high. Therefore, resilience strategies may need to be incentivized through measures such as reduced insurance rates and premiums; federal, state or local grants for resilience strategies; tax incentives; mortgages and loans for mitigation plans; and improved resilience-based codes[33].

As resources are limited, the short- and long-term infrastructure needs must be characterized and prioritized[34,35]. We must develop and apply tools for life-cycle cost and life-cycle performance (e.g., life-cycle resilience[36]) analysis to evaluate infrastructure projects. Future projects should have funding plans that cover maintenance, operation, and end of service life costs, in addition to the initial costs of projects. Reliable characterization and prioritization of needs require extensive data from the built environment. Facilitating the application of sensing technologies at large scales to various elements of our existing and new infrastructure along with broadband communication and technologies such as digital twin to collect, transfer, process, and learn from the data can enable highly effective proactive risk management for our infrastructure systems.

[26] American Society of Civil Engineers, "2017 Report Card for America's Infrastructure" (Reston, VA), accessed July 14, 2021, https://2017.infrastructurereportcard.org/wp-content/uploads/2019/02/Full-2017-Report-Card- FINAL.pdf.

[27] Len Wright et al., "Estimated Effects of Climate Change on Flood Vulnerability of US Bridges," *Mitigation and Adaptation Strategies for Global Change* 17, no. 8 (2012): 939–55.

[28] Multi-Hazard Mitigation Council, "Natural Hazard Mitigation Saves: 2019 Report" (Washington, DC: National Institute of Building Sciences, 2019), https://www.nibs.org/files/pdfs/NIBS_MMC_MitigationSaves_2019.pdf.

[29] Ehsan Fereshtehnejad and Abdollah Shafieezadeh, "A Multi-Type Multi-Occurrence Hazard Lifecycle Cost Analysis Framework for Infrastructure Management Decision Making," *Engineering Structures* 167 (2018): 504–17.

[30] Nariman L. Dehghani, Ashkan B. Jeddi, and Abdollah Shafieezadeh, "Intelligent Hurricane Resilience Enhancement of Power Distribution Systems via Deep Reinforcement Learning," *Applied Energy* 285 (2021): 116355.

[31] Nariman L. Dehghani, Chi Zhang, and Abdollah Shafieezadeh, "Evolutionary Optimization for Resilience-Based Planning for Power Distribution Networks," in *Nature-Inspired Computing Paradigms in Systems* (Elsevier, 2021), 47–61.

[32] Jieun Hur and Abdollah Shafieezadeh, "Multi-Hazard Probabilistic Risk Analysis Of Off-Site Overhead Transmission Systems," in *SMiRT-25* (Charlotte, NC: IASMiRT, 2019).

Integration of equity considerations in risk distribution into infrastructure decisions Apart from technical challenges, we face very important questions at the interface of science and policy about the distribution of risks. Socioeconomically vulnerable communities are taking a higher share of infrastructure disruption risks relative to the rest of the population. This disparity manifests in both hazard exposure and impacts of disruptions. In all stages of resilience response including pre-disaster mitigation projects as well as infrastructure and community recovery, we should consider the eventual impacts and benefits for different populations in the society, especially the vulnerable populations, to ensure that the risks are equitably shared.

Support research and development for resilient infrastructure and communities Infrastructure resilience is a highly complex problem with significant knowledge gaps in many areas including, among others, (i) evolving characteristics of hazards, (ii) physical and operational performance of the built environment during and in the aftermath of extreme, uncertain conditions of natural hazards, (iii) interactions of built, natural, and human systems over time and space, and (iv) innovative technologies and strategies that enable robust, adaptive, and cost-effective pathways to infrastructure resilience in the evolving uncertain hazard environment. We must increase investment in basic and applied research to address these gaps in science and technology. Moreover, critical infrastructure resilience research is often hampered by limited access to reliable integrated and spatially explicit data related to infrastructure and hazard impacts. Policies are needed to require critical infrastructure ownersand operators to collect and make the data available. This step, in addition to benefiting research to understand and enhance resilience, will lend to a transparent environment where infrastructure stakeholders can learn about the performance of service providers and makeinformed decisions for risk management.

[33] Multi-Hazard Mitigation Council, "Developing Pre-Disaster Resilience Based on Public and Private Incentivization" (Washington, DC: National Institute of Building Sciences, 2015), https://www.nibs.org/files/pdfs/NIBS_MMC_ResilienceIncentivesWP_2015.pdf.
[34] Ehsan Fereshtehnejad, Abdollah Shafieezadeh, and Jieun Hur, "Optimal Budget Allocation for Bridge Portfolios with Element-Level Inspection Data: A Constrained Integer Linear Programming Formulation," *Structure and Infrastructure Engineering*, 2021, 1–15.
[35] Ehsan Fereshtehnejad et al., "Ohio Bridge Condition Index: Multilevel Cost-Based Performance Index for Bridge Systems," *Transportation Research Record* 2612, no. 1 (2017): 152–60.
[36] Nariman L. Dehghani, Yousef Mohammadi Darestani, and Abdollah Shafieezadeh, "Optimal Life-Cycle Resilience Enhancement of Aging Power Distribution Systems: A MINLP-Based Preventive Maintenance Planning," *IEEE Access*, 2020.

14th Americas Conference on Wind Engineering: The Americas Conference on Wind Engineering (ACWE) will be hosted by The National Wind Institute (NWI) and Texas Tech University (TTU) in Lubbock, Texas on May 17-19, 2022. The website link is https://www.depts.ttu.edu/nwi/14ACWE/.

Did you know? The American Meteorological Statement on US Natural Hazards Policy change post Maria:

"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 [*sic*] as a shared public value."

https://www.ametsoc.org/index.cfm/ams/policy/studies-analysis/a-reset-for-u-s-natural-hazards-policy-lessons-from-harvey-irma-and-maria/

STATEMENT OF **DR. ROGER PIELKE JR**.to the COMMITTEE ON BANKING, HOUSING, AND URBAN AFFAIRS of the UNITED STATES SENATE

HEARING on
21st Century Communities: Climate Change, Resilience, and Reinsurance
Dirksen Senate Office Building 538
20 July 2021

My testimony focuses on the importance of securing robust scientific advice on climate change. Unfortunately, key scientific guidance on climate that informs policy– including central bank stress testing and U.S. government estimates of the social cost of carbon – has departed from basic standards of scientific integrity. A main reason for this departure is that climate science has increasingly been enlisted in support of policy advocacy rather than to inform policy debates and decisions. My biography is included at the end of this statement. My testimony today represents my individual views not those of any organization.

