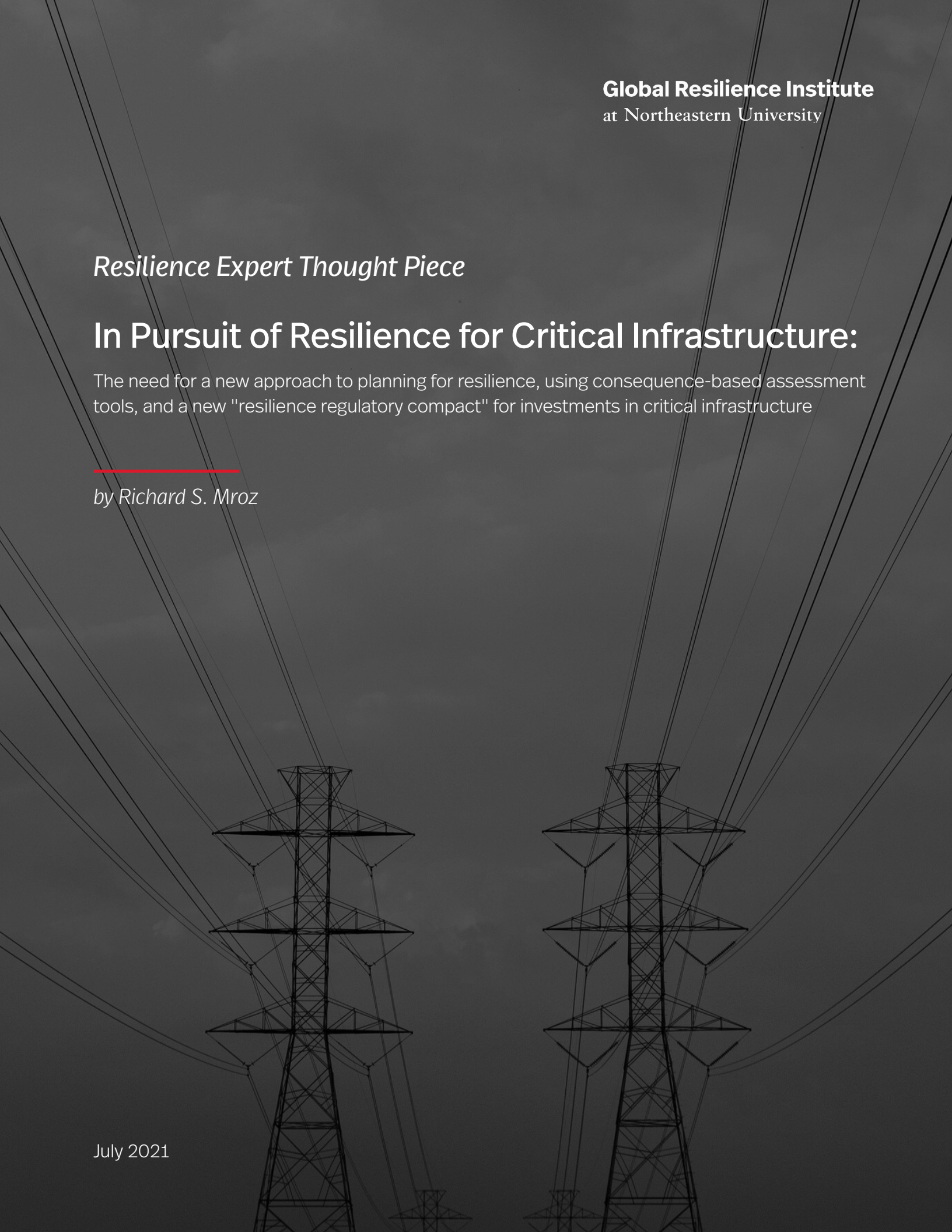
Global Resilience Institute
at Northeastern University

Resilience Expert Thought Piece

In Pursuit of Resilience for Critical Infrastructure:

The need for a new approach to planning for resilience, using consequence-based assessment tools, and a new "resilience regulatory compact" for investments in critical infrastructure

by Richard S. Mroz



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About the Author

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About GRI Distinguished Corporate Fellows

Serving as a GRI Distinguished Corporate Fellow (DCF) signals a mutual desire to find projects through which our collaborative participation can actively embed resilience design, planning, practice, and technology. Designation as a DCF is a recognition made to exception professionals from private business and industry to share GRI's commitment to advance societal resilience.

