The Preparedness Payoff: The Economic Benefits of Investing in Climate Resilience

2024 Climate Resiliency Report
Produced in partnership by the U.S. Chamber of Commerce, Allstate, and the U.S. Chamber of Commerce Foundation

U.S. Chamber of Commerce

Allstate

U.S. Chamber of Commerce Foundation

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Executive Summary

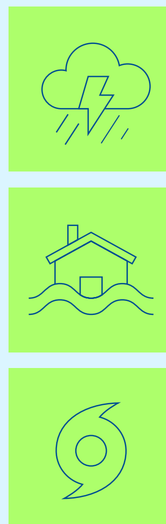
Preparing for climate-related catastrophes beats focusing on recovery alone

EACH $1 INVESTED IN DISASTER PREPARATION SAVES $13 IN ECONOMIC COSTS, DAMAGES, AND CLEANUP

The U.S. experiences a multitude of disasters each year. The cost of cleaning up and rebuilding destroyed homes, businesses, equipment, and infrastructure is immense and growing. In 2022 alone, the cost of natural disasters exceeded $360 billion across the globe, including more than 40 weather events causing over $1 billion in damage.[1]

Investments in resilience and preparedness can reduce the cost of damage after a disaster. An accepted ratio (see the Methodology section) is that $1 of investment reduces the damage and cleanup costs of a disaster by $6. What is less known—and what this study set out to find—is how investments in resilience and preparedness impact a community's local economy, including jobs, workforce participation, production (GDP), and earned income for residents.

The Climate Resiliency Report from the U.S. Chamber of Commerce, Allstate, and the U.S. Chamber of Commerce Foundation shows that investments in resilience and preparedness can substantially reduce the economic costs associated with disasters.



Natural disasters caused more than

$360 billion

in damage globally in 2022

The study revealed that each $1 of investment in resilience and disaster preparedness reduces a community's economic costs after an event by $7. That's the median ratio for the 25 disasters modeled as part of the study.

That $7 of savings for economic costs is in addition to the $6 of savings for damage already assumed in our model. Combining the two ratios finds that every $1 invested in resilience and disaster preparedness saves $13 in economic impact, damage, and cleanup costs after the event.

1 https://www.ajg.com/gallagherre/-/media/files/gallagher/gallagherre/gallagher-re-nat-cat-review-2022.pdf

Glossary

Climate-related catastrophe

A natural event in a weather cycle that is caused by climate change and has a significant negative impact. Examples include hurricanes, tornadoes, blizzards, droughts, floods, storms, heat waves, wildfires, and pollution.

Climate resilience

The ability to anticipate, prepare for, and respond to hazardous events, trends, or disturbances related to climate.

Natural disasters

The harmful impact on a society or community following a natural hazard event. Examples of natural hazard events include floods, droughts, earthquakes, tornadoes, and wildfires.

Pre-disaster mitigation

A sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards.

Preparedness

Precautionary measures in the face of potential disasters.

Five of the 25 disaster scenarios that we modeled and analyzed are described below. They range in damage and cleanup costs from $1 billion to $130 billion and involve communities of different sizes across the country.

Each scenario highlights the jobs saved, workforce preserved, and economic savings that would come from investing up-front in resilience and disaster preparedness programs and resources. This is true in larger metropolitan areas as well as smaller rural areas and towns. It is also true for more severe major disasters and less severe events. For example—

- $10.8 billion of investments in resilience and preparedness for a Category 4 hurricane striking Miami would prevent the loss of about 184,000 jobs and save about $26 billion of production and $17 billion of income.

- $833 million of investments in resilience and preparedness for a major earthquake striking San Diego would save about 38,000 jobs. The amount of production and income saved would be about $5.8 billion and $3.3 billion, respectively.

- $83 million of investments in resilience and preparedness for a serious tornado hitting Nashville would save more than 5,300 jobs. The amount of production and income saved would be more than $683 million and $464 million, respectively.
- $83 million of investments in resilience and preparedness for a drought/heat wave in Redding, California, would save 474 jobs, keep $67 million of output, and preserve more than $31 million of income in the area.
- $83 million of investments in resilience and preparedness for a major wildfire in Santa Fe would save 388 jobs, keep almost $45 million of output, and preserve more than $20 million of income in the area.

Investments in resilience and preparedness won't prevent losses, but they can significantly reduce them. This has economic benefits for a community in terms of both continued economic growth and income. It is vital that community members, small business owners and decision makers at every level have a firm grasp of how such investments can substantially reduce the economic costs of disasters. This study is one small step in that direction.

Report Highlights

The U.S. averages about 10 $1 billion disasters each year.
From 1980 to the present, the U.S. has suffered 383 weather and climate disasters that caused more than $1 billion in damage. Those disasters caused more than $2.7 trillion of damage in total.[3]

Investment in disaster preparedness pays off.
Every $1 invested in resilience and preparedness saves $13 in economic savings, damage, and cleanup costs after the event.

3 https://www.ncei.noaa.gov/access/billions/summary-stats#temporal-comparison-stats

Amount spent on preparedness reduces the economic impact on the local community. Every $1 spent on preparing for disasters is worth $7 in saved economic costs for the community, including job losses, reduced incomes, and other economic impacts.

Disaster preparedness is a good idea in large cities and small communities alike. Investments in resilience and preparedness have large potential benefits in smaller communities whether it's a large $1 billion disaster or a smaller one.

After investments in resilience and preparedness totaling $10.8 billion for **a Category 4 Hurricane striking Miami**, the area would prevent the loss of about 184,000 jobs. The amount of production and income saved would be $26 billion and $17 billion, respectively.

