JOHNS HOPKINS
21ST CENTURY CITIES INITIATIVE

AMERICAN FLOOD COALITION

REPORT

The Local Economic Impact of Flood-Resilient Infrastructure Projects

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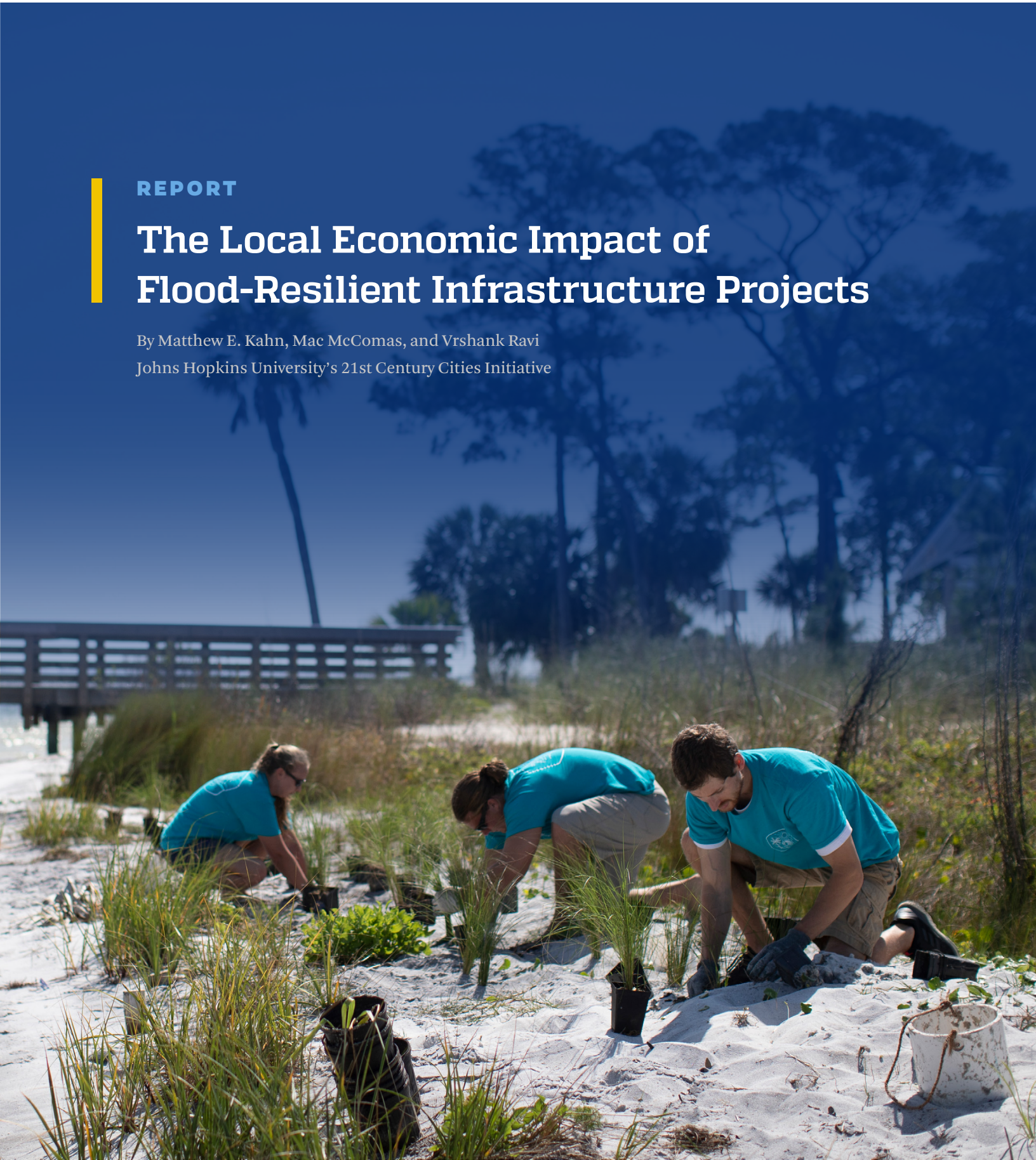
Johns Hopkins University's 21st Century Cities Initiative



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The **American Flood Coalition** is a nonpartisan group of cities, elected officials, military leaders, businesses, and civic groups that have come together to drive adaptation to the reality of higher seas, stronger storms, and more frequent flooding through national solutions that support flood-affected communities and protect our nation's residents, economy, and military installations. The coalition is a registered 501(c)(3) member-driven nonprofit organization created to provide a platform for communities to advocate with a unified voice for solutions. The Coalition has over 240 members across 19 states.

The **21st Century Cities Initiative (21CC) at Johns Hopkins University** is the campus hub for research, teaching, and outreach related to urban economic growth and urban quality of life. 21CC supports cities committed to opportunity, inclusion, and innovation. Our goal is to help cities transform neighborhoods and communities so that all urban residents can thrive in the 21st century. Through rigorous data analysis and policy evaluation, our center focuses on how to align the incentives of the private sector and federal, state, and local governments to unlock the full potential of cities including Baltimore, U.S., and international cities. We work closely with more than 200 Johns Hopkins faculty members across disciplines who are interested in issues related to cities.

This year has brought compounding disasters and devastation that previously would have been unimaginable. Between a record-breaking hurricane season, the COVID-19 pandemic, and an economic recession, countless communities across the country—especially those hit by major storms like Laura and Sally—are experiencing tragedy and hardship. Given the moment that we're in, we must ask: What can we do to protect our communities today while preparing these communities for the future? These challenges, when viewed holistically, outline the clear need for investments in resilience. We must meet these unprecedented times with an unprecedented investment in flood-resilient infrastructure, an investment that saves lives, creates jobs, and builds lasting, sustainable communities.

The American Flood Coalition brings together and amplifies the voices of more than 200 stakeholders across the country, from local, state, and federal officials to military leaders to business groups. In the face of extreme flooding and rising sea levels, it's never been more clear that we need on-the-ground solutions and proactive policy. With communities struggling with multiple disasters this year and grappling with the range of crises coming their way, now is the time to act. We must support communities across the country, and we can build resilience and boost the economy at the same time through federal investment in resilience.

We already know that investing in flood resilience makes good financial sense. Flood-resilient projects—elevating roadways, improving stormwater infrastructure, upgrading flood barriers—protect people and save money. Decades of research from the National Institute of Building Sciences shows that every $1 spent on disaster mitigation saves $4 to $7 on the back end.

Despite this, we've never known what matters most—exactly how this spending creates jobs, supports local businesses, or boosts our regional economy—until now. This study, from Johns Hopkins University's (JHU) 21st Century Cities Initiative, calculates the number of jobs created through investment in flood infrastructure and investigates how flood-resilient projects bring additional benefits. Through three in-depth case studies—focusing on coastal Louisiana; Cedar Rapids, Iowa; and Meriden, Connecticut—the research also explores the impact of resilient investment on local economies and the additional benefits that communities investing in resilience often experience. The research finds that:

- **Investing in flood-resilient infrastructure creates jobs:** JHU's research finds that a $1 million increase in funding for flood infrastructure projects in a metropolitan statistical area is associated with an increase in 40 jobs; 25 jobs in the construction industry and 15 jobs in retail trade. To achieve the necessary scale of infrastructure investment, however, we need not millions, but billions of dollars. Given these findings, we estimate that 10 billion dollars invested could be associated with up to 400,000 new jobs across the country.

- **Investing in resilience helps create new businesses:** An infusion of $1 million in funding for flood infrastructure is associated with an increase of 4 construction businesses in the year of the award.
- **Economic benefits of reducing flooding are local:** Flood infrastructure stimulates economies close to home, providing business for local contractors. An analysis of projects in Louisiana found that 80% of subcontracts went to businesses located in Coastal Louisiana parishes and 99% of subcontracts went to businesses in Louisiana.
- **Benefits extend far beyond flood reduction and include added recreational and green space:** Many communities have invested in green infrastructure, such as rain gardens or parks with stormwater retention basins, as a way to reduce flooding and create green space for residents to enjoy. This study confirmed previous research that found that these amenities can increase property values, in addition to reducing flood risk.

Over the past 15 years, the federal government has spent $450 billion in federal disaster assistance. This year, for the second time in recorded history, storms were named using the greek alphabet after the initial list of alphabetical names was exhausted. Despite this, flood-resilient infrastructure is still underfunded. We need to break this cycle of devastating storms and post-disaster spending. This research by JHU points us in a new direction, one that can create jobs in a time when they are desperately needed, save money over time, and most importantly, protect lives and livelihoods.

Melissa Roberts
Executive Director
American Flood Coalition

INTRODUCTION

Water, and proximity to water, has driven economies for centuries. Water provides us with substantial benefits and economic well-being, including trade through ports; jobs in tourism, entertainment, fishing, and resource extraction; and recreation for local residents. Living and working close to water, however, also brings with it risks, such as loss of life and property through flooding from hurricanes, sea level rise, storm surge, and heavy rainfall.

Flooding is the most common, deadliest, and costliest natural disaster in the United States. Severe flooding has tragic consequences: It endangers public health, disrupts livelihoods, and exacerbates existing inequalities. In addition to the devastating effects on individuals and communities, flooding also strains resources and damages economies. From 1980 to 2019, the U.S. experienced 32 flooding events where estimated damages exceeded $1 billion, with total losses at $146.5 billion.[1] People and places can protect themselves against this risk by investing in flood-resilient infrastructure, such as living shorelines, stormwater bioretention systems, wetlands restoration, elevating properties, seawalls, levees, and flood barriers.

From 1980 to 2019, the U.S. experienced **32 flooding events** where estimated damages exceeded $1 billion, with total losses at **$146.5 billion**.[1]

Despite increasing investment in flood-resilient infrastructure by localities, many flood infrastructure projects remain unfunded or underfunded. Compared to other types of infrastructure spending, the federal government spends little on water infrastructure.[2] Amid the ongoing economic depression onset by the COVID-19 pandemic, new federal investments in flood-resilient infrastructure can serve more than one purpose. In the short term, these investments can create new jobs in areas where investment takes place. In the medium term, these areas can reduce risk from future natural disasters and extreme weather events.

Amid the ongoing economic depression onset by the COVID-19 pandemic, new federal investments in flood-resilient infrastructure can serve **more than one purpose.**

[1] Note: This does not account for losses from tropical cyclones or severe storms. Smith and Adam 2020

[2] Congressional Budget Office 2013 and 2015.

INTRODUCTION

Much of the existing research on investing in flood-resilient infrastructure focuses on the costs and benefits of such investments. Their role as local economic stimulus projects is often overlooked. As capital-intensive construction projects, flood infrastructure projects can be associated with large employment gains at the local level. The local economic impact of investments in flood infrastructure projects can bring short-, medium-, and long-term gains in increased employment, increased property values, flood insurance savings, decreased lost days of work, and protections against future loss of life and property. The projects can also bring medium- and long-term improvements in neighborhood quality of life, leading to access to green amenities, improved health outcomes, and increased resilience to future floods. This report's core findings focus on the impact of flood-resilient infrastructure projects on short-term local economic development, but the report also discusses medium- and long-term gains.

As capital-intensive construction projects, flood infrastructure projects can be associated with **large employment gains** at the local level.

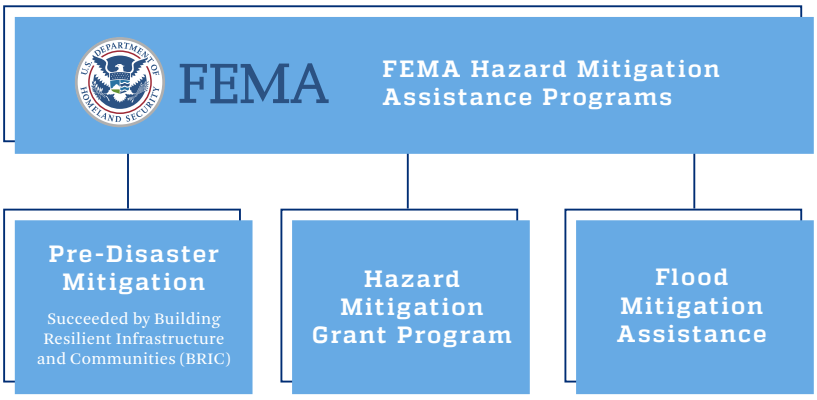
Using data from 2003 to 2018 on flood infrastructure investments from the Federal Emergency Management Agency (FEMA) and several local case studies, we explore how past investments in flood-resilient infrastructure projects were associated with local economic development and improvements in neighborhood quality of life. Recognizing the importance and impact of these investments, more local governments across the U.S. have started investing in flood-resilient infrastructure. To illustrate these investments, we examine the strategies and outcomes of three communities: Meriden, Connecticut; Cedar Rapids, Iowa; and Coastal Louisiana.

Finally, using historical estimates of flood infrastructure projects and job creation, we explore what areas might benefit most from increasing federal spending on such projects.

What is a "flood-resilient" infrastructure project?

Flood-resilient infrastructure projects are any type of infrastructure that reduces the risk of flooding, keeping people and property safe. In some cases, such as building a seawall, reducing flood risk is the primary purpose of a project. In other cases, such as building a public park, flooding may not be the primary purpose of the piece of infrastructure, though flood reduction benefits can still be incorporated into the project. Examples of flood infrastructure projects include wetlands restoration, marsh (re)nourishment, coral reef restoration, stormwater bioretention, riparian buffers, living shorelines, rain gardens, trees, public parks and green space, floodwalls, culverts, levees, berms, combined sewer overflow (CSO) tunnels, dams, flood gates, water pump stations, structure elevation, and at-risk building acquisition and demolition.

Estimating the local economic impact of a federal flood-resilient infrastructure program



Since 2000, the Federal Emergency Management Agency (FEMA) has invested billions of dollars in flood-resilient infrastructure projects through its Hazard Mitigation Assistance (HMA) programs. The three HMA programs—Pre-Disaster Mitigation (PDM),[3] Hazard Mitigation Grant Program (HMGP), and Flood Mitigation Assistance (FMA)—provide funding to states that allocate subawards to local business entities and governments for flood risk reduction projects. According to FEMA, the funding should go to areas with the greatest flood risk and economic need, as well as those areas with the highest rates of National Flood Insurance Program (NFIP) participation. Such capital-intensive projects may significantly affect local economies, providing an economic benefit beyond flood risk reduction.

Award amounts

As shown in Figure I, funding for flood infrastructure projects increased significantly from the mid-2000s to the mid-2010s. The largest project funded by HMA was over $388 million in 2015 for the Suffolk County (New York) Coastal Resiliency Initiative. That project eliminated almost 7,000 cesspools and septic systems in low-lying areas inundated by Superstorm Sandy and reduced nitrogen pollution to nearby wetlands.[4] The second-largest project was over $212 million in 2012 for a power plant in New Orleans. That project retrofitted the power plant to be more flood resilient after Hurricane Katrina damaged the plant in 2005.

