



Lessons from Sandy

Federal Policies to Build Climate-Resilient Coastal Regions



ROBERT PIRANI AND LAURA TOLKOFF

Lessons from Sandy: Federal Policies to Build Climate-Resilient Coastal Regions

Robert Pirani and Laura Tolkoff

Policy Focus Report Series

The Policy Focus Report series is published by the Lincoln Institute of Land Policy to address timely public policy issues relating to land use, land markets, and property taxation. Each report is designed to bridge the gap between theory and practice by combining research findings, case studies, and contributions from scholars in a variety of academic disciplines, and from professional practitioners, local officials, and citizens in diverse communities.

About This Report

This report identifies a set of policies, regulations, and administrative practices that federal agencies can adopt to help coastal regions become more resilient—able to recover quickly from natural disasters while at the same time reducing future risk in the face of climate change. The research draws on two convenings of experts on climate resilience (Appendices A and B). The Lincoln Institute of Land Policy and Regional Plan Association organized these gatherings in June 2013 and January 2014 in order to analyze the response to Hurricane Sandy, identify a national strategy for climate resilience, and assess the role of federal agencies in supporting climate adaptation.

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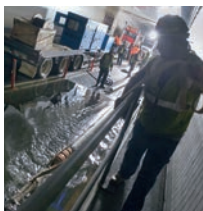


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Executive Summary



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Hurricane Sandy engulfs the fishing pier in Ocean Grove, New Jersey, hours before dragging the historic structure into the sea.

When Hurricane Sandy made landfall in Brigantine, New Jersey, on October 29, 2012, it brought much of the New York–New Jersey–Connecticut metropolitan area to a standstill. The storm spared little as it tore through New Jersey and New York. It flooded key arteries in and out of New York City, including the Brooklyn–Battery Tunnel and Amtrak’s Hudson River tunnel. It disabled power plants and transmission lines, leaving 8.5 million customers in three states without electricity, some for weeks. The storm surge easily overtopped protective dunes and floodwalls from Atlantic City to New London, damaging more than 600,000 homes and killing 60 people.

In the months following the disaster, the federal government marshaled significant

financial and technical resources to help communities recover and rebuild. With preliminary damage estimates in New York, New Jersey, and Connecticut topping \$65 billion, the scope of the devastation inspired new ideas about how to adapt to changing climate conditions.

Hurricane Sandy was a wakeup call that elevated the discussion about disasters and climate change at all levels of government. Public officials realized that the regional reach of the storm demanded a new approach to disaster relief and recovery. Current strategies for disaster recovery, urban planning, and coastal management would no longer be viable; in the face of rising sea levels, these outdated approaches would undermine coastal ecosystems and endanger people, property, and the economy.

The response to Hurricane Sandy offers a number of important lessons for building climate-resilient coastal regions. This report defines resilience as the capacity to recover quickly from shocks and stressors while at the same time reducing future risk. By strengthening and integrating this connection between disaster recovery and rebuilding—between short-term and long-range actions following a disaster—we gain further critical opportunities to build even greater resilience.

This report identifies a set of policies, regulations, and administrative practices that federal agencies can adopt to help coastal regions become more resilient. In addition, this research documents how state and local governments recovering from Hurricane Sandy sought to use federal aid to create a more resilient region, and it describes the obstacles they encountered.

Chapter 1 introduces why coastal regions matter and warrant stronger support from federal policies for a more integrated approach to coastal management and disaster relief.

This report defines resilience as the capacity to recover quickly from shocks and stressors while at the same time reducing future risk.

Chapter 2 outlines several federal disaster relief funds and recommends reforms to existing policies, regulations, and administrative procedures that could make disaster recovery aid more flexible and supportive of climate adaptation. Without reforms to these programs, it will be difficult for cities and their regions to adapt to climate change and for the federal government to reduce its fiscal exposure given the growing number of extreme weather events.

Chapter 3 examines federal flood insurance and risk management approaches. This report suggests that new reforms and incentives are needed to help metropolitan regions appropriately regulate vulnerable coastal land and remain attractive places to live and do business.



Storm surge left many lower Manhattan streets underwater on October 30, 2012.

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Chapter 4 maintains that resilience is the responsibility of all federal agencies, as well as state and local governments. The chapter recommends ways to integrate adaptation into funding programs and federal planning activities that influence infrastructure investments. The focus is on major federal expenditures that either shape physical infrastructure with regional implications or have broad impacts on state and local land-use decisions.

Chapter 5 describes the science, information, and planning tools that facilitate more adaptive planning and policymaking—particularly data-driven support tools that can help leaders make decisions in the face of uncertainty.

Chapter 6, in conclusion, offers specific policy recommendations to position federal agencies to help coastal regions adapt to a changing climate. These recommendations can advance a national strategy for disaster recovery that helps coastal regions adapt to future conditions by integrating hazard mitigation and risk management approaches into federal policies. They include the following measures:

Anticipate future climate impacts during the disaster recovery and rebuilding processes:

- Adjust the rules that govern the use of disaster relief aid to help communities not only rebuild but rebuild in a more resilient way.
- Strengthen connections between pre-disaster and post-disaster planning efforts.
- Evaluate projects on their true costs and risks, including life-cycle costs and environmental impacts.
- Develop new financing and insurance models that capture the value created through mitigation to support long-term investments in resilience.

Align federal policies and programs to reduce risk and restore the health and productivity of coastal resources over the long term:

- Remove incentives to develop in hazardous areas.
- Create risk reduction standards for multiple hazards, base them on future climate conditions, and build in a threshold for uncertainty.
- Enforce Executive Orders that serve to protect and restore ecological resources.

Enable effective urban infrastructure and development patterns:

- Incentivize regional planning across federal grant and loan programs.
- Incentivize state and local governments to play a leadership role in risk reduction and environmental protection.
- Support strategic investments in energy resilience.
- Distribute costs and responsibility for risks fairly and help low-income households access affordable housing in lower-risk areas.
- Reward cities for partial mitigation activities that reduce flood losses.

Develop and share data, guidance materials, and decision-support tools to help governments and property owners make forward-thinking decisions:

- Invest in science and decision-support tools to help both the public sector and the private sector make decisions that support resilience.
- Expand the use of new technologies to integrate two-way flows of information among all levels of government.
- Disseminate guidance and best practices across federal programs and use data visualization to effectively communicate risk to the public.



CHAPTER 1

Introduction: Learning from Disaster to Create Climate-Resilient Regions



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When Hurricane Sandy made landfall in Brigantine, New Jersey, on October 29, 2012, it brought much of the New York–New Jersey–Connecticut metropolitan area to a standstill. The storm spared little as it tore through New Jersey and New York. It flooded key arteries in and out of New York City, including the Brooklyn–Battery Tunnel and Amtrak’s Hudson River tunnel. It disabled power plants and transmission lines, leaving 8.5 million customers in three states without electricity, some for weeks. The storm surge easily overtopped protective dunes and floodwalls from Atlantic City

to New London, damaging more than 600,000 homes and killing 60 people.

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Hurricane Sandy was a wakeup call that elevated the discussion about disasters and climate change at all levels of government. Public officials realized that the regional

The Brooklyn–Battery Tunnel floods as Hurricane Sandy pummels New York City.



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Hurricane Sandy winds and storm surge carved a path through Fire Island in four places, leaving the biggest breach at Old Inlet in the federally protected Otis Pike High Dune Wilderness area.

reach of the storm demanded a new approach to disaster relief and recovery. Current strategies for disaster recovery, urban planning, and coastal management would no longer be viable. In the face of rising sea levels, these outdated approaches would undermine riverine and coastal ecosystems, endangering people, property, and the economy.

Many coastal regions are vulnerable to the effects of climate change, including extreme weather, sea level rise, erosion, and heavy precipitation. Important components of the nation's economy, coastal cities and their regions depend on healthy shoreline and marine ecosystems and reliable regional networks of infrastructure in order to function. As disasters become more severe and costly, a new federal approach will be necessary to minimize fiscal exposure to extreme weather and to help coastal regions become more resilient (box 1).

This report details how federal agencies can help coastal regions adapt to future climate conditions under their current legal

authorities. Small changes in how federal agencies structure and implement policies and programs can have large benefits. We use Hurricane Sandy as a touchstone that offers a number of important lessons for future federal actions and policies. The set of measures identified here can unify policies, regulations, and administrative practices into a more integrated framework for resilience that can help the New York metropolitan region and the nation alike.

PIVOTING FROM DISASTER RECOVERY TO CLIMATE ADAPTATION

The disaster recovery process is a set of actions undertaken to repair and restore communities affected by a disaster. Although response is key, scholars argue that effective disaster recovery should take place before, during, and after a disaster through planning, response and relief, and long-term rebuilding, respectively (Smith 2011). In the United States, disaster recovery policy tends to focus on response and relief. Without

appropriate planning before a disaster, however, tension can arise between the urge to return to normal and the desire to transform communities to become more resilient. While a swift rebound may be an expedient goal, it can also lead to forms of development that exacerbate risk and presage the next disaster.

From 1980 to 2013, the United States experienced 151 natural disasters that incurred at least \$1 billion in damages, according to the National Climatic Data Center. The federal government has repeatedly marshaled considerable financial and technical resources to help affected communities recover. Over time, the federal government has also assumed a higher proportion of the cost of extreme weather events. A changing climate will likely increase this fiscal exposure. However, the federal government cannot afford to simply rebuild the way things were before a major storm (U.S. Government Accountability Office 2013). Federal disaster recovery resources should be guided by a science-based frame-

BOX 1

How Do We Define Resilience?

“Resilience” emerged as a buzzword after Hurricane Sandy, but it has existed in many disciplines to describe a system’s capacity to recover from adversity. In the urban context, resilience is a community’s ability to rebound quickly from shocks and stressors while at the same time reducing future risk (Rodin and Garris 2012). Implicit in this definition is the focus on iterative learning, adapting in the face of adversity, and risk reduction. By incorporating resilience as a goal for planning, investment, and operations, metropolitan areas can become less vulnerable over time. Importantly, resilience is about managing known risks but also about preparing for the unpredictable. Consequently, resilience requires solutions that are robust across many future conditions, with multiple lines of defense, and with opportunities to learn as uncertainties become known.