After $833 million of investments in resilience and preparedness for **a major earthquake striking San Diego**, the area would save about 38,000 jobs. The amount of production and income saved would be about $5.8 billion and $3.3 billion, respectively.

After $83 million of investments in resilience and preparedness for **a serious tornado hitting Nashville**, the area would save more than 5,300 jobs. The amount of production and income saved would be more than $683 million and $464 million, respectively.

After $83 million of investments in resilience and preparedness for **a drought/heat wave, Redding, California**, would save 474 jobs, keep $67 million of output, and preserve more than $31 million of income in the area.

After $83 million of investments in resilience and preparedness for **a major wildfire, Santa Fe** would save 388 jobs, keep almost $45 million of output, and preserve more than $20 million of income in the area.

Investments in resilience and preparedness have economic benefits even if a disaster never occurs. As investments in disaster preparedness climb, communities see more jobs, the workforce grows, more people move to the area, and production and incomes increase.

Disaster Scenarios and Their Impacts

We've quantified the losses associated with different disasters, and the benefits of preparing for them. These scenarios show how impacts vary with the size of the population affected and the severity of the disaster.

The larger the disaster (in severity/scope), the larger the destruction and subsequent costs. Not surprisingly, disasters that hit large urban centers as opposed to small towns and rural areas have larger overall costs. It follows that the benefits of pre-disaster mitigation, resilience, and preparedness are greater for larger population centers and larger disasters. Although the savings for smaller areas and less costly disasters are proportionally smaller, they are still large in absolute dollar terms.

Larger disasters such as hurricanes, large storms, and earthquakes also require more investment to reduce the potential damage.

A major hurricane in a highly-populated region

A large hurricane hitting Miami (population 6.2 million) causing $130 billion in damage would be a major disaster, but that price tag would tell only a fraction of the human—and economic—story.

Cleaning up and rebuilding, including replacing destroyed homes, businesses, and equipment, requires significant time. The lost economic activity during this recovery time carries additional economic costs.

Category 4 Hurricane Hitting the Miami Area

Damage Inflicted: $130 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	**Economic Losses Caused by the Disaster After Resilience and Preparedness Investment**	**Economic Savings From Cutting Damage in Half**	**Gains from $10.8 Billion Invested in Resilience and Preparedness**
Jobs	-361,106	-177,074	184,032	126,388
Population	-210,989	-46,512	164,477	37,047
Labor Force	-139,633	-33,221	106,412	24,225
GDP	-$46,176,420,797	-$19,788,000,000	$26,388,420,797	$12,855,000,000
Income	-$29,155,182,522	-$12,192,000,000	$16,963,182,522	$8,556,000,000

361,000
jobs lost without preparedness investment

$26 billion
saved in GDP with preparedness investment

These other economic impacts would be vast. In addition to direct damage and deaths, the Miami area would lose more than 361,000 jobs (8% of all the jobs in the region). About 140,000 workers (3% of all workers) would leave the labor force, and close to 211,000 people (4% of the population) would move away. The costs would be over $46 billion in lost production and over $29 billion of lost income for local residents as the area recovers.

If policymakers invested enough in the Miami area to cut the damage from the same storm in half ($10.8 billion), the economic costs would be substantially less, and people and communities would be better protected. Such investments cannot prevent loss completely, but they would significantly reduce the overall long-term losses.

The same storm hitting Miami after these investments in resilience and preparedness would result in about 177,000 jobs lost, meaning the investments in resilience and preparedness would prevent the loss of 184,000 jobs. Those investments would prevent about 106,000 people from leaving the labor force and more than 164,000 from leaving the area. The amount of production and income saved would be $26 billion and $17 billion, respectively.

The payoff from investments in resilience and preparedness is enormous in this scenario. For instance, the Miami region could spend up to $26 billion and it would still see a positive return compared to the production losses it would suffer from a Category 4 hurricane.

The $10.8 billion invested would create more than 126,000 jobs, attract more than 37,000 people to the area, grow the workforce by more than 24,000, increase production by close to $13 billion, and grow the area's income by more than $8.5 billion. Additional investment, above $10.8 billion and up to $26 billion, would likely result in even larger economic gains.

An earthquake in a large metropolitan area

An earthquake hitting the San Diego area (population 3.2 million) causing $10 billion in damage would result in almost 77,000 job losses (3% of all the jobs in the region) and about 26,000 workers (2% of all workers) leaving the labor force. Close to 32,000 people (1% of the population) would likely move away. The dollar costs are over $11 billion in lost production and almost $6.5 billion in lost income for residents while the area recovers.

After $833 million of investments in resilience and preparedness, the same earthquake would result in about 39,000 jobs lost, meaning the investments in resilience and preparedness would save about 38,000 jobs. Similarly, those investments would save about 15,000 people from leaving the labor force and 18,200 from leaving the area. The amount of production and income saved would be about $5.8 billion and $3.3 billion, respectively.