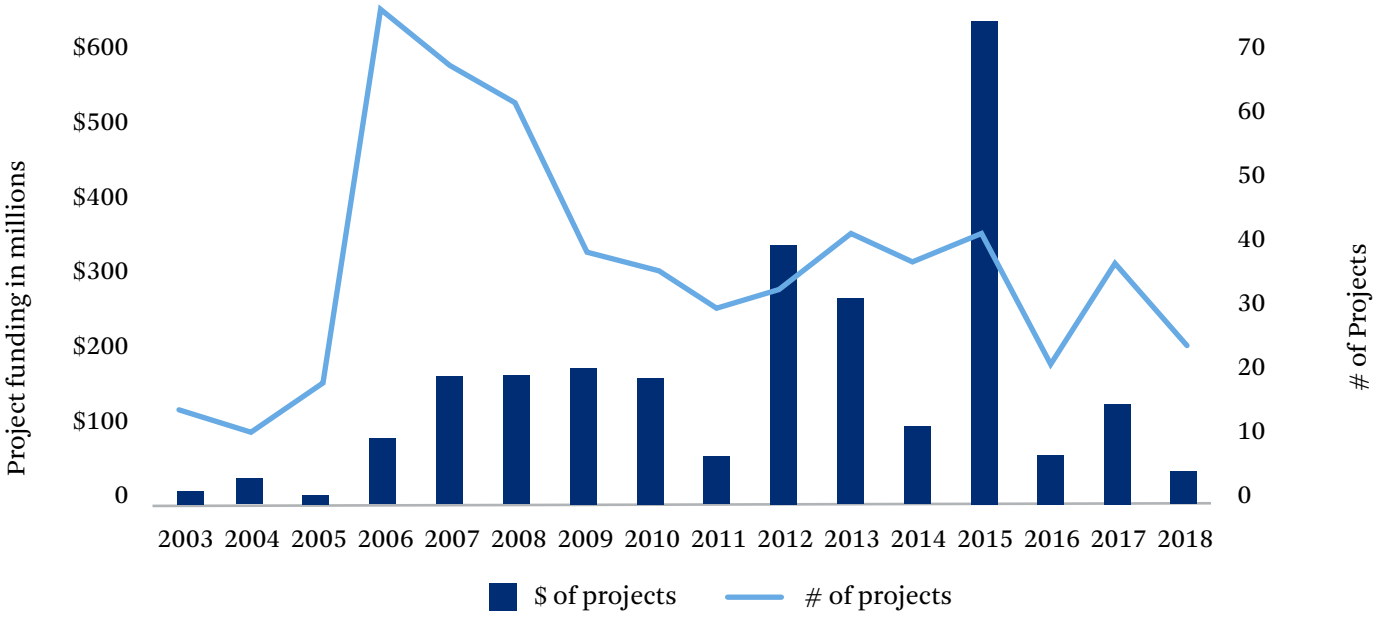
[3] FEMA replaced the Pre-Disaster Mitigation program with the Building Resilient Infrastructure and Communities program in 2020, announcing $500 million in available funding for the new program.

[4] Suffolk County, New York.

In total, we identified 593 FEMA awards for flood infrastructure projects between 2003 and 2018, for a total of $2.4 billion (in 2019 dollars).[5] We excluded projects for other types of natural disasters and projects limited to planning and design. See Appendix I for our full methodology and Appendix II for a full list of included project types.

Figure I

FEMA HMA flood infrastructure project funding by dollar amount (in 2019 dollars) and number, 2003-2018



Note: Total project funding includes the 25 percent minimum local cost share.

Award distribution

The Suffolk County and New Orleans projects also highlight the regional focus of FEMA awards. Over half the number and dollar amount of awards went to projects in southern states, while over 20% of the number of awards and 30% of the dollar amount went to northeastern states. Midwestern and western states received a similar number and amount of FEMA awards. This could raise concerns that the unique characteristics of places that received more FEMA awards may be responsible for the results and that a more geographically balanced and randomized allocation of funding would result in lower associated job gains. As more projects are completed and if better data on these projects are available, these concerns could be lessened.

Figure II

FEMA Awards by Region

Region	Number of Projects	Total Dollar Amount (in millions, 2019 dollars)
Northeast	63	$753
Midwest	37	$94
South	150	$1,213
West	41	$94

[3] Note: For our analysis, we aggregate these data from the county level to the MSA level.

The average award amount was around $3.5 million, and the median award amount was just over $750,000. Around 43% of all awards were over $1 million. Projects at this award amount include Fargo, North Dakota's $1 million HMGP award in 2006 for constructing a stormwater detention/retention basin and the Native Village of Fort Yukon, Alaska's $1 million HMGP award in 2018 for the elevation of nine structures on stilts. Projects under $100,000, such as Claremont and Lebanon, New Hampshire's $25,000 HMGP award in 2007 for the Thrasher Road culvert improvement project, account for 14% of all awards.

Pictured above is the schoolhouse in Fort Yukon, Alaska. In 2018, $1 million in HMGP was used to raise 9 structures onto stilts. Source: Alaska Public Media

Woodhaven in Fargo, North Dakota, has a large stormwater retention pond that collects stormwater runoff and drains it into an underground aquifer slowly, filtering the water in the process. Source: Alaska Public Media

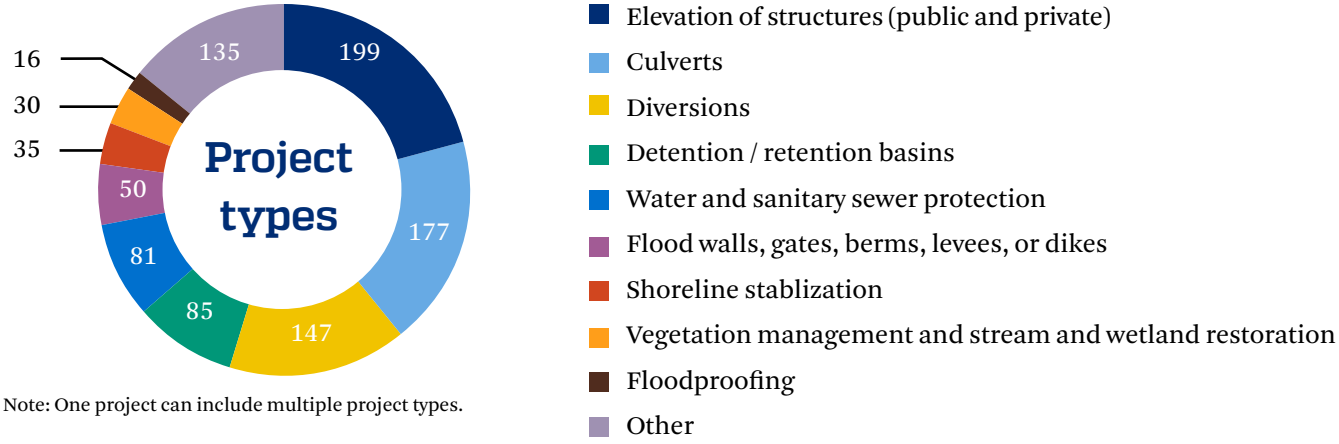
The Warren Brook & Cold River Habitat restoration in 2010. In 2007, another culvert at Thrasher Road received an HMGP award. Source: U.S. Fish and Wildlife Service

Project types

As shown in Figure III, 21% of projects included the elevation of public and private structures. The construction of culverts and diversions account for 34% of all project types. Nine percent of projects included the construction of detention or retention basins, like in Fargo, North Dakota, while 5% included the construction or improvement of flood walls, gates, berms, levees, or dikes.

Figure III

Flood-resilient infrastructure projects

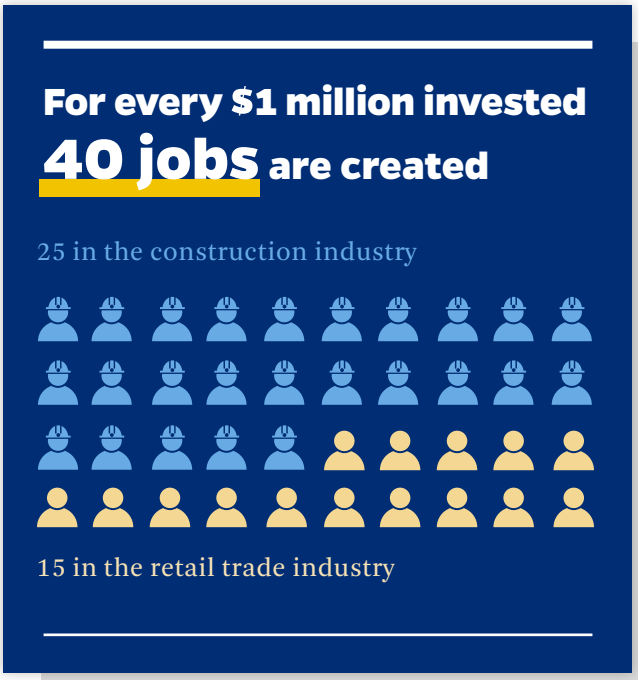


Note: One project can include multiple project types.

Job creation

To understand the impact of FEMA funding on local economies, we looked at the ratio of employment to population. If the ratio rises, more people are employed in a metropolitan area. For this analysis, we observe how employment levels change when communities receive funding for flood infrastructure projects.[6]

Overall, we find that increasing funding for flood infrastructure projects in a metropolitan statistical area by $1 million is associated with an increase of 40 jobs in the construction and retail trade industries, with 25 in the construction industry and 15 in retail trade. Given our results, we can estimate that $1 billion invested could be associated with up to 40,000 new jobs across the U.S.



[6] For a full explanation of our data and methodology, see Appendix I. For full regression results, see Appendix III.

The relatively large number of new jobs associated with an increase in $1 million in infrastructure project spending suggests the possibility of a local multiplier effect, where the **creation of new jobs in one sector** leads to the creation of new jobs in **another sector** in that same city.

For jobs in the construction industry, we did not find similar job increases in the second and third years following the award, suggesting that these were short-term job gains. We find significant regional heterogeneity, with stronger associated job gains in the construction industry in the southern and western states. This follows a national trend of recent increased population growth and construction activity in those regions. These regional differences could also be explained by state laws: Southern and western states tend to be right-to-work states with lower wages.

In Appendix IV, we report future estimates for job growth at the Congressional District level. We estimated how associated job growth changed across a variety of demographic variables and found statistically significant associations with education and unemployment. Congressional Districts with higher shares of unemployment and adults over 25 with a bachelor's degree or higher were associated with higher amounts of job growth. We estimate that a place such as Georgia's 14th Congressional District, which had both relatively low unemployment (3.8%) and a low share of adults over 25 with a bachelor's degree or higher (13.3%) in 2018, may see the creation of up to 12 jobs associated with a $1 million increase in flood infrastructure spending compared to a place such as Illinois' 5th Congressional District, which had relatively high unemployment (6%) and a high share of adults over 25 with a bachelor's degree or higher (24%) in 2018, may see the creation of up to 91 jobs.

Increasing investment in flood infrastructure projects by $1 million (in 2019 dollars) is associated with an increase in 20 jobs in the retail trade industry in the year of the award. When we account for pre-growth trends, associated growth falls to 15 jobs and borders on being statistically significant. Unlike the construction industry, the job gains are robust in the second and third years following the award, suggesting these jobs might be more permanent. We also find more job gains in the retail industry in the northeastern states and less jobs gains in midwestern and southern states.

The relatively large number of new jobs associated with an increase in $1 million in infrastructure project spending suggests the possibility of a local multiplier effect, where the creation of new jobs in one sector lead to the creation of new jobs in another sector in that same city. Enrico Moretti found that every manufacturing job created in a given city also creates 1.6 jobs in the non-tradable sector; additionally, a skilled job in the tradable sector creates 2.5 jobs in local goods and services.[7] A similar effect could be happening for flood infrastructure investments.

[7] Moretti 2010.

Public investment in flood-resilient green infrastructure may also signal to the private sector that it is now safe to invest in previously risky areas. That means housing prices could also be affected by increased investment in flood-resilient infrastructure. While findings vary, past studies have largely found that proximity to such infrastructure was associated with higher property values. One study, for example, found increases of 0.75%–2.52% associated with tree canopy cover and an increase of 19%–35% associated with suburban forest preserves.[8] Another study found that the construction of 1,666 flood defenses in England was associated with a rise in urban house prices between 12.6%–16.7%, with a small decrease in rural house prices. This could suggest that the perceived risk of redirected flooding in certain locations outweighs the general benefit.[9]

Business establishment creation

We also find similar growth in construction business establishments. Increasing FEMA funding by $1 million in a Metropolitan Statistical Area (MSA) is associated with an increase of four construction business establishments in the year of the award. When we include a three-year employment growth trend, the number of construction businesses falls to 2.6. Associated increases in construction business establishments are robust in the second and third year after the award. We again find evidence of regional heterogeneity, with stronger gains in construction businesses in southern and western states and weaker gains in all other regions of the country.

An increase in $1 million (in 2019 dollars) in FEMA flood infrastructure funding in a metropolitan statistical area is associated with an increase of **four construction business establishments** in the year of the award.

The Louisiana National Guard constructs a diversion system to protect wetlands. Source: Tarell J Bilbo, U.S. Army

APC Construction is an example of an establishment whose start corresponded with increased FEMA funding. Founded after Hurricanes Katrina and Rita in New Orleans, APC Construction has since worked on two flood-resilient projects for the Louisiana Coastal Protection and Restoration Authority alongside several other flood infrastructure projects. In 2015, the company of several hundred employees received the 2015 U.S. HUBZone Contractor of the Year award by the Department of Agriculture.

[8] Venkataramanan, Packman, Peters, Lopez, McCuskey, McDonald, Miller, Young 2019.

[9] Beltran, Maddison, Elliott 2018.

Limitations and unknowns

The associated increase of 40 jobs for every $1 million awarded is significantly larger than those found in similar studies—one study on the 2009 American Recovery and Investment Act found that spending $1 million on "green" projects was associated with an increase of 15 jobs.[10] While a large local multiplier might explain some of the difference, other forces are likely at play.

If FEMA funding went to places already experiencing economic growth, this could be a case of picking winners. For example, economically booming New York City received over $580 million in FEMA funding for flood infrastructure after Superstorm Sandy in 2013, more than double the amount any other region received and over 27% of total FEMA funding for flood infrastructure projects from 2003 to 2018. If FEMA funding mostly went to places already experiencing economic growth, other inputs may show similarly strong associations with job growth.

A bulldozer levels sand in Rockaway Beach in Queens, New York, after Superstorm Sandy. Source: John D'Ambrosio, U.S.ACE NY

Petaluma Payran Reach Flood Control and Floodways received a FEMA grant of $2.9 million. Source: FEMA

In analyzing the characteristics of metropolitan areas with flood risk, we found that metropolitan areas that received at least one FEMA flood infrastructure award were on average significantly more populous, wealthier, whiter, and more highly educated than metropolitan areas that received no FEMA awards (See Figure IV). They also had a higher share of properties with flood risk. There were not significant differences in the poverty or unemployment rates between areas that did and did not receive FEMA funding. Given these demographic differences, we do not know if future investment in areas that had not previously received a FEMA award would experience similar average job growth to those that did receive an award.

[10] Popp, Vona, Marin, Chen 2020.

Another issue is the allocation of FEMA funding. FEMA awards flood infrastructure funding to states, which then distribute funding where they think it would be most impactful. In this method of allocation, funding may only reach places with the local capacity to plan and oversee infrastructure projects, and those communities without the experience and staff capacity to implement flood infrastructure projects may miss out. This allocation of funding can be further influenced by politicians aggressively lobbying Congress for state funding, as we will see in the case of Cedar Rapids.

We also lack a good counterfactual. That is to say, we don't know how job growth looks if certain areas that received funding hadn't received funding. We can address some of these concerns with our three-year employment growth trend variable, which allows us to control for what employment growth might have been if no funding was received. Given the small number of flood-resilient infrastructure projects funded by FEMA, many additional projects that would benefit local economic development likely exist.

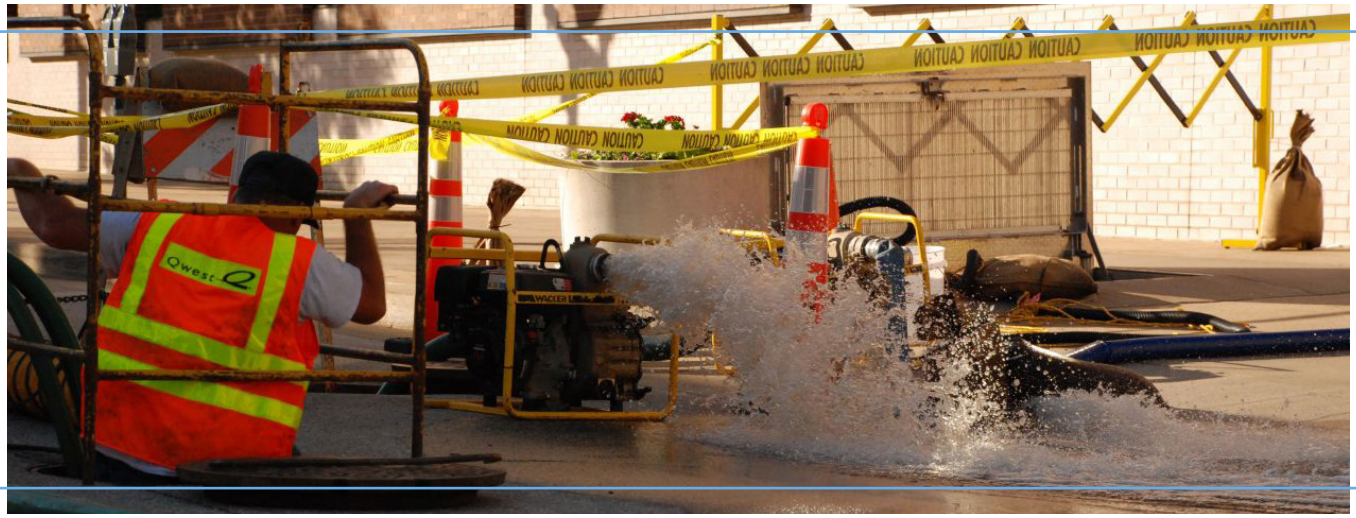
Figure IV

Metropolitan statistical areas (MSA) with flood risk that did and did not receive FEMA flood infrastructure funding, 2018 demographic data

Region	MSAs with Projects	MSAs without Projects
Number of MSAs	116	260
Population	162,646,671	112,272,259
Percent with a bachelor's degree or higher	36%	30%
Percent unemployed	6%	6%
Percent below poverty line	13%	14%
Percent white	76%	72%
Mean individual earnings	$71,562	$60,664
Percent of properties with flood risk	11%	8%

Note: Flood risk data is from the First Street Foundation county level risk data. Flood risk data was not available for Alaska, Hawaii, Puerto Rico, and the Harrisonburg and Staunton metro areas in Virginia. As such, those areas are not included in the above table. Their inclusion would not significantly change the reported demographics.