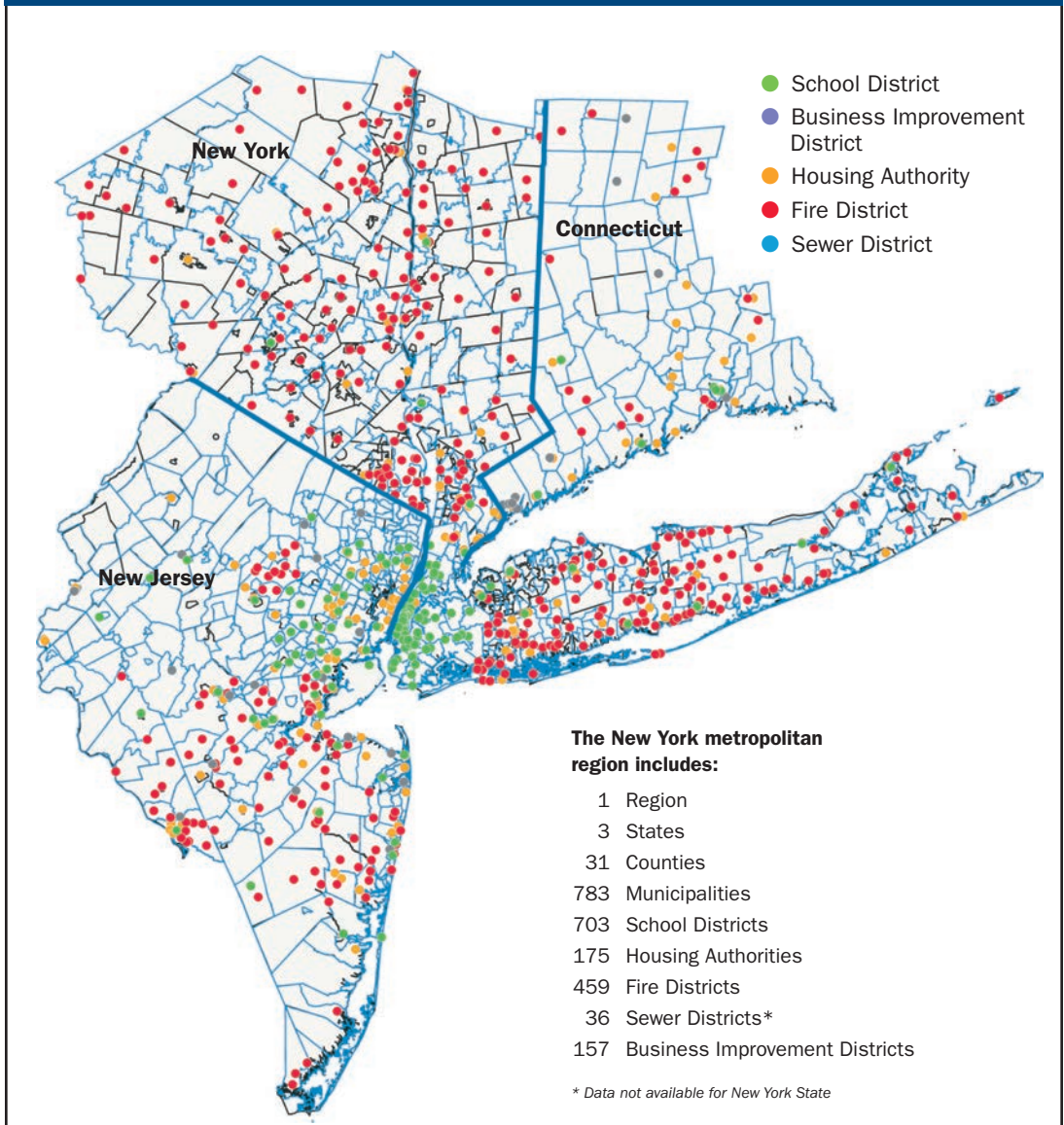
work that helps communities manage current and future risk more effectively. This approach can optimize the use of federal resources and develop coastal regions that are better prepared to recover from the effects of climate change.



This rendering of Asbury Park by HR&A Advisors/Cooper Robertson and Partners shows how the historic beach community could be reimagined and revitalized through a combination of resilience measures, including a boardwalk-berm system.

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FIGURE 1
Fragmentation of Governance in the New York Metropolitan Region



This map shows that planning and decision-making in the New York metropolitan region are fragmented.

Source: Regional Plan Association

WHY DO REGIONS MATTER?

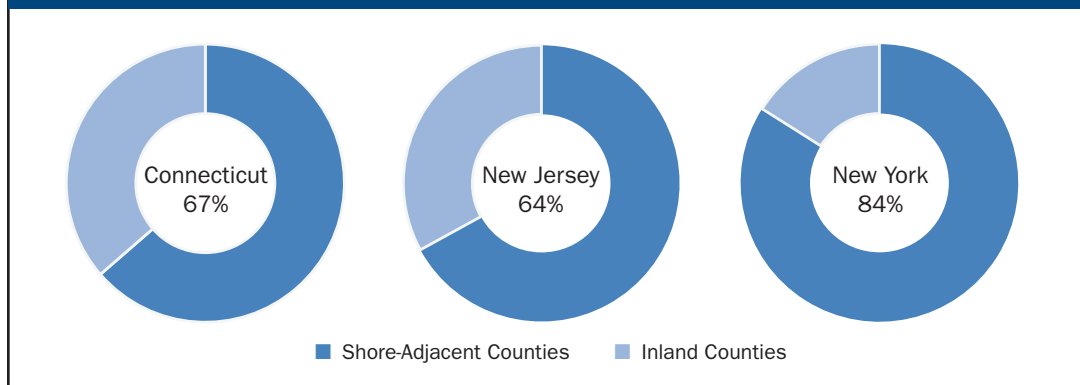
Metropolitan regions consist of cities and subcenters that are geographically defined by linked economic and labor markets, shared natural resources, and integrated transportation systems.

Climate change—like many other environmental, social, and economic challenges—cannot be solved by independent governments acting alone. Figure 1 illustrates the fragmentation of responsibility manifested

in the myriad of local governments and special authorities in the United States. This fragmentation gives rise to development patterns and management regimes that make it difficult to address the needs of shared regional systems in the face of this global challenge.

In particular, the impacts of extreme weather events are not constrained by political or administrative boundaries. Heavy precipitation may flood low-lying areas

FIGURE 2

Average Share of State GDP Generated in Shoreline-Adjacent Counties, 2000–2012

Source: NOEP Ocean Economics Data Portal

and disrupt wastewater treatment facilities, hospitals, or airports. Such disruptions can have regional implications for public health, mobility, and the economy. Weak links in infrastructure and supply chains can lead to cascading failures. New coastal protection measures that protect one area of a city may magnify flooding elsewhere. Strengthening connections between a city and its region can help to alleviate economic pressures, housing shortages, and other challenges as municipalities recover from disasters and adapt to future climate conditions.

Finally, most local jurisdictions do not have the financial or technical resources to adequately address climate risks. Regional cooperation can yield greater expertise for solving technical difficulties and provide efficiencies of scale for both capital and operating costs.

Coastal Regions are High Value

Coastal regions are critical to the nation's economy. In 2011, \$6.6 trillion (45 percent of our nation's gross domestic product) was generated in coastal counties of the oceans and the Great Lakes region (NOAA 2011). Figure 2 illustrates the percent of state GDP generated in the shoreline-adjacent counties of New York, New Jersey, and Connecticut from 2000 to 2012. In order to remain attractive places to live and do business,

these coastal economies depend on healthy coastal ecosystems and dependable, uninterrupted infrastructure.

Coastal regions are also growing, as illustrated by figure 3 (p. 11) (King 2013). Although more people are settling in these areas, the land is increasingly at risk. Shorelines are dynamic and shaped by weather, subsidence, sea level rise, and erosion. As climate change accelerates these processes, more of the land that supports development and settlement along the shoreline will become hazardous. We can expect increased economic and insured losses from disasters such as floods, hurricanes, and nor'easters as more people and businesses locate in areas that are increasingly vulnerable to littoral hazards and extreme weather.

Regional Mobility and Critical Infrastructure

Transportation systems depend on a multitude of complex and interrelated components in order to function. When one component fails, the effects can be catastrophic to the system as a whole. During and after Hurricane Sandy, the entire Northeast Corridor, from Washington, D.C., to Boston, was disabled due to the failure of a key component of the region's supporting infrastructure—the NJ Transit substation in Kearny, New Jersey.

The segment of the Northeast Corridor located in New Jersey—from New York’s Penn Station to Trenton, including Princeton, New Brunswick, and Newark—is one of the nation’s busiest rail lines, carrying more than 150,000 passengers per day on Amtrak and NJ Transit, in addition to freight trains. To prepare for Hurricane Sandy, the segment of the corridor in northern New Jersey was shut down, but these preemptive efforts did not fully address the infrastructure interdependencies.

The Kearny substation provides power for a rail segment near Newark, New Jersey, just to the west of the facility. Located in low-lying marshlands, the substation was inundated with brackish water, which destroyed much of the electrical equipment on site. After the water retreated, Amtrak and NJ Transit began to clear tracks and pump out the flooded North River tunnels. After pumping the first tunnel, both train

operators resumed extremely limited service starting November 2, 2012. After pumping the second tunnel, service was restored to 63 percent of its normal capacity, but the lack of a fully functional substation in Kearny prevented both Amtrak and NJ Transit from resuming operations at full capacity (Goldmark 2012). NJ Transit finally restored 90 percent of its operations on November 16, 2012, when the Kearny substation was repaired, but full service was not restored until a year later, in October 2013, when the train line replaced railcars destroyed by Hurricane Sandy.

Regions encompass many networks of systems, and one weak link can lead to catastrophic failures. Federal guidelines, regulations, and assistance to support infrastructure resilience will be critical for helping regions sustain the movement of people and goods necessary in times of disaster as well as in times of calm.

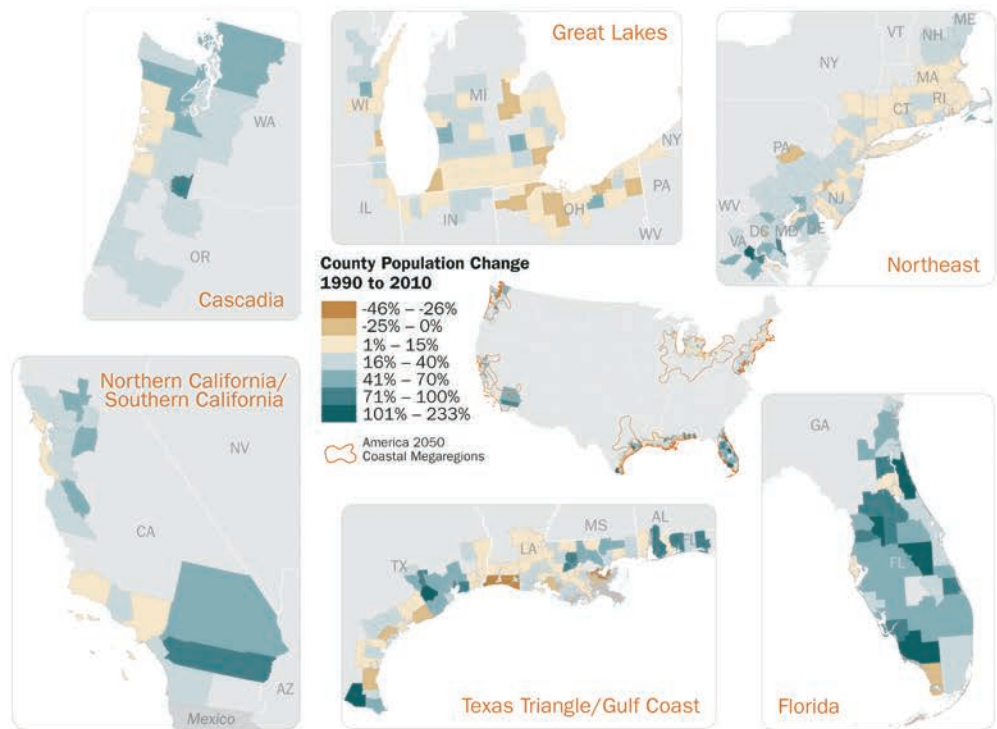
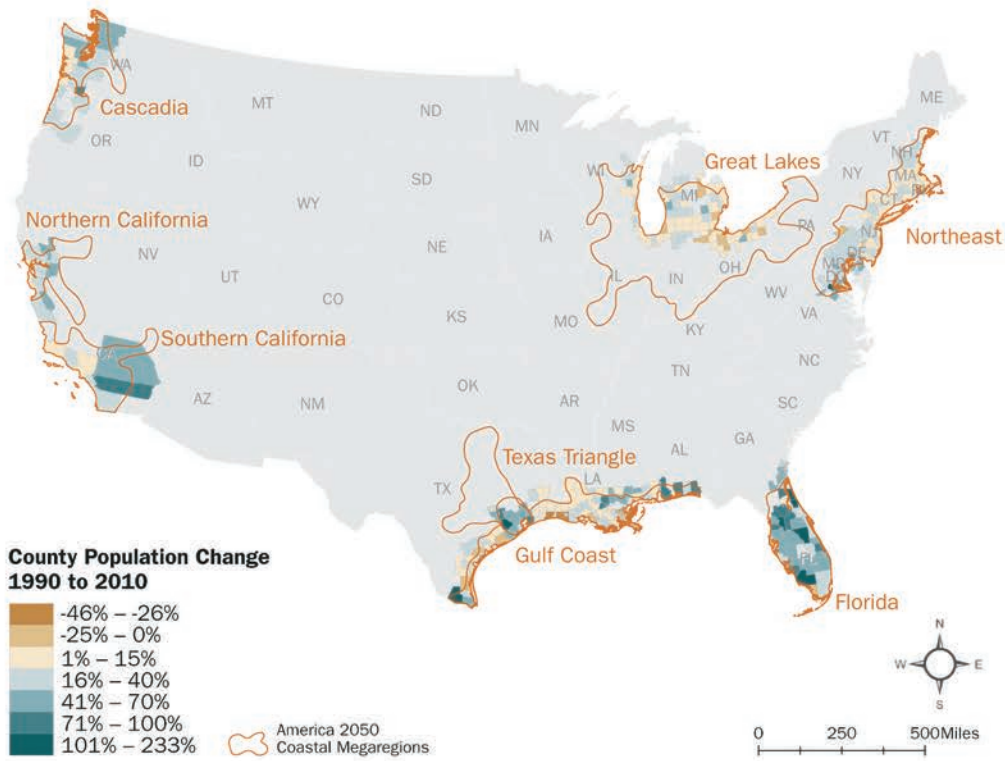
Laborers work to protect the Kearny train substation with sandbags as a temporary measure to prevent flooding until the power center can be relocated and raised.