Earthquake Hitting the San Diego Area

Damage Inflicted: $10 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	**Economic Losses Caused by the Disaster After Resilience and Preparedness Investment**	**Economic Savings From Cutting Damage in Half**	**Gains from $833 Million Invested in Resilience and Preparedness**
Jobs	-76,656	-38,688	37,968	7,239
Population	-31,533	-13,288	18,245	2,060
Labor Force	-25,642	-11,260	14,382	1,823
GDP	-$11,393,343,555	-$5,614,000,000	$5,779,343,555	$938,000,000
Income	-$6,446,026,228	-$3,164,000,000	$3,282,026,228	$564,000,000

$3.2 billion

in earned income saved with preparedness investment

31,533

people leave the area without preparedness investment

In addition to lessening the destruction from a disaster, the payoff from investments in resilience and preparedness is large. For instance, if the San Diego region spent up to $5.8 billion, it would see a positive return compared to the lost output it would suffer from the earthquake. The $833 million invested would likely create about 7,200 jobs, attract more than 2,000 people to the area, grow the workforce by more than 1,800 workers, increase production by close to $1 billion, and grow the area's income by more than $560 million. Additional investment, above $833 million and up to $5.8 billion, would also mean larger economic gains, further mitigating the losses should a disaster strike.

A tornado in a medium-size community

A tornado hitting the Nashville area (population 2 million) causing $1 billion in damage would likely result in 10,500 job losses (1% of all the jobs in the region) and about 2,300 workers (0.2% of all workers) leaving the labor force. Close to 3,500 people (0.2% of the population) would move away. The costs would likely total over $1.3 billion in lost production and $911 million in lost income for residents while the area recovers.

The path of a tornado only strikes a concentrated area, but the Nashville metropolitan statistical area (MSA) has both dense urban and less dense suburban locations. If a tornado strikes the dense, urban downtown entertainment district, it would likely cause $1 billion in damage in a concentrated area. But, if it were to strike in a less-dense suburban area, the damage would be more spread out. The results here are the average across the MSA.

Tornado Hitting the Nashville Area

Damage Inflicted: $1 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $83 Million Invested in Resilience and Preparedness
Jobs	-10,591	-5,267	5,324	965
Population	-3,463	-1,498	1,965	307
Labor Force	-2,308	-1,012	1,296	201
GDP	-$1,335,261,266	-$652,000,000	$683,261,266	$105,000,000
Income	-$911,023,444	-$447,000,000	$464,023,444	$84,000,000

2,308
people leave the labor force without preparedness investment

5,324
jobs saved with preparedness investment

The same tornado hitting Nashville after $83 million of investments in resilience and preparedness would likely save more than 5,300 jobs. Those investments would likely prevent about 1,300 people from leaving the labor force and almost 2,000 people from leaving the Nashville area. The amount of production and income saved would be more than $683 million and $464 million, respectively.

Aside from lessening the destruction from a disaster, the returns from the investments in resilience and preparedness would be huge. In this scenario, the Nashville region could spend up to $683 million and still see a positive return (when taking into account lost production alone). The jobs, population, production, and income saved are detailed in the table.

A drought/heatwave in a small community

A drought/heat wave hitting the Redding, California, area (population 180,000) causing $1 billion in damage would likely result in the loss of 975 jobs (1% of all the jobs in the region) and 246 workers (0.3% of all workers) leaving the labor force. Close to 265 people (0.1% of the population) would move away. That's about $124 million in lost production and about $61 million of lost income for residents while the area recovers.

The same drought/heat wave hitting Redding after $83 million of investments in resilience and preparedness would likely result in 501 jobs lost, 55 people leaving the workforce, and 37 people moving away. Those investments would preserve 474 jobs, keep 191 workers in the labor force, and cause 228 people to stay in the area. The investments would also save about $68 million of output and $31.7 million in income.

Drought/Heatwave Hitting the Redding, CA Area

Damage Inflicted: $1 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	**Economic Losses Caused by the Disaster After Resilience and Preparedness Investment**	**Economic Savings From Cutting Damage in Half**	**Gains from $83 Million Invested in Resilience and Preparedness**
Jobs	-975	-501	474	530
Population	-265	-37	228	143
Labor Force	-246	-55	191	134
GDP	-$123,740,847	-$56,000,000	$67,740,847	$63,000,000
Income	-$60,700,785	-$29,000,000	$31,700,785	$33,000,000

530

jobs gained from preparedness investment

$63 million

in GDP gained with preparedness investment

After accounting for the gains from these preparedness investments, Redding would likely see a net gain in all five economic measures after a disaster occurs. The investments would create 530 jobs, bring 134 people into the labor force, bring 143 people into the region, and lead to $63 million in increased economic output and $33 million in income. Each of these amounts is greater than the losses from the heat wave. Therefore, with the right investments in preparedness, the Redding area economy would likely be stronger after the drought/heat wave.

Additional investment, above $83 million, for example, would also likely produce additional economic gains for the region.

A wildfire in a small community

A severe wildfire hitting the Santa Fe, New Mexico, area (population 89,000) causing $1 billion in damage would likely result in the loss of 788 jobs (1% of all the jobs in the region), and about 157 workers (0.2% of all workers)

Wildfire Hitting the Santa Fe Area

Damage Inflicted: $1 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	**Economic Losses Caused by the Disaster After Resilience and Preparedness Investment**	**Economic Savings From Cutting Damage in Half**	**Gains from $83 Million Invested in Resilience and Preparedness**
Jobs	-788	-400	388	405
Population	-188	-33	155	92
Labor Force	-157	-36	121	78
GDP	-$81,829,248	-$37,000,000	$44,829,248	$39,000,000
Income	-$38,262,181	-$18,000,000	$20,262,181	$19,000,000

$81 million
in lost GDP without preparedness investment

$44 million
in GDP saved with preparedness investment

leaving the labor force. Close to 188 people (0.1% of the population) would move away. That's nearly $82 million in lost production and $38 million of lost income for residents while the area recovers.