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In Pursuit of Resilience for Critical Infrastructure

The need for a new approach to planning for resilience, using consequence-based assessment tools, and a new "resilience regulatory compact" for investments in critical infrastructure.

The frequency and intensity of disruptive events these days has led to a growing interest in "resilience". It is generally defined to include efforts to better withstand man-made threats and naturally occurring hazards, as well as to be prepared to respond and recover when the disruptive event or threat occurs. It can be applied to weather events or cyberattacks and how certain industries and sub-sectors can ensure business and operational continuity.

> ***...we are still...in the early days of developing and implementing resilience measures for critical infrastructure.***

I have observed that many in industry or the regulatory community, when discussing resilience, are immediately asking for "metrics" to define results. They seem to expect that a scientific calculation could be devised to guide their decision making. Such calls have become more insistent in the wake of the Texas Power Crisis triggered by Winter Storm Uri and have been incorporated in other recent storm response reviews in New England. Recent cyber hacks that have targeted energy infrastructure, such as the Colonial Pipeline and a Florida water system, have highlighted the need for new assessment tools that can guide efforts to ensure mission readiness. However, we are still only in the early days of developing and implementing resilience measures for critical infrastructure. And I am of the opinion that there are efforts that we must take that go beyond simply relying on such calculations.

My own experience in "resilience" was formed in the aftermath of Superstorm Sandy in my home state of New Jersey. As the President of the New Jersey Board of Public Utilities (NJBPU), I presided over the implementation of more than 100 post storm recommendations for our regulated utilities to harden infrastructure and improve systems and operations to withstand severe weather and respond and recover if there were sustained outages, regardless of the cause. We at the NJBPU, along with other agencies, also instituted other resilience initiatives.

We established an "Energy Resilience Bank"– the first of its type in the country – with Post Sandy Federal Mitigation Funding to provide grants to water, waste-water, and hospital systems for on-site generation to ensure continued operations of that critical infrastructure. Another initiative which I presided over focused on town center microgrids that could island from the grid. Working with local government sponsors, we awarded grants for feasibility studies for developing these microgrids focused on ensuring continuity of operations of critical facilities, such as for emergency operations and public safety in the event of a sustained grid outage. Read more ***here***.

In a significant initiative, our regulated utilities made proposals to upgrade and harden energy and utility infrastructure. Our state's largest electric and gas company, PSEG, sought and we approved an almost $1 billion infrastructure hardening effort to make sure that electric and gas service would be less likely to be disrupted. This program, named "Energy Strong," was subsequently approved by the NJBPU to allow for another $800 million in investments, including projects like lifting substations, improving transmission, and replacement of gas pipelines and hardening compressor stations. Read more ***here***.

These measures were driven by the PSEG's analysis of the improvements necessary to ensure that systems could withstand future weather events like severe flooding and high winds. The company and the NJBPU engaged in a process, with some negotiation, considering the consequences that the company, and we as regulators, wanted to avoid from future severe weather events. Other New Jersey utilities likewise initiated other programs to upgrade and harden energy and utility infrastructure. These programs were unprecedented, but the collaboration that made it possible was precipitated by the social and economic consequences of Sandy and a shared desire to make sure we were "resilient".

Our focus in New Jersey was on the public and private sectors directly confronting the potential consequences of future disruptions by investing in measures that would ensure future resilience of our energy and utility infrastructure. We did not simply seek out some calculus that would give us a computation of what resilience measures to support. Based on our experience in New Jersey coming out of Superstorm Sandy, I believe a new collaboration is needed to address resilience investments. And I believe the rush to just rely upon metrics misses a critically important step: Industry and regulators must first undertake an operational consequence analysis as a preliminary evaluation to guiding resilience solutions.

Metrics will be important when evaluating such resilience investments, but the efforts currently underway to develop assessment tools by private companies, government agencies, and academia have not yet been consistently embraced by industry or policymakers. This is likely due to the fact that there is no comprehensive coordination or organizing convention to fund or deliver these tools for the intended targeted operation or subsector. Therefore, I believe a new approach is needed that has three tasks for industry and policy makers and regulators:

Industry and regulators must first undertake an operational consequence analysis as a preliminary evaluation to guiding resilience solutions.

- First, the circumstances for which we seek resilience must be clearly defined.
- Second, there must be a consequence analysis to define the threats we are seeking to avoid and continuity of operations we are seeking to assure.
- Third, with newly improved tools or metrics, decision makers can then evaluate the relative probability, risks, costs, benefits and prudence of any measures and the associated investments.