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FIGURE 3
Coastal Megaregions in the United States

Coastal regions are growing as more people settle on shorelines and revitalize urban waterfronts.



Source: Regional Plan Association

Federal Efforts to Address Climate Change

Federal agencies are already taking action to advance resilience. Some of these efforts are focused on adapting to climate change broadly, while others specifically address the use of disaster relief appropriations. These actions are critical steps toward a national strategy for climate resilience.

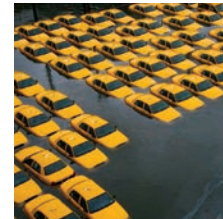


August 29, 2005
Hurricane Katrina made landfall in New Orleans, overwhelming the Mississippi Delta region with both heavy rainfall and surge. The city's low-lying topography and social

vulnerabilities made the devastation particularly catastrophic when the water overtopped the city's levees. Physical and economic recovery has been slow, exacerbating many of the vulnerable conditions that predated the storm. However, Hurricane Katrina was a cataclysmic event that helped to make federal agencies rethink flood management policies, including the roles of flood protection and hazard mitigation.

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November 2009
The Federal Interagency Floodplain Management Task Force was reconvened to prepare recommendations for a national strategy for floodplain management and to align federal policies and programs in order to support smart floodplain management.



October 29, 2012
Hurricane Sandy made landfall in Brigantine, New Jersey, as a post-tropical cyclone. Although the storm was relatively weak on the Saffir-Simpson

scale, it colluded with other weather systems, making it very large and powerful. Sandy was primarily a surge event, flooding many communities not only from the coast but also from surge that traveled through rivers and tributaries. Federal agencies deployed throughout the eastern seaboard in preparation for Hurricane Sandy. President Obama activated the new National Disaster Recovery Framework, one of the first times the strategy was deployed.

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2005

2006

2007

2008

2009

2010

2011

2012

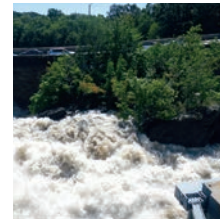
October 5, 2009

Executive Order 13514 (2009), "Federal Leadership in Environmental, Energy and Economic Performance," recognized that climate change will impact the missions, operations, and assets of federal agencies. The order tasked agencies with developing and implementing strategic sustainability performance plans, reducing agency greenhouse gas emissions, and developing other ways to minimize resource intensity. The Executive Order established the Interagency Climate Change Adaptation Task Force, spearheaded by the White House Council on Environmental Quality and the White House Office of Science and Technology. The task force is responsible for coordinating federal adaptation efforts and identifying strategic adaptation priorities for the federal government.

October 5, 2010

The federal Interagency Climate Change Adaptation Task Force released its first progress report, which outlined five policy goals in support of a national climate adaptation strategy.

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August 28–29, 2011

Tropical Storm Irene made landfall in the Bahamas, the Outer Banks of North Carolina, New Jersey, and Brooklyn, before striking again in Vermont and New Hampshire. Much of the Northeast suffered record rainfall, which flooded rivers and tributaries and downed many important transportation routes, including the Garden State Parkway and the Holland Tunnel.

December 7, 2012

President Obama signed Executive Order 13632 (2012), "Establishing the Hurricane Sandy Rebuilding Task Force," to provide coordination necessary to support resilient rebuilding between federal agencies and in concert with state and local authorities. The task force, chaired by Shaun Donovan, secretary of the U.S. Department of Housing and Urban Development (HUD), also focused on "[removing] obstacles to resilient rebuilding."

January 29, 2013

The Sandy Recovery Improvement Act (SRIA) was passed to streamline the administration of disaster relief funding to Sandy-affected communities authorized as part of the Disaster Relief Appropriations Act of 2013 (FEMA 2013). SRIA provided important legislative changes to the Stafford Act, which is the key statute that governs disaster relief funds (Smith and Grannis 2013). SRIA made disaster relief funds more flexible in order to support resilience in the recovery and rebuilding processes.

June 25, 2013

President Obama released his Climate Action Plan. The first cross-cutting strategy is to reduce carbon emissions from energy production and power generation, transportation, and buildings. The second strategy is to promote climate-resilient infrastructure and to protect the economy through improved resource management and better science and decision-support tools. The third strategy promotes leadership abroad.

November 1, 2013

President Obama issued Executive Order “Preparing the United States for the Impacts of Climate Change” to help implement the President’s Climate Action Plan. In addition, it established an Interagency Council on Climate Preparedness and Resilience to coordinate federal efforts on climate change and resilience. It also established a State, Local and Tribal Leaders Task Force on Climate Preparedness and Resilience, which will make recommendations for removing obstacles for addressing climate change in 2014.

February 2013

The Government Accountability Office designated the federal government’s fiscal exposure to climate change as a “high risk” problem that requires the attention of the Executive branch as well as Congressional oversight (GAO 2013).

2013

February 28, 2013

The National Oceanic and Atmospheric Administration and the U.S. Army Corps of Engineers jointly signed the Infrastructure Systems Rebuilding Principles. These principles present a unified approach for rebuilding and restoring coastal infrastructure in the Sandy-affected region (NOAA and USACE 2013). They emphasize intergovernmental collaboration, a systems-based approach to coastal protection and restoration, and actionable science and risk awareness.

August 19, 2013

The Hurricane Sandy Rebuilding Task Force released the Hurricane Sandy Rebuilding Strategy, which includes 69 recommendations to rebuild the Sandy-affected region in a more resilient manner. Agencies work to adopt and implement the recommendations as Sandy supplemental funds are administered.

November 15, 2013

HUD issued Floodplain Management and Protection of Wetlands, a final rule on the agency’s activities in these sensitive areas. The final rule prohibits the use of HUD formula funds (e.g., Choice Neighborhoods and Community Development Block Grants) and Federal Housing Administration mortgage guarantees for new construction in Coastal High Hazard Areas (V-zones) (HUD 2013c). It also clarifies the application of Executive Order 11988, which was issued in 1977 and limits federal support for the unwise use of floodplains.

June 20, 2013

HUD launched Rebuild by Design, an initiative of the Hurricane Sandy Rebuilding Task Force (HUD 2013a). The competition is aimed at using innovative design to get in front of climate change while addressing other community needs in the Sandy-affected region.

December 23, 2013

FEMA issued a memorandum that allows Hazard Mitigation Grant Program applicants to account for projections of sea level rise in their Benefit-Cost Worksheets.



CHAPTER 2

Disaster Relief

Disaster relief funding provides a critical opportunity for cities and regions to invest in their roadways, sewage treatment plants, and other assets. Many state and local governments already suffer from budget shortfalls and are unable to maintain existing infrastructure, which may be aging, operating beyond capacity, or in need of repair long before a disaster strikes. When the President declares a disaster, financial aid becomes available through the Disaster Relief Act (1974) and the Stafford Act (1988). Unfortunately, these laws have not been modified to reflect the changing climate or the current fiscal environment. Amending these laws would take an act of Congress, but, in the meantime, there are several ways that federal agencies can ensure that financial

aid reaches disaster-affected communities in a timely way that encourages regional cooperation and integrates risk reduction into the rebuilding process.

TIMING OF ASSISTANCE

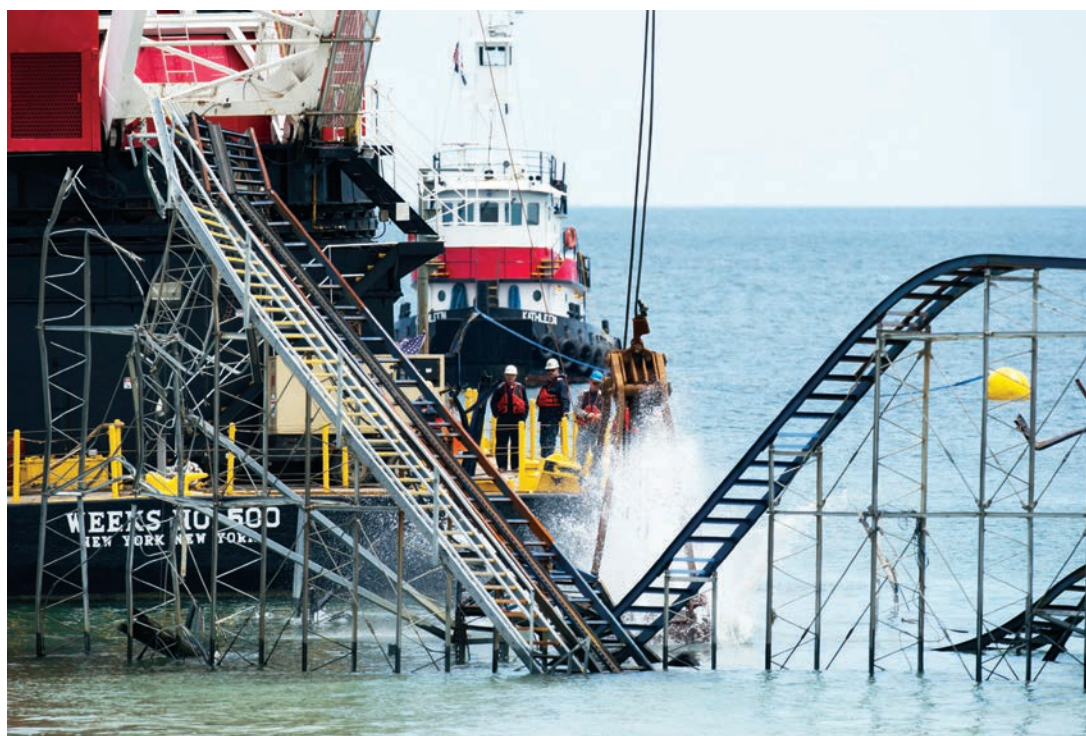
After an extreme weather event, it is important to release federal disaster relief funding quickly and with clear guidelines to ensure that recovery aligns with national priorities for resilience and risk management. While swift delivery of aid can help communities recover more rapidly, guidance and requirements are necessary to combat the tendency to simply return to pre-disaster conditions. Federal agencies can tie discretionary funding to specific policy objectives.