Below: Workers unleash storm pumps on the flooded streets of Cedar Rapids during the flood of 2008. Source: CRartist Flickr



Additional benefits of flood infrastructure

In this report, we explore several other potential benefits of flood infrastructure projects, including more recreational and green space, increased resilience to floods for local economies, new industries and techniques, and reduced cost of building flood-resilient infrastructure in the future.

A Wildlands Restoration worker smooths land at the Sombrero Marsh Revegetation near Boulder, Colorado. Source: Wildlands Restoration Volunteers

Recreational and green space

Flood-resilient infrastructure projects have traditionally been gray infrastructure projects, such as floodwalls, levees, combined sewage overflow tunnels, culverts, floodgates, and pump stations. However, in recent decades, more communities have invested in green infrastructure, such as rain gardens, bioretention and detention parks, marsh nourishment, wetland restoration, and tree wells.

Green infrastructure improves quality of life by providing recreational opportunities, reducing urban heat island effect, improving air quality, and reducing energy usage, which can lead to increased property values. A meta-analysis of 57 peer-reviewed studies found that green infrastructure generally reduces water pollution and its associated public health risks.[11] Trees that help reduce stormwater runoff can also reduce urban heat island effect, which can lead to less heat-related deaths and health problems.[12]

Several studies have associated green infrastructure with increases in property values.[13] A study of floodplain conservation efforts in St. Louis County, Missouri, found that increases in nearby home prices were three times larger than avoided flood damages.[14] However, a recent study on stormwater basins in Baltimore County, Maryland found that nearby home prices decreased 13% to 14%, a negative effect that increases as the stormwater basin ages and drainage concerns arise.[15]

Increasing property values in places that invest in flood-resilient infrastructure raises concerns about gentrification. The Atlanta Beltline project converted 22 miles of a disused rail corridor into a pedestrian and bicycle path with parks and other environmental and green amenities. During the major construction and buildout period of the project from 2011 to 2015, home prices within a half-mile of the Beltline rose between 17.9 and 26.6 percent more than home prices elsewhere in the city. This had significant implications for low-income renters, who had to pay higher housing costs or be displaced, and for low-income homeowners who stayed in the neighborhood and had to pay significantly higher property taxes.[16] Communities can take steps to alleviate such concerns by incorporating affordable housing components into flood-resilient infrastructure projects or by allowing more housing development in areas with decreased flood risk.

Recreation and other co-benefits can be incorporated into flood-resilient infrastructure projects. A study of two residential subdivisions in College Station, Texas, explored this by estimating differences in housing prices between “single-use” flood control detention basins that solely served as flood infrastructure and “multi-use” detention basins that doubled as recreational parks. The single-use basins were associated with significantly lower property values for houses with a view of the basin and had no effect on nearby houses without a view of the basin, while multi-use basins with parks were associated with higher housing prices.[17]

The case of Meriden, Connecticut, shows how green flood infrastructure in a multi-use floodwater retention basin that doubles as a recreational park can maximize co-benefits in places facing increasing flood risk.

[11] Jaffe, Zellner, Minor, Gonzalez-Meler, Cotner, Bucci, Miller 2010.
[12] O’Neill, Carter, Kish, Gronlund, White-Newsome, Manarolla, Zanobetti, Schwartz 2009.
[13] Venkataramanan, Packman, Peters, Lopez, McCuskey, McDonald, Miller, Young 2019.
[14] Kousky and Walls 2014.
[15] Irwin, Klaiber, Irwin 2017.
[16] Immergluck and Balan 2017.
[17] Lee and Li 2009.

Going Green in Meriden, Connecticut

The small city of Meriden, Connecticut, has experienced eleven 100-year floods since the 1860s. The city saw two of those 100-year floods in the 1990s, after the Harbor Brook, which runs through the city center, overflowed twice in five years, causing an estimated $25–30 million in damages. To mitigate future flood risk, the city laid the groundwork for the Meriden Green, a 14-acre public park that doubles as a flood water bioretention green space. The project highlights how a city can build flood-resilient green infrastructure that also revitalizes the economy, remedies environmental hazards, and creates public recreation space.

Figure V

Demographic and business statistics for Meriden, Connecticut

Population (2020)	62,875
Median household income (2013-2017)	$57,350
Median housing price (2013-2017)	$173,100
Poverty rate (2013-2017)	10.8%
Bachelor's degree or higher (2013-2017)	22%
Number of businesses (2018)	1,366
Number employed by Meriden businesses (2018)	23,246
Major industries by employment (2018)	Healthcare, retail, administrative

Source: 2016-2019 Connecticut Economic Resource Center Data, Advance CT

The site of the Meriden Green was home to a manufacturing facility in the mid-1800s, before being used as a site for glass cutting, silver manufacturing, door manufacturing, and most recently a mall. By 2007, the land lay vacant and contaminated with semi-volatile and volatile organic compounds and heavy metals.[18]

In 2007, the city received $2.9 million in state and federal funds with local matching dollars to assess environmental damages at the future site of Meriden Green. By 2013, the city secured over $15 million in state bond funds and $3.5 million in state Urban Act funds to redevelop the park. The city contracted the local engineering firm Milone and MacBroom, headquartered in neighboring Cheshire, Connecticut, for planning and design and the local LaRosa Construction company for all demolition, environmental hazardous waste removal, and construction.

The city opened the park in 2016, complete with trails, walkways, an amphitheater, and a bridge. In addition to mitigating flood risk through stormwater retention and flood evacuation routes, the park also serves as a site for public events and recreation. While the city has not experienced another 100-year flood since the park opened, the Meriden Green helped prevent flooding after heavy rains in 2018.[19] The city plans to expand the Green and improve its flood control capabilities. The city is also exploring private development around the Meriden Green, which would include mixed-income housing and retail and restaurant commercial space.

[18] Environmental Protection Agency 2013.

[19] Ragali 2017.

The former manufacturing facilities that now house the Meriden Green. Source: Record-Journal 2018

Top right, the Meriden Green, 2020. Source: Meriden 2020

Beyond benefiting the public and sparking economic development, the Meriden Green raised existing property values. In Meriden, the Meriden Green had the additional benefit of removing 220 commercial and residential properties from the floodplain. With some homeowners paying $300 a month for flood insurance, this translates into significant savings.[20] Since the park opened in September 2016, home prices in Meriden have risen by 13 percent, from $153,000 to $174,000 in March 2020.[21] Overall, the park shows how a city can build flood-resilient green infrastructure that also revitalizes the economy, remedies environmental hazards, and creates public recreation space.

[20] Spiegel 2019.

[21] Zillow Home Value Index.

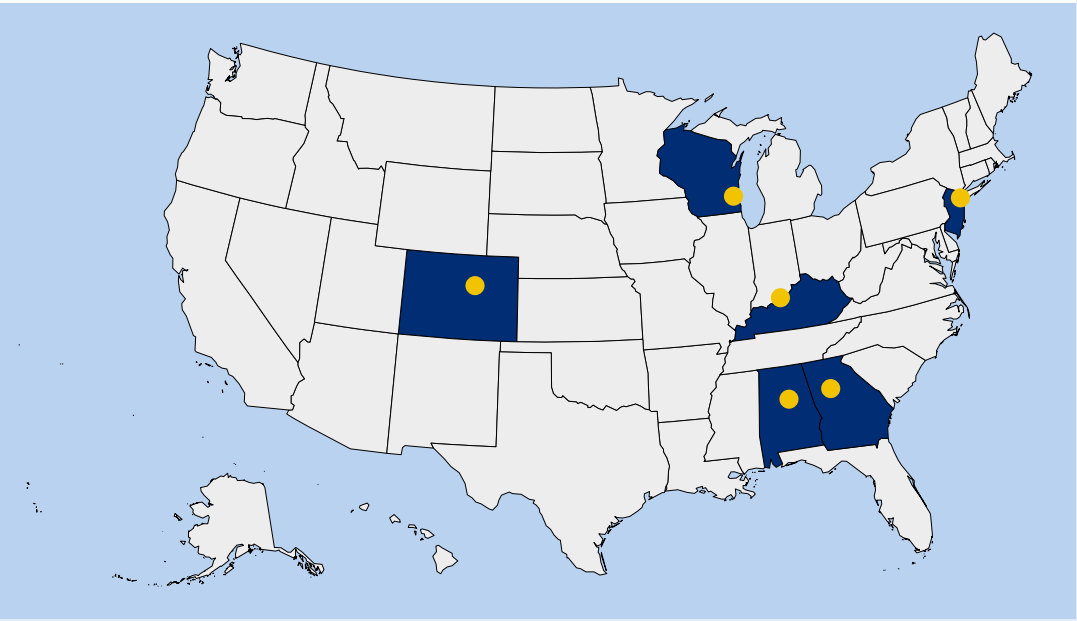
Meriden is not the only place turning vacant commercial land into flood-resilient parks with public amenities. In 2019, Hoboken, New Jersey, completed the $90 million Northwest Resiliency Park, the largest public park in the city. The park includes athletic fields, pavilions, a seasonal ice skating rink, playground equipment, water features, gardens, and a retention system capable of holding two million gallons of rainwater.[22] Atlanta completed its 17-acre Historic Fourth Ward Park in 2011, which includes a pond, skatepark, playground, walkways, and system capable of detaining water from a 500-year flood event. The project came in at $17 million less than the alternative $40 million CSO tunnel.[23] Cities across the country have had similar successes with parks, all serving the dual purpose of public recreation and floodwater retention: Expo Park and Utah Park in Aurora, Colorado; Railroad Park in Birmingham, Alabama; County Ground Park in Milwaukee, Wisconsin; and Waterfront Botanical Gardens in Louisville, Kentucky.

[22] Baer 2019.
[23] The Trust for Public Land 2016.

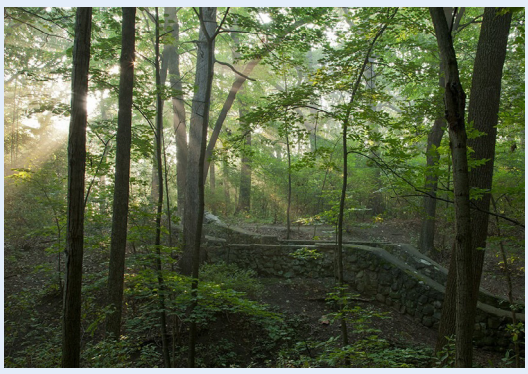
Hoboken, NJ
Northwest Resiliency Park
Source: City of Hoboken

Atlanta, GA
Fourth Ward Park
Source: Nate Shivar

Birmingham, AL
Railroad Park
Source: Wally Argus



Aurora, CO
Railroad Park
Source: Wikimedia Commons



Milwaukee, WI
County Grounds Park
Source: Friends of County Grounds Park

Louisville, KY
Waterfront Botanical Gardens

Public sector innovation

Local governments can be hesitant to build new public amenities. When planning budgets, officials may focus on operating and maintenance costs over the long-term benefits of increased resilience. When the Meriden Green floods as designed, for example, debris and garbage from the brook may remain after the floodwaters recede.[24] While the cleanup that follows is a short-term cost, the avoided property and infrastructure damage likely outweigh these costs. Other benefits include lower water treatment costs, less damage to public infrastructure, and higher property taxes given the proximity to a green space. Local governments must avoid short-sightedness and take a broad view to achieve long-term resilience and fiscal responsibility.

Governments can also consider creative methods of financing maintenance, such as entrusting new green infrastructure to a local foundation or business district or developing a dedicated revenue stream, such as increases in local property tax revenues or leasing publicly owned land near the park. These parks can boost economies and more than pay for themselves in additional benefits. In Atlanta, for example, developers pointed to the city's $23 million Historic Fourth Ward Park as the main reason they invested $400 million in the nearby Ponce City Market.[25]

To alleviate some concerns associated with new investment, cities should connect with other local governments who have proven strategies and designs. This type of peer learning network can be facilitated by regional resilience collaboratives and national and international groups such as the American Flood Coalition, Global Resilient Cities Network, MetroLab Network, C40 Cities, Resilient Cities Catalyst, and Johns Hopkins' Centers for Civic Impact.

Protecting local businesses and homeowners

America's cities and towns seek to attract and retain footloose people and businesses by offering places to live and work with high quality of life. By threatening normal routines, flooding can cause people and firms to relocate. At the least, flooding can cause lost days of work and production. At worst, flooding can shutter businesses forever and destroy homes. To avoid these threats and help people and businesses adapt, local governments must invest in flood-resilient infrastructure.

Tidal flooding in Annapolis, Maryland.
Source: City of Annapolis

Flooding, property damage, and economic losses

Flooding can prevent people from visiting businesses, which reduces sales. A study of high-tide flooding in Annapolis, Maryland, found that such events reduced visits to the downtown corridor by 1.7% and that an additional 3 inches of sea level rise could reduce visits by 3.6%.[26] Mitigation efforts, however, can reduce these effects while preventing property damage. An economic valuation found that the Otter Creek near Middlebury, Vermont, reduced flood damages from 10 historical floods by 54–78%, providing an annual value of $126,000–$450,000 in flood mitigation benefits.[27]

[24] Ragali 2017.
[25] The Trust for Public Land 2016.
[26] Hino, Belanger, Field, Davis, Mach 2019.
[27] Watson, Ricketts, Galford, Polasky, O'Niel 2016.

Around 50% of small businesses close after a natural disaster—**90% close in less than a year** if they cannot resume operations within five days of a natural disaster.