Five Take-Home Points

1. At the outset, I emphasize explicitly and unequivocally that human-caused climate change is real, that it poses significant risks to society and the environment, and that various policy responses in the form of mitigation and adaptation are necessary and make good sense.
2. However, the reality and importance of climate change does not provide a rationale or excuse for the evasion or avoidance of meeting basic standards of research integrity in the provision of scientific advice to policy makers.
3. Currently, policy makers are being badly misled in a number of crucial areas related to climate science, impacts and economics. Specifically:
    - The climate scenarios that underlie much of climate research are badly outdated and no longer offer insight to plausible futures;
    - Economic losses associated with extreme events are routinely attributed to changes in climate, while changes in society and its exposure and vulnerability – which also influence future risks -- are largely ignored;
    - Trends in the incidence of extreme weather events in the United States and around the world are far more nuanced than discussions found in the media and in politics.
4. Shortfalls in robust science advice on climate are more than just an academic issue – they also show up in important policy contexts, such as:
    - Proposals for "climate stress testing" in the global and national financial systems;
    - The estimated "social cost of carbon" of the Biden, Trump and Obama administrations;
    - Proposed Congressional legislation to address financial system risks related to climate change.
5. Climate change is too important to allow shortfalls of scientific integrity in science advice to persist. Congress should enhance its oversight of the U.S. Global Change Research Program and its National Climate Assessment to ensure that the scientific advice that it receives is up-to-date and accurate.

The remainder of my written testimony elaborates and substantiates these five take-home points.

Elaboration of the Five Take-Home Points

1. At the outset, I emphasize explicitly and unequivocally that human-caused climate change is real, that it poses significant risks to society and the environment, and that various policy responses in the form of mitigation and adaptation are necessary and make good sense.

The Intergovernmental Panel on Climate Change has for more than 30 years through its Working Group 1 provided routine assessments of the physical science aspects of climate change.[1] The IPCC WG1 is scheduled to release its 6th assessment report on 9 August 2021. These assessments have documented changes in climate that have been detected and attributed to human causes, notably the emission of carbon dioxide and other greenhouse gases.

My views on the importance of climate policy have been consistent for almost three decades. For instance, in 2006 I testified before the House of Representatives on the conclusions of the IPCC: "on this basis alone I am personally convinced that it makes sense to take action to limit greenhouse gas emissions. Of course, the answer to what action is not at all straightforward. It involves questions of on what time scales, at what cost, with what consequences, with what foregone opportunities, and what mix of adaptation and mitigation."[2] Such complexities are why the provision of expert advice to Congress and the federal agencies is so important.

For more insight on my views on the science and policy of climate, please see my book **The Climate Fix** (2010). Nothing in the testimony that follows should be interpreted as downplaying the importance of climate change or policy responses to it. In fact, the issue is so crucial that we should expect the absolute highest standards of scientific integrity in the information being provided to policy makers.

2. However, the reality and importance of climate change does not provide a rationale or excuse for the evasion or avoidance of meeting basic standards of research integrity in the provision of scientific advice to policy makers.
"Scientific integrity," as I use the phrase here, is defined by several leading scholars to consist "of proper reasoning processes and handling of evidence essential to doing science" and "a respect for the underlying empirical basis of science."[3] It is uncontroversial that we want good science to inform policy.

The U.S. Congress has established countless mechanisms for the provision of science advice to government across many areas of policy making – such as in the more than 1,000 FACA (Federal Advisory Committee Act) committees that provide guidance on topics as varied as vaccine approval and the regulation of pollutants.[4]

In 1990, the U.S. Congress established an advisory mechanism for climate science in the form of a national climate assessment.[5] That legislation required the national climate assessment to be produced every four years by the interagency U.S. Global Change Research Program and, among other tasks, is to document "the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity" in order to provide "usable information on which to base policy decisions relating to global change."[6]

In practice, however, the U.S. National Climate Assessment (NCA) has been politicized in varying degrees by both Democratic and Republic administrations. It has been used less as a mechanism of science advice to Congress and the President (as mandated in law) but as a tool for promoting the climate policy agenda of the administration. This continues today. The main reason for the politicization of the NCA is that it is housed in the Executive Office of the President (under the Office of Science and Technology Policy) and is ultimately led by political appointees – which is not an ideal structure for effective science advice.[7]

Thus, due to the politicization of the NCA, the ability of the U.S. government's primary science advisory body on climate to ensure scientific integrity, and to correct course when things get off track, is limited. I say more on how to address these shortfalls under #5 below.

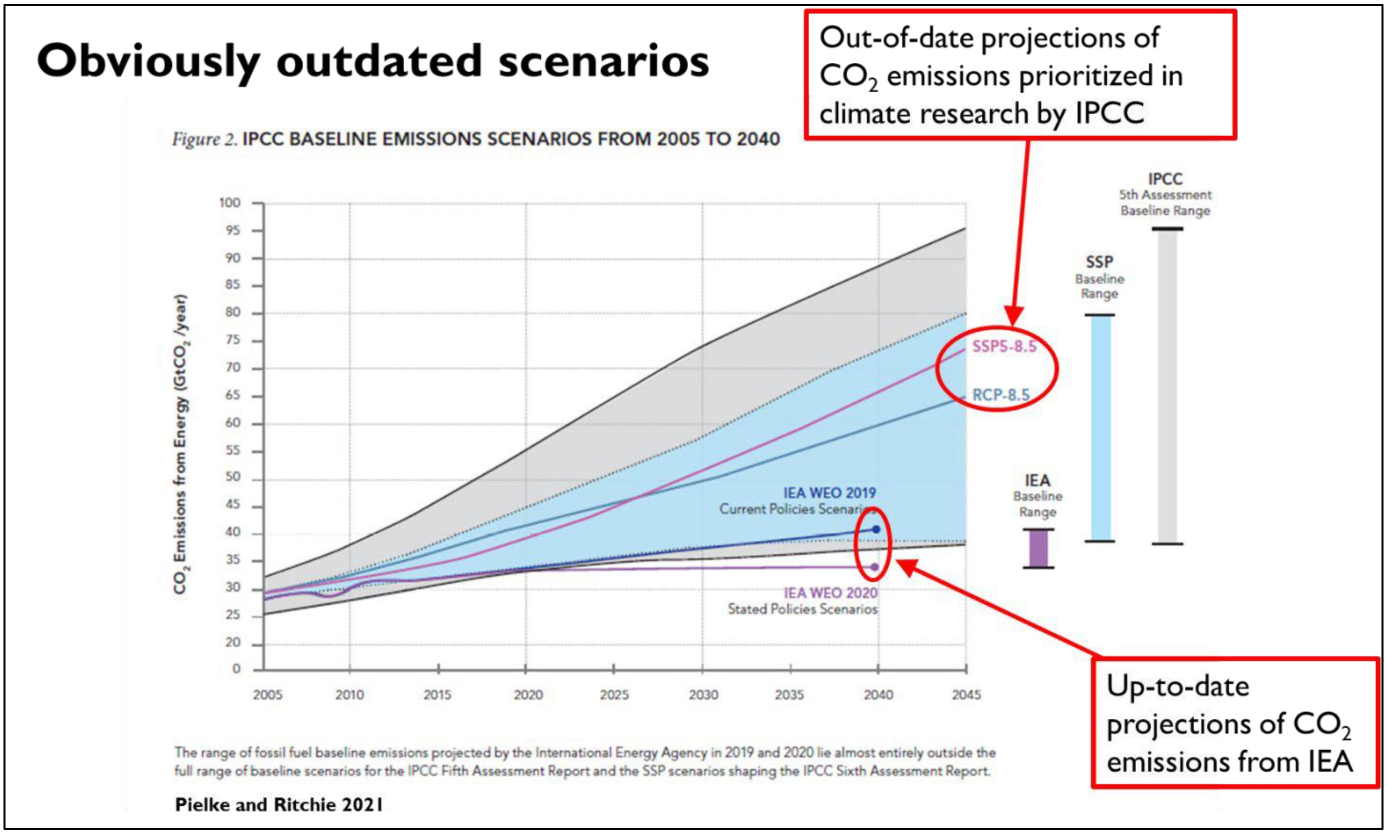
[1] https://www.ipcc.ch/
[2] https://www.govinfo.gov/content/pkg/CHRG-109hhrg29932/html/CHRG-109hhrg29932.htm
[3] Douglas, H. E., & Bour, E. (2014). Scientific integrity in a politicized world. In *Logic, Methodology, and Philosophy of Science: Proceedings of the Fourteenth International Congress* (pp. 253-268).
[4] https://www.facadatabase.gov/FACA/FACAPublicPage
[5] https://www.govinfo.gov/content/pkg/STATUTE-104/pdf/STATUTE-104-Pg3096.pdf
[6] Pielke, R. A. (1995). Usable information for policy: an appraisal of the US Global Change Research Program. *Policy Sciences*, *28*(1), 39-77.
[7] For more details see: https://rogerpielkejr.substack.com/p/fixing-the-us-national-climate-assessment