The same wildfire hitting Santa Fe after $83 million of investments in resilience and preparedness would likely result in about 400 jobs lost, 36 people leaving the workforce, and 33 people moving away. Those investments would preserve 388 jobs, keep 121 workers in the labor force, and cause 155 people to stay in the area. The investments would also save $44 million of output and $20 million in income.

After accounting for the gains from these preparedness investments, Santa Fe would likely see a net gain in all five economic measures after a disaster occurs. The investments would create 405 jobs, bring 78 people into the labor force, bring 92 people into the region, and lead to $39 million in increased economic output and $19 million in income. Each of these amounts is greater than the losses from the wildfire. Therefore, with the right investments in preparedness, the Santa Fe area economy would likely be stronger after the wildfire.

Additional investment, above $83 million, for example, would also likely produce additional economic gains for the region.

Other Scenarios

We simulated 21 other disasters using the same model (see Appendix). They show similarly large benefits from resilience and preparedness investments. In fact, these investments have large potential benefits in smaller communities, greater than the losses caused by a $500 million disaster.

For example, measures taken to prepare for $1 billion disasters in communities like Santa Fe, New Mexico, and Gulfport, Mississippi, would provide more benefits after a disaster than the up-front costs. The benefits in a community the size of Wilmington, North Carolina, are about equal to the costs of the disaster.

If a disaster does not hit, communities still enjoy the economic gains from investments in preparedness. Those gains are seen in the tables in the appendix.

In large or small metropolitan areas, whether rural or urban, investing in resilience and preparedness would likely preserve jobs and income that would otherwise be lost following a serious disaster. And the larger the investment, the larger the potential benefits.

Conclusion: Resilience and Preparedness Pay Big Dividends

Federal, state, and local policymakers—as well as families and businesses—face hard choices about how much to invest in resilience, preparedness, and pre-disaster mitigation. They must balance the need to spend on other priorities with the need to protect their communities, homes, and livelihoods in case of disaster.

Many often focus on the tangible cleanup and repair costs that are typically directly spent to recover after a disaster. However, there are frequently other economic costs that go unseen: lost jobs, lost homes, lost population, lower labor force numbers, reduced economic production, and missing income that must be accounted for in city budgets and by planning commissions.

While investments in resilience and preparedness cannot totally prevent these losses, they can significantly reduce them. In fact, as this study shows, dollars spent on preparedness and resilience are much more effective at reducing the overall cost of disasters than dollars spent after the fact on recovery. Over time, these preparedness investments can have economic benefits as quantified in this report.

Resilience, preparedness, and pre-disaster mitigation investments pay big returns—no matter what the disaster. They cannot prevent or erase the direct, obvious damage, but they can greatly lessen the human toll over the long term, which is more important than any economic benefits.

Actions To Improve Resilience to Disasters

Across a range of hazards, communities, businesses, and families have many options for reducing risk. The resilience and preparedness investments analyzed in this study were assumed to be in the following categories:

For communities investing in infrastructure

- **Reducing Underlying Risk**

  This approach focuses on encouraging preventive action before a disaster strikes through community-based efforts that ensure residents have access to basic services.

- **Early Warning Systems**

  To alert community members of impending disasters.

- **Mitigation Planning**

  Adopt zoning, land-use practices, and building codes to prevent or reduce damage from hazards.

For businesses

- **Hazard Mitigation Measures**

  These include structural improvements, adjustments based on professional hazard audits, accessibility updates, and employee training for emergency response.

- **Disaster Risk Reduction Practices**

  Apply one or more of the five essentials for businesses in their pursuit of disaster risk reduction. The five essentials as outlined by the United Nations Office of Disaster Risk Reduction are as follow:

  - Promote and develop public private partnerships.
  - Leverage private sector expertise and strengths.

- Foster a collaborative exchange and dissemination of data.
- Support national and local risk assessments.
- Support the development and strengthening of national and local laws, regulations, policies, and programs.

- **Integration of Preparedness With Disaster Response**

  This can foster resilience and support diversified, resilient livelihood strategies.

For families and households

- **Awareness and Education**

  Understand the types of disasters that could occur in your area and learn how to stay safe.

- **Preparedness**

  Create a family disaster plan that includes meeting places in case family members are separated.

- **Home Improvements**

  Make structural improvements so your home can withstand disasters. This could include elevating electrical appliances, using flood-resistant materials, and roof maintenance/upgrades.[4]

4 https://nap.nationalacademies.org/read/1840/chapter/6; https://preparecenter.org/story/how-to-create-effective-and-inclusive-early-warnings-11-recommendations-from-research/; https://www.nibs.org/reports/resilience-incentivization-road-map-20; https://www.ready.gov/be-informed; https://fortifiedhome.org/frequently-asked-questions/

Methodology

We analyzed seven types of disasters to find the economic savings resulting from resilience and preparedness measures:

1. Hurricanes
2. Large Storms (mostly winter storms, but also including a superstorm like Sandy)
3. Earthquakes
4. Tornadoes
5. Floods
6. Wildfires
7. Droughts/heat waves

We used a variety of methods to calculate the destruction caused by these disasters. Those costs include cleanup and repairing and replacing destroyed property: residential buildings, business structures and business equipment, and civil infrastructure.

We estimated the indirect economic damage that results from the direct destruction and cleanup costs using the REMI PI+ model to conduct an analysis of jobs, population, labor force, GDP, and income.

