

INVESTING IN RESILIENCE



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INTRODUCTION

The climate is changing, and society is facing significant climate impacts including more frequent and severe weather, ocean warming and acidification, extended periods of drought, and extreme temperatures. The ability to prepare for, recover from, and adapt to these impacts is known as “climate resilience.” Resilience efforts must be made at the local level, sometimes even at the level of individual structures or facilities. This requires an unprecedented combined and coordinated effort. Fortunately, addressing these risks will not only protect people

and property, but also generate economic activity that will create domestic jobs and help with U.S. competitiveness globally.

For all levels of government, the greatest challenge to becoming more resilient is making the investments needed in resilience planning, infrastructure upgrades, and other projects. This brief explores existing funding streams, the financial aspects of climate resilience, and discusses challenges and new options for valuing these important investments.

RESILIENCE COSTS AND SAVINGS

More cities, towns, and businesses are investing in resilience. The expected increases in the frequency and severity of impacts and the associated high cost of being unprepared demonstrate a growing value of investing in resilience. A large body of research clearly shows that the payback on resilience investments is great, up to ten times or more above the cost of addressing these risks. Policy discussions have been less focused on the costs of inaction, especially looking at the indirect impacts of climate-fueled disasters, but this is beginning to change.

The United States faces hundreds of billions of dollars in annual losses due to the impacts of climate change.¹ In the past five years alone, losses from extreme weather events have approached \$500 billion total, and these

events are increasing in both frequency and severity.² The cost of impacts from a changing climate affect all sectors within our society. The U.S. Government Accountability Office recognizes climate change as a high fiscal risk to the federal budget and estimates that the federal government has spent more than \$450 billion in disaster recovery assistance since 2005.³

The National Institute of Building Sciences’ (NIBS) publication, *National Hazard Mitigation Saves: 2018 Interim Report* considers benefits of Federal Emergency Management Agency (FEMA) post disaster funds and breaks out the benefit-cost ratios by hazard and other factors. The NIBS study also looks at the benefits versus costs of mitigation grants from several federal agencies includ-

Box 1: The Payoff of Improved Building Codes

Model building codes, such as the International Building Code and International Residential Code are issued every three years by the International Code Council, a non-profit association of industry leaders and government officials. These codes represent the most current science and engineering and one of the most effective tools to drive broad community resilience.⁴

Additional research looked at the benefit of the adoption of a new building code in Florida following the catastrophic losses attributed to Hurricane Andrew in 1992. The Florida legislature adopted one of the strongest codes in the nation in 2001. A review of ten years of insurance loss data showed that the adoption of this stronger building code reduced the number of claims and the total value of claims was 72 percent less for the buildings built since 2000. In that ten-year period, Florida received \$3.50 in benefit (due to the lower number and value of insurance claims) for every \$1.00 of additional cost associated with implementing the building code. One notable aspect of this study is that it used actual insured loss data as opposed to probabilistic estimates of future losses.⁵

ing FEMA, Economic Development Agency, and the U.S. Department of Housing and Urban Development (HUD), over a 23-year period. The study found that these grants returned \$6 in value for every dollar invested⁶ (considerably more than the four dollars of benefits returned for each federal dollar in NIBS's 2005 report).⁷ These benefits accrue to international investments as well. The Global Commission on Adaptation found that a \$1.8 trillion investment over the next ten years globally would return \$7.1 trillion in net benefits.⁸

The new NIBS study shows that one of the most beneficial approaches to improve the resilience of buildings is to widely adopt the most current model building codes. The study found that building to the current common model building code standards as opposed to the model codes from the 1990s returns an average of \$11 for every dollar (11:1) invested pre-disaster. The study also presents a range of other benefit-cost ratios by disaster type.⁹ Adoption and enforcement of current building codes by states and municipalities was a recommendation of the Hurricane Sandy Rebuilding Task Force in 2013,¹⁰ but adoption of model building codes varies greatly from jurisdiction to jurisdiction so this could continue to be a cost-effective strategy for states and municipalities to improve resilience.