Around 50% of small businesses close after a natural disaster—90% close in less than a year if they cannot resume operations within five days of a natural disaster.[28] Louisiana Highway 1, which is the only route to Louisiana's Port Fourchon, has to close around 10 days a year due to flooding. A 2014 study estimated that each day LA-1 is closed costs the U.S. $46 million in oil and gas production and over $500 million in total U.S. GDP.[29] After a 2016 flood, businesses in Cedar Rapids, Iowa, reported $25.7 million in losses, primarily from lost productivity and sales, as well as the cost of private flood mitigation.[30]

A National Guardsman stands in front of a traffic sign on Highway 1 keeping vehicles away as the Army Corp of Engineers open bays to relieve pressure off the Mississippi River. Source: Toby M. Valadie, Louisiana National Guard

Businesses aren't the only ones at risk. Floods also threaten critical infrastructure, such as hospitals, highways, and water systems. In 2005, Hurricane Rita hit Beaumont, Texas, causing $58 million in damage to Memorial Hermann Baptist Hospital. The hospital used temporary power for 12 days as facilities were restored. Following the disaster, the hospital received a $2.6 million grant through FEMA's Hazard Mitigation Grant Program to improve its resilience to future hurricanes. When Hurricane Ike hit the hospital again in 2008, the hospital sustained almost no damage.[31]

Home values are also greatly affected by floods. In 2013, the households of most middle income Americans had 62.5% of their wealth in their principal residence.[32] Increased flood risk for properties is associated with decreased housing market value, with much larger decreases after storms.[33] In some cases, decreased housing value caused by storms can persist for years.[34] Recent research on properties at risk of sea level rise in Florida suggests a profound impact on residential housing market dynamics: Sales of at risk properties fell while prices for those same at-risk properties rose. The authors caution that this could indicate a coming housing bubble.[35]

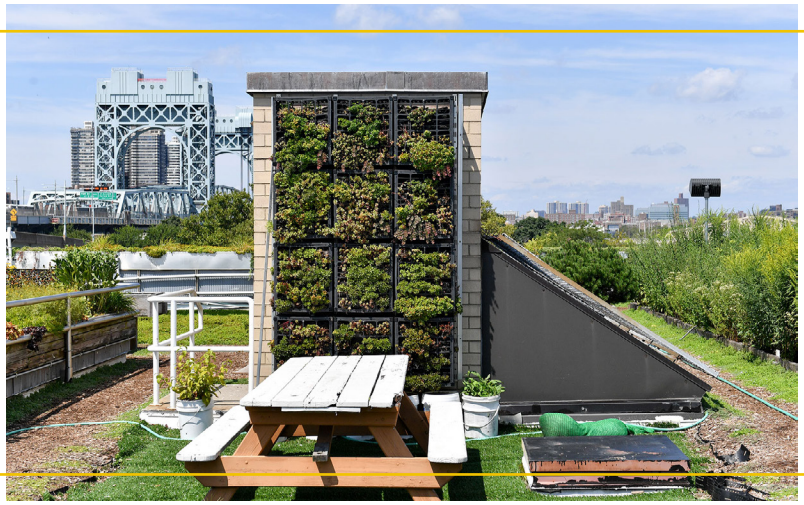
[28] Federal Emergency Management Agency 2019.
[29] Greater LaFourche Port Commission 2014.
[30] City of Cedar Rapids 2017.
[31] Federal Emergency Management Agency 2008.
[32] Wolff 2016.
[33] Bin and Polasky 2004.
[34] Bin and Landry 2013.
[35] Keys and Mulder 2020.

Increased flood risk for properties is associated with **decreased housing market value,** with much larger decreases after storms.

In general, many of these homes are also more threatened than previously thought. Recent research from the First Street Foundation estimated that up to 14.6 million properties in the U.S. (10% of all properties) have substantial flooding risk, which is 70% more than FEMA's estimate. Additionally, 3.6 million properties have a 20% annual probability of flooding.[36] The researchers also found that from 2005–2017 five states lost a combined $13.2 billion in home value due to tidal flooding from sea level rise.[37] Given all these risks, without mitigation, a significant portion of the U.S. is at risk of suffering a severe financial shock.

The impact of protection

Local investments in flood-resilient infrastructure can reduce losses to property value, which protects homeowners and businesses. A study of the city of Chesterfield in St. Louis County, Missouri, found that in 100-year flood plains, commercial properties with levee protections sold for around 8% more than similar properties without levee protections.[38] Another study found that in New York City, green infrastructure improvements were associated with a 2.7% rise in housing prices, while structural elevation increased housing prices by 14.3%; in Miami, green structural improvements were associated with a 9.7% rise in housing prices, while structural elevation increased housing prices by 6.6%. The study also found that in areas with non-effective or no action, housing prices depreciate faster after a hurricane.[39]



A green roof on the NYC Parks Department building on Randall's Island. Source: NYC Parks

How a community responds after a natural disaster can determine its future. Risk-averse people and businesses may relocate if they think communities are not protecting them against future shocks. Local governments should instead work with businesses and residents to plan for future flooding.

[36] First Street Foundation 2020.
[37] First Street Foundation 2020.
[38] Fell and Kousky 2015.
[39] Kim 2019.

"The Year of the River:"

Revitalizing riverfront neighborhoods in Cedar Rapids, Iowa

The city of Cedar Rapids, Iowa, declared 2008 the "Year of the River." For most of the 19th and 20th centuries, the city had seen economic success in steel manufacturing, food processing, and early technology development. By the end of the 20th century, however, the city suffered from a decades-long decline in manufacturing, along with the immediate fallout from the burst of the telecom bubble. In early 2008, the city took the first steps of a 25-year plan to revitalize its downtown and riverfront.[40]

But in June 2008, a severe flood threw a wrench in those plans. Floodwaters covered more than 14% of the city's land area, damaging 900 businesses and 5,390 homes, displacing 10,000 residents, and costing the city $5.4 billion. More than 300 public buildings were affected, forcing the city to relocate its central fire station, police station, city hall, courthouse, administrative offices, and jail.[41]

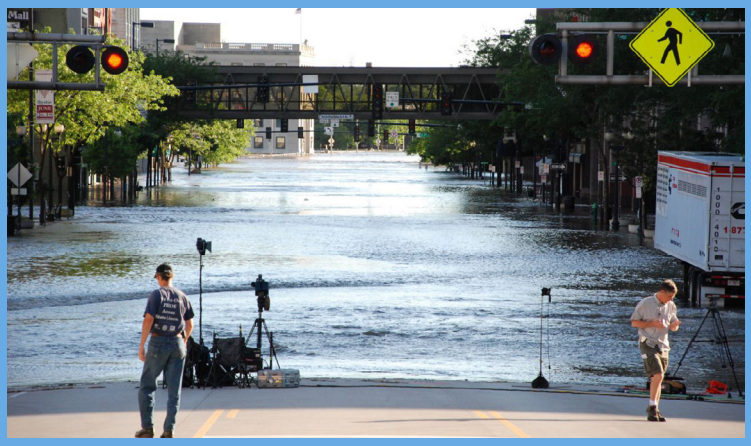
Rather than impede progress, however, the flood accelerated the city's redevelopment timeline. Just four days after the flood, which came to be known as "Iowa's Katrina," the Cedar Rapids City Council began planning a

Figure VI

Demographics and business statistics for Cedar Rapids, Iowa

Population (2018)	131,360
Median household income (2018)	$59,152
Median housing price (2018)	$140,200
Poverty rate (2018)	11.6%
Bachelor's degree or higher (2018)	32.5%
Number of businesses (2017)	3,005
Number employed in Cedar Rapids (2017)	97,347
Major industries by employment (2017)	Manufacturing, health care, retail

Sources: 2018 5-year ACS and 2017 Annual Business Survey



Cedar Rapidians observe the flood of 2008. Source: CRartist on Flickr

[40] Raice and Shayndi 2017.

[41] Cedar River Flood Control System (FCS) Master Plan.

very different revitalization, one that reimagined the city's relationship with the river that ran through it. The city coupled investments in flood-resilience with public amenity redevelopment and businesses in mind. It aggressively pursued federal funding while simultaneously raising money through local tax measures.

What resulted was over $500 million (in 2017 dollars) invested in flood-resilient infrastructure projects.[42] In the six years after the flood, the city acquired and demolished more than 1,300 commercial and residential properties in the flood zone, an investment that totaled $128 million by December 2014. From 2012 to 2017, the city partnered with the Iowa Economic Development Authority to build 900 new homes outside the flood zone. In addition to building permanent and removable flood walls, levees, pump stations, and detention basins, the city also created 220 acres of new green space, an amphitheater that doubles as a levee, 12 miles of trails along the river's edge, 15 acres of playing fields, and eight acres of wetlands.[43]

This investment and planning may have had a significant impact on commercial revitalization and property values in the city as a whole and in areas immediately adjoining the new flood protective infrastructure. Gross domestic product in Linn County, where Cedar Rapids is located, increased 44% from 2008 to 2018, compared to 39% in all of Iowa.[44] Residential units in downtown Cedar Rapids increased 62% from 2007 to 2017, while total property values in the city increased 18%.[45]

The city's New Bohemian district, which is adjacent to downtown Cedar Rapids and the Cedar River, saw its property valuation rise from $29 million to $46 million between 2008 and 2016. After the flood, the city invested $44 million in its Czech Village/New Bohemia Main Street District, giving rise to a burgeoning arts and entertainment district.[46]

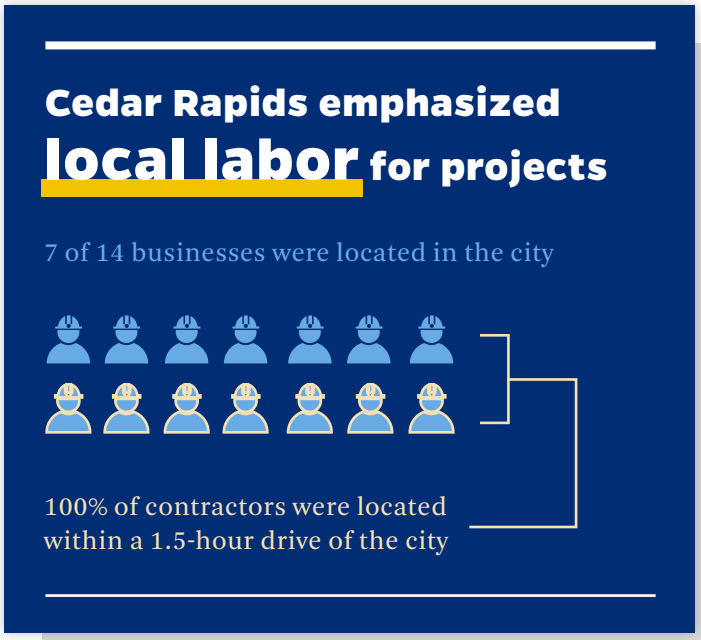
The famous Sykora Bakery in the Czech Village area of Cedar Rapids. Source: Wikimedia Commons

In addition to public spending, private developers invested in flood-resilient infrastructure, including floodwalls and levees, pedestrian walkways, lighting, and an amphitheater.

"When you add flood control, I think that's going to give confidence to future investors about the city's commitment to the area," said Cedar Rapids City Manager Jeff Pomeranz, who used a development model that focused on housing, jobs, and entertainment.[47]

[40] Raice and Shayndi 2017.
[41] Cedar River Flood Control System (FCS) Master Plan.
[42] City of Cedar Rapids Department of Public Works. Flood Control System Funding FAQs.
[43] City of Cedar Rapids Flood Control System. Timeline of Flood Protection.
[44] Bureau of Economic Analysis.
[45] Raice 2017.
[46, 47] Ramm 2017

Local economic development organizations, such as Cedar Rapids Metro Economic Alliance, advocated for the use of local labor for flood infrastructure projects, which seemed to pay off.[48] Seven of the 14 businesses the city contracted with were from Cedar Rapids or had a satellite office in the city, and all contractors were within a 90-minute drive of the city, according to a survey we conducted. In several industries, job growth in the Cedar Rapids Combined Statistical Area (CSA) was particularly pronounced. The wholesale industry, which provides the raw materials for infrastructure construction, saw employment increase 13.6% over the construction period, compared to a statewide decrease of 0.78%. This growth was even more pronounced in the durable goods sector of the wholesale industry, where employment increased 21%, compared to 13% statewide.[49]



While employment in construction increased nearly 10%, total construction employment across the state actually increased 19.79%. However, employment in the construction sector of heavy and civil engineering increased 61% over the construction period, compared to just 22% statewide. Growth was particularly strong from 2014 to 2019, when the majority of the flood infrastructure projects were underway: The industry saw the number of jobs increase 58%.

Gathering fiscal and political support

Facing the threat of future damages from flooding, the state of Iowa and the city of Cedar Rapids committed significant financial and political resources to flood mitigation. After statewide floods in 2011, Iowa passed the Growth Reinvestment Initiative, which allows local governments to keep a portion of their state sales tax revenue to finance flood-resilient infrastructure projects. Though the state is expected to forgo almost $600 million in revenue over 20 years, the benefits could outweigh the costs if the investments are able to significantly reduce flood risk.[50]

[48] Cedar Rapids Metro Economic Alliance 2020.
[49] Quarterly Census of Employment and Wages (QCEW).
[50] Lieb 2019.

Some local business owners supported increasing local property taxes to pay for the city's flood control system, especially those affected directly by flooding. For example, since 1993, six floods have threatened Pierson's Flower Shop & Greenhouse in Cedar Rapids. The shop's owner, Al Pierson, showed gratitude for the measures already taken and expressed hope for more in a video testimonial: "They've done an awful lot of good things. The plan is good, the levee looks good, we just need to find that gap in the funding… We need to be prepared to pay for it. And if that means my property taxes go up, I'll pay for it. If that means we extend sales tax, I'll pay for it, I'll support it." [51]

At the federal level, Iowa Republican Senators Joni Ernst and Chuck Grassley advocated for $117 million in federal funding from the U.S. Army Corps of Engineers' Long Term Disaster Recovery Investment Program. With $17 billion provided in the the Bipartisan Budget Act of 2018, the Army Corps announced that it would use the funds, in part, to construct 60 flood and storm damage reduction projects in 16 states, including the Cedar Rapids project. After this funding was secured, the Cedar Rapids City Council approved a plan to issue $20 million in bonds each fiscal year from 2020 to 2029 to finance the local portion of the flood control system. The plan included a local property tax levy increase of 22 cents per $1,000 in property value.[52] The federal, state, and local commitments totalled $750 million for a flood control system of levees, walls, and pump stations that will ultimately protect the city along 7.5 miles of the Cedar River.[53] Moving forward with the city's plan for a flood-resilient future required financial and political commitments at the federal, state, and local level and a willingness to pay among business owners and residents.

[51] City of Cedar Rapids 2018.
[52] Corridor Business Journal 2018.
[53] Morelli 2018.

Home market effect, specialization, and the creation of new industries

While Meriden, Connecticut, and Cedar Rapids, Iowa, both significantly invested in flood resilience, their geographic reach and affected populations are relatively small. What would happen if larger investments in flood resilience were made in larger geographic areas?

In the 1980s, Nobel Laureate economist Paul Krugram popularized the theory of the home market effect, positing that places with large populations can specialize in certain industries. If enough of a home market exists, businesses can benefit from offering a unique product and then export the product due to their specialization gained from producing it.

A good example of this theory in practice is with the global market for pharmaceuticals. If enough places face enough risk for a certain disease, then companies will invest in drug research to address this risk due to the aggregate demand.

Renewable energy markets provide further evidence of the home market effect. Denmark invested early in wind turbines, partly because of national policy that facilitated a home market through generous tax breaks. As these tax breaks were phased out, the combination of home market demand and exports kept the industry flourishing, demonstrating how governments can support nascent industries where sufficient home market demand exists.

The home market effect can also be applied to flood resilience. As more communities face increased risk of flooding, demand for products that increase resilience will rise. This was the case with Coastal Louisiana, which recently invested heavily in an emergent water management industry to reduce flood risk to its coast.

Dredging and sand berm construction coastal Louisiana protect Louisiana's marshlands.
Source: Coastal Protection and Restoration Authority

Protecting a coastal economy:

Louisiana's Coastal Protection and Restoration Authority

After Hurricanes Katrina and Rita devastated the region in 2005, Coastal Louisiana became the site of the largest investment in climate resiliency in the U.S. To protect one of the most productive economic regions in the U.S. from continued flooding, the state formed the Coastal Protection and Restoration Authority (CPRA) and created a 50-year $50 billion Coastal Master Plan.[54] The plan calls for over 130 projects to protect tens of thousands of acres of coastline by constructing or improving hundreds of miles of levees, building or maintaining over 800 square miles of land, floodproofing 1,400 structures, elevating more than 22,400 structures, and acquiring 2,400 at-risk structures. The goal of what is one of the most ambitious flood resilience plans is to protect one of the most productive economic regions in the U.S. from the continued threat of flooding.[55]

Coastal Louisiana is home to the largest deep water crude oil port in the U.S. and is the third-largest producer of natural gas, with 18% of the country's oil supply flowing through the region. The region is also home to five of America's top 15 ports, with $120 billion in annual exports that include 60% of all grain, 75% of all commercially harvested fish species, and 36% of all shrimp and oysters. The value of the Mississippi Delta is estimated at $1.3 trillion,[56] and the value of commercial, residential, and infrastructure assets at risk of storm damage is estimated at $138 billion.[57]

Louisiana is investing **$50B** in resilience through its Coastal Protection and Restoration Authority

Over **130** projects

Protection of **tens of thousands** of acres of coastline and the people and businesses that are located there by:

Constructing or improving **hundreds of miles** of levees

Building or maintaining more than **800 square miles** of land

Floodproofing **1,400** structures

Elevating over **22,400** structures

Acquiring **2,400** at-risk structures

[54] Louisiana Coastal Protection and Restoration Authority 2017.
[55] Rich 2020.
[56] Louisiana Coastal Protection and Restoration Authority 2019.
[57] Louisiana Coastal Protection and Restoration Authority 2017.
[58] Louisiana Coastal Protection and Restoration Authority 2020.