Our analysis involved two components. The first was the direct damage from a disaster: for instance, a tornado that inflicted $1 billion in damage. We assumed the damage was distributed equally among households, businesses, and infrastructure. Our analysis also accounted for the negative impact on employment. Each type of disaster has unique impacts detailed in the specific modeling parameters below. We estimated the losses in five categories of economic well-being—jobs, population, labor force, economic production (GDP), and income—that resulted from the damage the disaster inflicted on a community.

Then we ran the analysis again, but with enough investment in resilience and preparedness spread equally among households, business structures, and equipment, to reduce the size of the various disasters in half—from $1 billion to $500 million, for instance.

To determine the amount of investment in each community, we used research from the National Institute of Building Sciences (NIBS), which determined that $1 of investment in resilience and preparedness from federal mitigation grants (provided by the Federal Emergency Management Agency, the Economic Development Administration, and the U.S. Department of Housing and Urban Development) reduces the amount of damage from disasters by $6.[5] The reduction of damage was divided by $6 to determine the amount of investment necessary to halve the damage.

That would be dividing $500 million (the amount of damage saved) by $6 to arrive at $83.3 million of investment. It then accounted for the loss of jobs, population, labor force, economic production, and income that would occur from the same disaster hitting the location again, but this time with the investments in preparedness and resilience fully in place.

The $6-$1 ratio was chosen for all disasters modeled after careful consideration of several factors. That ratio is a widely used industry standard and cited often by authorities such as FEMA. The source is NIBS.

NIBS presents a range of ratios for the different types of events modeled. It also presents a range based on the types of investment communities make. NIBS does not list a ratio for tornadoes because “necessary hazard information was in flux at the time of their publication, and the analysis might have quickly become obsolete.”

5 https://www.nibs.org/files/pdfs/NIBS_MMC_MitigationSaves_2019.pdf

Table 1: Benefit-Cost Ratio by Hazard and Mitigation Measure

	ADOPT CODE	ABOVE CODE	BUILDING RETROFIT	LIFELINE RETROFIT	FEDERAL GRANTS
Overall Benefit-Cost Ratio	11:1	4:1	4:1	4:1	6:1
Cost ($ billion)	$1/year	$4/year	$520	$0.6	$27
Benefit ($ billion)	$13/year	$16/year	$2200	$2.5	$160
Riverine Flood	6:1	5:1	6:1	8:1	7:1
Hurricane Surge	not applicable	7:1	not applicable	not applicable	not applicable
Wind	10:1	5:1	6:1	7:1	5:1
Earthquake	12:1	4:1	13:1	3:1	3:1
Wildland-Urban Interface Fire	not applicable	4:1	2:1	not applicable	3:1

Given the wide ranges of the various ratios, using the $6-$1 ratio is a sensible middle ground because it is the industry standard and because it is approximately in the middle for each of the disasters listed in the table.

The ratio used in the model impacts the amount of investment a community must make to halve the damage from an event. The lower the ratio, the more the community has to invest to achieve that result. The higher the ratio, the less it must invest. The damage saved is fixed in the model at half the cost of the original disaster. Changing the amount invested would not alter the savings that result from cutting the damage in half. It alters the benefits of investment depending on if more (lower ratio) or less (higher ratio) investment is necessary to cut damage in half.

The results presented in this study are a high-level overview of the benefits of preparedness for a selection of disasters. The $6-$1 ratio was the best fit for this purpose. Future research could refine the results by applying different ratios to the types of disasters modeled as detailed in the NIBS report.[6]

The difference in the economic impacts of the five categories of economic well-being before and after the preparedness investments was measured. The difference in the two analyses is the savings from investing in resilience and preparedness.

The estimated jobs lost are full-time equivalents, meaning they equate to hours of work lost during the immediate aftermath of the disaster and while cleanup and recovery occur—many of which are fully lost during the recovery period, as well as permanently.

6 https://nap.nationalacademies.org/read/1840/chapter/6;
https://preparecenter.org/story/how-to-create-effective-and-inclusive-early-warnings-11-recommendations-from-research/;
https://www.nibs.org/reports/resilience-incentivization-roadmap-20;
https://www.ready.gov/be-informed

Analyses of the different types of disasters were simulated in Metropolitan Statistical Areas varying in size and geographic locations around the U.S. Disasters were assigned to locations where they generally occur, such as hurricanes in the Gulf and Southern states, large storms in places with intense winters, earthquakes near known fault lines, tornadoes in the Midwest and South, floods in traditional flood plains, and wildfires and droughts/heat waves in the West and Southwest.

Each disaster is assumed to occur in 2025. The investments in resilience and preparedness occur in the years before so that they are fully in place for the second analysis.

Following are more details about the assumptions made for each type of disaster.

Hurricanes

Four hurricanes were simulated using historical examples as a guide for damage caused by the hurricane and the approximate geographic location it struck.[7] The hurricanes used were Ian and Harvey (Category 4), Ike (Category 2), Charley (Category 4), and Sally (Category 2).

The following was assumed:

- The Ian and Harvey-type storm inflicted $130 billion in damage in the Miami-Fort Lauderdale-Pompano Beach, Florida, MSA (population 6.2 million).
- The Ike-type storm caused $54 billion in damage in the Tampa-St. Petersburg-Clearwater, Florida, MSA (population 3.3 million).
- The Charley-size storm caused $25 billion damage in the New Orleans-Metairie, Louisiana, area (population 1.2 million).
- The Sally-like storm caused $7 billion in damage in the Gulfport-Biloxi, Mississippi, MSA (population 420,000).

It assumed a sizable negative employment impact in the year the hurricane hit and then a declining impact for two additional years as cleanup and repairs continue.