In addition to accounting for insurance and reconstruction costs, the human impacts of damage from disasters are being factored into these assessments. The NIBS study looks at issues such as the economic losses

from productivity impacts of damaged facilities and the post-traumatic stress on the survivors. A more full-cost accounting approach to understanding direct and indirect benefits of resilience investments allows better assessment of the impacts of policy decisions.

Research like the NIBS study and other evaluations of the benefits of resilient investment such as on building codes suggest that the value of a resilience investment outweighs the costs in avoided losses. It also suggests that integrating resilience into broad policy (such as building codes) that moves the entire market is an effective way to ensure that entire communities become more resilient.

Just as there are direct and indirect costs of climate change, both types of benefits accrue to governments, companies, and individuals when they invest in resilience. Considering the comprehensive set of benefits offered by resilience can improve access to funding. It is challenging, but important, to determine who derives what benefit from these investments. A flood wall between a neighborhood and the sea or a river clearly affords safety and risk reduction to the residents who live there, but who else benefits? What if in addition to the neighborhood, the flood wall protects a public hospital, a fire station, water treatment plant, and private businesses? Whether it's Manhattan, Miami Beach, or Des Moines, the calculation of costs and benefits becomes very complex, but it is critical to ensure that the costs and benefits are equitably distributed.

RESILIENCE FUNDING STRATEGIES

Under current funding strategies, everyone in America pays for climate change, but the costs are not shared equitably, and proactive investment to reduce risks is not incentivized. The following section presents a number of funding sources and programs. A number of these funding opportunities are tied to disaster aid spending, addressing risk only after a disaster. Planning for disaster recovery is very important, but governments should pay more attention to preparing communities and states for the next disaster, not just cleaning up and rebuilding from the last one. This is typically called pre-disaster mitigation or disaster risk reduction in the U.N.'s international framework around reducing disaster risk.¹¹ The funding sources below are for both proactive pre-disaster mitigation as well as building back resiliently after a natural disaster. Some of these funds are for specific projects often within specific geographic areas, resulting in a hurdle for communities taking a holistic approach to building and paying for resilience. Many of the cities or states in the lead are using a combination of funding sources.

FEDERAL FUNDING

Billions of federal dollars are currently being spent to help U.S. communities, states and companies be more resilient to the impacts of climate change after disasters. Some of the following funding programs support proactive, pre-disaster risk management, but much of that funding comes post-disaster. Communities like New York City and Houston that plan for resilience before disaster strikes (like Hurricane Sandy in 2012 and Hurricane Harvey in 2017) are much better positioned to use recovery funding strategically. They have a head start on the planning process and understand the risks, and have been building consensus around solutions. Even with pre-planning, it's not simple or uncontroversial to plan for a resilient future – it can require hard political decisions. In Louisiana, for example, the state water plan accepts a future where the highest risk areas will be unable to safely support homes and communities.

FEMA Pre-Disaster Mitigation Funds

FEMA's Pre-Disaster Mitigation Grant Program has assisted in reducing risk to communities for years, but the program has historically had limited funding (in the tens of millions of dollars annually) with rare occasions

where a few hundred million dollars were appropriated to fund projects across the nation. FEMA also funds some future risk reduction through the Hazard Mitigation Grant Program (HMGP), a post-disaster program to reduce future losses.¹² While the HMGP can be used for proactively financing resilience, funding is based on the FEMA funds allocated to a specific federal disaster declaration.¹³ Therefore, HMGP is only available to states following a major disaster and in proportion to the funds spent on recovery from the current disaster, not the risk they face from future events.

National Public Infrastructure Pre-Disaster Mitigation Fund

Congress also created a program in the 2018 Disaster Recovery Reform Act that allows FEMA to allocate funds for pre-disaster mitigation without an annual appropriation.¹⁴ The National Public Infrastructure Pre-Disaster Mitigation fund, which will be implemented through a program called Building Resilient Infrastructure and Communities, will allow FEMA to invest in communities before a disaster strikes by allocating an additional percentage of the funds spent on disaster recovery to the new fund. Based on the scope and scale of disaster costs over the past 10 years, FEMA estimates this program may generate between \$200 and 300 million a year for resilience projects.