3. Currently, policy makers are being badly misled in a number of crucial areas related to climate science, impacts and economics. For instance:

- *The climate scenarios that underlie much of climate research are badly outdated and no longer offer insight to plausible futures;*

A large proportion of research on climate science, impacts and economics depends upon scenarios of the long-term future to produce projections of future changes in climate, their impacts on society and the environment and the consequences of alternative possible policy actions.[8] However, the scenarios that are currently prioritized in climate research and in policy analyses are badly outdated, and for a range of reasons have not been updated.[9]

The figure below shows clearly that carbon dioxide emissions in the real world are already at a level far less that those projected in the highest priority climate scenarios (which are typically used to represent a "business as usual" or reference case projection of the future).



- *Economic losses associated with extreme events are routinely attributed to changes in climate, while changes in society and its exposure and vulnerability – which also influence future risks -- are largely ignored;*

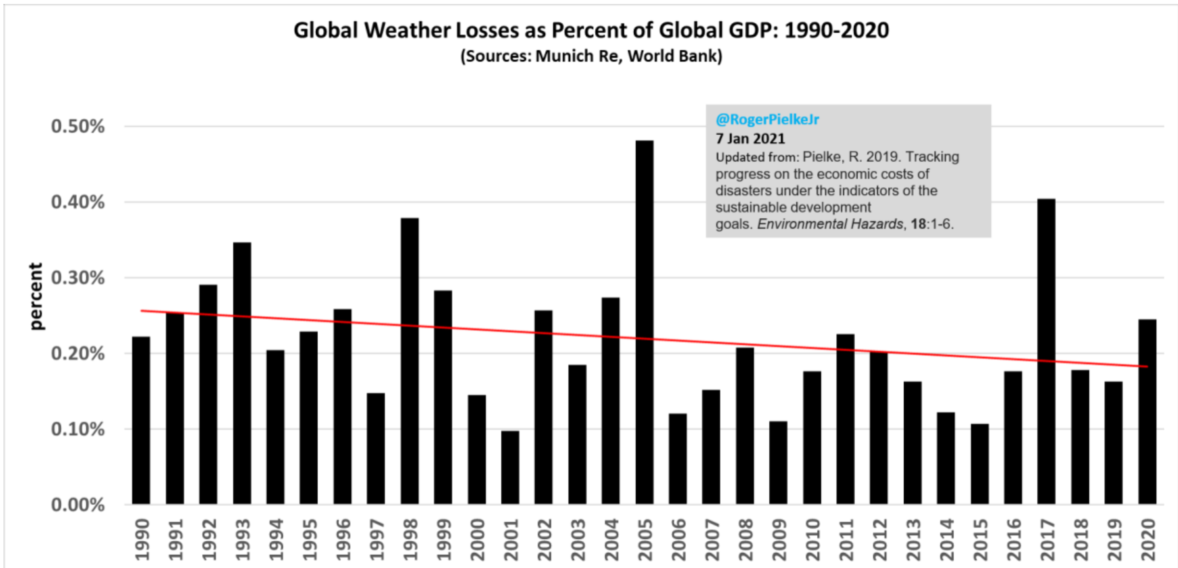
[8] Brian C. O'Neill, Timothy R. Carter, Kristie Ebi, Paula A. Harrison, Eric Kemp-Benedict, Kasper Kok, Elmar Kriegler, Benjamin L. Preston, Keywan Riahi, Jana Sillmann, Bas J. van Ruijven, Detlef van Vuuren, David Carlisle, Celia Conde, Jan Fuglestvedt, Carole Green, Tomoko Hasegawa, Julia Leininger, Seth Monteith, and Ramon Pichs-Madruga, "Achievements and needs for the climate change scenario framework," *Nature Climate Change* 10 (2020): 1074–1084.

[9] R. Pielke Jr. and J. Ritchie, 2021. How Climate Scenarios Lost Touch With Reality, *Issues in Science and Technology*, Summer. And for a deeper, more technical analysis see: Pielke Jr, R., & Ritchie, J. (2021). Distorting the view of our climate future: The misuse and abuse of climate pathways and scenarios. *Energy Research & Social Science*, *72*, 101890.

Every day, somewhere on planet earth extreme weather events are happening. With 21st century communication technology and platforms we are all able to witness disasters in ways that in earlier times just wasn't possible. But the visceral appreciation of extremes and their impacts is no substitute for data and evidence.

Data and evidence indicate that since at least 1990 (about when global data on disaster losses is judged to become reliable) the economic damages associated with extreme weather have in fact *decreased* when measured in the context of global GDP. This is shown clearly in the graph on the next page, based on data from the global reinsurance company Munich Re and global GDP from the World Bank.[10] The trend of decreasing impacts of weather as a proportion of GDP holds for countries at all income levels.[11] This data should not be confused with data on the frequency or intensity of weather events – weather and climate data will always better serve for that purpose.

What the evidence shows is that the world has become *less vulnerable* to the direct economic impacts of weather and climate extremes as the global economy has grown.[12] This is in fact very good news, but there is no guarantee that it will continue, unless we pay greater attention in policy making to societal exposures and vulnerabilities to climate variability and change.



Regrettably, one of the U.S. governments most important science agencies has for years been contributing to the spread of misinformation on the economic costs of disasters. The National Oceanic and Atmospheric Administration (NOAA)[13] maintains a dataset of "billion dollar disasters" since 1980 that provides simple count of the number of disasters each year that exceed $1 billion in losses.[14] The U.S. government uses this simple metric as an indicator of climate change.[15]

What the dataset actually shows is a combination of poor methodology and the consequences of a growing society, with more people and property in locations exposed to loss from extreme weather. It is not an indicator of climate change. Climate data, not economic data, should be used for that purpose.