Protecting an economy, creating an industry

Large, sustained investment in flood-resilient infrastructure can have a local market effect for businesses in the water management sector. From 2007 to 2019, Coastal Louisiana completed billions of dollars worth of flood infrastructure projects aimed at protecting its economy. What effect did this investment have on jobs and business creation?

We analyzed 25 infrastructure projects in Coastal Louisiana and identified prime contractors and subcontractors awarded a total of $186 million from 2006 to 2019. We found that 59 of 74 subcontracts (80%) went to businesses in Coastal Louisiana parishes and that all subcontracts but one went to businesses located in Louisiana. One such company is HydroTerra Technologies, a firm that specializes in land survey and hydrographic solutions, which performed surveying services on five CPRA projects from 2011 to 2019.

Past research on Southeast Louisiana found that the area had a significant local water management sector, defined as businesses in the construction and business services industries. The sector maintained a location quotient[58] greater than 1 from 2004 to 2014, the most recent year in the analysis. Since 2010, the industry has outperformed national growth rates, ranking 8th-highest in the nation.[59]

Figure VII

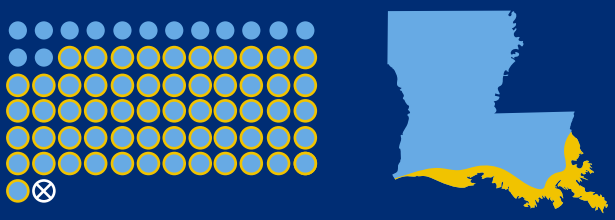
Demographics and business statistics for Coastal Louisiana

Population (2018)	1,947,597
Median household income (2018)	$53,106
Median housing price (2018)	$174,992
Poverty rate (2018)	17.5%
Bachelor's degree or higher (2018)	25.1%
Number of businesses (2017)	34,524
Number employed in coastal Louisiana (2017)	673,297
Major industries by employment (2017)	Accomodation and food services, retail, health care

Sources: 2018 5-Year ACS and 2017 Annual Business Survey. Data on businesses was suppressed for Vermilion parish.

*Includes the following parishes: Ascension, Assumption, Cameron, Iberia, Jefferson, Lafourche, Livingston, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist, St. Mary, St. Tammany, Terrebonne, and Vermilion.

Louisiana flood infrastructure projects went to local contractors



59 of 74 contracts (80%) went to businesses located in Coastal Louisiana

[58] A location quotient is a measure of industry concentration in a given area. A location quotient greater than 1 indicates that the industry is more heavily concentrated in the area than at the national level.

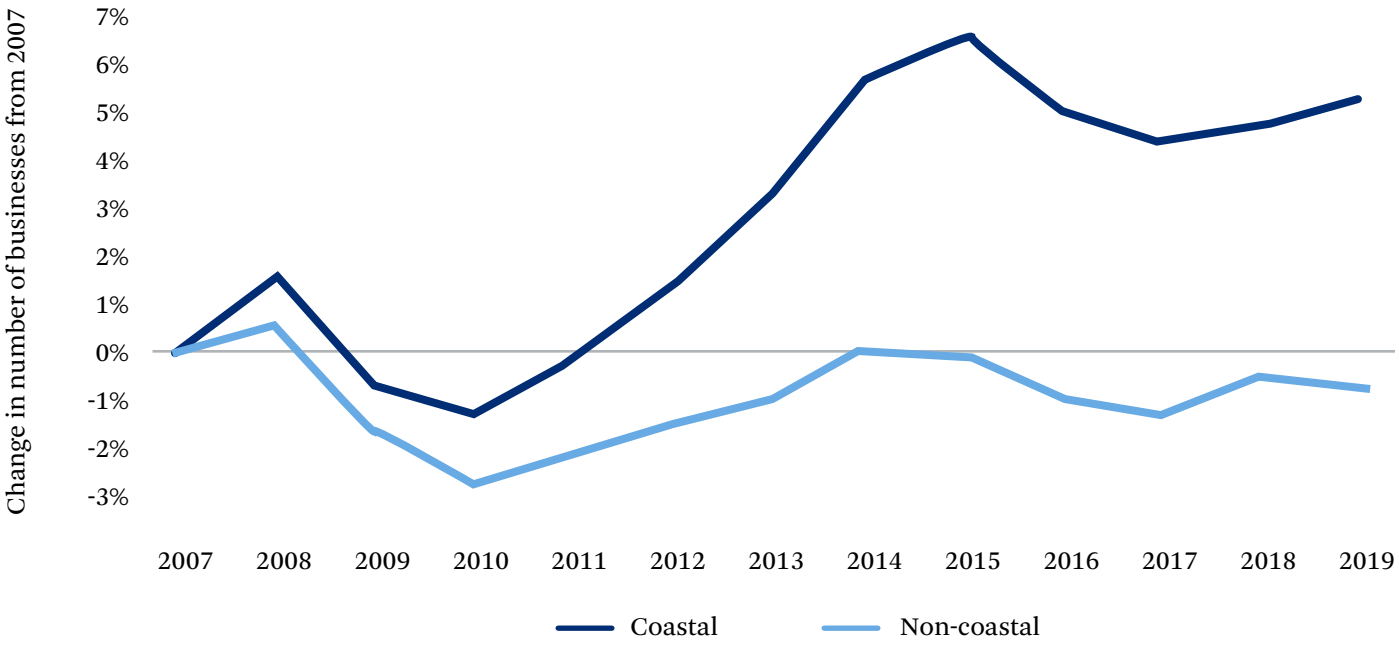
[59] The Data Center 2014.

From 2007 to 2019, Coastal Louisiana saw $8.5 billion worth of flood infrastructure investments through CPRA. Using a combination of local, state, and federal funds, CPRA built 60 miles of barrier islands and berms, repaired or improved 315 miles of levees, utilized 152 million cubic yards of fill, and made other flood-resilient improvements on 46,058 acres of land across 20 coastal parishes in the state.[60] The most common types of funded projects included barrier island restoration (13 projects for $757 million), marsh creation (23 projects for $535 million), and shoreline protection (24 projects for $397 million).

Before the completion of the first CPRA project in 2007, job growth in Louisiana's coastal and non-coastal parishes was very similar.[61] After 2004, the two regions diverged, with coastal parishes losing 13% of jobs from 2004 to 2006 and non-coastal parishes gaining 4%. Following the financial crisis in 2008 and during the national economic boom that followed several years later, the two regions once again diverged. This time, coastal Louisiana's job growth far outpaced that of non-coastal parishes. This growth is impressive considering the impact of the 2010 Deepwater Horizon oil spill on the region's tourist and fisheries industries, although subsequent funding from settlements and the RESTORE Act may have contributed to some of this growth.

Figure VIII

Cumulative job growth in Louisiana's coastal and non-coastal parishes



Source: BLS QCEW

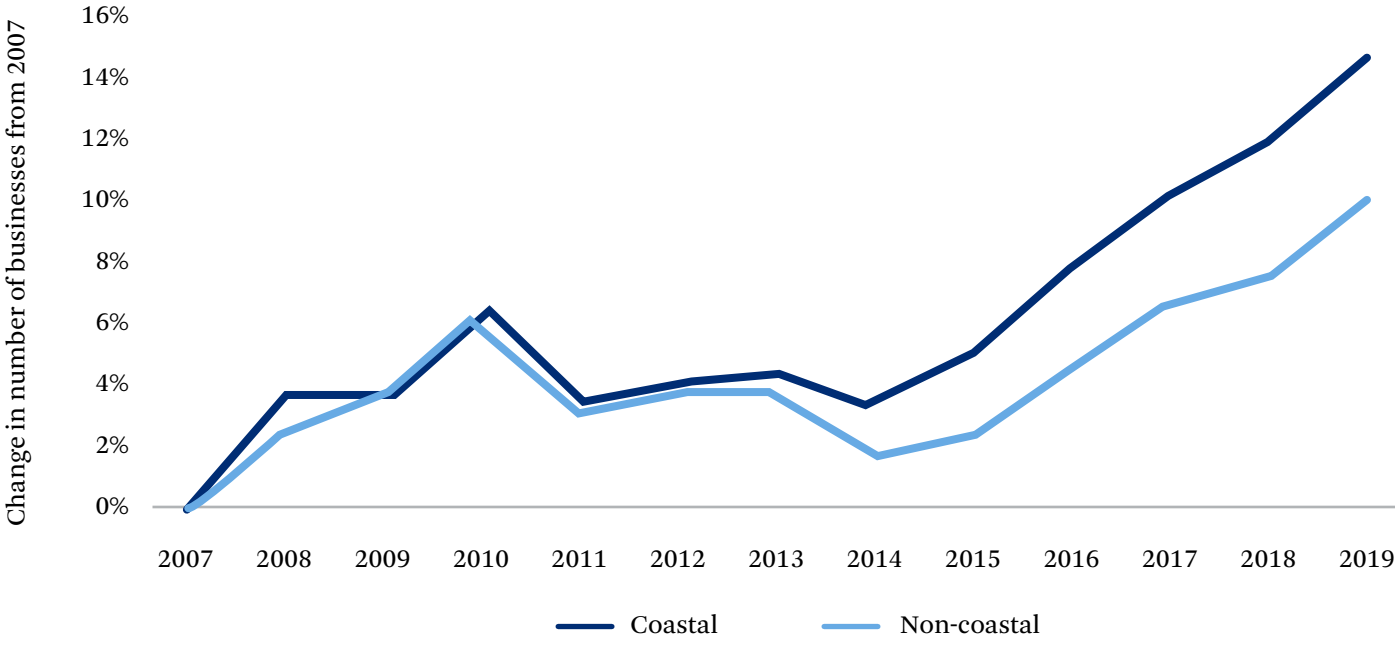
[60] Louisiana Coastal Protection and Restoration Authority 2019.

[61] The following Parishes are defined as "Coastal" because they were the location of at least one CPRA project: Ascension, Assumption, Cameron, Iberia, Jefferson, Lafourche, Livingston, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist, St. Mary, St. Tammany, Terrebonne, and Vermilion.

As shown in Figure VIII, the total number of jobs in Coastal Louisiana parishes grew by 5% from 2007 to 2019 compared to a 1% reduction in non-coastal parishes. This period also saw significant investments in flood-resilient infrastructure projects through CPRA. The first CPRA project, the Sabine Refuge Marsh Creation project in the Cameron parish, was completed in 2007 at a cost of just under $3 million. Major projects followed, with the completion of the $1 billion Lake Pontchartrain surge barrier in 2014 and the nearly $4 billion repair and upgrade of over 100 miles of levees and structures in Greater New Orleans in 2017.[62]

Figure IX

Cumulative business establishment growth in Louisiana's coastal and non-coastal parishes



Source: BLS QCEW

Figure IX shows cumulative growth in the number of businesses in coastal and non-coastal parishes from 2007 to 2019. While the two regions experienced similar growth trends from 2007 to 2013, coastal parishes saw greater growth in the number of parishes beginning in 2014, coinciding with the completion of the first $1 billion CPRA project. The state's clear, long-term commitment to protecting coastal industries may have served as a strong signal to the private sector that investing in an area once perceived as risky may now be more promising.

[62] Louisiana Coastal Protection and Restoration Authority 2019.

Learning by doing and a market for flood resilience

Most infrastructure is costly, and flood-resilient infrastructure is no exception. As new techniques and methods for engineering and technologies are developed, however, infrastructure solutions can become more affordable. But much of that progress hinges on market incentives and federal funding as much as it does on skilled problem solvers.

While some states and cities, such as Iowa, Louisiana, Houston, and New York City, have started investing in flood-resilient infrastructure, the federal government has invested relatively little. In the absence of federal funding, costs can be prohibitively expensive for smaller local governments to cover. Significant federal investment could create a market for new solutions, reducing the costs of flood-resilient infrastructure projects. With enough aggregate demand for flood-resilient infrastructure, companies will invest in affordable solutions that can be applied in multiple geographies rather than in unique solutions for each geographical application.

Take Pentair, a residential and commercial water solutions company based in Minneapolis, Minnesota, as an example. In 2007, the company was awarded a $22 million contract by the U.S. Army Corps of Engineers for providing 11 high capacity water pumps, called Fairbanks pumps, for use in New Orleans. The company sold the same pumps to over a dozen other flood control projects across the Gulf Coast in the preceding years.[63] Pentair was able to deploy the same solution in multiple locations, making their investment in research and development of the Fairbanks pump more profitable.

The company Pentair custom-designed 11 pumps for the Gulf Intracoastal Waterway West Closure Complex (GIWW) to protect the city from storm surge.
Source: U.S. Chamber of Commerce Foundation

This example provides insight into how previous investments and rising demand can both improve technology used to address flood risk and build up human capital that can inform others working on similar issues.

[63] Pentair 2007.

Underinvestment and opportunity

To date, the federal government has spent comparatively little on flood-resilient infrastructure.[64] Funding appropriated by Congress is often intermittent. Legislation, like the Water Resources Development Act, relies on increasingly contentious Congressional budget negotiations for funding. Meanwhile, flood risk is increasing in many American communities. In the absence of federal investment, many states and cities are taking it upon themselves to invest in flood resilience. Since 2005, the state of Louisiana has spent more on flood-resilient infrastructure than FEMA's HMA program. In 2019, voters in Texas overwhelmingly approved Proposition 8, which dedicates $793 million from the state's rainy day fund for flood control projects. Iowa, Missouri, and Arkansas have used state funding to repair levees and purchase removable floodwalls.[65]

Meanwhile, flood risk is increasing in many American communities. In the absence of federal investment, **many states and cities are taking it upon themselves** to invest in flood resilience.

The private sector is also increasingly realizing the importance of investments in resilience. In a recent interview, the vice president of transit and infrastructure at the U.S. Chamber of Commerce, Ed Mortimer, said that businesses are willing to pay for infrastructure upgrades: "It's time to modernize. We need to build it to last... This is not a partisan issue. America used to be a leader [in infrastructure], and we need to be a leader again. The longer we wait, the longer it will take." [66]

In 2015, the country had a **$109.4 billion funding gap** to repair the nation's existing dams and levees and a **$105 billion funding gap** for the nation's water and wastewater infrastructure.

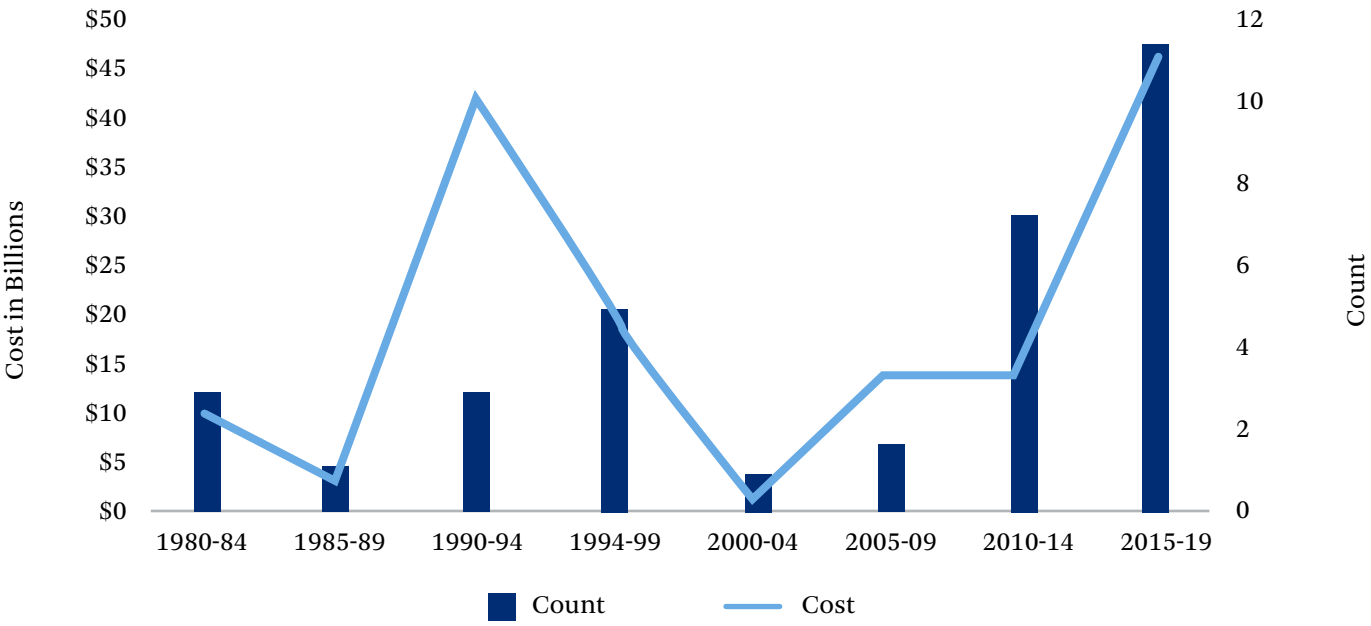
While some states and businesses have started addressing flood resilience and adaptation, the national backlog of flood control projects remains high. In 2015, the country had a $109.4 billion funding gap to repair the nation's existing dams and levees and a $105 billion funding gap for the nation's water and wastewater infrastructure.[67] These figures reflect only the backlog of repair and maintenance, not the increased need for new projects.