The Need to Define the Context for Resilience Measures

When I first began to speak about the need for resilience in the energy and utility infrastructure after Superstorm Sandy, I focused on the need to withstand severe weather impacts. And I knew that, regardless of the setting, we could all identify the benefits that come from making such investments.

I soon came to recognize that resilience was a concept being discussed by numerous industries and sub-sectors, and that it was being used in very different ways depending on the context it was being applied. While I and many others have been advancing resilience by calling for critical infrastructure hardening in the face of severe weather or cybersecurity threats, the term resilience is increasingly being applied for much broader discussions. These include projects or programs that address climate change and the expansion of renewable energy and distributed energy resources.

Just in the energy industry, "resilience" has been used as a prevailing approach applied to:

- Energy markets
- Generation infrastructure
- The overall mix or spectrum of various generation sources
- Dual or multiple generation fuel sources
- Pipeline supply and/or redundant supply
- Pipeline integrity and hardening
- Electric transmission and distribution hardening
- Electric transmission and distribution expansion to support renewable energy
- Expansion of electric systems for expanding distributed resources
- Expansion of distributed resources with islanding
- Protection of physical infrastructure from intentional attacks
- Protection of physical infrastructure from weather related threats
- Cybersecurity protection of the energy infrastructure across all sub-sectors

Given the spectrum of these applications, there is a need to first define the context in which resilience is being used and the general consequence that one wants to avoid – operational or financial – as an essential stepping off point for advancing resilience measures or improvements. Only then can the relevant industry representatives, policymakers, regulators and related stakeholders evaluate specific resilience measures.

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A New Approach to the Historic Regulatory Compact – Resilience Decisions with Consequence-Based Evaluations

In seeking to build resilience capabilities, I have often heard decision makers indicate they will do so when they have metrics. Or there is the call for the industry to "show us the metrics". There are many emerging frameworks, assessment tools, calculators and metrics. However, there is no set universally identifiable or embraced mature benchmarks nor comprehensive perspective on such tools, and many are still in the early days of development.

Furthermore, many such assessment tools use a pre-determined baseline for the application. Assessment tools such as the ICE calculator, for example, base its output on a 24-hour outage duration. The ICE Calculator is very good for what it offers, but only within that baseline and parameter. If policy makers decide that they cannot live with a 24-hour outage, or even a 12-hour duration, and decide that some level of operational incapacity, for example at 4 hours is unacceptable, then a different assessment must be made.

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Within the energy and utility sectors, the concept of "reliability" is fairly well established in law, regulation, and operations. The well-known metrics for SAIDI, SAFI and CADI allow for a qualitative formula to evaluate investments for and progress toward reliability. But the concept of "resilience" goes beyond "reliability".

The desire for resilience in critical infrastructure must also include the issues of inter-dependencies – the consideration of the nexus to and mufti-factorial relationship between the electric grid that supports other essential critical infrastructure such as water, waste-water, gas, and communications, which in turn are essential to support other critical infrastructure including financial services, transportation, logistics, critical healthcare, and food production and distribution, as well as infrastructure critical to national defense. Such an approach must inevitably go well beyond traditional perspectives on reliability.

I believe that there is another essential step in a framework whose aim is to implement resilience measures: The owner or operator of critical infrastructure must establish what consequence they seek to avoid and identify what measures would allow them to withstand a disruption or respond and recover sufficiently.

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With a consequence analysis, the owner can articulate how to achieve resilience in that specific circumstance. If this evaluation is not undertaken, there is always the risk that such investments and measures are not sufficient to ensure adequate prevention, response and recovery within an "acceptable" period. Additionally, such an evaluation will help to articulate for regulators what is at stake. Only by making such a case can the owner or operator position proposed resilience investments for regulatory approval. It seems to me that decision makers are grasping for metrics in place of the difficult policy determinations that this consequence-driven analysis will provide.

Conversely, even assuming later that some metrics can quantify the investments, the prudence of such investments might be called into question. Ultimately, this approach calls for a subjective qualitative evaluation driven by that consequence evaluation. When a consequence-based analysis is completed, the owner, along with any regulator, policymakers or decisions-makers, should collaboratively determine if those measures are appropriate. This clearly requires that regulators and industry leaders embrace resilience-enhancing measures as a matter of clearly articulated public policy.

With a foundation built on this qualitative consequence analysis, it is possible to put in place frameworks and the metrics for balancing risks, probability, alternative measures, contingency operations, systems, workforce, costs, and benefits of the required investments. This is essentially the process that was used in New Jersey post-Superstorm Sandy for considering and ultimately approving those infrastructure hardening – or resilience – investments.