[10] Pielke, R. (2019). Tracking progress on the economic costs of disasters under the indicators of the sustainable development goals. *Environmental Hazards*, *18*(1), 1-6.

[11] https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(19)32596-6/fulltext

[12] Formetta, G., & Feyen, L. (2019). Empirical evidence of declining global vulnerability to climate-related hazards. *Global Environmental Change*, *57*, 101920.

[13] I worked for 16 years in a NOAA cooperative institute and have great respect for its scientists. NOAA's longstanding promotion of the "billion dollar disaster" tabulation is in my view an aberration from what is typically one of the nation's most rigorous science agencies.

[14] https://www.ncdc.noaa.gov/billions/

[15] https://www.globalchange.gov/browse/indicators/billion-dollar-disasters

Consider just one example that illustrates the flawed methodology: Hurricane Kate made landfall near Mexico Beach, Florida, in 1985 and caused about $600 million in damages in current dollars—not enough to make NOAA's list for that year. But estimates that I developed with colleagues, published in the journal *Nature Sustainability* in 2018,[16] show that if we take into account the 50% increase in the region's population over almost four decades, and the parallel rise in the value of homes, their contents and other built infrastructure, that exact same storm today would cause damages amounting to some $2 billion. Yet, Hurricane Kate doesn't appear in the NOAA tabulation.

The "billion dollar disaster" list is routinely used in policy settings to suggest that disasters costs are increasing dramatically due to climate change, but what the dataset really indicates is growing wealth in locations exposed to loss. Every time you see this dataset invoked as evidence of human- caused climate change you should think instead about the state of scientific integrity in U.S. federal science agencies.

A more accurate and scientifically robust picture of the economic losses associated with extreme weather in the United States is available. For instance, based on work I've conducted with a number of colleagues, the three panels on the following page show the economic impacts of floods, hurricanes and tornadoes, considering growth in wealth and exposure. The picture that emerges is very different than that conveyed by the misleading NOAA dataset.

The three panels [*figures on next page*] show:

Top: U.S. flood damage as a proportion of U.S. GDP from 1940 to 2019 (updated from Downton et al. 2005). The data show a sharp decline in the toll of flood damage as a proportion of the U.S. economy. This trend can be attributed to a combination of factors, including policy, development and climate.

Middle: U.S. hurricane damage normalized to 2020 values, based on population, wealth and inflation (updated from Weinkle et al. 2018). The data show no trend and are consistent with trends in landfalling hurricanes.

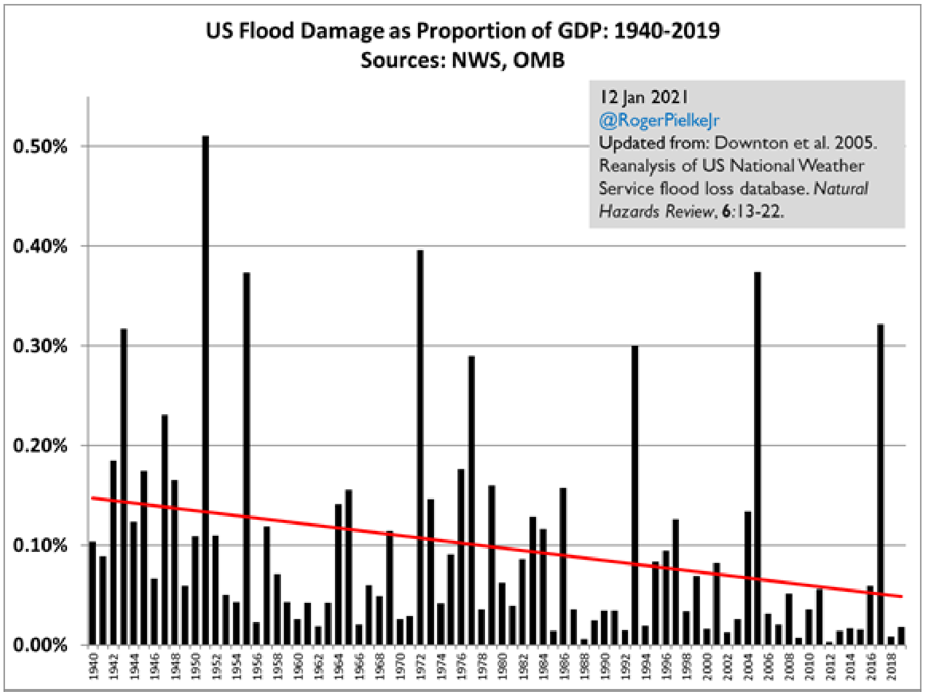
Bottom: U.S. tornado damage normalized to 2017 values, based on population, building stock and wealth, and inflation (updated from Simmons et al. 2012). The data show a downward trend which can be attributed to a number of factors, including a decrease in the incidence of strong tornadoes.

- *Trends in the incidence of extreme weather events in the United States and around the world are far more nuanced than discussions found in the media and in politics.*

Detecting changes in the frequency, intensity and other dimensions of extreme events beyond observed natural variability on climate time scales (that is, according to the IPCC, of >30 to 50 years) is scientifically challenging. Evidence for detection of change is often subject to competing expert perspectives on data, methods and conclusions as in many cases the signals of change are small in the context of observed variability. Detection and attribution of trends is also difficult because extreme events – by definition – are rare.

Such competing views are normal and indicate healthy scientific activity in the context of a complex field. Leading assessments accurately reflect the complexities and nuance associated with identifying changes in the behavior of extreme events. However, virtually all of this nuance is lost in public and policy debate, as extreme events have become enlisted as symbols in the public debate over climate change and are used to represent the need for changes in energy policy. In addition to oversimplifying the science on extremes, the loss of nuance also has the unfortunate consequence of pushing aside the reality that the most effective policy responses to extreme events in the context of climate variability and change will be adaptive and highly local in order to reduce societal exposure and vulnerabilities.

[16] Weinkle, J., Landsea, C., Collins, D., Musulin, R., Crompton, R. P., Klotzbach, P. J., & Pielke, R. (2018). Normalized hurricane damage in the continental United States 1900–2017. *Nature Sustainability*, *1*(12), 808-813.