After Hurricane Sandy, it was unclear how much aid Congress would appropriate

President Barack Obama discusses post-Sandy recovery efforts on October 31, 2012, with then-homeland security secretary Janet Napolitano, then-defense secretary Leon Panetta, and HUD secretary Shaun Donovan.



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More than six months after Hurricane Sandy pulled Seaside Heights' rollercoaster into the sea, workers dismantled and removed the remnants.

for recovery. During this time, the Federal Emergency Management Agency (FEMA) encouraged private property owners to apply for Small Business Administration (SBA) loans. Many people wanted to return to normal as soon as possible and applied for the loans. This rush led to complications once the Disaster Relief Appropriations Act of 2013 was finally passed, in January 2013. For example, a business owner who received an SBA loan became ineligible for a grant from Community Development Block Grants-Disaster Recovery (CDBG-DR), authorized by the Disaster Relief Appropriations Act. To address this problem, the U.S. Department of Housing and Urban Development (HUD) informed CDBG-DR grantees (state, local, and tribal governments) that property owners with SBA loans could still be eligible for grants at the discretion of the CDBG-DR grantee. While this discretionary authority helped private property owners, it became an administrative burden to governments that were

already trying to navigate complex disaster recovery laws, regulations, and administrative policies.

While it is critical that assistance flow swiftly to state, local, and tribal governments, it is also important to ensure that recipients have enough time to create a coordinated, forward-thinking plan for spending the money and rebuilding in a more resilient way. To receive CDBG-DR funds, states (and sometimes municipalities) must submit state action plans that detail how the money will be spent. HUD establishes requirements that each action plan must consider. For the notice of funding availability for the second tranche of CDBG-DR aid in October 2013, HUD required a comprehensive regional risk assessment and other requirements to ensure that monies would be used to support resilience (HUD 2013b).

A forward-looking action plan can take time to create, but cities and states with a strong hazard mitigation plan or a pre-

disaster strategy may be better positioned to write an action plan that is timely, publicly accepted, and aligned with national priorities. Better integration of a hazard mitigation plan into other planning functions, such as a comprehensive plan, can help ensure that disaster recovery funds will meet long-term goals for resilience.

COORDINATION OF ASSISTANCE

State, local, and tribal governments can mix and match disaster relief aid to pay for recovery and long-term rebuilding projects. However, each agency uses different project evaluation methods and has different requirements for each funding source. It can be costly and time consuming to meet these requirements while piecing together multiple funding sources in each project.

One common challenge is following the requirements of each agency's Benefit-Cost Analysis framework. FEMA, for example, permits applicants to consider environmental benefits only when the benefit-cost ratio reaches .75, whereas the Department of Interior sets no such threshold (National Fish and Wildlife Foundation 2013).

It is especially difficult to piece together funding for multiphase projects or for projects that seek to build multiple layers of protection. For instance, FEMA has a specific definition of a "project," which can differ from the definition used by other agencies. The Hazard Mitigation Grant Program (HMGP), administered by FEMA, is not well-designed for multi-phase or adaptive projects. The FEMA Benefit-Cost Analysis framework requires that a complete project have only one phase (Lakhia 2014). Additionally, cities that implement mitigation measures on the land may no longer qualify for a structural or nonstructural flood protection measure from the U.S. Army Corps of Engineers (USACE);

this restriction can discourage states and cities from minimizing risk on their own.

Requirements among different funding streams should be better integrated and coordinated, based on an understanding of how they are being combined to support resilience. Federal agencies should develop shared investment criteria and resiliency standards that ensure that long-term rebuilding projects work towards a shared vision for resilience.

SOURCES OF ASSISTANCE

The Stafford Act enables Congress to provide aid to state, local, and tribal governments when the President declares a disaster, which triggers the appropriation of federal aid to the Disaster Relief Fund (DRF) to underwrite activities such as debris removal or the repair of damaged public infrastructure. Disaster relief assistance is conveyed from the DRF to federal agencies and then to state, local, and tribal governments through specific programs.

Public Assistance Program

The Public Assistance Program is used to repair, restore, or replace public facilities according to pre-disaster conditions. Administered by FEMA, the program can be coupled with HMGP funds (specifically §406) to pay for hazard mitigation activities as well. Because such improvements add to the cost of rebuilding, however, they are not reimbursable by FEMA. State and local governments must cover the extra costs. Although alternative types of disaster assistance can be used to fill the funding gap, other political and logistical challenges may arise (Smith and Grannis 2013). For instance, if a roadway runs through multiple jurisdictions, some cities or towns may lack the resources or the desire to build to a higher standard. One such weak link can undermine all the improvements to a



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system. Mandatory risk reduction standards and incentives for regional cooperation could help address this challenge.

Furthermore, the Public Assistance Program does not permit the relocation of public facilities. In light of climate impacts, it may be more cost effective to relocate public facilities from hazardous areas than it is to repair, restore, or replace them. A life-cycle approach to project evaluation could advance resilience by minimizing development in risky areas.

Hazard Mitigation Grant Program

The 1988 Stafford Act authorizes FEMA to fund two types of post-disaster hazard mitigation activities, which can be underwritten through the HMGP. The Act authorizes

hazard mitigation activities that apply to a particular damaged structure, such as a public library. It also authorizes a wider range of mitigation activities in which aid is based on a formula related to the total amount of disaster relief monies that are appropriated, such as a buy-out program. Either set of hazard mitigation activities are intended to decrease the losses of life and property from future hazards (Smith and Grannis 2013).

For many of its programs, FEMA relies on historical data to identify hazards and vulnerabilities without properly accounting for future risks (Smith and Grannis 2013). As of December 2013, however, FEMA permits cities and states to include projections of sea level rise in their Benefit-Cost

In February 2013, the U.S. Army Corps cleared debris from the site in Breezy Point, New York, where 110 homes burned to the ground during Hurricane Sandy.

TABLE 1
Requirements for Future Climate Impact Consideration in Plans

Plan Type	Required	Optional
Hazard Mitigation Grant Program Benefit-Cost Worksheet		●
Hazard Mitigation Plans		●
State Action Plans for Community Development Block Grants-Disaster Recovery*	●	
Non-Federal Partner Floodplain Management Plans		●
Long-Range Transportation Plans	●	

* Note: Applies only to the Sandy supplemental appropriations at this time.

Analysis Worksheet for their applications to the HMGP. This measure helps account for future climate impacts and benefits that accrue over the life cycle of a project. Although FEMA still allows applicants to determine which sea level rise projections to incorporate—if any—this step fosters a more forward-thinking approach to hazard mitigation.

Although many federal agencies require applicants to complete extensive planning processes in order to receive formula-based or discretionary funds, they do not always require applicants to consider future climate impacts. Table 1 shows that consideration of future climate impacts is often encouraged but optional.

Currently, HMGP funds are awarded to state-level emergency program management offices. For large municipalities such as New York City, it may be more efficient and timely to permit direct allocations of HMGP funds, as CDBG-DR is structured. Direct funding to municipal governments, however, would require an amendment to the Stafford Act.

At present, states and municipalities must have a Hazard Mitigation Plan (HMP) in place in order to receive HMGP funds after a disaster. FEMA requires an inventory of risks and vulnerabilities but does not require state and local governments to consider

future climate impacts in the plan (New Jersey Future 2013). When a disaster occurs, and a state or local government becomes eligible for hazard mitigation funds, the grantee must demonstrate that the mitigation activity is cost effective in the long run. Such proof can be difficult if decisions are based only on historical records.

Community Development Block Grants-Disaster Recovery

Another form of disaster recovery aid is CDBG-DR, which is administered by HUD. The federal government issues CDBG-DR grants directly to state, local, and tribal governments, which have a high degree of discretion over how to use the money. This source of federal disaster recovery aid is the most flexible. For instance, CDBG-DR can be used to fund mitigation activities, pay a local match to meet federal cost-share requirements, or cover the costs of structural improvements to public infrastructure.

Although CDBG-DR should remain flexible, HUD could tie this funding source to investment criteria that advance resilience. For the Sandy supplemental, HUD required new construction and replacement structures to conform to LEED or Energy Star green building standards. For the second tranche of funding, HUD required each covered project to complete a vulnerability assessment that accounts for future climate change. This approach can help to prioritize long-term recovery and rebuilding projects that align with national priorities. By mitigating greenhouse gas emissions and hazards, it can also reduce the long-term need for these supplemental appropriations in the future.

Federal Highway Administration Emergency Relief

The Emergency Relief (ER) program of the Federal Highway Administration

(FHWA) is a good example of how to structure federal disaster recovery assistance to build resilience. The program allows grantees to rebuild highway infrastructure and manage future risks through its standards for comparable facilities and betterments. The FHWA will reimburse states for the costs of a comparable facility, which need not be built to pre-disaster conditions. A comparable facility must meet the standards required for the types and volume of traffic that the structure will carry over its design life (i.e., the length of time it is expected to

be operational). Because the design life standard is future oriented, transportation planning authorities are better able to anticipate climate impacts. Additionally, the ER program allows states to mitigate future risk through “betterments,” which are “added protective features,” different from what existed prior to the disaster. FHWA allows grantees to take a life-cycle approach to cost-benefit analysis; betterments are approved when they are deemed cost effective and necessary over the design life of the structure (FHWA 2012).

Drivers churn through a flooded highway in Toms River, New Jersey, on October 30, 2012.



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CHAPTER 3

Insurance and Flood Risk Management



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Sea level rise will elevate flood risk and insurance rates in low-lying residential oceanfront communities such as Bay Head, New Jersey.

In coastal regions, developable land is at a premium. Waterfront access and other amenities continue to attract people and businesses, and coastal areas are projected to grow rapidly through the 21st century (Urban Land Institute 2013). At the same time, sea levels are expected to rise from 7 to 80 inches by 2100 (see table 2). In the face of more severe storms and sea level rise, risks to life and property will certainly increase. Although all federal agencies are responsible for managing the proliferation of coastal flood risks, insurance can play a key role in sending appropriate market signals to encourage effective planning in hazardous areas.