HUD Community Development Block Grants

HUD's Community Development Block Grant – Disaster Recovery (CDBG-DR) program is some of the most flexible federal money provided to states and municipalities after major disasters. One of Congress's significant advances in funding pre-disaster mitigation included an appropriation in 2018 of nearly \$16 billion in funding directed at mitigating future risks to communities that faced devastating loss in recent disasters, to be distributed through the CDBG-DR.¹⁵ While these funds are more flexible, they must be appropriated and authorized by Congress each time as there is not permanent CDBG-DR program created in statute.

Other Federal Programs

In addition to FEMA and HUD, several other federal agencies have programs that are being used to improve

community resilience. The Department of Transportation (USDOT) has added resilience to the criteria for project design and while most of the resilience-specific funding from USDOT is tied to disaster recovery, new capital investments in roads, transit, airports, and ports will result in new and more resilient infrastructure.

Some states have been able to leverage two EPA state revolving fund programs that help finance drinking water and wastewater treatment projects. The programs provide grants to all 50 states and Puerto Rico to provide low-interest loans to communities for public water facility improvements. The programs also have some additional flexibility for small and disadvantaged communities in the form of loan forgiveness and other benefits. These are not specifically designed to provide resilience funding, but the program rules do allow consideration of resilience as a co-benefit in project design. One of these programs, the Clean Water State Revolving Fund, has provided \$133 billion to projects since it was established in 1987. Because of local match and the revolving nature of the fund (using program income to reinvest in new projects), the \$133 billion only required \$43 billion in federal funding.

STATE AND LOCAL FUNDING AND FINANCING

In addition to leveraging federal funding, state and local governments use a variety of revenue strategies to fund resilience projects. Most states and communities must access some local funding or financing to provide a match to federal funds. Others have been able to use local financing strategies to cover the bulk of resilience initiatives and provide specialized, flexible, pre-disaster funding for specific local or state projects.

Service and Impact Fees

Service fees, like stormwater and utility fees can be collected for general revenue purposes or be set aside for resilience investments. At the state and local level, the demand on general revenue funds (such as income, sales, and property tax revenue) is high, and state and local tax revenue is often assigned in an annual budgeting process where all options are on the table. This makes dedicating funds for future risk reduction challenging when local budgets are often stretched to cover immediate needs. For example, where states and local governments are striving for a balanced budget, any new investment means a higher tax rate or that another program must go unfunded. Increases in tax rates are rarely popular but some regions have found tying them to specific outcomes

that reduce long-run costs make them more palatable.

Specific impact fees such as development and stormwater levies are used to fund infrastructure upgrades, and can be used for resilience projects. The fees are typically applied to new development or residents, not in the form of property taxes. Local governments can show that infrastructure projects may reduce future costs, and therefore avoid the need for special assessments or general revenue funds. The process to establish impact fees (as well as service fees) or use general revenue for resilience at the local level, however, varies geographically, and can be very public and contentious.

Infrastructure Banks

Another option some states have explored are state infrastructure banks. Often these have been branded as green or resilience banks depending on the criteria for loans and the capitalization source. In New Jersey, the state created an energy resilience bank, capitalized using federal funds provided for the Hurricane Sandy recovery. In New York, the NY Green Bank was capitalized using funds set aside as part of the investor-owned utility fees paid by businesses and homeowners. The NY Green Bank is more focused on sustainability and energy innovation, but projects like renewable generation and microgrids improve resilience, so there is a co-benefit that is recognized and encouraged. In Rhode Island, the state infrastructure bank is essentially a clearing house for various revolving funds and other infrastructure loan programs, creating a one-stop shop for public infrastructure lending. The Infrastructure Bank is committed to bringing the state resilience plan's recommended projects to implementation, is involved in refining timelines for completing different resilience actions and developing a system for tracking progress and performance.