US Flood Damage as Proportion of GDP: 1940-2019
Sources: NWS, OMB
12 Jan 2021
@RogerPielkeJr
Updated from: Downton et al. 2005. Reanalysis of US National Weather Service flood loss database. Natural Hazards Review, 6:13-22.
0.50%
0.40%
0.30%
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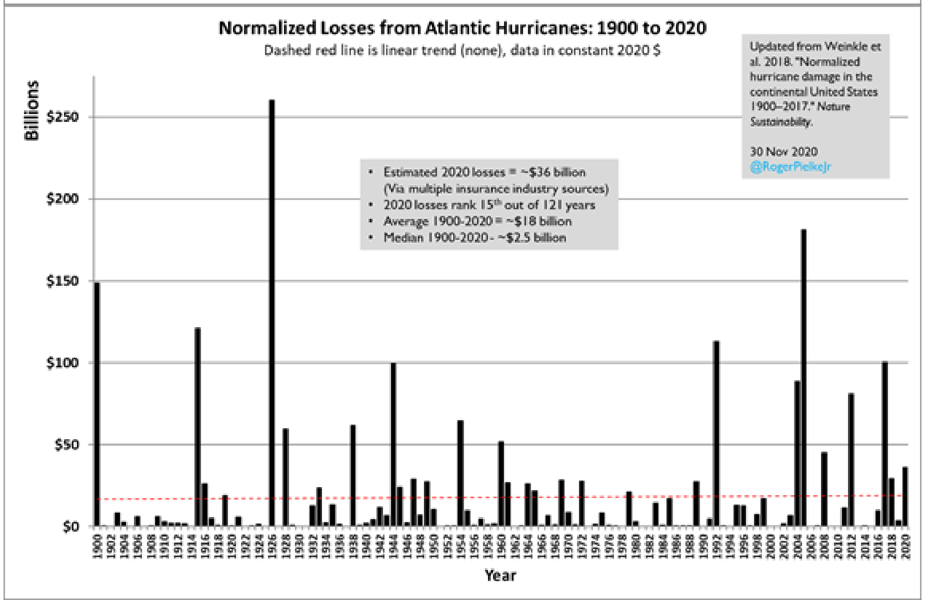
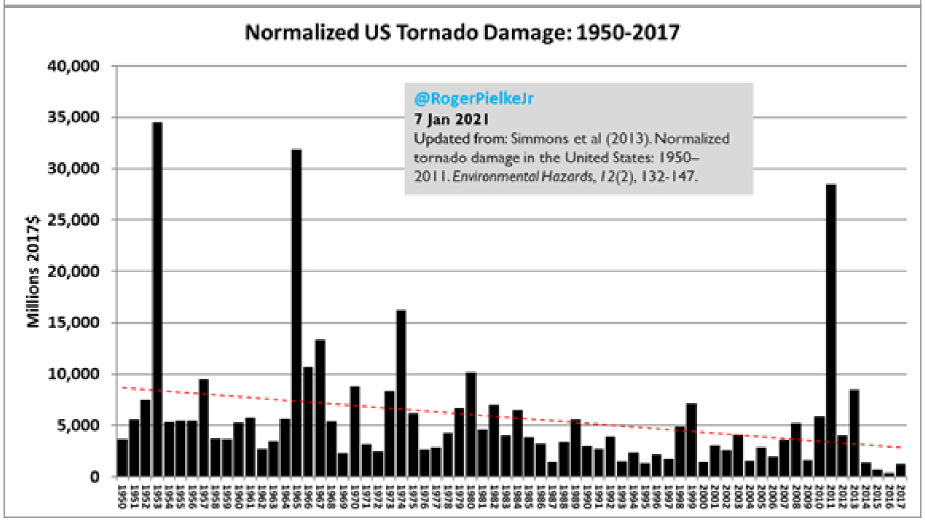
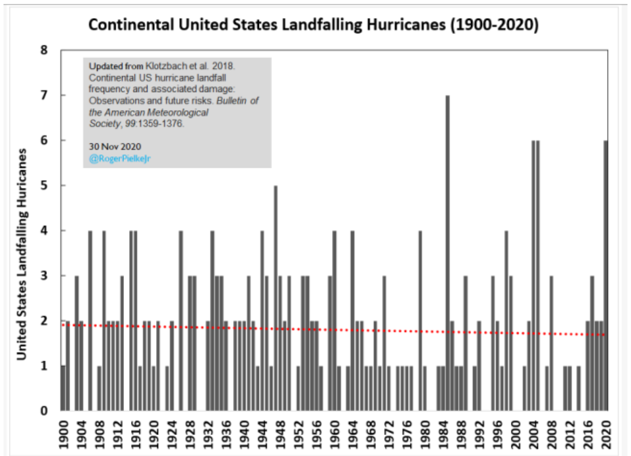
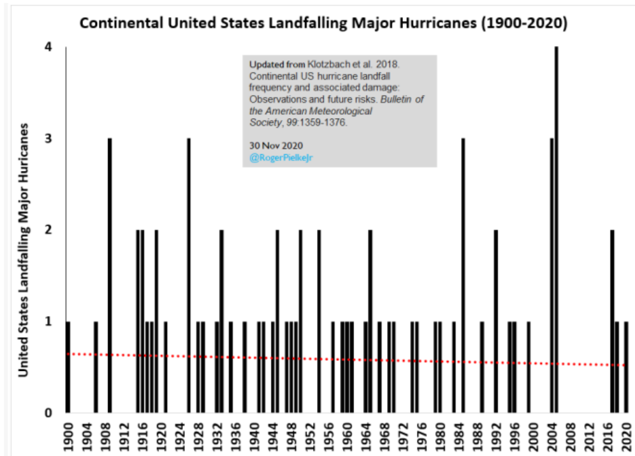

Normalized Losses from Atlantic Hurricanes: 1900 to 2020
Dashed red line is linear trend (none), data in constant 2020 $
Updated from Weinkle et al. 2018. "Normalized hurricane damage in the continental United States 1900–2017." Nature Sustainability.
30 Nov 2020
@RogerPielkeJr
• Estimated 2020 losses = ~$36 billion (Via multiple insurance industry sources)
• 2020 losses rank 15th out of 121 years
• Average 1900-2020 = ~$18 billion
• Median 1900-2020 - ~$2.5 billion
Billions
Year


Normalized US Tornado Damage: 1950-2017
@RogerPielkeJr
7 Jan 2021
Updated from: Simmons et al (2013). Normalized tornado damage in the United States: 1950–2011. Environmental Hazards, 12(2), 132-147.
Millions 2017$

As just one example of important nuance that is overlooked -- the most recent U.S. National Climate Assessment did not show trend data on the incidence of landfalling hurricanes in the United States. Landfalling hurricanes cause considerable damage and are always at the center of discussion of climate change. Thus, the failure to show trends in hurricane incidence is a major oversight for a U.S.-focused climate science assessment.

That data is shown [in the plots]. Neither hurricane nor major hurricane landfalls have increased in the United States over the past century – contrary to much conventional wisdom represented in the media and in political debates. Nor have tropical cyclone landfalls of hurricane-strength increased globally since at least 1970.[17] The case for action on energy policy is strong with or without evidence of more hurricanes hitting the US (or around the world), and policy makers should know these trends. It is remarkable that they were not included in the US NCA.