THE NATIONAL FLOOD INSURANCE PROGRAM

The federal government offers flood insurance through the National Flood Insurance Program (NFIP), established in 1968 and administered by FEMA. The purpose of the NFIP is twofold: First, it pools risk and helps guarantee the availability of flood insurance. Second, it reduces risk by requiring communities to adopt a floodplain management ordinance that meets or exceeds minimum federal standards. Property owners are eligible to purchase flood insurance from the NFIP when their community adopts a floodplain management ordinance and the Flood Insurance Rate Map (FIRM)

provided by FEMA. Property owners are required to have flood insurance coverage in order to obtain a federally backed mortgage in flood hazard areas.

Pooling Risk

The NFIP has not been effective at pooling risk, in part due to subsidies on many policies, limited coverage, and incomplete data. For instance, the NFIP has historically subsidized properties incurring severe repetitive losses, second homes, and buildings that were built prior to when their community joined the NFIP. At the outset of the NFIP, these subsidies were necessary to encourage communities to participate in the program. As the program has matured, however, the NFIP has struggled to remain solvent and meet its policy objectives.

In recent years, the NFIP has undergone major changes in response to significant flood events (AECOM 2013). In 2012, the federal government passed the Biggert-Waters Flood Insurance Reform Act to improve the NFIP's financial situation and limit federal exposure to flood losses. As written, Biggert-Waters would have employed a "beneficiary pays" model by eliminating many subsidies, including those for severe repetitive loss properties and second homes. It would also have instituted risk-based pricing by raising premiums over the course of four years. Because the law would impose high costs on homeowners, Congress voted in March 2014 to delay the phase-out of subsidies for three years.

Data Gaps in the NFIP

Buildings with floors below ground level are common in dense urban areas, but FEMA does not have complete data for buildings below the Base Flood Elevation (BFE). FEMA also lacks full elevation data for buildings that were constructed prior to their community's adoption of FIRMs; approximately 20 percent of all policies in

TABLE 2 Projected Sea Level Rise by 2100		
Source	Scale	Sea Level Rise Projection
Intergovernmental Panel on Climate Change 2007	National	7" to 23"
Rahmstorf 2007	National	20" to 55"
Pfeffer et al. 2008	National	31" to 80"
Rohling et al. 2008	National	63"
National Panel on Climate Change 2010	Regional	12" to 23" (or 41" to 55" with rapid ice melt scenario by 2080)
Miller and Kopp 2012	Regional	44" by 2100
National Panel on Climate Change 2013	Regional	11" to 24" (or 31" with rapid ice melt by 2050)



Flood waters rose 7 feet above sea level in the Rockaways.

© CAMERON BLAYLOCK

force nationwide predate their local FIRMs. With these critical gaps in the data, it is difficult to assess accurate risk-based premiums.

If implemented as it is currently written, Biggert-Waters will have important implications for coastal regions. First, the law will help shift responsibility for floodplain management to state and local governments as well as private property owners. By 2050, 1,813,088 housing units (21 percent) in the New York metropolitan region will be located in the coastal floodplain. However, it may be difficult to bring urban structures into compliance through approved measures in urban areas. Failure to mitigate risks by complying with new BFEs will be costly to property owners and could shape housing markets and development trajectories on urban waterfronts.

Floodplain Management Regulations

The second policy goal of the NFIP is to reduce flood losses over the long term by requiring that new and substantially

improved structures meet or exceed NFIP standards. For example, the lowest floor of new homes must be built above the BFE, which describes the height of the one percent annual chance flood (sometimes referred to as the “100-year” flood).

Additionally, the Community Rating System (CRS) supports broader efforts to reduce flood risk. The CRS is a voluntary incentive program that encourages local floodplain management to implement mitigation activities beyond national requirements by rewarding policyholders with discounted insurance rates. Municipalities that implement mitigation measures advance into CRS classes ranging from 1 to 10. Class 1 communities have taken the maximum steps to reduce flood risks; class 10 communities have taken the minimum number of steps to become eligible for the CRS (FEMA 2013). As communities take more initiative to mitigate flood risks, policyholders benefit from lower insurance premiums. By translating good practice into real financial incentives, the CRS helps local government sustain flood-smart standards.

Most municipalities are not able to take advantage of the full potential of the CRS. Although 67 percent of all the NFIP policies in force are located in CRS communities, some participating local governments do not move beyond the minimum requirements. Of the 1,273 localities enrolled in the CRS nationwide as of October 2013, only 11 communities are in classes 1 to 4 (FEMA 2013).

Few CRS communities move beyond minimum requirements because the demands of eligibility are burdensome, and communities do not have sufficient resources to take the additional steps required to reduce flood risk comprehensively. In addition, some of the approved activities are not suitable in an urban context. For instance, the NFIP recommends elevating houses,

BOX 2

Minimizing Resistance to FIRMs and ABFEs

After Hurricane Sandy, FEMA released Advisory Base Flood Elevation Maps (ABFEs) to help determine where to reconstruct buildings damaged by the storm in New York City, Westchester County, and New Jersey. These maps were updated from the 1983 Flood Insurance Rate Maps (FIRMs), but they relied on data collected prior to Hurricane Sandy. These maps did not reflect the erosion that occurred in areas that were hard-hit by the superstorm. Although FIRM maps are not intended for planning purposes, misinformation and outdated data can encourage resistance to ABFEs and FIRMs.

FEMA also lacks a substantial amount of elevation data on properties with insurance policies that predate FIRMs—an estimated 20 percent of all policies nationwide. Additionally, FEMA does not have data on buildings below the base flood elevation and does not appropriately assess and price the risk for these structures, which are common in urban areas. Additional data collection is needed in order to implement risk-based pricing for flood insurance premiums.

TABLE 3
Infrastructure Located Within the 100-Year Floodplain in New York, New Jersey, and Connecticut in 2014 and 2050

	Total	100-Year Floodplain in 2014		100-Year Floodplain in 2050	
		Number	Percentage	Number	Percentage
Train Stations	905	62	7%	115	13%
Train Tunnels	12	12	100%	12	100%
Subway Yards	21	4	19%	7	33%
Airports	6	4	67%	4	67%
Ports	6	6	100%	6	100%
Electric Generation Capacity (MWh)	32,636	9,127	28%	19,181	59%
Public Housing Developments	6,372	361	6%	907	14%
Public Housing Units	228,317	19,968	9%	47,382	21%
Hospitals	462	22	5%	40	9%
Hospital Beds	80,426	5,112	6%	9,214	11%
Nursing Homes	880	30	3%	49	6%
Nursing Home Beds	140,862	6,750	5%	11,145	8%

Source: Regional Plan Association

Note: For New York State and New Jersey, the 100-year floodplain in 2050 is calculated by combining the best available 100-year floodplain data for the 31 counties of the New York metropolitan region with NOAA'S highest sea level rise scenarios. We combined the 100-year floodplain data from FEMA'S Preliminary Work Maps with the NPCC and NOAA'S highest sea level rise scenario for 2050 for New York City. For Connecticut, we combined the FIRM maps with the highest sea level rise scenarios produced by The Nature Conservancy.

but it's not possible to elevate the attached multifamily homes that are common in cities. Federal agencies may need to modify and expand the CRS to reward community efforts to manage flood risk, including partial mitigation efforts such as relocating heating equipment above base flood elevation.

FLOOD INSURANCE RATE MAPS

FIRMs (box 2) are used to determine flood insurance rates and communicate flood risk. Inaccurate flood maps present a major challenge for property owners and local planning officials, as well as for the solvency of the NFIP.

FEMA's FIRMs reference historical data and therefore do not anticipate future climate conditions or fully map all properties that

are at risk. Although FEMA is currently in the process of updating its maps through RiskMAP, FEMA has not been authorized to consider sea level rise or long-term erosion when updating the maps (U.S. GAO 2013). Table 3 shows that the infrastructure that supports the New York metropolitan region is already at risk today but is increasingly at risk when we account for sea level rise. While the RiskMAP revisions will certainly change the number of properties included in the NFIP, these reforms will still underestimate the number of people and properties at risk of flooding. This could undermine efforts to implement more adaptive land use and planning decisions in coastal zones and may send inconsistent messages to property owners.



CHAPTER 4

Urban Infrastructure

Sandy inundated and incapacitated the PATH and NJ Transit commuter rail terminal in Hoboken, New Jersey, which serves 50,000 passengers daily.

Regions rely on interconnected infrastructure systems for transportation, clean water, communication, food, and other essential goods and services. These systems are highly interdependent. When the electric grid is disrupted, hospitals, transit, and other systems cannot function, which leads to catastrophic failures. Regions will need to protect infrastructure that cannot be moved while planning to locate new infrastructure in nonhazardous places. Through their formula-based and discretionary funding streams, federal agencies can influence how cities and regions plan their infrastructure to accommodate a changing coastline and reduce risk over the long run.

TRANSPORTATION

Climate change will pose a major challenge for metropolitan transportation networks, including roads, highways, rail lines, tunnels, and public transit, which carry freight and passengers across metropolitan regions. Like other metropolitan infrastructure, transit networks are often inadequately funded, operating beyond capacity, and in poor repair (box 3). These problems will be exacerbated by the effects of climate change. Sea level rise and severe storms could flood important routes and lead to scour and corrosion, while extreme heat could buckle road surfaces and cause thermal misalignment on steel railroad tracks. Major investments are needed to prepare transportation systems for climate



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change, including the design and location of system components, materials and equipment, and operations.

Several federal statutes and regulations provide opportunities to make the transportation system more resilient. Title 23 of the Code of Federal Regulations requires transportation planning authorities to consider climate change mitigation—specifically in relation to energy and air pollution (FHWA 2014a). However, transportation planning authorities can also advance climate resilience by completing all the required elements in the transportation planning process. The FHWA provides guidance on how to interpret the planning requirements to create climate-resilient transportation systems. Some key opportunities include preserving and maintaining infrastructure, preserving corridors and system connectivity, and advancing economic competitiveness. For example, sea level rise threatens to submerge parts of the Northeast Corridor by the end of the century, which will make it difficult to maintain the corridor and system connectivity. Additionally, transportation authorities are directed to coordinate and consult with related programs, investment schedules, and other plans within the course of the transportation planning process. These activities can support greater consistency with other plans that may also consider climate change, such as municipal comprehensive plans and hazard mitigation plans.

Long-Range Transportation Plans (LRTPs) provide opportunities to apply these federal requirements and improve regional climate resilience. Sections 134 and 135 of U.S. Code Title 23 require Metropolitan Planning Organizations (MPOs) to create LRTPs, which plan for a regional transportation system and guide project prioritization and federal transportation funding over a 25-year planning

horizon. Increasingly, MPOs are incorporating climate change into their LRTPs, but there are large variations based on the level of autonomy that each MPO has and on the other planning authorities with which an MPO must work (FHWA 2014b) (ICF International 2010). Although the FHWA provides guidance on how to mitigate and adapt to climate change, federal agencies will need to strengthen planning attention to the risks that transportation systems will encounter. Moreover, to avoid unwise development, federal agencies will need to encourage transportation planning agencies to develop and shift transportation infrastructure into areas that are not hazardous.