Municipal Bonds

Some communities have also floated municipal bonds for the specific purpose of funding resilience investments. The City of Miami approved a \$400 million Miami Forever Bond in 2017, focused on addressing sea level rise and flooding. About \$10 million from the bond is being invested in six demonstration projects to identify future projects.¹⁶ The City of Miami Beach has also issued \$439 million in general obligation bonds to fund resilient infrastructure and other improvements and has identified 57 projects which are expected to begin construction this summer.¹⁷

Another approach being explored is the use of environmental impact bonds (EIBs). The EIB is an environmentally focused version of a social impact bond, where the investors' return is based on the success of the funded project. Washington, D.C.'s Department of Water and Sewer (D.C. Water) issued one of the first EIBs with the performance aspect based on the success of its green infrastructure program in reducing stormwater runoff.¹⁸ EIBs are being used in D.C. Water's program and other pilot projects to transfer some of the risk of new types of investments (such as using green infrastructure for stormwater management). The concept has opportunities to be expanded to have investors who benefit from the success also fund some of the investment.

Debt Financing

Debt financing for businesses and homeowners is also available for resilience improvements in some states and post-disaster through federal loan programs. In Florida, for example, the state has used the property assessed clean energy (PACE) program to allow businesses and homeowners to access long-term loans to fund clean energy and wind resilience improvements. PACE for commercial properties has been more successful nationally than the residential version of PACE because the federal agency overseeing the two main government-sponsored financial enterprises (Fannie Mae and Freddie Mac) and HUD's Federal Housing Administration (FHA), which controls FHA-backed mortgages, have restricted them from buying or refinancing residential mortgages with PACE liens.^{19,20} This does not restrict a homeowner from getting a PACE loan, but it may be difficult to sell or refinance the home unless the debt is paid off first.

Capital Improvement Projects

The largest slice of municipal budgets is typically spent on capital improvement projects (CIP). Paving roads, replacing old bridges, building new schools, and upgrading wastewater and storm water systems are the bread and butter of municipal public works departments. Companies also have CIP programs for their capital assets. Most of these funds are not earmarked as specific "climate" or "resilience" projects, but rather as investments in infrastructure, facilities, factories, and offices. Every project, however, could be a resilience project if it was designed and constructed with an understanding of and appreciation for the forwarding looking risks of climate change.

The marginal cost of building a climate resilient proj-

ect can be very small when included in initial planning and design. The city of Moore, Oklahoma, for example, adopted a new building code that required structures to be designed to withstand the 135-mph windspeed of an EF2 tornado instead of the previous 90-mph previous standard in 2014. Moore is located just south of Oklahoma City, in what is often called "tornado alley" and had seen three major tornadoes in the previous 15 years.²¹ The new code increased the builders' cost by approximately \$2 per square foot, but sales data showed it did not increase the price of the new homes, nor did it impact their sales. It is important to note that climate change's impact on the frequency and intensity of tornadoes is unknown (and there may in fact be none). However, this example of building code to improve wind resilience has lessons for areas threatened by tropical storms which will likely be made more intense by a warming ocean and atmosphere.

Other states and local communities have made strides in this area by changing building codes or in the case of Alabama, mandating insurance discounts to homeowners who meet the Institute for Building and Home Safety's FORTIFIED standard for wind resilience.²² Communities are looking at how to partner with the private sector to bring more private capital into resilient building. Philanthropic and institutional investors are exploring new ways to pay for these projects like resilience investment funds.