The role of climate change in observed and projected hurricane behavior is the subject of ongoing research and according to recent assessments of the World Meteorological Organization there is not presently a scientific consensus that a signal of climate change has been detected or attributed to human causes in observed activity with high levels of certainty.[18] As two NOAA scientists observed last week: "Various scientists within NOAA have differing opinions about global warming's impact on hurricanes and there is no official NOAA policy on the topic. Varying ideas on an issue often mean that it is a science in progress with no definitive answers."[19]

[17] Weinkle, J., et al. (2012). Historical global tropical cyclone landfalls. *Journal of Climate*, *25*(13), 4729-4735.
[18] The four recent WMO assessments are:
Knutson, T., Camargo, S. J., Chan, J. C., Emanuel, K., Ho, C. H., Kossin, J., Mohapatra, M., Satoh, M., Sugi, M., Walsh, K., & Wu, L. (2019). Tropical cyclones and climate change Assessment: Part I: Detection and attribution. Bulletin of the American Meteorological Society, 100(10), 1987–2007.
Knutson, T., Camargo, S. J., Chan, J. C., Emanuel, K., Ho, C. H., Kossin, J., Mohapatra, M. & Wu, L. (2020). Tropical cyclones and climate change assessment: Part II: Projected response to anthropogenic warming. *Bulletin ofthe American Meteorological Society*, *101*(3), E303-E322.

Lee, T. C., Knutson, T. R., Nakaegawa, T., Ying, M., & Cha, E. J. (2020). Third assessment on impacts of climate change on tropical cyclones in the Typhoon Committee region – part I: Observed changes, detection and attribution. Tropical Cyclone Research and Review, 9(1), 1–22.
Cha, E. J., Knutson, T. R., Lee, T. C., Ying, M., & Nakaegawa, T. (2020). Third assessment on impacts of climate change on tropical cyclones in the Typhoon Committee Region–Part II: Future projections. *Tropical Cyclone Research and Review*, *9*(2), 75-86.
[19] https://noaanhc.wordpress.com/2021/06/30/was-2020-a-record-breaking-hurricane-season-yes-but/

The IPCC and the World Meteorological Organization have each produced recent assessments of the state of scientific understandings of hurricanes (tropical cyclones) and together do an admirable job overall in identifying what is known, what is not yet known and areas of uncertainty and fundamental ignorance.

If you happen to among those who believe incorrectly that U.S. hurricanes or major hurricanes have increased since 1900 (when data is reliable) or global tropical cyclone landfalls (since 1970 when data is reliable), you should think about the integrity of science advice being provided to policy makers on climate**.**

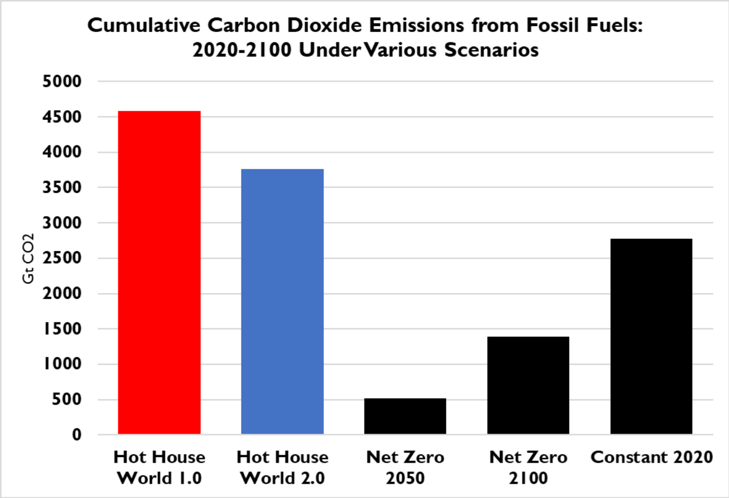
4. Shortfalls in robust science advice on climate are more than just an academic issue – they also show up in important policy contexts, such as:

- *Proposals for "climate stress testing" in the global and national financial systems;*

The Network for Greening the Financial System (NGFS) is voluntary consortium comprised of more than 60 central banks representing almost 50% of the global economy.[20] The NGFS provides climate scenarios for use by governments and businesses to "stress test" their activities in the context of projected climate change and proposed climate policies. To their credit the NGFS is one of the few institutions that that has recognized that the most commonly used climate scenarios (of the IPCC) "were designed about 10 years ago and do not match well with recent emissions trends."[21] The NGFS has thus taken it upon itself to create new scenarios for climate stress testing.

However, despite the recognition that the IPCC scenarios are outdated, the reference scenario created by the NGFS (called "Hot House World") – both its first iteration and then an update released last month[22] -- are also well out of date when compared to recent emissions trends and projections. This can easily be seen in the graph below which compares cumulative carbon dioxide emissions 2020 to 2100 for the two NGFS "Hot House World" scenarios (red and blue) with those that assume constant 2020 emissions to 2100, and then two that assume the world moves toward net-zero carbon dioxide in 2050 and 2100 (in black).

The scenarios underlying climate stress testing assume continued growth in emissions to at least 2090, to a level about ~50% greater than those of today. Whether or not such an assumption is plausible has not been explored, but if such aggressive growth in emissions is implausible (and our work suggests that it is implausible), then the "stress tests" conducted under the scenario will have no real-world meaning and instead will just be academic exercises.



[20] https://www.ngfs.net/sites/default/files/medias/documents/synthese_ngfs-2019_-_17042019_0.pdf
[21] https://www.ngfs.net/sites/default/files/ngfs_climate_scenario_technical_documentation_final.pdf
[22] https://www.ngfs.net/en/communique-de-presse/ngfs-publishes-second-vintage-climate-scenarios-forward-looking-climate-risks-assessment

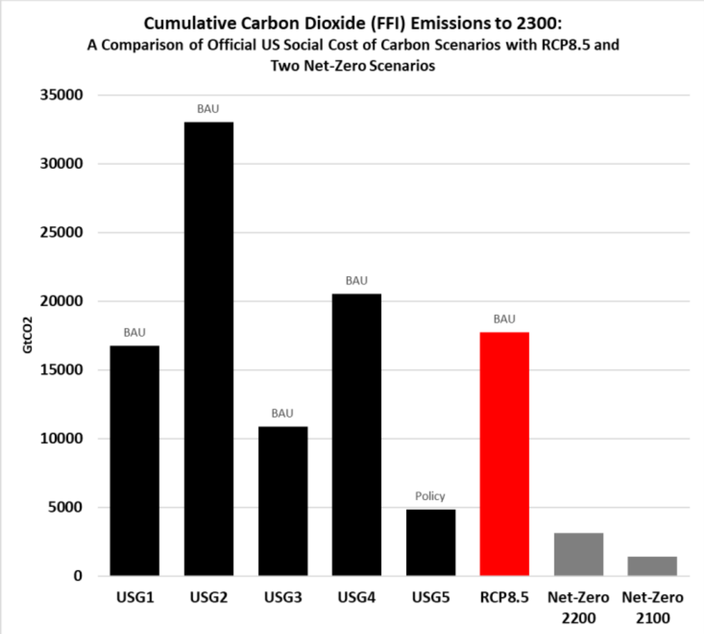
- *The estimated "social cost of carbon" of the Biden, Trump and Obama administrations;*