LAND USE

Although local governments hold primary authority over land use in their communities, federal statutes, policies, and programs can also encourage future development to be more resilient. The federal government can reduce risk and reinforce environmental conservation and restoration priorities by aligning federal policies and programs that

BOX 3

The Hoboken Terminal

Hurricane Sandy severely damaged NJ Transit's Hoboken Terminal, an historic landmark that serves more than 50,000 customers daily. The Hudson River flooded the terminal with over five feet of salt water, debris, sediment pollutants, and bacteria. The facility urgently needed remediation, but the restoration required approval by the State Historic Preservation Office. Despite the difficulty of integrating adaptive design and planning into historic preservation requirements, NJ Transit was able to install 60 access panels for fans to help dry out the terminal in the event of future flooding (New Jersey Transit Corporation August 2013). Even so, the work required a long time to complete; NJ Transit wasn't able to reopen the terminal's waiting room until November 18, 2013—more than a year after the superstorm made landfall (WABC-TV/DT 2013).

shape land-use decisions, leveraging state and local policies, and developing minimum standards that encourage state and local governments to plan to accommodate future coastal conditions.

At present, a number of federal regulations and requirements direct growth to protect coastal resources and reduce flood risks. Specifically, the federal government regulates tidal wetlands and navigable waters through the authorities of the Clean Water Act, the Rivers and Harbors Act, and other legislation. To participate in the NFIP, communities are required to adopt building codes and zoning regulations that meet or exceed federal standards. For USACE-partnered projects, nonfederal partners must prepare and implement floodplain management plans. Each of these programs is an opportunity to reinforce risk management in land and water planning.

Two other federal programs are underutilized but have the potential to build resilience, especially if state and local priorities are aligned with a national strategy for resilience. First, the Coastal Barrier Resources Act (CBRA), administered through the U.S. Fish and Wildlife Service (USFWS), protects undeveloped barrier islands in the John H. Chafee Coastal Barrier Resource System (CBRS). Federal financial assistance for development-related activities, such as Federal Home Administration loan guarantees and flood insurance, are not permitted on islands protected in the CBRS (U.S. House of Representatives 2012). Efforts to digitize maps of the CBRS have stalled due to the lack of federal funding. This delay can lead to incomplete information for both property owners and public officials. When state and local regulations are aligned with federal efforts to conserve barrier islands, they can continue to protect people and property against storms.

Second, the Coastal Zone Management Act (CZMA) authorizes and funds state-directed coastal zone management programs (CZMPs), which balance competing needs for conservation, recreation, maritime use, energy production, and urban development in coastal areas. The following three provisions within the law make coastal zone management programs effective for climate resilience: the federal consistency requirement, coastal land acquisition authority, and the coastal zone enhancement objective (Davis and Carter 2007). Together, these three provisions make it possible for states to regulate land use in a way that supports resilience.

Federal Consistency Requirement

The federal consistency requirement of the CZMA states that federal activities that affect the coastal zone must comply with policies of approved state CZMPs. For example, affordable housing units built with federal assistance (such as low-income housing tax credits) within the coastal zone must comply with any risk reduction standards established under the program. The federal consistency requirement is an opportunity to ensure that higher design flood elevations or other risk reduction standards are enforceable in hazardous areas.

Coastal Land Acquisition Authority

The CZMA also authorizes states to acquire coastal land if the purchase is consistent with the goals of the state's program. If a state identifies locations for managed retreat in its CZMP, it can acquire property to accommodate coastal change or protect coastal watersheds. Combined with the Coastal Estuarine Land Conservation Program, the coastal land acquisition authority is a powerful tool for restoring and protecting the ecological value of coastal resources, which also reduce upland flooding.



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Coastal Zone Enhancement Objective

In addition, the CZMA incentivizes states to strengthen the CZMP in one or more of nine enhancement areas, such as wetlands, coastal hazards, and special area management plans (NOAA 2009). Planning for sea level rise and other climate change impacts are eligible enhancement activities (NOAA 2009).

ENERGY

Energy plays a critical role in the functioning of cities and their regions. When the electric grid is disrupted, hospitals, transit, and other systems cannot function, which leads to catastrophic failures. Cities are also generally load centers—places that require an enormous amount of energy. In the wake of Hurricane Sandy, cities and regions are looking to increase the resilience of the electric grid to ensure economic competi-

tiveness, reduce greenhouse gases, improve air quality, and generate jobs.

The existing electric grid is a complex patchwork of regionally diverse systems originally designed to serve customers through a one-way flow of electricity and information from large, central station power plants over a high-voltage grid to local distribution systems where the voltage is stepped down for customer use in a limited service area. This model has served the country well for more than a century; however, it is increasingly vulnerable to shocks and stressors. Climate change will directly and indirectly affect energy production, supply, and consumption in coastal regions. Increasing temperatures, sea level rise, water availability, and extreme weather events will significantly affect the energy sector. For instance, more frequent and severe heat waves will increase peak demand for energy in summer months.

Storm surge flooded Brooklyn streets beneath the Manhattan Bridge on October 29, 2012.

By 2017, Con Edison will spend more than a billion dollars on storm protection in New York City and Westchester County to prevent catastrophes like the massive explosion at the substation on 14th St. that darkened lower Manhattan on October 29, 2012.



© ISTOCKPHOTO/ANDREW CRIBB

More than 8.5 million customers lost power during Hurricane Sandy. The outage made the region more aware of electric infrastructure, its dependencies, and its vulnerability to the future effects of climate change. Figure 4 shows that much of the New York metropolitan region's power generating capacity (58 percent) will be in the 100-year floodplain by 2050. In New York City, 53 percent of the electric-generating capacity and 88 percent of the steam-generating capacity are located within the current 100-year floodplain (Special Initiative for Rebuilding and Resiliency 2013). As a result, many communities damaged by Sandy are looking to adapt electric infrastructure to future climate impacts and are using disaster recovery aid to do it. Many communities in the Sandy-affected region are exploring improvements such as microgrids and solar arrays. In New Jersey, 640 applicants submitted requests for hazard mitigation grants to fund distributed generation that would support critical infrastructure (Hotchkiss et al. 2013).

Federal leadership is required to facilitate strategic investments in a more resilient electric grid. It is difficult to shift to a smarter and more resilient framework under the existing regulatory and business models that govern it. One key obstacle is the way that investor-owned utilities are authorized to make infrastructure investments. Most investments in the electric grid are made by investor-owned utilities, which leverage private financing and spread these investments over their customers (rate base) to pay for the cost. Funding must be approved by state regulatory agencies such as the Board of Public Utilities in New Jersey and the Public Service Commission in New York.

At present, federal and state laws permit investments in electric reliability, but reliability is only one component of resilience. Outside the investor-owned utility model, cities and states that sustained damage from Sandy are using flexible disaster relief aid to support grid resilience, including FEMA's HMGP, FEMA's Alternative Projects Program, and CDBG-DR funding.

However, these monies are conveyed through a number of agencies and are not sufficiently coordinated to realize at-scale benefits or optimize federal funding by leveraging resources and technical knowledge.

WATER MANAGEMENT

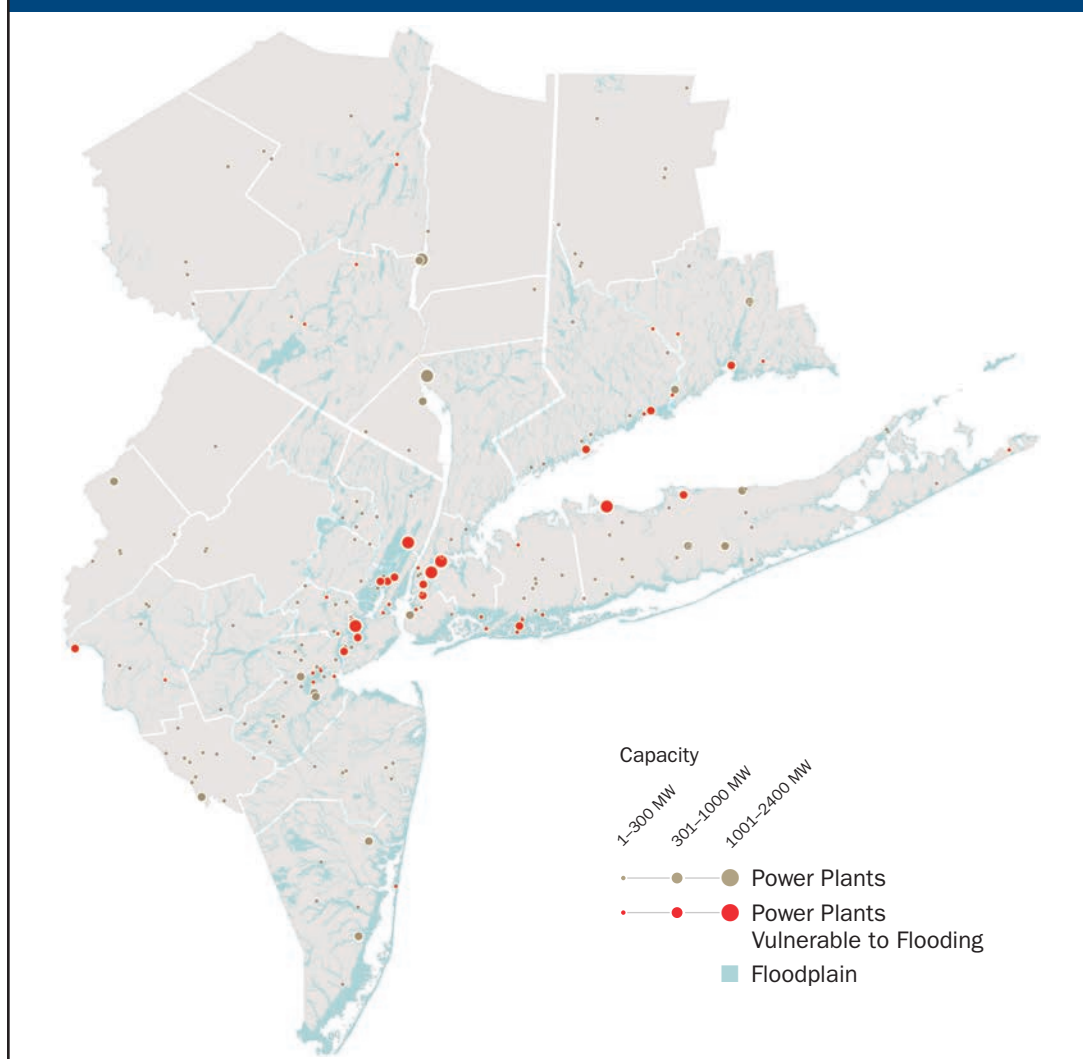
In many cities, waterfront redevelopment strategies have driven people, infrastructure, and high-value property into hazardous areas. Coastal regions must manage excess

water through a combination of infrastructure that can capture, store, divert, and treat storm water runoff, in concert with coastal protection infrastructure that can reduce surge and wave action. However, the current federal framework for coastal protection does not adequately support efforts to adapt to climate change and build resilient coastal regions.

The USACE is the nation's largest manager of water resources. The agency is responsible for federal flood mitigation, water quality, and navigation activities

FIGURE 4

Electric Generation Capacity in the 100-Year Floodplain in 2050 in the New York Metropolitan Region



Source: Regional Plan Association

(box 5). Congress “directs the [USACE] through authorizations, appropriations, and oversight of its studies, construction projects, and other activities” (Carter and Stern 2013). Army Corps projects are typically authorized by an omnibus legislation called the Water Resources Development Act (WRDA), but on occasion projects are funded by supplemental authorizations. Since

reauthorization of WRDA in 1986, the Army Corps is required to work with non-federal partners to develop projects and share in the costs of investigations, design, construction, and maintenance. This partnership can optimize federal investments; however, too few metropolitan-scale entities have the capacity to become non-federal sponsors.