Utility Leadership

Many communities and private (investor-owned) utilities are working to understand their climate risk and designing facilities for not only the risk they face today, but the increasing risk that climate change will bring. After Hurricane Sandy cut a swath of devastation from its landfall near Atlantic City up across the entire state of New Jersey, one of the local investor-owned utilities, Public Service Electric & Gas Company (PSE&G), worked with the state's utility regulator to get approval to spend \$1.2 billion on disaster resilient infrastructure.²³ PSE&G knew from downscaled climate projections that powerful storms were not going to come around only once every hundred years or more. The National Climate Assessment and other data sources made clear that this was a hazard they would face much more frequently. Now PSE&G is working with the state to get approval for an

Box 2: Congress Continues to Improve Disaster Recovery

Congress has made many changes to federal disaster recovery programs to address identified problems and roadblocks in recent years. The most recent package of changes came in the form of the Disaster Recovery Reform Act, enacted in October 2018. The act includes some 50 provisions. Among them are structural reforms of how federal recovery programs are funded and implemented. New dedicated funding for the National Public Infrastructure Pre-Disaster Mitigation fund (discussed above) was authorized through a 6 percent set-aside of disaster funding expenditures from key federal recovery programs. Congress also directed the Federal Emergency Management Agency to study integrated federal reviews for historic and environmental laws and expands definitions and coverage for wildfire, flooding, and earthquake mitigation for states and local governments. These small shifts from post disaster to pre-disaster funding signify a changing landscape of disaster preparedness and resilience investment.

additional \$2.5 billion as part of the second phase of their Energy Strong program.²⁴

Across the Hudson River in New York, the state's largest utility, Consolidated Edison (ConEd) also worked with its regulators to gain approval for a \$1 billion package of resilient infrastructure investments that would protect its power lines, substations, and other assets from damage in future storms.²⁵ This not only reduces future costs to rate payers, but also keeps the power on during and after disasters when the direct and indirect impacts of the grid failing can cost lives and billions in productivity. In considering resilience investments, the state regulators considered comments from a wide range of parties and one significant outcome was a requirement that ConEd base its resilience plan on the best available climate science.

Puerto Rico is rebuilding its power system, using federal disaster assistance provided after Hurricanes Irma and Maria in 2017. It is also looking at opportunities to partner with the private sector and leverage the public funds with private capital and have a system with more distributed supply and electricity generation from renewable sources. Renewable energy sources are not only more sustainable but are more reliable in this respect because they don't require fuel supply when the transportation and port infrastructure may be compromised.

PRIVATE INVESTMENT

The funding approach that has been used the least for resilience, but offers great opportunity, is private investment. Some programs like California utility PG&E's investment in the Better Together Resilient Communities Grant program and AT&T's Climate Resiliency Community Challenge are great examples of corporate philanthropy. The larger challenge, though, is targeting investment that drives company revenue. The key to unlocking private capital is being able to make the business case for the value of resilience investments, not only in cost avoidance from risk reduction, but in opportunities for economic activity and growth. There are opportunities to not only create jobs and prosperity building more resilience communities in the United States, but this expertise and innovation can be exported to the entire world and leverage the global market for resilience investments. Communities and business leaders are starting to have these conversations, but more needs to be done to streamline the approval and building process, create revenue streams that can fund the debt and operating costs, and recognize the long-term value to the entire community from these investments.

CHALLENGES TO INVESTING IN RESILIENCE

There are several challenges to accessing funding and investing in resilient assets and communities. Some are systemic in nature, others driven by data or knowledge gaps, and some based on policies that create unintended consequences making it more difficult to invest in resilience. Understanding these challenges can help communities identify appropriate potential funding sources, and highlights the need for the private and public sector to develop different, and creative options to funding resilience.

SYSTEMS CHALLENGES

In places like South Florida, the real estate markets are starting to recognize flooding risk and price it accordingly. A study of coastal homes exposed to sea level rise found they sold, on average, for 7 percent less than other homes equidistant from the ocean at higher elevations (and therefore less vulnerable to near-term sea level rise).²⁶ The research shows that the rate of discounts for these risks is increasing, so action needed to protect the value of these communities is a current fiscal problem. While sea level rise is a chronic risk, the impacts of risks like hurricanes are episodic, so making large capital investments to address a risk that will happen periodically over a 20-year period is harder to explain to people who are not looking at the problem from a larger or systems perspective.