In 2008, a federal court ruled that the U.S. Department of Transportation was in error in conducting a benefit-cost analysis when it assigned a value of zero to the economic consequences of carbon dioxide emissions, concluding, "while the record shows that there is a range of values, the value of carbon emissions reduction is certainly not zero."[23] This judgment meant that the government would need to develop a defensible estimate of economic consequences of carbon dioxide emissions.[24] Subsequently, in 2009 the Obama administration established an "interagency working group" (IWG) to develop estimates of the "social cost of carbon" (SCC), "to ensure that agencies were using the best available science and to promote consistency in the values used across agencies."[25]

Soon after, in 2010 the IWG estimated the SCC at $26 (in 2007$ for 2020) per ton of carbon dioxide, and following several updates, in 2016 set the value at $42 (in 2007$ for 2020) per ton in 2016.[26] In March, 2017, the Trump administration disbanded the IWG and issued a new and much lower estimate for the SCC of $7 per ton (in 2018$ for 2020).[27] Recently, the Biden administration restored the final estimate of the Obama administration (now $51 per ton in inflation-adjusted 2020$ for 2020), as an "interim step" to issuing updated estimates sometime in the next year.[28]

In order to estimate future damages resulting from the emissions of carbon dioxide into the atmosphere, plausible estimates of how that future might unfold are necessary. The IWG based its original 2010 SCC on eight different scenarios of the climate future, developed decades ago.[29] Four of the scenarios were to represent different visions of how the future might unfold in the absence of climate policies (called "business as usual") and four others were combined into a single scenario to reflect a future with climate policy. These five scenarios looked out to 2100, so the IWG extended them to 2300 using a range of assumptions. Each of the five scenarios is weighted equally in estimating the SCC.

These scenarios are all badly outdated and have never been updated in the IWG methodology.[30] All of them, including the policy scenario, envisage enormous emissions of carbon dioxide from the burning of fossil fuels to 2300. None of these futures are remotely plausible. This can be seen in the figure below, which shows the scenarios of the IWG (in black) compared to the implausible "business as usual" scenario of the IPCC Representative Concentration Pathways (in red), as well as two much more plausible scenarios that assume the world achieves net-zero carbon dioxide in 2100 and in 2200 (in grey).



[23] https://bit.ly/3wHyKK2
[24] https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/circulars/A4/a-4.pdf
[25] https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf

- *Proposed Congressional legislation to address financial system risks related to climate change*.

Recently introduced legislation risks exacerbating the issues of scientific integrity related to climate science discussed in this testimony. Two examples follow:

- H.R. 1549 introduced in early 2021 would create a new scientific advisory body called the"Climate Risk Advisory Committee" to advise the Financial Stability Oversight Council.[31] The proposed legislation establishes no connection of new advisory committee with existing climate advisory bodies of the U.S. government, notably the U.S. Global Change Research Program and its National Climate Assessment. This new advisory body would set the stage for disparate, conflicting or unclear guidance being provided to policy makers across uncoordinated advisory mechanisms.
- H.R. 3571, also introduced in early 2021, would create yet another expert advisory body, the "Climate Risk Scenario Technical Development Group" under the Board of Governors of the Federal Reserve.[32] The proposed legislation exempts the advisory group from the Federal Advisory Committee Act and requires that it develop one business-as-usual scenario and two policy scenarios and update them every three years. Not only would this add further complexity and possible dissonance in expert advice to policy makers, but it also risks codifying in law the establishment of flawed scenarios (imagine if new scenarios were produced in December, 2019, on the eve of the pandemic – these would have been immediately out-of-date). Congress should not mandate the substance of scenarios or howoften they shall be updated.

5. *Climate change is too important to allow shortfalls of scientific integrity in science advice to persist. Congress should enhance its oversight of the U.S. Global Change Research Program and its National Climate Assessment to ensure that the scientific advice that it receives is up-to-date and accurate.*

In 1990, Congress established in legislation (P.L. 101-606) the U.S. Global Change Research Program to provide "usable information on which to base policy decisions relating to global change."[33] In the legislation Congress also mandated that the USGCRP produce a "national climate assessment" (NCA) not less frequently than every four years, to provide guidance to Congress and the president on

(1) integrates, evaluates, and interprets the findings of the Program and discusses the scientific uncertainties associated with such findings;
(2) analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and
(3) analyzes current trends in global change, both human-inducted and natural, and projects major trends for the subsequent 25 to 100 years.[34]

Crucially, the NCA does not exist to promote or to sell the policy agenda of the current administration — regardless of the merits of a particular administration's policy proposals. The NCA exists to produce a "scientific assessment" which can certainly including evaluation of policy alternatives, but as a mechanism of expert advice, it does not exist to advance the political goals of the White House.

However, in every administration since the first NCA was produced under President Bill Clinton, the NCA has been overseen by the White House and, ultimately, political appointees. This has created what is apparently an irresistible temptation to manage the NCA in such a way as to promote the current administration's policy agenda. This dynamic of influencing the substance of the NCA for apparent political gain is predictably bipartisan. Ultimately, the politicization of the NCA means that neither Congress nor the president are receiving the quality of scientific advice on climate of the sort envisioned by Congress when it established the USGCRP in 1990.

[31] https://financialservices.house.gov/uploadedfiles/bills-117pih-addressingclimatefinancialr.pdf

[32] https://financialservices.house.gov/uploadedfiles/bills-1173571ihccfra.pdf

[33] Pielke, R. A. (1995). Usable information for policy: an appraisal of the US Global Change Research Program. *Policy Sciences*, *28*(1), 39-77.

[34] https://www.govinfo.gov/content/pkg/STATUTE-104/pdf/STATUTE-104-Pg3096.pdf

[35] Sarewitz, D., & Pielke Jr, R. A. (2007). The neglected heart of science policy: reconciling supply of and demand for science. *environmental science & policy*, *10*(1), 5-16.

Roger Pielke, Jr. has been on the faculty of the University of Colorado Boulder since 2001, where he teaches and writes on a diverse range of policy and governance issues related to science, technology, innovation and sports. Roger is a professor in the Environmental Studies Program. Roger is currently leading the EScAPE project (Evaluation of Science Advice in a Pandemic Emergency) a 16-country evaluation of science advice in the COVID-19 pandemic, sponsored by the U.S. National Science Foundation. Roger holds degrees in mathematics, public policy and political science, all from the University of Colorado. In 2012 Roger was awarded an honorary doctorate from Linköping University in Sweden and was also awarded the Public Service Award of the Geological Society of America. In 2006, Roger received the Eduard Brückner Prize in Munich, Germany for outstanding achievement in interdisciplinary climate research.

Roger has been a Distinguished Fellow of the Institute of Energy Economics, Japan since 2016. From 2019 he has served as a science and economics adviser to Environmental Progress. Roger was a Fellow of the Cooperative Institute for Research in Environmental Sciences from 2001 to 2016. He served as a Senior Fellow of The Breakthrough Institute from 2008 to 2018. In 2007 Roger served as a James Martin Fellow at Oxford University's Said Business School. Before joining the faculty of the University of Colorado, from 1993 to 2001 Roger was a Scientist at the National Center for Atmospheric Research.