BOX 4

How Does the National Environmental Policy Act of 1969 (NEPA) Affect the Way We Rebuild?

Normally, projects that receive federal money must comply with the environmental impact statement (EIS) requirements of the National Environmental Policy Act of 1969 (NEPA). Projects funded through disaster relief aid are exceptions to this rule. For instance, nearly all FEMA-funded actions are statutorily or categorically excluded from NEPA (Luther 2011). They are exempted from NEPA's provisions so that communities can return to normal as quickly as possible. Nevertheless, projects may still be required to comply with other federal environmental laws that otherwise would have been identified by the NEPA process, such as the Clean Water Act, the Rivers and Harbors Act, and state and local environmental laws.

The rules are clear regarding whether NEPA standards apply to a disaster relief project; for aid recipients that must comply, however, the relative level of review is determined on a case-by-case basis (NEPA Task Force 2003). Typically, long-term construction and mitigation projects that receive federal disaster aid, such as filling open waters or relocating structures, are still subject to NEPA's environmental review process. In some instances, the Council on Environmental Quality (CEQ) will work with a disaster relief aid grantee to develop an alternative arrangement, in order to comply with NEPA while expediting the work.

It is in the federal government's interest to rebuild from extreme weather events in a way that will reduce risk in future disasters. The NEPA process can ensure that

development does not occur in vulnerable locations, such as floodplains. However, activities that could be most beneficial over the long term are deterred by ambiguity about the duration and intensity of environmental review required for disaster recovery and reconstruction projects. This deterrent is exacerbated by the deadline for spending disaster relief aid. Once CDBG-DR funds are obligated, a grantee has only two years to spend the money. This short timeframe may not accommodate the lengthy environmental review required for long-term construction and mitigation projects.

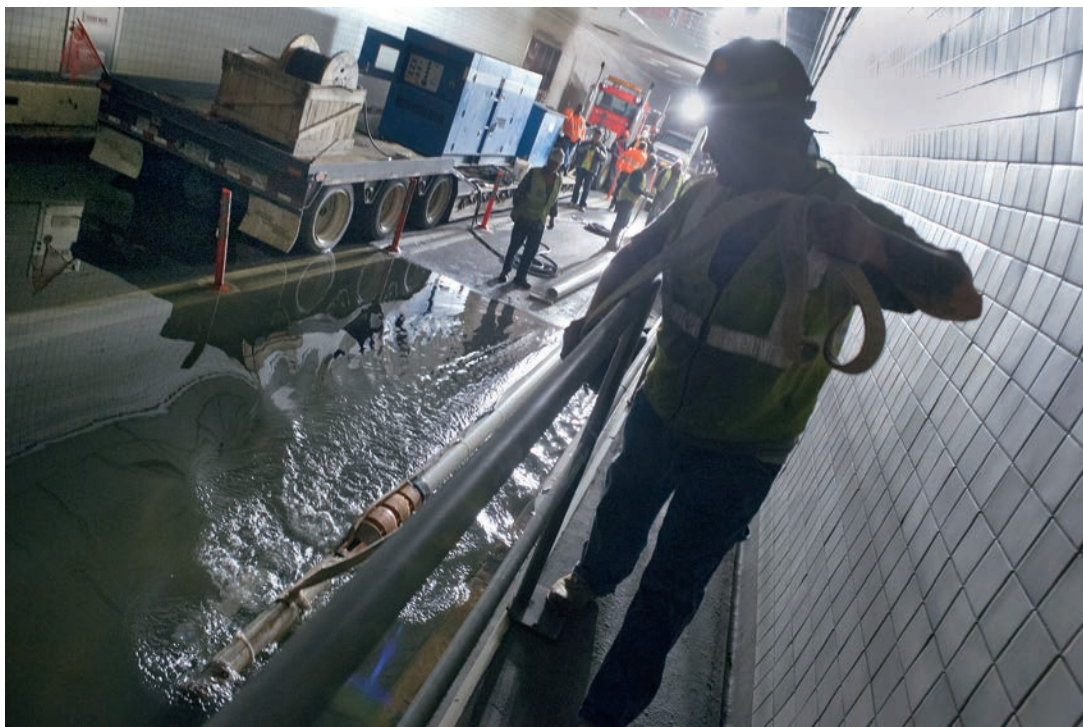
Innovation in adaptation and resilience is also deterred by the ambiguous environmental review requirements. There is a strong desire to return to normal quickly after a disaster. Planners, designers, and decision makers are likely to conclude that simpler projects without significant environmental impacts are more likely to move forward than ambitious and innovative projects that could require a more substantial review. More guidance about the level of review required for projects—including precedents and alternative arrangements in the early stages of rebuilding and reconstruction—could benefit long-term resilience goals. Use of programmatic EIS statements can help focus and accelerate delivery of the scope of alternatives, environmental analyses, and mitigation documented in subsequent statements and more detailed analyses. This tiered approach can make the process more efficient and effective by addressing the cumulative impacts of a number of individual projects (Carter and Stern 2013).

BOX 5

Aligning Army Corps Projects with Climate Adaptation

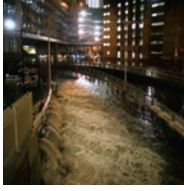
More than 1,000 studies and construction projects authorized by the U.S. Army Corps of Engineers (USACE) have not received funding (Carter and Stern 2013). Recent appropriations have focused on finishing authorized projects near completion rather than funding new studies and projects. The Sandy supplemental funds provide USACE with the appropriations to complete authorized but unconstructed projects. The Corps is now applying its SMART Planning approach to this portfolio of legacy projects to ensure that they all consider sea level rise, to identify which projects have the most potential to reduce risk, and to align the project development process with national priorities.

However, the evaluation methods for USACE projects are not well suited to advancing coastal resilience. The Office of Management and Budget (OMB) requires that the economic benefits of Army Corps projects outweigh their costs. In March 2013, the Council on Environmental Quality (CEQ) and the Army Corps adopted a new set of principles and requirements that govern how the Corps internally evaluates proposed projects. The Army Corps will be able to account for future impacts on communities and the environment as well as on the economy. Currently, these considerations have not been integrated into grant and capital programs, in part due to current federal discount rates and accounting methods that do not effectively account for climate scenarios (Office of Management and Budget, Executive Office of the President 2013) (Leggett 2011). This means that some projects with clear long-term environmental or community benefits may not be authorized.



Workers pump 43 million gallons of water from each tube of the Brooklyn-Battery Tunnel.

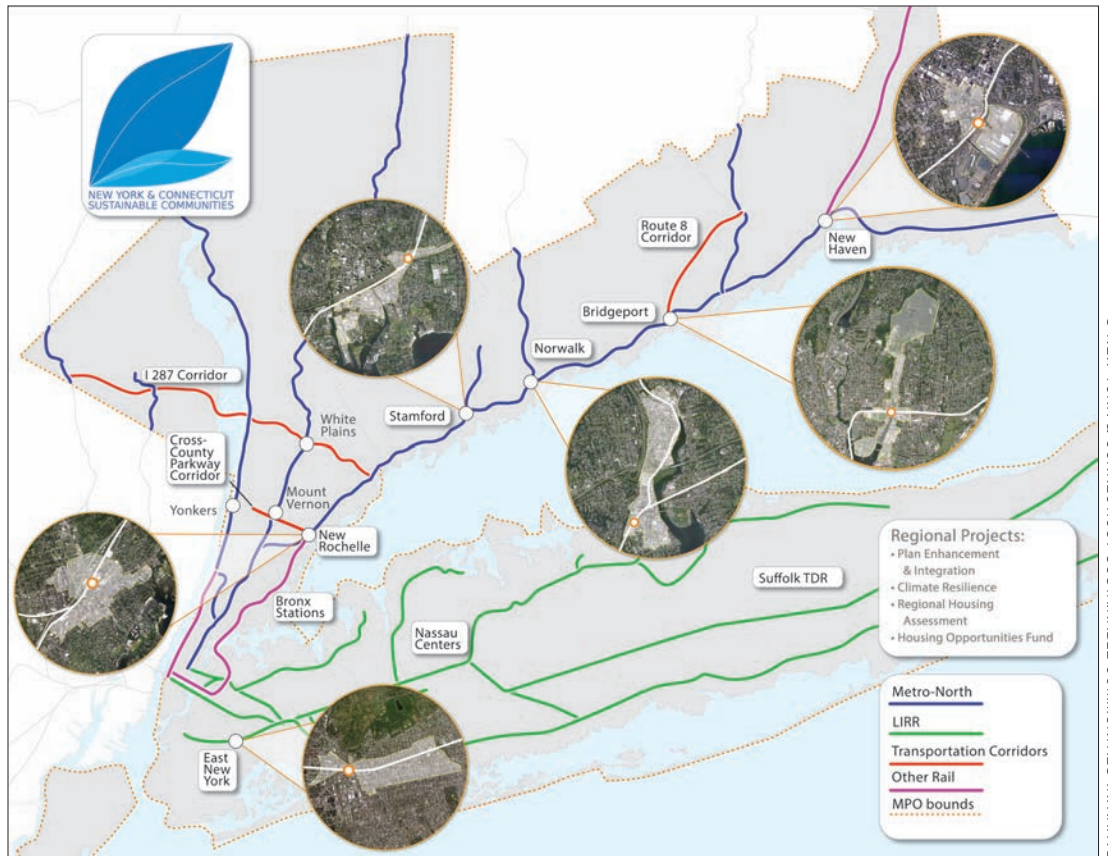
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CHAPTER 5

Science, Decision-Support, and Guidance

Municipalities in the New York metropolitan region work together with federal agencies under the Sustainable Communities Initiative to share data, conduct research and planning studies, and coordinate on plans that are local in nature but have regional implications.



In order to help public officials make decisions that support resilience, the management of coastal land and water needs to be grounded in sound science and strengthened by the right tools and expert guidance. The federal government is responsible for providing resources and assistance to implement policy mandates and legal statutes—including data, scientific models, technical assistance, and decision-support tools. While the federal agencies have taken great strides to make climate information more accessible and available at smaller, actionable geographies, many needs remain unmet.

First, federal agencies should continue making data and science widely available

through the Internet. The National Oceanic and Atmospheric Administration's (NOAA's) Digital Coast has successfully made geo-spatial data and data visualization tools accessible to the public. The President's new Climate Data Initiative reflects a long-term commitment to supporting climate readiness. These tools are helpful for making decisions related to policy and planning and for communicating risk to the public. These data-driven tools should be expanded to help visualize the consequences of structural and nonstructural risk mitigation measures. For instance, data visualization tools could be used to show how breakwaters, constructed islands, or other wave attenuation measures may affect wave heights in specific locations,

which could in turn influence recreational use and tourism. These types of tools can help people visualize the tradeoffs of technical solutions and support forward-thinking decisions.

Second, federal agencies should support information sharing and analysis across public and private infrastructure planners, owners, and operators. Infrastructure systems may be highly fragmented, leading to incomplete knowledge about interdependencies and vulnerabilities (Association of Bay Area Governments 2013). For instance, liquid fuel terminals may be owned and operated by different companies than pipelines and gas stations. Regional partnerships supported by federal resources—such as the Sustainable Communities Initiative, the Landscape Conservation Cooperatives, and Regional Integrated Sciences and Assessments—could be strengthened to fill this important data gap and support a comprehensive technical understanding of regional infrastructure vulnerabilities as a baseline for risk reduction strategies.