Such an approach can most likely be undertaken with existing authority of most public utility laws, both federal and state. Generally speaking, both federal and state laws have historically required as a baseline the need for the industry to provide "safe and reliable service" or "safe and adequate services" to all customer classes. So there is likely sufficient inherent latitude under delegated authority in most jurisdictions and under federal law for decision makers or regulators to make such a determinations, that go beyond historic investments for "reliability" and look to go beyond those benchmarks under what we can all consider a new "Resilience Regulatory Compact".

Need for New Resilience Assessment Tools and Metrics Under This Refined Approach

This new approach would include this "consequence analysis" that forms the foundation for specific resilience measures. Depending on the setting, specific type of facility, or nature of the operation, a judgement as to the consequence of specific disruptions would establish a foundation to accept the need for additional measures to ensure continuity of operations. Then the regulators or those with oversight authority can begin that quantitative analysis using metrics to evaluate the sufficiency and prudency of the measures.

This quantitative assessment could then evaluate elements such as economic impacts of business interruption, replacement costs, lost revenue, and profit; but also social impacts of loss of services particularly for an extended period. This phase of consideration would also entail a more traditional prudency evaluation balancing the costs of the consequences without resilience investments, or conversely the benefits that come with such, weighed against the cost of the resilience investments.

At this point in this process, it is necessary to consider, or reconsider, what are "just and reasonable rates" for prudency considerations. Historically, such prudency review is a subjective consideration based on articulated cost-benefit analysis. However, historically, this would be based upon "reliability", not this enhanced incremental level of "resilience". Assuming that such costs and benefits can be articulated as to the potential financial and non-economic impacts of a loss of operations from a sustained outage of utility servicer, then a viable new paradigm could be established to justify resilience measures. However, as suggested already, these quantitative factors may vary from operation to operation; facility to facility; function to function. The need to ensure continuity and thus resilience of lifeline functions for water systems, healthcare, financial services, would be different than others.

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Generally speaking, there are currently no comprehensively embraced assessment tools or approaches for evaluating the costs and benefits of resilience measures. And in the energy and utility sectors there is no such industry-wide recognized assessment tools for this purpose. There are many efforts underway to craft and validate these tools and their applications and there are important efforts being made to enhance others, such as the ICE Calculator. What is urgently needed is for industry, policymakers and regulators to begin in earnest to identify and embrace specific assessment tools and metrics to evaluate measures that deliver "resilience".

Conclusion and a Path Toward Resilient Critical Infrastructure Investments

The approach I outline here is admittedly a bold step away from our traditional perspectives of reliable and adequate energy and utility services or operations – as well as the costs we have historically accepted. But our collective expectations have changed as have our reliance on these critical services; first and foremost, electric and energy, and then the nexus to other services including water, waste-water, and telecommunications – all of which go on to support critical facilities or operations such as the healthcare, banking, finance, transportation, logistics, and defense critical activities.

We now look at and expect much more of critical energy and utility infrastructure. This includes the need to keep the lights on, water flowing, and our wireless phone and streaming services up and running. Importantly, there is also the need to ensure that critical infrastructure, such as that for critical national defense facilities, is able to stay mission ready in what is an increasingly unstable and threatening world. Therefore, we need new approaches to encouraging and evaluating enhanced protective, response, and recovery measures that will ensure "resilience" in so many situations.

Government officials, regulators, industry members and thought leaders have much work to do to advance adequate levels of resilience. This includes the need to clearly outline what resilience measures they want to undertake, to determine what measures that will avoid disruption, and to show the costs and benefits to customers so that our energy and utility systems are resilient.

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About the Global Resilience Institute

Based at Northeastern University in Boston, MA, the Global Resilience Institute's (GRI) research and educational mission is to develop and deploy practical and innovative tools, applications, and skills that drive social and technical changes, which strengthen the capacity of individuals, communities, systems, and networks to adapt to an increasingly turbulent world. Launched in 2017, GRI is the world's first university-wide institute to respond to the resilience imperative. Today, GRI undertakes multi-disciplinary resilience research and education efforts that draw on the latest findings from network science, health sciences, coastal and urban sustainability, engineering, cybersecurity and privacy, social and behavioral sciences, public policy, urban affairs, business, law, game design, architecture, and geospatial analysis. GRI works in close partnership with industry, government, communities, and non-governmental organizations, as well as engages in external outreach to inform, empower, and scale bottom-up efforts that contribute to individual and collective resilience.

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