A large initial negative impact to tourism in the immediate aftermath of the storm that declined over the two-year recovery was also assumed.

It was assumed the hurricanes hitting these areas after the investments in resilience and preparedness caused half the damage as they did before those investments, so $65 billion for the Miami hurricane, $27 billion for the Tampa hurricane, $12.5 billion for the New Orleans hurricane, and $3.5 billion for the Gulfport-Biloxi hurricane. The amount of investment necessary to achieve these reductions was $10.8 billion, $4.5 billion, $2.1 billion, and $583 million, respectively.

Large Storms

This report includes analyses of four large storms that were not hurricanes. The largest example was a Hurricane Sandy-like storm. The remaining three were $1 billion winter storms in metro areas often hit by such events.

The following was assumed:

- The Sandy-type storm inflicted $89 billion in damage in the New York, MSA (population 20 million).
- Three $1 billion winter storms in these MSAs: Boston-Cambridge-Newton, Massachusetts/New Hampshire (population 4.9 million); Denver-Aurora-Lakewood, Colorado (population 2.9 million); and Milwaukee-Waukesha, Wisconsin (population 1.6 million).

It assumed a sizable negative employment impact in the year the hurricane hit. For the Sandy-like storm, it assumed a reduced negative impact on employment one year after the storm and a one-year negative impact on tourism.

The storms hitting these areas after the investments in resilience and preparedness were assumed to cause half the damage as they did before those investments, so $44.5 billion for the New York storm and $500 million for the Boston, Denver, and Milwaukee storms. The amount of investment necessary to achieve these reductions was $7.4 billion and $83 million, respectively.

Earthquakes

Four earthquakes were analyzed using data from the 1989 Loma Prieta and the 1994 Northridge quakes to create a simulation in four MSAs:

- An earthquake that caused $40 billion in damage in Los Angeles-Long Beach-Anaheim, California (population 13 million).
- An earthquake that caused $25 billion in damage in San Francisco-Oakland-Berkeley, California (population 4.5 million).
- An earthquake that caused $10 billion in damage in San Diego-Chula Vista-Carlsbad, California (population 3.2 million).
- An earthquake that caused $1 billion in damage in Redding, California (population 180,000).

It assumed a sizable negative employment impact in the year of the earthquake and half that impact in the second year. It was assumed the earthquakes hitting these areas after the investments in resilience and preparedness caused half the damage as they did before those investments, so $20 billion for the Los Angeles quake, $12.5 billion for the San Francisco quake, $5 billion for the San Diego quake, and $500 million for the Gulfport-Biloxi hurricane. The amount of investment necessary to achieve these reductions was $3.3 billion, $2.1 billion, $833 million, and $83 million, respectively.

Tornadoes

Four tornadoes, all of which it is assumed caused $1 billion in damage, were analyzed. They were in the following locations:

- Atlanta-Sandy Springs-Alpharetta, Georgia, MSA (population 6.2 million).
- Indianapolis-Carmel-Anderson, Indiana, MSA (population 2.1 million).
- Nashville-Davidson—Murfreesboro—Franklin, Tennessee (population 2 million).
- Oklahoma City, Oklahoma, MSA (population 1.5 million).

It assumed a negative employment impact in the year of the tornado.

It was assumed the tornadoes hitting these areas after the investments in resilience and preparedness caused half the damage as they did before those investments, so $500 million in all of them. The amount of investment necessary to achieve these reductions was $83 million.

Tornadoes are incredibly destructive. There is no amount of investment in preparedness that will save a home, business, or infrastructure from a direct strike. The loss is almost always total in these cases.

Yet tornadoes are spawned from powerful storms that impact broader geographic areas than just the concentrated spots where the tornado causes catastrophic loss. There is damage from high winds, intense rain, hail, and swirling debris. Communities can prepare for these impacts. The analysis presented in this study focuses on this damage.

Floods, Wildfires, and Droughts/Heat waves

The study conducted analyses of floods, wildfires, and droughts/heat waves (droughts/heat waves were modeled together). It simulated three events for each category of disaster.

The three types of events were modeled together because their inputs are the same. They are all $1 billion disasters that are assumed to have the same impact on employment in the year the disaster occurs, including a separate negative impact on farm employment and farm output in the year of the events.

Floods were assumed in the following:

- Houston-The Woodlands-Sugar Land, Texas, MSA (population 7.3 million).
- Pittsburgh, Pennsylvania, MSA (population 2.4 million).
- Wilmington, North Carolina, MSA (population 300,000).

Wildfires were assumed in the following:

- Los Angeles-Long Beach-Anaheim, California, MSA (population 13 million).
- Phoenix-Mesa-Chandler, Arizona, MSA (population 5 million).
- Santa Fe, New Mexico, MSA (population 155,000).

Droughts/heat waves were assumed in the following:

- Dallas-Fort Worth-Arlington, Texas, MSA (population 8 million).
- Salt Lake City, Utah, MSA (population 1.3 million).
- Redding, California, MSA (population 180,000).

It was assumed that the events hitting these areas after the investments in resilience and preparedness caused half the damage as they did before those investments, so $500 million for all of them. The amount of investment necessary to achieve these reductions was $83 million.

Calculating the $7-to-$1 Ratio of Economic Savings to Investment in Resilience and Preparedness

To calculate the ratio for economic savings as a result of prior resilience and preparedness investment, we divided the production (GDP) saved in each disaster modeled by the amount invested in the area before the disaster struck.

For instance, the $26 billion of production saved in Miami after a Category 4 hurricane was divided by the $10.8 billion of investment to produce a ratio of $2.4 saved to every $1 invested.