[64] Congressional Budget Office 2013 and 2015.
[65] Lieb 2019.
[66] Tompkins 2019.
[67] American Society of Civil Engineers 2017.

Meanwhile, the U.S. faces an increasing number of damaging and costly floods. In the 1980s, an average of 0.4 billion-dollar floods occurred annually, with $1.39 billion in annual costs. During the 2010s, an average of 1.8 billion-dollar floods occurred annually, with $6.08 billion in annual costs.

Figure X

Billion-dollar flooding events



Source: NOAA National Centers for Environmental Information 2020

Given the gap in funding and increasing risk, the country is likely underinvesting in resilience. Despite more localities investing in flood-resilient infrastructure in recent years, a significant number of communities still face increasing flood risk, in a time when flood infrastructure projects are largely unfunded or underfunded.

Despite more localities investing in flood-resilient infrastructure in recent years, a significant number of communities still face increasing flood risk, in a time when flood infrastructure projects are largely unfunded or underfunded.

We use county-level data to identify places with high historic and future risk levels but have received comparatively little funding through FEMA's HMA programs for flood infrastructure projects. To define historic flood risk, we observe the total dollar amount of National Flood Insurance Program (NFIP) payouts since 2000. To define future risk levels, we use data from the First Street Foundation's First National Flood Risk Assessment on the estimated increase in properties that will be at risk of flooding by 2050. [68] Figure XI shows these county-level rankings, where lower-ranking counties have greater opportunity to receive federal flood infrastructure projects.

Figure XI

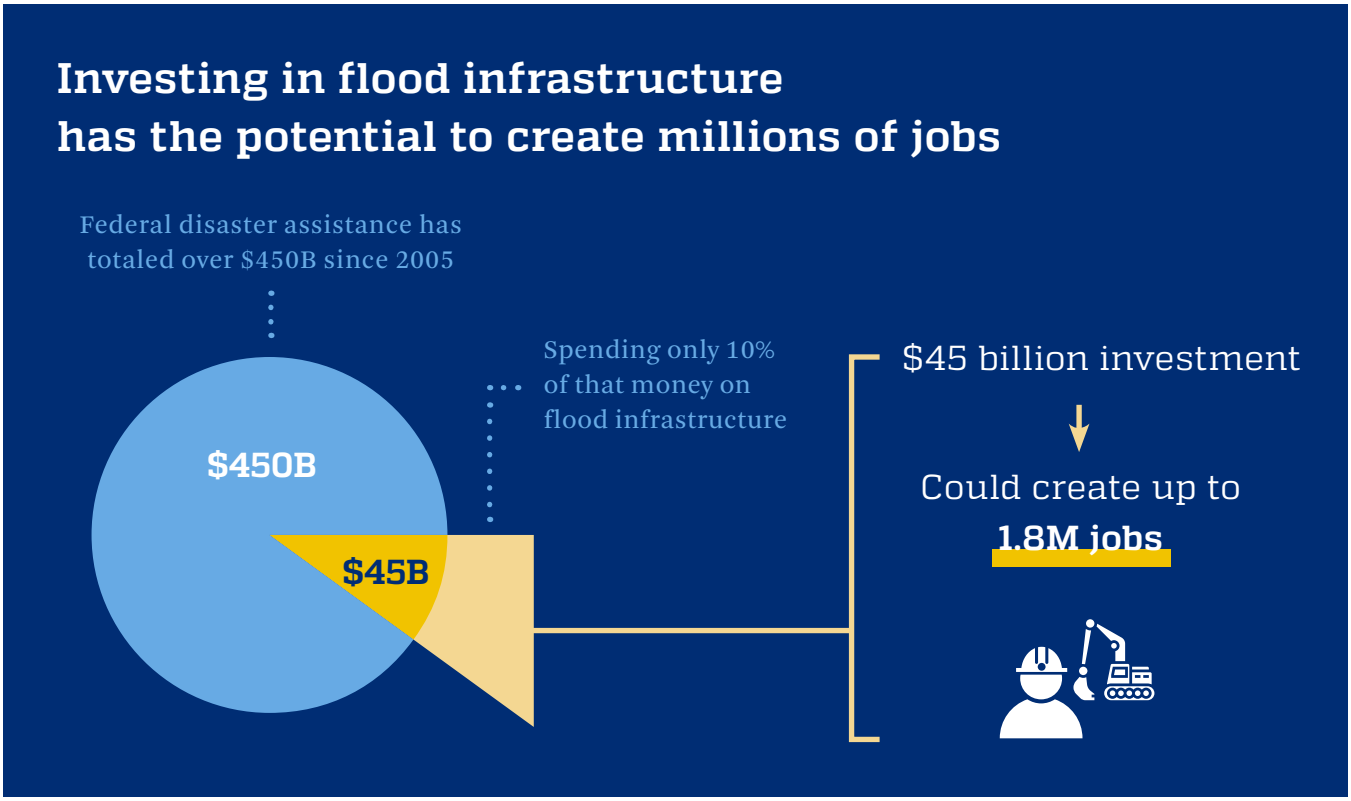
County rankings for federal flood infrastructure funding

County	State	FEMA Funding	NFIP Claims	30-Year Increase in Properties at Risk	Percent Increase of Properties at Risk
Brazoria	TX	$0	$621,790,917	24,034	31%
St. Johns	FL	$0	$217,392,602	8,120	23%
Pinellas	FL	$0	$185,009,004	9,702	9%
Mobile	AL	$0	$364,276,379	5,407	12%
Kings	NY	$0	$312,679,840	4,888	20%
Fort Bend	TX	$0	$443,058,076	3,512	5%
Hudson	NJ	$0	$170,070,896	5,959	48%
St. Charles	LA	$0	$102,401,770	10,746	46%
Citrus	FL	$0	$114,688,901	8,076	21%
Craven	NC	$0	$236,094,179	3,678	21%
Pasco	FL	$0	$134,533,581	5,855	13%
Carteret	NC	$0	$124,414,145	5,377	18%
Baldwin	AL	$0	$538,879,166	2,545	12%
Bergen	NJ	$0	$336,264,938	2,694	12%
New Hanover	NC	$0	$168,859,394	3,586	14%

Source: Authors calculation of OpenFEMA Hazard Mitigation Assistance Projects, FIMA NFIP Redacted Claims, and First Street Foundation data

This report is not a comprehensive assessment of future and historic risk, but rather an illustrative thought experiment that highlights places with both high historic and future risk that may be overlooked for resilient infrastructure funding. We also note that a county without funding from FEMA for flood infrastructure projects may still invest in flood resilience through other funding sources. For example, Brazoria County in Southeast Texas has the 22nd-highest number of NFIP claims in the country yet has received no HMA program funding for FEMA. Without FEMA funding, the county has still benefited from work done by the U.S. Army Corps of Engineers on containment.

[68] First Street Foundation 2020.



Areas like Brazoria County are still likely prime locations for investments in flood resilience. While the 15 counties that have received the highest number of NFIP claims have all received some amount of FEMA HMA funding, Hancock, Mississippi, which ranks 16th in NFIP claims, has received no FEMA HMA funding. Given that the purpose of FEMA's HMA program is to reduce future NFIP claims, the federal government could gain from targeting more investments in these places.

Since 2000, 10 counties received over $4 billion in total NFIP payouts, but no FEMA flood infrastructure funding. If, instead of being spent on recovery after disaster strikes, this $4 billion had been invested in flood infrastructure projects designed to reduce risk before disasters hit—based on our analysis and assuming similar characteristics of the average FEMA flood infrastructure project—it could have been associated with an increase of 160,000 new jobs in the construction and retail industries and prevented tens of millions in losses.

[69] Government Accountability Office (2019). Disaster Recovery: Recent Disasters Highlight Progress and Challenges

Building a resilient future

Since 2005, federal disaster assistance has totaled over $450 billion.[69] Spending only 10% of that money on flood infrastructure would not only prepare us for future disasters but could be associated with up to 1.8 million new jobs in the construction and retail trade industries. Cities and states across the country would greatly benefit from federal investment to help fund their local resilience plans. For instance, in New Jersey, funding Jersey City's $2 billion adaptation master plan could be associated with 80,000 new jobs, while in Virginia, funding Norfolk's Coastal Resilience Strategy—which lays out over $1 billion in projects such as floodwalls, elevated roadways, improved stormwater pumps, culverts, and dune restoration—could be associated with up to 40,000 new jobs.

Both sides of the political aisle have been calling for a national infrastructure bill for years but have failed to reach an agreement. Flood-resilient infrastructure projects have proven popular in both Republican states like Iowa, Arkansas, Louisiana, Texas, and Missouri, and Democratic cities like New York, Philadelphia, Washington, D.C., and San Francisco. But the daunting scale of the issue demands national attention and federal funding. The time could be right for a large-scale public works program that invests in flood-resilient communities.

FEMA has increased funding for resilience

$500 million
Building Resilient Infrastructure and Communities (BRIC) program, 2020

$56 million
Pre-disaster Mitigation Program, on average from 2009-2016

The federal government has taken some steps to increase funding for resilience projects. In August, 2020, FEMA announced Building Resilient Infrastructure and Communities (BRIC), a new $500 million program, with billions more expected, that will increase investments in resilient infrastructure. The Department of Housing and Urban Development began a similar $16 billion program. The U.S. Army Corps of Engineers has started switching from offering voluntary buyouts and relocations to using eminent domain to purchase and demolish properties with high flood risk.[70]

CONCLUSION

The COVID-19 pandemic has pushed the U.S. into an economic recession, the depths of which we are only beginning to understand. A significant federal investment in flood-resilient infrastructure projects would combine job creation in the private sector with cost-effective infrastructure. These jobs would help teach in-demand skills to the nation's workforce, while creating careers with competitive wages and low barriers for entry.[71] Based on our historical estimates, every $1 billion spent on flood infrastructure spent could be associated with an upper bound increase of 40,000 jobs in the construction and retail industries. Our analysis shows that the country has an opportunity to blunt the economic fallout from the COVID-19 pandemic with investments in flood-resilient infrastructure. With strategic nationwide investments, the government could fund millions of jobs, improve safety, and create a more resilient future for communities across the country.

Our analysis shows that the country has an opportunity to blunt the economic fallout from the COVID-19 pandemic with investments in flood-resilient infrastructure.

[69] Government Accountability Office (2019). Disaster Recovery: Recent Disasters Highlight Progress and Challenges

[70] Flavelle 2020.

[71] Kane 2016.

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APPENDIX I

Methodology and Data

Our main source of data on flood infrastructure project investments is the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Assistance projects dataset from OpenFEMA. We do not use projects without award dates, nor do we use projects with award dates before 2003 or after 2018. This selection aligns with our three year pre-growth trend controls. We pull data from four program areas: Flood Mitigation Assistance (FMA) grant program, Hazard Mitigation Grant Program (HMGP), Legislative Pre-Disaster Mitigation (LPDM) grant program, and Pre-Disaster Mitigation (PDM) grant program. Finally, we use projects with codes related to flood-resilience infrastructure. For example, we do not use projects that engaged only in planning or design. For a full list of project codes and descriptions, see Appendix II. We aggregate this data from the county level to the Metropolitan Statistical Area (MSA) level to create observations at the MSA/year level. If multiple projects in the same MSA exist in a given year, we combine funding amounts and observe the total amount of funding that an MSA received for flood infrastructure projects each year. We adjust for inflation to 2019 dollars using the Bureau of Labor Statistics' (BLS) Consumer Price Index for urban areas.

We include data on 369 metropolitan areas in our estimates, 120 of which had at least one FEMA-funded project. MSAs that did not have an awarded project in a given year had their award amount coded to zero, not blank.

Data on employment and business establishments is from the BLS Quarterly Census of Employment and Wages (QCEW). To define industries, we use the North American Industry Classification System (NAICS) industry code in the QCEW data. Demographic data is from the Census Bureau's five-year ACS for the corresponding year. Data on Gross Domestic Product (GDP) by MSA is from the Department of Commerce's Bureau of Economic Analysis.

We estimate employment growth in the following regressions. Our main specification is equation (2), for which we report our main findings:

1. $Employment_{ymt} = a*Award + b*Year_{t-ti}$
2. $Employment_{ymt} = a*Award + b*Year_{t-ti} + c*Employment\ Growth\ Trend$
3. $Employment_{ymt} = a*Award + b*Year_{t-ti} + c*Lag1 + d*Lag2$
4. $Employment_{ymt} = a*Award*i.region + b*Year_{t-ti}$
5. $Employment_{ymt} = a*Award*i.region + d*Lag1 + e*Lag2 + b*Year_{t-ti}$

In all regressions, the dependent variable is employment per 100,000 people in industry y, MSA m, and year t. In equation (1), this is regressed on Award and the total award amount in dollars per 100,000 in population and includes both a control, b*Yeart-ti, for time-fixed effects and place-fixed effects. We cluster standard errors by MSA.

The remaining equations include additional controls and robustness checks. In equation (2), we add a three-year employment growth trend control to the regression. In equation (3), we include Lag1 and Lag2, which observe job growth in the year. In equation (4), we include an interaction between the award amount and a regional dummy for the Northeast, Midwest, West, and South regions of the U.S.

Establishment growth is estimated in the same method, where employment in an industry per 100,000 people is replaced by the number of establishments in an industry per 100,000 people.

APPENDIX II

Code	Description
201.1	Relocation of Private Structures - Riverine
201.3	Relocation of Public Structures - Riverine
201.4	Relocation of Public Structures - Coastal
202.1	Elevation of Private Structures - Riverine
202.2	Elevation of Private Structures - Coastal
202.3	Elevation of Public Structures - Riverine
202.4	Elevation of Public Structures - Coastal
203.1	Wet Floodproofing Private Structures - Riverine
203.3	Wet Floodproofing Public Structures - Riverine
203.4	Wet Floodproofing Public Structures - Coastal
204.1	Dry Floodproofing Private Structures - Riverine (Commercial)
204.2	Dry Floodproofing Private Structures - Coastal (Commercial)
204.3	Dry Floodproofing Public Structures - Riverine
300.1	Vegetation Management - Natural Dune Restoration
300.4	Vegetation Management - Non Coastal Shoreline Stabilization
300.6	Vegetation Management - Erosion
301.1	Shoreline Stabilization (Riprap, etc.)
303.1	Wetland Restoration/Creation
303.2	Floodplain and Stream Restoration
401.1	Water and Sanitary Sewer System Protective Measures
403.1	Stormwater Management - Culverts
403.2	Stormwater Management - Diversions
403.3	Stormwater Management - Flapgates/Floodgates
403.4	Stormwater Management - Detention/Retention Basins
403.5	Floodwater Storage and Diversion
404.1	Localized Flood Control System to Protect Critical Facility
405.1	Other Minor Flood Control
500.1	Flood Control - Floodwall
500.2	Flood Control - Berm, Levee, or Dike
500.3	Flood Control - Dam

Figure XII

Construction industry employment

Variables	(1)	(2)	(3)	(4)	(5)
Project cost in millions ($) per 100K population	45.07*** (13.23)	25.22** (10.79)	40.28*** (13.16)	17.51 (13.12)	3.431 (14.89)
3 year employment growth trend		11.79*** (1.432)			
Year 2 growth dummy			13.99 (14.39)		15.69 (13.67)
Year 3 growth dummy			1.607 (17.43)		0.722 (17.71)
Midwest dummy				-48.15 (41.39)	-26.05 (39.47)
South dummy				38.28 (24.82)	47.28* (25.10)
West dummy				46.25 (29.40)	59.62* (32.20)
Constant	2,300*** (18.74)	2,002*** (23.30)	2,138*** (25.27)	2,306*** (18.63)	2,144*** (32.20)
Observations	6,344	5,099	5,632	6,296	5,590
R-squared	0.842	0.884	0.884	0.840	0.843

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Note: Standard errors are clustered by MSA. We include but do not report year dummy variables.