His books include **Hurricanes: Their Nature and Impacts on Society** (with R. Pielke Sr., 1997, John Wiley), **Prediction: Science, Decision Making and the Future of Nature** (with D. Sarewitz and R. Byerly, 2001, Island Press), **The Honest Broker: Making Sense of Science in Policy and Politics** published by Cambridge University Press (2007), **The Climate Fix: What Scientists and Politicians Won't Tell you About Global Warming** (2010, Basic Books). **Presidential Science Advisors: Reflections on Science, Policy and Politics** (with R. Klein, 2011, Springer), and **The Edge: The War Against Cheating and Corruption in the Cutthroat World of Elite Sports** (Roaring Forties Press, 2016). His most recent book is **The Rightful Place of Science: Disasters and Climate Change** (2nd edition, 2018, Consortium for Science, Policy & Outcomes).

Editor's Notes:

- The text has been lightly edited to fit into the space provided.
- Apologies to our non-U.S. members for the focus on U.S. policy matters. The newsletter would be happy to print similar articles for other member countries in the AAWE.
- If you have any thoughts about these testimonies, please write a letter or essay providing your perspective for publication.

Memorials

Dr. Ernie Kiesling passed away recently. Kiesling joined TTU in 1969 as chair of the Civil Engineering Department. He helped create the Institute for Disaster Research(IDR) after an EF-5 tornado hit Lubbock, Texas. IDR became the Wind Science Engineering Research Center which in recent years became the National Wind Institute. He is most well-known as the ***father of the tornado saferoom***. His work in this area resulted in the establishment of the National Storm Shelter Association. According to Dr. Marc Levitan of NIST, he and Kiesling "have worked together for much of the last two decades on the ICC 500 Storm Shelter Standard and building the National Storm Shelter Association organization". In addition to Dr. Levitan, many in the tornado community have been mentored by Dr. Kiesling. The following link has more details about Dr. Kiesling:
https://today.ttu.edu/posts/2021/10/Stories/Remembering-Ernst-Kiesling

Dr. Ernie Kiesling,
Source: TTU website

Dr. Arn Womble of IBHS was a casualty of the COVID-19 virus. A memorial written about Arn was sent out to the membership via e-mail. It is also on the AAWE website.

AAWE wishes to express its sincerest condolences on the loss of these two men. They will be remembered not only for their contributions to the wind engineering community, but also their contributions to education and mentoring of younger engineers and scientists.

Dr. Arn Womble
Source: IBHS

President's Corner

Dear Members:

Infrastructure Week and the Glasgow Climate Change Conference reminded me of the testimonies this summer regarding infrastructure and climate change, which comprise most of the issue. They are intended to be "food for thought" for the membership. AAWE does not take any official positions on governmental decisions or policies.

At our recent meeting, the AAWE Board approved the following Diversity, Equity, and Inclusion Policy Statement drafted by Dr. Catherine Gorle:

<u>AAWE Diversity, Equity, and Inclusion Policy</u>
AAWE aims to promote an inclusive environment, providing equal opportunities to a diverse community of different backgrounds, race, age, gender, sexual orientation, disability, religion, and national origin. We believe collaboration is key to innovation in wind engineering, where ideas are shared across multidisciplinary and multicultural platforms and each person's unique skills and abilities are considered valuable contributions.

As AAWE, our mission to mitigate wind damage through engineering is inextricably tied with socio-economic and environmental justice issues. It is our collective duty to educate ourselves about the historical and current inequities that cause some groups to be underrepresented and undervalued in, as well as underserved by, our community.

We encourage our members to actively contribute to prioritizing the values of diversity, equity, and inclusion in their local communities.

The next edition of the newsletter will focus on performance-based design with articles written by Drs. Don Scott, Teng Wu and Seymour Spence.

Please contact me at dorothy.reed@aawe.org if you have any articles, news or suggestions for the future.

Take care and stay safe.

With best wishes.

Dorothy

Call for nominations: AAWE Awards for 2022

Please send all nominations/applications to awards@aawe.org.

Michael Gaus Distinguished Service Award Description

The Michael Gaus Distinguished Service Award recognizes the contributions to Wind Engineering from a distinguished AAWE Member for involvement in AAWE activities, research, consulting, and outreach. This prestigious award honoring an individual is typically presented every 4 years at the America's Conference on Wind Engineering (ACWE). Award is accompanied by a certificate and a prize of $1000.

Requirements

- Applicant must be an AAWE member in good standing
- Applicants must have demonstrated significant contributions to the field of Wind Engineering for at least the 4 years prior to December 2021. In most cases such a contribution will extend back many more years.

Application

- Applicants should be nominated by a member of AAWE
- Nominators should submit a 5 summary of the applicant's career highlights along with a detailed Curriculum Vitae.
- **Nominations/applications are due by April 1, 2022.**

Note Applications that do not meet the requirements above will not be reviewed.

Nominators may only nominate a single applicant for this award

Industry Innovation Award Description

The Industry Innovation Award recognizes a distinguished AAWE Member or AAWE Corporate Member for their contribution or change to the practice of wind engineering or for their use of wind engineering to make a contribution to society. This prestigious award is typically presented every 4 years at the America's Conference on Wind Engineering. Award is accompanied by a plaque (no monetary prize).

Requirements

Applicant or nominating person must be an AAWE member or corporate member in good standing.

Applicants must have demonstrated significant contributions to the field of Wind Engineering in the 4 years preceding the ACWE.

Application

- Applicants should submit a 3-page summary of their work, which could be a product, development, facility, study, code change or other contribution along with a detailed Curriculum Vitae.
- Applicants can be nominated, or they can apply directly for this award.
- **Nominations/applications are due by April 1, 2022**.

Note Applications that do not meet the requirements above will not be reviewed.

Nominators may only nominate a single applicant for this award

Call for nominations: AAWE Awards for 2022

Please send all nominations/applications to awards@aawe.org.

Best Journal Paper Award for 2021 Description

The Best Journal Paper Award recognizes the contributions to Wind Engineering from an AAWE Member for the best journal paper within the calendar year. This prestigious award honoring AAWE member(s) is presented annually, and typically awarded at the America's Conference on Wind Engineering and/or AAWE Workshop. Award is accompanied by a certificate and a prize of $250.

Requirements

- Applicant must be an AAWE member in good standing, and half (a simple majority) of the authorship of the paper must be comprised of AAWE members in good standing.
- Applicant must have published a paper in a refereed journal within the calendar year 2021, according to the DOI number of the publication. The journal paper must be in a topic related to Wind Engineering.

Application

- Applicants should submit a 3-page resume and a copy of the journal paper under consideration for this award
- Applicants nominated for this award can also be nominated for either the Richard Marshall Award or the Robert Scanlan Award.
- Nominations/applications are due by April 1, 2022.

Note Applications that do not meet the requirements above will not be reviewed.
Applicants may only nominate a single paper for this award

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