We repeated this process for each of the 25 disasters modeled. The $7-to-$1 ratio is the median ratio of dollars of economic costs saved for $1 of investment in preparedness and resilience for the 25 disasters modeled.

The $7 of savings is for economic costs, on top of the reduction in damage assumed in the model. In the analysis, we assumed that $1 of investment reduced the damage and cleanup costs of each disaster by $6. Combining the two ratios finds that $13 can be saved for every $1 invested in resilience and preparedness when including reduced damage, cleanup costs, and less economic damage.

Appendix: Preparedness Saves in Other Disasters

A total of 25 disasters were modeled in this study. The main ones are described in the body of the report, and the remaining 20—simulated using the same model—are seen in the following tables. They show similarly large benefits from prudent resilience and preparedness investments in the face of disasters.

The scenarios are grouped by the type of disaster occurring.

Hurricanes

Table 1: Category 2 Hurricane Hitting the Tampa Area

Damage Inflicted: $54 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $4.5 Billion Invested in Resilience and Preparedness
Jobs	-141,373	-69,321	72,052	47,802
Population	-86,337	-19,746	66,591	14,197
Labor Force	-70,141	-18,970	51,171	13,037
GDP	-$17,454,987,552	-$7,699,000,000	$9,755,987,552	$4,879,000,000
Income	-$9,937,322,796	-$4,305,000,000	$5,632,322,796	$2,883,000,000

Table 2: Category 2 Hurricane Hitting the New Orleans Area

Damage Inflicted: $25 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $2.1 Billion Invested in Resilience and Preparedness
Jobs	-71,369	-27,386	43,983	18,589
Population	-34,488	-7,022	27,466	4,874
Labor Force	-28,108	-6,586	21,522	4,469
GDP	-$8,716,930,798	-$3,035,000,000	$5,681,930,798	$1,856,000,000
Income	-$4,989,194,111	-$1,710,000,000	$3,279,194,111	$1,125,000,000

Table 3: Category 2 Hurricane Hitting the Gulfport/Biloxi, MS Area

Damage Inflicted: $7 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $583 Million Invested in Resilience and Preparedness
Jobs	-6,284	-2,785	3,499	3,512
Population	-3,658	0	3,658	965
Labor Force	-2,931	-205	2,726	898
GDP	-$699,103,434	-$273,000,000	$426,103,434	$288,000,000
Income	-$324,478,066	-$113,000,000	$211,478,066	$157,000,000

Large Storms

Table 4: Super Storm Hitting the New York Area

Damage Inflicted: $89 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $7.4 Billion Invested in Resilience and Preparedness
Jobs	-455,866	-201,579	254,287	52,823
Population	-246,396	-90,981	155,415	12,577
Labor Force	-188,950	-70,992	117,958	11,822
GDP	-$90,541,679,319	-$37,749,000,000	$52,792,679,319	$7,619,000,000
Income	-$49,776,778,870	-$21,071,000,000	$28,705,778,870	$4,749,000,000

Table 5: Large Winter Storm Hitting the Boston Area

Damage Inflicted: $1 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $83 Million Invested in Resilience and Preparedness
Jobs	-88,947	-44,477	44,470	745
Population	-27,594	-13,573	14,021	225
Labor Force	-17,288	-8,495	8,793	141
GDP	-$14,481,396,190	-$7,232,000,000	$7,249,396,190	$104,000,000
Income	-$8,460,133,209	-$4,226,000,000	$4,234,133,209	$70,000,000

Table 6: Large Winter Storm Hitting the Denver Area

Damage Inflicted: $1 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $83 Million Invested in Resilience and Preparedness
Jobs	-59,930	-29,937	29,993	894
Population	-20,399	-9,912	10,487	302
Labor Force	-12,608	-6,126	6,482	187
GDP	-$7,931,957,609	-$3,951,000,000	$3,980,957,609	$110,000,000
Income	-$5,073,371,972	-$2,528,000,000	$2,545,371,972	$75,000,000

Table 7: Large Winter Storm Hitting the Milwaukee Area

Damage Inflicted: $1 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $83 Million Invested in Resilience and Preparedness
Jobs	-23,660	-11,832	11,828	802
Population	-8,195	-3,880	4,315	280
Labor Force	-5,080	-2,410	2,670	175
GDP	-$2,852,547,304	-$1,416,000,000	$1,436,547,304	$90,000,000
Income	-$1,729,135,638	-$859,000,000	$870,135,638	$61,000,000

Earthquakes

Table 8: Earthquake Hitting the Los Angeles Area

Damage Inflicted: $40 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $3.3 Billion Invested in Resilience and Preparedness
Jobs	-339,177	-175,705	163,472	31,418
Population	-137,638	-61,454	76,184	8,487
Labor Force	-103,887	-47,564	56,323	7,008
GDP	-$54,393,928,968	-$27,118,000,000	$27,275,928,968	$3,995,000,000
Income	-$30,051,391,079	-$15,191,000,000	$14,860,391,079	$2,553,000,000

Table 9: Earthquake Hitting the San Francisco Area

Damage Inflicted: $25 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $2.1 Billion Invested in Resilience and Preparedness
Jobs	-130,503	-67,157	63,346	11,415
Population	-52,338	-23,275	29,063	3,012
Labor Force	-30,280	-13,440	16,840	1,758
GDP	-$35,188,820,679	-$17,540,000,000	$17,648,820,679	$2,221,000,000
Income	-$16,635,178,963	-$8,401,000,000	$8,234,178,963	$1,279,000,000