Figure XIII

Retail trade industry employment

Variables	(1)	(2)	(3)	(4)	(5)
Project	19.51**	14.51	16.89***	69.57***	45.66***
	(8.696)	(10.55)	(6.602)	(12.40)	(11.81)
3 year employment growth trend		18.36***			
		(2.686)			
Year 2 growth dummy			20.18***		17.74**
			(7.231)		(7.148)
Year 3 growth dummy			19.55***		19.21**
			(7.503)		(7.148)
Midwest dummy				-57.65**	-33.67
				(23.30)	(28.57)
South dummy				-60.84***	-36.64
				(13.13)	(13.04)
West dummy				-13.32	10.26
				(26.32)	(22.09)
Constant	5,662***	5,101***	5,107***	5,671***	5,113***
	(25.52)	(20.36)	(19.44)	(25.52)	(19.64)
Observations	6,766	5,595	6,017	6,713	5,970
R-squared	0.908	0.939	0.917	0.906	0.915

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Note: Standard errors are clustered by MSA. We include but do not report year dummy variables.

Figure XIV

Construction industry business establishments

Variables	(1)	(2)	(3)	(4)	(5)
Project cost in millions ($) per 100K population	3.949*** (1.288)	2.631*** (1.116)	3.063*** (1.103)	-0.869 (2.316)	-3.395 (2.583)
3 year employment growth trend		0.369*** (0.0755)			
Year 2 growth dummy			4.093*** (1.179)		4.389*** (1.231)
Year 3 growth dummy			3.343*** (1.154)		3.271*** (1.193)
Midwest dummy				-2.562 (4.387)	1.255 (4.668)
South dummy				6.048** (2.872)	7.588** (3.101)
West dummy				8.236 (5.258)	11.52** (5,536)
Constant	283.6*** (2.307)	246.0*** (1.763)	246.8*** (1.575)	285.0*** (2.307)	248.3*** (1.589)
Observations	6,785	5,099	6,070	6,718	6,009
R-squared	0.915	0.933	0.923	0.913	0.921

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Note: Standard errors are clustered by MSA. We include but do not report year dummy variables.

APPENDIX IV: Congressional District Employment Estimates

Methodology

We estimate the potential associated job growth that future investments in flood infrastructure projects could have in the 116th Congressional Districts. We use historical data at the county level on FEMA flood infrastructure projects and calculate the land area intersection with 116th Congressional Districts to assign the dollar amounts of past investments. We calculate each Congressional District's demographics by using county-level data from the U.S. Census. While some data are available at the Congressional District level, not all are, so we transform county-level data for consistency. We use the same geography for Congressional Districts over time so that our estimates of future investments are consistent.

We estimated associated job growth across a variety of demographic variables and found statistically significant associations with the unemployment rate and the share of adults over 25 with a bachelor's degree or higher. Using data on Congressional Districts from 2018, we assign each district to a different bucket for education and unemployment rates. The buckets were generated by observing the distribution and selecting for appropriate ranges — four for unemployment rate and two for education (percent of adults over 25 with a bachelor's degree or higher). We then regressed job growth on these variable buckets, one variable at a time. The coefficient on funding was noted as a new variable, given the ranges. To combine the effect of multiple variables, a new variable was generated that was an equally weighted combination of the individual variable contribution to the coefficient on project award.

The estimates assume that all other demographic variables are held constant and that future awards will be made in places with similar characteristics, including flood risk, to those where past awards were made. The limitations of our sample should be considered while extrapolating growth estimates to amounts or geographies not considered previously. The synergistic effects and economies of scale of a large, consolidated spending effort, allied with possible crowding out of private sector jobs at that level, are some of the hypothesized consequences of a national jobs program that has no historical precedent.

Figure XV

Job growth per $1 million invested in flood infrastructure

Estimates for 116th U.S. Congressional Districts

State	Congressional district	Unemployment rate (2018)	Share of adults over 25 with a bachelor's degree or higher	Job growth estimate
Alabama	1	4%	17%	14
Alabama	2	6%	16%	78
Alabama	3	6%	14%	78
Alabama	4	5%	12%	14
Alabama	5	4%	23%	27
Alabama	6	6%	23%	91
Alabama	7	6%	20%	78
Alaska	At-large	6%	20%	78
Arizona	1	7%	14%	78
Arizona	2	6%	16%	78
Arizona	3	5%	20%	49
Arizona	4	5%	18%	49
Arizona	5	5%	21%	14
Arizona	6	5%	21%	14
Arizona	7	5%	21%	14
Arizona	8	5%	21%	14
Arizona	9	5%	21%	14
Arkansas	1	5%	15%	49
Arkansas	2	4%	19%	12
Arkansas	3	3%	19%	12
Arkansas	4	5%	14%	14
California	1	6%	19%	78
California	2	5%	25%	27
California	3	6%	18%	78
California	4	6%	20%	78
California	5	5%	23%	62
California	6	5%	21%	49
California	7	5%	21%	49
California	8	7%	14%	78
California	9	6%	17%	78
California	10	8%	12%	78
California	11	5%	27%	27
California	12	3%	36%	25
California	13	4%	28%	25
California	14	4%	33%	25
California	15	4%	27%	25
California	16	10%	10%	78
California	17	4%	28%	25

Job growth per $1 million invested in flood infrastructure (Cont.)

State	Congressional district	Unemployment rate (2018)	Share of adults over 25 with a bachelor's degree or higher	Job growth estimate
California	18	4%	28%	27
California	19	4%	28%	25
California	20	5%	18%	49
California	21	9%	12%	78
California	22	9%	12%	78
California	23	8%	14%	78
California	24	5%	21%	49
California	25	6%	21%	91
California	26	4%	20%	14
California	27	6%	21%	91
California	28	6%	21%	91
California	29	6%	21%	91
California	30	6%	21%	62
California	31	7%	14%	78
California	32	6%	21%	91
California	33	6%	21%	91
California	34	6%	21%	91
California	35	6%	20%	78
California	36	6%	14%	78
California	37	6%	21%	91
California	38	6%	21%	62
California	39	5%	25%	27
California	40	6%	21%	91
California	41	6%	14%	78
California	42	6%	14%	78
California	43	6%	21%	91
California	44	6%	21%	91
California	45	4%	26%	27
California	46	4%	26%	27
California	47	5%	22%	62
California	48	4%	26%	27
California	49	5%	25%	27
California	50	5%	23%	62
California	51	7%	20%	78
California	52	5%	23%	62
California	53	5%	23%	62
Colorado	1	4%	31%	25
Colorado	2	3%	31%	25
Colorado	3	6%	17%	78

Job growth per $1 million invested in flood infrastructure (Cont.)

State	Congressional district	Unemployment rate (2018)	Share of adults over 25 with a bachelor's degree or higher	Job growth estimate
Colorado	4	4%	26%	25
Colorado	5	5%	23%	62
Colorado	6	4%	23%	25
Colorado	7	3%	25%	25
Connecticut	1	5%	22%	62
Connecticut	2	5%	20%	49
Connecticut	3	6%	19%	78
Connecticut	4	6%	26%	91
Connecticut	5	5%	22%	62
Delaware	At-large	6%	18%	78
Florida	1	5%	18%	49
Florida	2	6%	16%	78
Florida	3	7%	18%	78
Florida	4	5%	21%	49
Florida	5	6%	20%	78
Florida	6	5%	17%	14
Florida	7	4%	25%	27
Florida	8	5%	21%	49
Florida	9	5%	16%	49
Florida	10	4%	23%	27
Florida	11	7%	14%	78
Florida	12	5%	18%	49
Florida	13	5%	21%	49
Florida	14	5%	22%	62
Florida	15	5%	19%	49
Florida	16	5%	20%	49
Florida	17	5%	16%	49
Florida	18	5%	19%	49
Florida	19	4%	19%	14
Florida	20	5%	21%	49
Florida	21	5%	23%	62
Florida	22	5%	20%	49
Florida	23	5%	20%	49
Florida	24	5%	20%	14
Florida	25	4%	21%	14
Florida	26	4%	20%	14
Florida	27	4%	20%	14

Job growth per $1 million invested in flood infrastructure (Cont.)

State	Congressional district	Unemployment rate (2018)	Share of adults over 25 with a bachelor's degree or higher	Job growth estimate
Georgia	1	6%	19%	78
Georgia	2	10%	14%	78
Georgia	3	4%	18%	14
Georgia	4	5%	24%	62
Georgia	5	5%	27%	62
Georgia	6	4%	30%	27
Georgia	7	3%	25%	25
Georgia	8	5%	16%	49
Georgia	9	3%	21%	12
Georgia	10	4%	18%	12
Georgia	11	4%	28%	27
Georgia	12	7%	16%	78
Georgia	13	5%	26%	27
Georgia	14	4%	13%	12
Hawaii	1	4%	23%	25
Hawaii	2	4%	22%	25
Idaho	1	4%	20%	12
Idaho	2	4%	20%	14
Illinois	1	6%	23%	91
Illinois	2	6%	21%	91
Illinois	3	6%	23%	91
Illinois	4	7%	23%	91
Illinois	5	6%	24%	91
Illinois	6	4%	27%	27
Illinois	7	7%	23%	91
Illinois	8	5%	26%	62
Illinois	9	7%	23%	91
Illinois	10	6%	25%	91
Illinois	11	4%	26%	25
Illinois	12	5%	16%	49
Illinois	13	6%	17%	78
Illinois	14	4%	23%	27
Illinois	15	6%	17%	78
Illinois	16	5%	17%	49
Illinois	17	6%	16%	78
Illinois	18	4%	21%	14
Indiana	1	6%	15%	78

Job growth per $1 million invested in flood infrastructure (Cont.)

State	Congressional district	Unemployment rate (2018)	Share of adults over 25 with a bachelor's degree or higher	Job growth estimate
Indiana	2	4%	16%	12
Indiana	3	4%	18%	14
Indiana	4	3%	23%	25
Indiana	5	4%	24%	25
Indiana	6	4%	17%	14
Indiana	7	6%	21%	78
Indiana	8	6%	16%	78
Indiana	9	4%	19%	12
Iowa	1	4%	22%	25
Iowa	2	4%	24%	25
Iowa	3	3%	26%	25
Iowa	4	5%	22%	62
Kansas	1	5%	26%	62
Kansas	2	4%	22%	27
Kansas	3	3%	30%	25
Kansas	4	4%	19%	14
Kentucky	1	7%	14%	78
Kentucky	2	4%	14%	12
Kentucky	3	5%	20%	49
Kentucky	4	4%	21%	27
Kentucky	5	7%	14%	78
Kentucky	6	4%	23%	27
Louisiana	1	19%	6%	78
Louisiana	2	21%	7%	78
Louisiana	3	18%	5%	14
Louisiana	4	15%	6%	78
Louisiana	5	14%	8%	78
Louisiana	6	19%	5%	49
Maine	1	2%	25%	25
Maine	2	4%	16%	14
Maryland	1	5%	20%	49
Maryland	2	5%	21%	62
Maryland	3	5%	23%	27
Maryland	4	6%	21%	78
Maryland	5	5%	20%	49
Maryland	6	5%	23%	27
Maryland	7	5%	24%	62
Maryland	8	4%	25%	25

Job growth per $1 million invested in flood infrastructure (Cont.)

State	Congressional district	Unemployment rate (2018)	Share of adults over 25 with a bachelor's degree or higher	Job growth estimate
Massachusetts	1	5%	19%	49
Massachusetts	2	4%	23%	27
Massachusetts	3	4%	27%	25
Massachusetts	4	4%	24%	27
Massachusetts	5	4%	28%	27
Massachusetts	6	5%	25%	62
Massachusetts	7	6%	26%	91
Massachusetts	8	5%	26%	62
Massachusetts	9	5%	22%	27
Michigan	1	5%	22%	27
Michigan	2	4%	20%	12
Michigan	3	5%	22%	62
Michigan	4	5%	15%	49
Michigan	5	7%	14%	78
Michigan	6	5%	20%	49
Michigan	7	5%	19%	49
Michigan	8	4%	25%	27
Michigan	9	4%	20%	14
Michigan	10	5%	15%	49
Michigan	11	5%	23%	62
Michigan	12	8%	16%	78
Michigan	13	8%	15%	78
Michigan	14	6%	20%	78
Minnesota	1	2%	24%	25
Minnesota	2	3%	29%	25
Minnesota	3	4%	32%	25
Minnesota	4	3%	27%	25
Minnesota	5	4%	32%	25
Minnesota	6	3%	23%	25
Minnesota	7	5%	19%	14
Minnesota	8	5%	19%	14
Mississippi	1	6%	18%	78
Mississippi	2	7%	22%	91
Mississippi	3	5%	18%	14
Mississippi	4	9%	14%	78
Missouri	1	5%	23%	62
Missouri	2	4%	25%	25
Missouri	3	4%	21%	

Job growth per $1 million invested in flood infrastructure (Cont.)

State	Congressional district	Unemployment rate (2018)	Share of adults over 25 with a bachelor's degree or higher	Job growth estimate
Missouri	4	4%	23%	27
Missouri	5	4%	20%	14
Missouri	6	4%	21%	14
Missouri	7	4%	17%	12
Missouri	8	4%	14%	14
Montana	At-large	3%	23%	25
Nebraska	1	3%	26%	25
Nebraska	2	4%	26%	25
Nebraska	3	24%	3%	25
Nevada	1	6%	16%	78
Nevada	2	4%	19%	14
Nevada	3	6%	16%	78
Nevada	4	6%	16%	78
New Hampshire	1	3%	25%	25
New Hampshire	2	4%	22%	25
New Jersey	1	6%	20%	78
New Jersey	2	6%	19%	78
New Jersey	3	5%	22%	27
New Jersey	4	4%	26%	27
New Jersey	5	4%	27%	25
New Jersey	6	5%	28%	27
New Jersey	7	4%	28%	27
New Jersey	8	4%	27%	27
New Jersey	9	4%	28%	25
New Jersey	10	6%	23%	91
New Jersey	11	5%	25%	62
New Jersey	12	5%	25%	62
New Mexico	1	6%	19%	49
New Mexico	2	6%	15%	78
New Mexico	3	7%	15%	78
New York	1	4%	20%	12
New York	2	4%	23%	25
New York	3	4%	24%	25
New York	4	3%	25%	25
New York	5	5%	21%	49
New York	6	5%	21%	49
New York	7	5%	25%	62
New York	8	5%	23%	62

Job growth per $1 million invested in flood infrastructure (Cont.)