Reducing both chronic and episodic risks clearly benefits the owners of the impacted properties, but there is also benefit to everyone in the local community because property taxes (based on the value of the homes) pay for municipal services like police, fire, roads, and schools. Reducing the risk of flooding also lowers the potential that federal aid will be needed to rebuild after a major hurricane or storm, and that benefits all American taxpayers. Even when commercial property is not located in the area being made more resilient, local businesses likely benefit because their employees and customers live in these places and that affects the businesses' ability to operate, along with the demand for their goods and services. Not investing in resilience would put communities into a downward spiral, but managing the risk allows them to protect their citizens and their economic base, which is in everyone's best interest, when viewed in the larger context.

As the financial and insurance markets more effectively put a price on risk, reducing or managing those

risks should lead to more available and less expensive borrowing and more affordable insurance. This requires several things to happen. First lenders, rating agencies, and insurers need to be able to quantify not only the risk faced by borrowers and policy holders, but the value of the efforts done to reduce that risk. Second, federal and state regulators need to allow this type of risk-based pricing to occur, as these industries are governed by federal and state regulations. These efforts are beginning to happen, such as the example with wind insurance in Alabama and major rating agencies' support for the recommendations of the Task Force on Climate Related Financial Disclosures. However, more progress is needed to make a stronger business case for these investments.

KNOWLEDGE BARRIERS

A lack of understanding about risk in general and climate risk in particular is a significant barrier to effective resilience planning and investment. Communities tend to take a short-term view of the problem, or to look at the past as an indicator of the future. To make the case for resilience investments, communities must understand and acknowledge the risks, establish policies that reduce, transfer, or accept the risks appropriately, and equitably balance the costs and the benefits across the parties they affect.

In local communities, access to relevant, understandable, and actionable information informs resilience investments and can justify those costs. However, global and regional climate data may not be available in a form where it is useful for local planning and decision making. Low cost or free data may not be at a high enough resolution, while downscaled and packaged climate risk information from companies and research organizations can be too expensive or unavailable for local stakeholders. Local stakeholders would benefit from access to actionable data and support on how to incorporate that information into their community's existing decision-making processes.

A significant barrier to innovative, resilient designs is that implementing new methods or approaches can introduce more project uncertainty if, for instance, they have not been tested over time or tested only in other countries. It can be harder to access funds for pilot projects, initial capital or operating costs may be higher, and the benefits or payback over time is more challenging to estimate. For example, the Dutch government has

used an innovative method of beach replenishment (i.e., replacing the sand on a beach that has been lost to erosion or storm damage). This approach, known as a sand motor, consists of constructing a large artificial island of sand at one end of a beach and letting the natural erosion process replenish the entire beach over time. The initial capital cost is higher than traditional beach replenishment and the only examples of this technique being used are from other countries, so it may be seen as riskier from an owner or investor (public or private) to select this approach. Government agencies, such as the U.S. Army Corps of Engineers, who are responsible for many of the coastal protection projects in the U.S., have extensive testing and evaluation requirements before they can use a new approach on a project. These requirements were established to ensure public monies are well spent but may have the unintended consequence of slowing innovation, hampering creativity, and blocking funding for the resilience projects and technologies that might be the most effective. This may be an area where the environmental impact bonds can help speed innovation.

POLICY CHALLENGES

Policy challenges occur at all levels of government, and can have more significant impacts on some communities, especially vulnerable populations.

Local

The costs of adapting communities and their systems to the impacts of climate change are often borne primarily by front-line communities, while the benefits of taking action may accrue to a wider number of parties, some of whom may not have directly contributed to paying for the solution. This means communities investing in resilience might be providing benefits for non-residents who work in the city, or employers in neighboring communities that do not pay municipal tax in that community. More regional planning and investment in resilience can even out this imbalance on a macro scale and can help ensure

that the costs and benefits are more equally shared.