Table 10: Earthquake Hitting the Redding, CA Area

Damage Inflicted: $1 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $83 Million Invested in Resilience and Preparedness
Jobs	-3,001	-1,548	1,453	530
Population	-1,182	-428	754	143
Labor Force	-1,014	-401	613	134
GDP	-$422,646,978	-$210,000,000	$212,646,978	$63,000,000
Income	-$192,502,868	-$95,000,000	$97,502,868	$33,000,000

Tornadoes

Table 11: Tornado Hitting the Atlanta Area

Damage Inflicted: $1 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $83 Million Invested in Resilience and Preparedness
Jobs	-26,813	-13,409	13,404	828
Population	-8,231	-3,941	4,290	247
Labor Force	-6,178	-2,972	3,206	185
GDP	-$3,359,784,783	-$1,669,000,000	$1,690,784,783	$95,000,000
Income	-$1,957,336,522	-$974,000,000	$983,336,522	$59,000,000

Table 12: Tornado Hitting the Indianapolis Area

Damage Inflicted: $1 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $83 Million Invested in Resilience and Preparedness
Jobs	-8,734	-4,355	4,379	775
Population	-2,923	-1,268	1,655	263
Labor Force	-2,048	-902	1,146	180
GDP	-$1,123,526,920	-$551,000,000	$572,526,920	$92,000,000
Income	-$716,738,828	-$353,000,000	$363,738,828	$63,000,000

Table 13: Tornado Hitting the Oklahoma City Area

Damage Inflicted: $1 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $83 Million Invested in Resilience and Preparedness
Jobs	-5,154	-2,573	2,581	713
Population	-1,540	-622	918	211
Labor Force	-1,447	-613	834	199
GDP	-$516,591,610	-$251,000,000	$265,591,610	$65,000,000
Income	-$325,824,970	-$159,000,000	$166,824,970	$43,000,000

Floods

Table 14: Flood Hitting the Houston Area

Damage Inflicted: $1 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $83 Billion Invested in Resilience and Preparedness
Jobs	-32,549	-16,267	16,282	1,027
Population	-9,762	-4,649	5,113	310
Labor Force	-8,058	-3,876	4,182	258
GDP	-$3,858,168,792	-$1,916,000,000	$1,942,168,792	$108,000,000
Income	-$2,576,242,248	-$1,281,000,000	$1,295,242,248	$79,000,000

Table 15: Flood Hitting the Pittsburgh Area

Damage Inflicted: $1 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $83 Million Invested in Resilience and Preparedness
Jobs	-8,617	-4,332	4,285	796
Population	-2,574	-1,128	1,446	244
Labor Force	-2,469	-1,118	1,351	235
GDP	-$825,028,016	-$535,000,000	$290,028,016	$91,000,000
Income	-$636,611,491	-$316,000,000	$320,611,491	$59,000,000

Table 16: Flood Hitting the Wilmington, NC Area

Damage Inflicted: $1 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $83 Million Invested in Resilience and Preparedness
Jobs	-1,768	-887	881	753
Population	-557	-110	447	238
Labor Force	-470	-116	354	185
GDP	-$186,866,465	-$85,000,000	$101,866,465	$73,000,000
Income	-$89,422,949	-$41,000,000	$48,422,949	$39,000,000

Wildfires

Table 17: Wildfire Hitting the Los Angeles Area

Damage Inflicted: $1 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $83 Million Invested in Resilience and Preparedness
Jobs	-54,433	-27,333	27,100	786
Population	-14,964	-7,368	7,596	212
Labor Force	-12,267	-6,068	6,199	175
GDP	-$7,404,986,960	-$3,694,000,000	$3,710,986,960	$100,000,000
Income	-$4,479,085,184	-$2,244,000,000	$2,235,085,184	$64,000,000

Table 18: Wildfire Hitting the Phoenix Area

Damage Inflicted: $1 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $83 Million Invested in Resilience and Preparedness
Jobs	-22,058	-11,055	11,003	1,052
Population	-8,009	-3,745	4,264	393
Labor Force	-6,175	-2,902	3,273	266
GDP	-$2,653,344,273	-$1,312,000,000	$1,341,344,273	$124,000,000
Income	-$1,594,790,980	-$793,000,000	$801,790,980	$79,000,000

Droughts/Heatwaves

Table 19: Drought/Heatwave Hitting the Dallas Area

Damage Inflicted: $1 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $83 Million Invested in Resilience and Preparedness
Jobs	-39,768	-19,865	19,903	1,103
Population	-13,016	-6,235	6,781	357
Labor Force	-8,313	-3,992	4,321	225
GDP	-$4,783,715,764	-$2,375,000,000	$2,408,715,764	$125,000,000
Income	-$3,124,831,682	-$1,553,000,000	$1,571,831,682	$88,000,000

Table 20: Drought/Heatwave Hitting the Salt Lake City Area

Damage Inflicted: $1 Billion				
	Economic Losses Caused by the Disaster Before Resilience and Preparedness Investment	Economic Losses Caused by the Disaster After Resilience and Preparedness Investment	Economic Savings From Cutting Damage in Half	Gains from $83 Million Invested in Resilience and Preparedness
Jobs	-6,722	-3,373	3,349	816
Population	-2,007	-839	1,168	248
Labor Force	-1,281	-539	742	156
GDP	-$893,321,582	-$435,000,000	$458,321,582	$103,000,000
Income	-$401,450,713	-$198,000,000	$203,450,713	$51,000,000

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