State	Congressional district	Unemployment rate (2018)	Share of adults over 25 with a bachelor's degree or higher	Job growth estimate
New York	9	5%	23%	62
New York	10	5%	29%	27
New York	11	4%	22%	27
New York	12	5%	30%	27
New York	13	5%	30%	62
New York	14	9%	16%	78
New York	15	10%	13%	78
New York	16	8%	18%	78
New York	17	5%	24%	62
New York	18	5%	21%	14
New York	19	5%	18%	49
New York	20	5%	20%	49
New York	21	4%	17%	12
New York	22	5%	14%	49
New York	23	5%	14%	49
New York	24	5%	17%	49
New York	25	5%	22%	62
New York	26	4%	20%	12
New York	27	4%	19%	12
North Carolina	1	4%	24%	25
North Carolina	2	4%	27%	25
North Carolina	3	7%	18%	78
North Carolina	4	3%	32%	25
North Carolina	5	5%	18%	49
North Carolina	6	5%	19%	49
North Carolina	7	4%	21%	14
North Carolina	8	6%	20%	78
North Carolina	9	5%	23%	62
North Carolina	10	5%	16%	49
North Carolina	11	5%	18%	14
North Carolina	12	4%	30%	25
North Carolina	13	5%	19%	49
North Dakota	At-large	3%	26%	25
Ohio	1	4%	24%	25
Ohio	2	4%	19%	14
Ohio	3	5%	25%	27
Ohio	4	4%	12%	14
Ohio	5	5%	17%	49

Job growth per $1 million invested in flood infrastructure (Cont.)

State	Congressional district	Unemployment rate (2018)	Share of adults over 25 with a bachelor's degree or higher	Job growth estimate
Ohio	6	7%	13%	78
Ohio	7	4%	16%	14
Ohio	8	5%	17%	49
Ohio	9	6%	18%	78
Ohio	10	6%	18%	78
Ohio	11	7%	20%	78
Ohio	12	4%	24%	27
Ohio	13	6%	17%	78
Ohio	14	5%	18%	49
Ohio	15	5%	22%	27
Ohio	16	5%	19%	14
Oklahoma	1	5%	20%	14
Oklahoma	2	4%	17%	14
Oklahoma	3	4%	18%	12
Oklahoma	4	4%	18%	12
Oklahoma	5	4%	20%	14
Oregon	1	4%	27%	25
Oregon	2	6%	18%	78
Oregon	3	4%	27%	25
Oregon	4	6%	17%	78
Oregon	5	5%	20%	49
Pennsylvania	1	4%	25%	25
Pennsylvania	2	8%	18%	78
Pennsylvania	3	8%	18%	78
Pennsylvania	4	4%	27%	27
Pennsylvania	5	6%	21%	78
Pennsylvania	6	4%	30%	25
Pennsylvania	7	6%	18%	78
Pennsylvania	8	5%	16%	14
Pennsylvania	9	5%	14%	49
Pennsylvania	10	4%	19%	14
Pennsylvania	11	4%	18%	12
Pennsylvania	12	5%	16%	14
Pennsylvania	13	4%	16%	12
Pennsylvania	14	4%	17%	14
Pennsylvania	15	4%	16%	12
Pennsylvania	16	5%	17%	49
Pennsylvania	17	4%	23%	27

Job growth per $1 million invested in flood infrastructure (Cont.)

State	Congressional district	Unemployment rate (2018)	Share of adults over 25 with a bachelor's degree or higher	Job growth estimate
Rhode Island	1	5%	20%	49
Rhode Island	2	5%	20%	49
South Carolina	1	3%	26%	25
South Carolina	2	6%	19%	78
South Carolina	3	5%	16%	49
South Carolina	4	5%	20%	49
South Carolina	5	5%	19%	14
South Carolina	6	5%	20%	49
South Carolina	7	5%	15%	49
South Dakota	At-large	3%	22%	22%
Tennessee	1	5%	15%	49
Tennessee	2	4%	20%	14
Tennessee	3	5%	18%	49
Tennessee	4	5%	19%	49
Tennessee	5	3%	26%	25
Tennessee	6	3%	18%	12
Tennessee	7	4%	30%	27
Tennessee	8	7%	18%	78
Tennessee	9	8%	19%	78
Texas	1	5%	15%	49
Texas	2	6%	20%	78
Texas	3	4%	33%	25
Texas	4	4%	24%	27
Texas	5	5%	18%	49
Texas	6	4%	21%	14
Texas	7	6%	20%	78
Texas	8	4%	23%	25
Texas	9	6%	21%	78
Texas	10	5%	23%	62
Texas	11	3%	16%	12
Texas	12	5%	21%	14
Texas	13	4%	17%	14
Texas	14	5%	18%	49
Texas	15	6%	14%	78
Texas	16	6%	16%	78
Texas	17	4%	22%	25
Texas	18	6%	20%	78
Texas	19	3%	19%	12

Job growth per $1 million invested in flood infrastructure (Cont.)

State	Congressional district	Unemployment rate (2018)	Share of adults over 25 with a bachelor's degree or higher	Job growth estimate
Texas	20	6%	17%	78
Texas	21	5%	23%	27
Texas	22	5%	27%	62
Texas	23	6%	17%	78
Texas	24	4%	21%	14
Texas	25	4%	26%	27
Texas	26	4%	30%	25
Texas	27	6%	14%	78
Texas	28	6%	16%	49
Texas	29	6%	20%	78
Texas	30	4%	20%	14
Texas	31	6%	24%	91
Texas	32	4%	21%	14
Texas	33	4%	21%	14
Texas	34	5%	12%	49
Texas	35	4%	27%	27
Texas	36	5%	18%	49
Utah	1	3%	21%	12
Utah	2	3%	22%	25
Utah	3	3%	26%	25
Utah	4	3%	25%	25
Vermont	At-large	4%	34%	25
Virginia	1	4%	26%	25
Virginia	2	5%	22%	62
Virginia	3	5%	17%	49
Virginia	4	4%	24%	25
Virginia	5	2%	25%	25
Virginia	6	4%	18%	14
Virginia	7	4%	24%	27
Virginia	8	3%	32%	25
Virginia	9	3%	21%	12
Virginia	10	4%	30%	25
Virginia	11	4%	30%	25
Washington	1	4%	26%	25
Washington	2	5%	21%	14
Washington	3	5%	19%	49
Washington	4	5%	13%	49
Washington	5	4%	20%	14

Job growth per $1 million invested in flood infrastructure (Cont.)

State	Congressional district	Unemployment rate (2018)	Share of adults over 25 with a bachelor's degree or higher	Job growth estimate
Washington	6	4%	18%	14
Washington	7	4%	31%	25
Washington	8	4%	26%	25
Washington	9	4%	31%	25
Washington	10	5%	21%	14
West Virginia	1	6%	16%	78
West Virginia	2	5%	15%	49
West Virginia	3	5%	12%	49
Wisconsin	1	4%	20%	12
Wisconsin	2	2%	27%	25
Wisconsin	3	3%	22%	25
Wisconsin	4	4%	19%	14
Wisconsin	5	3%	24%	25
Wisconsin	6	3%	18%	12
Wisconsin	7	2%	19%	12
Wisconsin	8	3%	21%	12
Wyoming	At-large	3%	17%	12

APPENDIX V: Historic FEMA Disaster Declarations by Congressional District

State	Congressional district	Number of declarations
Alabama	1	18
Alabama	2	18
Alabama	3	27
Alabama	4	23
Alabama	5	15
Alabama	6	24
Alabama	7	26
Alaska	At-large	22
American Samoa	At-large	4
Arizona	1	20
Arizona	2	12
Arizona	3	16
Arizona	4	18
Arizona	5	12
Arizona	6	12
Arizona	7	12
Arizona	8	12
Arizona	9	12
Arkansas	1	40
Arkansas	2	35
Arkansas	3	34
Arkansas	4	42
California	1	26
California	2	30
California	3	27
California	4	24
California	5	26
California	6	21
California	7	20
California	8	33
California	9	25
California	10	20
California	11	20
California	12	10
California	13	20
California	14	18
California	15	22
California	16	18
California	17	20
California	18	20
California	19	16
California	20	25
California	21	24
California	22	16
California	23	28
California	24	34
California	25	27
California	26	27
California	27	31
California	28	25
California	29	25
California	30	27
California	31	28
California	32	25
California	33	25
California	34	25
California	35	31
California	36	30
California	37	25
California	38	26
California	39	31
California	40	25
California	41	30
California	42	30
California	43	25
California	44	25
California	45	23
California	46	23
California	47	26
California	48	23
California	49	28
California	50	33
California	51	29
California	52	26

State	Congressional district	Number of declarations
California	53	26
Colorado	1	8
Colorado	2	13
Colorado	3	12
Colorado	4	11
Colorado	5	10
Colorado	6	8
Colorado	7	8
Connecticut	1	8
Connecticut	2	8
Connecticut	3	7
Connecticut	4	6
Connecticut	5	7
Delaware	At-large	6
Florida	1	11
Florida	2	12
Florida	3	6
Florida	4	6
Florida	5	9
Florida	6	8
Florida	7	2
Florida	8	3
Florida	9	4
Florida	10	2
Florida	11	5
Florida	12	7
Florida	13	5
Florida	14	6
Florida	15	6
Florida	16	10
Florida	17	8
Florida	18	3
Florida	19	5
Florida	20	6
Florida	21	2
Florida	22	6
Florida	23	5
Florida	24	5
Florida	25	7
Florida	26	4
Florida	27	4
Georgia	1	9
Georgia	2	12
Georgia	3	12
Georgia	4	10
Georgia	5	8
Georgia	6	9
Georgia	7	5
Georgia	8	13
Georgia	9	14
Georgia	10	14
Georgia	11	10
Georgia	12	12
Georgia	13	10
Georgia	14	12
Guam	At-large	1
Hawaii	1	9
Hawaii	2	18
Idaho	1	20
Idaho	2	13
Illinois	1	17
Illinois	2	17
Illinois	3	17
Illinois	4	15
Illinois	5	16
Illinois	6	18
Illinois	7	15
Illinois	8	16
Illinois	9	15
Illinois	10	17
Illinois	11	17
Illinois	12	23
Illinois	13	24
Illinois	14	18
Illinois	15	24
Illinois	16	23
Illinois	17	26
Illinois	18	28
Indiana	1	17
Indiana	2	16

State	Congressional district	Number of declarations
Indiana	3	17
Indiana	4	20
Indiana	5	13
Indiana	6	21
Indiana	7	12
Indiana	8	24
Indiana	9	23
Iowa	1	41
Iowa	2	38
Iowa	3	35
Iowa	4	40
Kansas	1	39
Kansas	2	22
Kansas	3	30
Kansas	4	37
Kentucky	1	37
Kentucky	2	34
Kentucky	3	14
Kentucky	4	33
Kentucky	5	49
Kentucky	6	32
Louisiana	1	22
Louisiana	2	25
Louisiana	3	25
Louisiana	4	24
Louisiana	5	32
Louisiana	6	28
Maine	1	30
Maine	2	32
Maryland	1	8
Maryland	2	6
Maryland	3	7
Maryland	4	4
Maryland	5	4
Maryland	6	10
Maryland	7	6
Maryland	8	9
Massachusetts	1	11
Massachusetts	2	16
Massachusetts	3	17
Massachusetts	4	18
Massachusetts	5	15
Massachusetts	6	17
Massachusetts	7	16
Massachusetts	8	17
Massachusetts	9	14
Michigan	1	8
Michigan	2	9
Michigan	3	9
Michigan	4	14
Michigan	5	14
Michigan	6	11
Michigan	7	8
Michigan	8	8
Michigan	9	9
Michigan	10	10
Michigan	11	9
Michigan	12	8
Michigan	13	8
Michigan	14	9
Minnesota	1	28
Minnesota	2	21
Minnesota	3	16
Minnesota	4	16
Minnesota	5	17
Minnesota	6	23
Minnesota	7	40
Minnesota	8	30
Mississippi	1	25
Mississippi	2	36
Mississippi	3	34
Mississippi	4	25
Missouri	1	27
Missouri	2	32
Missouri	3	38
Missouri	4	45
Missouri	5	32
Missouri	6	44
Missouri	7	34
Missouri	8	37

State	Congressional district	Number of declarations
Montana	At-large	20
Nebraska	1	38
Nebraska	2	20
Nebraska	3	39
Nevada	1	9
Nevada	2	12
Nevada	3	9
New Hampshire	1	21
New Hampshire	2	24
New Jersey	1	8
New Jersey	2	14
New Jersey	3	11
New Jersey	4	13
New Jersey	5	12
New Jersey	6	11
New Jersey	7	14
New Jersey	8	11
New Jersey	9	10
New Jersey	10	11
New Jersey	11	14
New Jersey	12	12
New Mexico	1	14
New Mexico	2	25
New Mexico	3	17
New York	1	12
New York	2	12
New York	3	14
New York	4	11
New York	5	13
New York	6	9
New York	7	11
New York	8	9
New York	9	8
New York	10	10
New York	11	10
New York	12	11
New York	13	9
New York	14	9
New York	15	7
New York	16	14
New York	17	14
New York	18	18
New York	19	30
New York	20	18
New York	21	26
New York	22	26
New York	23	28
New York	24	16
New York	25	12
New York	26	19
New York	27	23
North Carolina	1	5
North Carolina	2	4
North Carolina	3	7
North Carolina	4	4
North Carolina	5	11
North Carolina	6	5
North Carolina	7	6
North Carolina	8	4
North Carolina	9	4
North Carolina	10	8
North Carolina	11	9
North Carolina	12	2
North Carolina	13	3
North Dakota	At-large	44
Northern Mariana Islands	At-large	2
Ohio	1	13
Ohio	2	18
Ohio	3	10
Ohio	4	18
Ohio	5	20
Ohio	6	23
Ohio	7	18
Ohio	8	13
Ohio	9	18
Ohio	10	7
Ohio	11	12
Ohio	12	20
Ohio	13	12

State	Congressional district	Number of declarations
Ohio	14	15
Ohio	15	18
Ohio	16	13
Oklahoma	1	24
Oklahoma	2	46
Oklahoma	3	47
Oklahoma	4	39
Oklahoma	5	28
Oregon	1	18
Oregon	2	20
Oregon	3	11
Oregon	4	20
Oregon	5	17
Pennsylvania	1	13
Pennsylvania	2	11
Pennsylvania	3	11
Pennsylvania	4	13
Pennsylvania	5	12
Pennsylvania	6	13
Pennsylvania	7	11
Pennsylvania	8	18
Pennsylvania	9	16
Pennsylvania	10	10
Pennsylvania	11	11
Pennsylvania	12	22
Pennsylvania	13	19
Pennsylvania	14	12
Pennsylvania	15	18
Pennsylvania	16	11
Pennsylvania	17	13
Pennsylvania	18	11
Puerto Rico	At-large	15
Rhode Island	1	4
Rhode Island	2	3
South Carolina	1	2
South Carolina	2	4
South Carolina	3	4
South Carolina	4	4
South Carolina	5	4
South Carolina	6	5
South Carolina	7	2
South Dakota	At-large	35
Tennessee	1	22
Tennessee	2	23
Tennessee	3	29
Tennessee	4	27
Tennessee	5	17
Tennessee	6	32
Tennessee	7	33
Tennessee	8	30
Tennessee	9	15
Texas	1	22
Texas	2	20
Texas	3	10
Texas	4	20
Texas	5	17
Texas	6	18
Texas	7	20
Texas	8	28
Texas	9	20
Texas	10	26
Texas	11	19
Texas	12	17
Texas	13	19
Texas	14	19
Texas	15	18
Texas	16	8
Texas	17	25
Texas	18	20
Texas	19	19
Texas	20	9
Texas	21	19
Texas	22	22
Texas	23	18
Texas	24	16
Texas	25	27
Texas	26	16
Texas	27	25
Texas	28	18
Texas	29	20

State	Congressional district	Number of declarations
Texas	30	12
Texas	31	10
Texas	32	13
Texas	33	15
Texas	34	23
Texas	35	17
Texas	36	26
Utah	1	6
Utah	2	8
Utah	3	5
Utah	4	3
Vermont	At-large	38
Virgin Islands	At-large	6
Virginia	1	12
Virginia	2	7
Virginia	3	6
Virginia	4	11
Virginia	5	15
Virginia	6	16
Virginia	7	10
Virginia	8	8
Virginia	9	3
Virginia	10	7
Virginia	11	5
Washington	1	31
Washington	2	28
Washington	3	30
Washington	4	21
Washington	5	21
Washington	6	29
Washington	7	29
Washington	8	27
Washington	9	24
Washington	10	27
West Virginia	1	38
West Virginia	2	42
West Virginia	3	48
Wisconsin	1	16
Wisconsin	2	19
Wisconsin	3	27
Wisconsin	4	12
Wisconsin	5	14
Wisconsin	6	19
Wisconsin	7	28
Wisconsin	8	12
Wyoming	At-large	7