Equity

The impacts of severe weather, drought, heat stress, and other climate change-induced impacts have a greater impact on lower-income and other vulnerable communities because they have less adaptive capacity.²⁷ Having limited time and financial resources makes it harder for these communities to adapt to disruption and recover from both acute shocks and chronic stresses. A Federal Reserve Board survey found that about 40 percent of respondents were not prepared to cover an unexpected \$400 expense without selling some personal property or borrowing the money.²⁸

In lower-income communities, the ability to borrow is more limited and creates a larger challenge in dealing with disruptions such as higher utility costs, cancelled work shifts, or more severe impacts such as damage from storms or floods. Credit worthiness is also a challenge as access to more traditional and lower-cost capital is often unavailable in these communities, leaving them with the choice of doing business with extremely high-cost sources (i.e., payday lenders) or doing without. There is not only a moral rationale for improving the resilience of vulnerable communities, there is also an economic benefit as the effective growth of our economy relies on workers across the skill and wage spectrum. The loss of productivity in lower wage workers affects them and their families most directly, with rippling through the economy.

Federal

Some of the biggest policy challenges to making climate resilience investments with public funds revolve around how costs are calculated, benefits evaluated, and federal funds budgeted. Because of these challenges, significant public funding for community resilience often only comes after a major disaster has occurred rather than before when it would have been less costly. These issues are more fully discussed in the C2ES document: *Climate Essentials: Resilience*.

THE PATH FORWARD

Governments, companies, and individuals have become more adept at recovering from disasters, but as the frequency and severity of these disasters is increasing, staying one step ahead is not good enough. The most effective way to significantly reduce the cost and speed of recovery is to be more prepared and adapted to what the future holds. Understanding today's risk and how that risk will change over time is the first step and allows for smarter and cost-effective planning and preparedness. The financial and insurance markets have matured in how they quantify and price these risks and will continue to do so sending stronger market signals about the value of managing climate and disaster risks.

Designing solutions that incrementally adapt to changes in the future is another cost-effective tool for resilience. Investments in infrastructure, housing, and commercial facilities are long-term investments, with the design life of these assets sometimes exceeding 50 years. The concept of adaptive design allows the cost and action needed to manage the risks to be staged over the life of the asset. Another way to look at this is that facilities can be designed to become more resilient over time as the threat grows, not requiring all the investment on the front end, allowing for flexibility, and balancing costs and benefits over a longer timeframe.

Ignoring future threats can reduce the useful life of these investments and create unforeseen and unneeded costs for the next generation. With the information garnered from climate science and risk analysis, existing facilities can be evaluated and then determinations made about improvements and whether it's more cost effective to replace the asset now or in the future. This type of analysis is not new. It's the basic process of municipal and commercial capital asset planning, but adding in the additional data from climate science ensures that these

new or retrofitted facilities are prepared for a changing future.

To break the cycle of spending more and more on cleaning up and rebuilding after disasters, greater pre-disaster resilience investments are needed. Congress has made a good start with the HUD mitigation funding and FEMA's new pre-disaster infrastructure fund. However, structural challenges to how funding is appropriated will continue to impede consideration of resilience across all investments. It's just good fiscal planning to buy down future costs when the payback is many multiples of the investment.

Incentivizing resilience for individuals and companies through programs like insurance discounts and by increasing understanding of climate risk will help bring more private capital into this effort. This challenge cannot be overcome without significant engagement of the private sector. The programs discussed above are a start to this effort, but these investments must be tied back directly to corporate revenue and risk reduction to make the strongest business case. A resilient nation is both a physically strong nation, but also an economically strong one because these investments reduce public and private fiscal risk, create jobs and revenue opportunities, and grow wealth across all geographic and demographic sectors. This will not happen without a strong partnership between business and government and a framework within which both groups understand that this approach brings greater value to everyone.

Building a more resilient future requires research, planning, and investment, but sometimes being ready for disaster means being ready to rebuild better. Not everyone has the resources to do everything they need or want today, but being informed and making risk-based decisions is a smart way to plan for the future.

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ENDNOTES

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