Third, public officials must grapple with significant uncertainties including the time-scale and magnitude of climate impacts, as well as the effects of federal laws and policy on planning at the state, regional, and local levels. Scenario planning is one way to support decision making under complex and highly uncertain circumstances (box 6). Federal agencies should expand the availability of scenario planning tools to support resilience.

Similarly, it is important to understand how mitigation and adaptation decisions interact across geographies as well as natural and built systems. There are many uncertainties about how coastal strategies, such as offshore breakwaters or bathymetry modification, may alter the hazard profiles of adjacent neighborhoods. This uncertainty is not only a scientific issue, but also

BOX 6

Scenario Planning for Resilience

All units of government are using scenario planning to support decision making about climate adaptation. Scenario planning is a decision-support tool that moves uncertainty to the forefront of the policy-making process to generate creative pathways that are robust across multiple and equally plausible scenarios of the future. The tool is particularly useful for developing solutions to complex problems with high uncertainty or for decision makers or resource managers who have little control over the major factors that drive change over time. Organizations that used scenario planning after Hurricane Sandy include:

- **Strategic Sciences Group (SSG):** The Department of the Interior (DOI) established the SSG to provide science-based assessments and scenarios that would help the DOI make decisions about the agency's resources and facilities. Used to select more than \$300 million in hazard mitigation projects, the scenarios model the social, environmental, and economic impacts of Hurricane Sandy.
- **The Nature Conservancy (TNC):** TNC developed the Future Scenarios Map—a mapping tool that combines sea level rise projections, shore-hardening infrastructure, and wetland migration data to inform coastal development and conservation decisions in Connecticut and New York (The Nature Conservancy 2013). TNC also used scenario planning in the Hudson Valley to identify policy pathways to adapt to rising sea levels (The Nature Conservancy 2009).
- **Regional Plan Association (RPA):** RPA worked with the Joint Climate Committee of the New York–Connecticut and New Jersey Sustainable Communities Consortia to develop scenarios that could be used to support resilient long-term recovery decisions (RPA and Lincoln Institute of Land Policy 2013).
- **New Jersey Transportation Planning Authority (NJTPA):** In October 2012, the NJTPA, together with the Federal Highway Administration (FHWA) and Federal Transit Administration, sponsored a workshop to share lessons learned about using scenario planning tools. This peer-to-peer workshop was held to help prepare scenarios for NJTPA's 2013 update to its Regional Transportation Plan (FHWA 2013).

a legal one. Municipalities may be held liable for actions that result in increased damages to other people or property (Kusler and Medlock 2011).



CHAPTER 6

Recommendations



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For Rebuild by Design, teams created innovative proposals to build resilience in the Sandy-affected region, such as BIG's multi-functional berm system, designed to reduce flooding in lower Manhattan.

Resilience is the capacity to recover from shocks and stressors and at the same time reduce future risk. Currently, federal policies for disaster recovery, hazard mitigation, floodplain management, coastal management, and infrastructure development are not able to support a national strategy for resilience. However, with small changes, federal policies and administrative practices can create a strong foundation to create climate-resilient regions.

The following recommendations are designed to address the major challenges that cities, states, and communities in the New York metropolitan region encountered as they recovered from Hurricane Sandy. These recommendations can help build resilience in the New York metropolitan

region and the nation alike. These recommendations were identified by planners, policymakers, infrastructure operators, urban designers, and architects who are working to rebuild. They were validated by federal agencies, advocates, and others in two policy forums (Appendices A and B).

Anticipate future climate impacts during the disaster recovery and rebuilding processes.

Federal agencies should adjust the rules that govern the use of disaster relief aid to help communities rebuild in a more resilient way. FEMA should make the Public Assistance Program more flexible. One way to do this is to modify regulations that give preference to repair over replacement or relocation of public facilities. When full

life-cycle costs are considered, relocation may be more cost-effective than repairing or replacing a facility. The Sandy Recovery Improvement Act amended the Stafford Act with Section 428, which permitted two pilot programs that made the Public Assistance Program more flexible: the Alternative Procedures Pilot Program and the Alternate Projects Pilot Program. These pilots made it possible for grantees to build facilities that are more appropriate for future climate conditions. These pilot programs should be evaluated and made permanent where appropriate.

Strengthen connections between pre-disaster and post-disaster planning efforts.

Municipalities are required to have FEMA-approved hazard mitigation plans in place in order to receive disaster recovery assistance. However, there is a large disconnect between federal hazard mitigation plans and the action plans that states submit to HUD for CDBG-DR funding. Hazard mitigation plans should inform post-disaster recovery. There are three ways to strengthen this connection:

First, FEMA should set additional requirements for the completion of hazard mitigation plans that more effectively support resilience, such as incorporating sea level rise projections. Second, HUD could require state action plans to reference hazard mitigation plans. Third, hazard mitigation plans should include a risk assessment of regional infrastructure and the implications of infrastructure failures on regional mobility, housing needs, and ecological resources. For example, a hazard mitigation plan should consider what could happen to regionally significant transit networks or hospitals if power plants, transmission lines, or distribution networks fail.

Evaluate projects based on their true costs and risks by utilizing a life cycle approach and assessing environmental impacts.

Federal policies and programs that account for all the costs and benefits over the life of an investment can curb policies that enable risky development and reduce the exposure of the federal treasury for future disasters. FEMA has started to account for environmental benefits in the HMGP, and the USACE is leading efforts to quantify social and environmental costs and benefits. However, these methods have not been fully put into practice in their programs. Agencies should coordinate efforts to account for life-cycle costs and social and environmental costs. CEQ, the National Science Foundation (NSF), and federal agencies should work together to evaluate benefit-cost analysis frameworks and the federal discount rate to account for future climate impacts.

Develop new financing and insurance models that capture the value created through mitigation and adaptation, and support long-term investments in resilience.

Hazard mitigation creates value in the form of avoided costs. Together with the Office of Management and Budget (OMB) and the NSF, federal agencies should develop ways to capture these avoided costs to support such investments or to offset rising insurance rates. For instance, avoided costs could be monetized and used to maintain levee safety or to support an insurance assistance program for low-income households with residual risk. This value-capture approach is analogous to the concept of the systems benefits charge, which captures the avoided expense of new transmission and distribution infrastructure to encourage utilities to invest in energy efficiency programs (Cobleigh 2013).

Align federal policies and programs to reduce risk and restore the health and productivity of coastal resources over the long term.

Remove incentives to develop in hazardous areas. Federal programs and policies should remove incentives to develop in hazardous areas, such as the availability of federal funding and flood insurance. One program that does this well is the Coastal Barrier Resources Act (CBRA), which restricts federal spending on undeveloped barrier islands. A study conducted by the USFWS in 2002 estimated that the CBRA has saved taxpayers \$1.3 billion; by 2050, the study estimates that the Act will have saved \$200 million in disaster relief funding alone. If fully resourced, the USFWS could digitize its maps of protected barrier islands, which would enable state and local governments to protect these resources.

Independent of Congressional action, several agencies are already taking steps to remove incentives to develop in hazardous areas. For instance, HUD's Final Rule on Executive Order 11988 eliminates new Federal Housing Administration (FHA) loan guarantees in special flood hazard areas. By expanding the alternate projects pilot program, FEMA could encourage relocation in areas that are not hazardous. Federal transportation grant programs should consider flood risks when siting new facilities and retrofitting or repairing existing facilities to ensure that transportation investments do not encourage unwise development. To continue this progress, the CEQ should work with federal agencies to remove or limit programs and policies that subsidize unwise development in hazardous areas.

Federal agencies should anticipate future climate conditions when developing risk reduction standards for multiple hazards.

Agencies should then prioritize investments that meet those criteria. The CEQ and the National Institute of Standards and Technology (NIST) should lead this effort in partnership with federal agencies. Risk reduction standards offer the best opportunities for integrating forward-thinking information into disaster recovery, and they help states and local governments pivot toward resilience. For instance, the flood risk reduction standard endorsed by HUD and the Department of Transportation for projects funded by the Sandy supplemental is FEMA's Base Flood Elevation plus one foot of freeboard (ASFMF 2013). CEQ and NIST should work with federal agencies to institutionalize this flood risk reduction standard across agency programs and activities beyond the scope of the Sandy supplemental, and they should develop new standards that are appropriate for the design life of each type of infrastructure. A one percent annual chance of failure is not acceptable for many types of infrastructure. Other risk reduction standards may include the wind speeds that hospitals can withstand and the percent of green or impervious surfaces required within special flood hazard areas.

Enforce Executive Orders that serve to protect and restore ecological resources.

CEQ should work with federal agencies to ensure that their programs and policies are consistent with Executive Orders, such as Executive Order 11988, which protects floodplains by limiting federal activities in these sensitive areas. CEQ could build off HUD's final ruling in November 2013, which specified how Executive Order 11988 applies to the use of CDBG-DR and FHA



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BIG's multipurpose operable walls on the FDR Highway would flip down to protect the Lower East Side during a storm; under normal conditions, they would be stored underneath the highway, and the sides would feature local art and be illuminated to create an urban promenade.

loans. This rule states that HUD will not guarantee FHA loans in special flood hazard areas. Enforcing Executive Orders and other policies that support ecosystems will improve consistency across federal programs and policies in support of resilience.

Enable effective urban infrastructure and development patterns

Incentivize regional planning across federal grant and loan programs. Municipalities will need to work together to address the environmental and social consequences of climate change. With the second tranche of CDBG-DR funding, HUD directs grantees to use “a regional and cross-jurisdictional approach to resilience, in which neighboring communities and states come together to identify interdependencies among and across geography and infrastructure systems, compound individual investments toward shared goals, foster leadership, build capacity, and share information and best practices on infrastructure resilience.” Infrastructure projects that benefit multiple counties and

will receive \$10 million in CDBG-DR are required to demonstrate that the project was selected through a collaborative process. The Silver Jackets Program is state-directed and administered by the USACE, bringing together agencies at all levels of government to address the state’s flood management priorities. The program should engage regional entities such as metropolitan planning organizations, councils of government, and other public and private regional organizations to address regional issues. Special attention should be paid not only to watershed regions but also to other functional geographies where existing regional institutions can partner on USACE projects. For instance, the New York metropolitan region depends on many different watersheds but functions as a single economic region. Attention to functional geographies can help build the capacity of regional entities to partner on USACE projects and to promote positive outcomes for coastal regions.

Provide incentives for state and local governments to play a leadership role in coastal risk reduction and environmental protection. State and local programs and policies should align with a national strategy for resilience. One way that states can play a larger role is by creating and enforcing risk reduction standards that meet or exceed federal requirements. For example, although FEMA does not require states to consider future climate conditions in hazard mitigation plans, New York State does require plans to incorporate climate projections. Federal agencies could encourage state and local governments to play a stronger part by defining key roles and responsibilities for the state regarding hazard mitigation, economic and community development, and infrastructure investments (Association of State Floodplain Managers Foundation 2013). Resources and assistance for such actions could be provided through Coastal Zone Management and other programs. The rules for federal cost-share programs should be modified so that state and local governments pay more for disaster recovery projects if they do not take steps to manage risk in high-hazard areas through planning, partial or full hazard mitigation, or conservation.

Support strategic investments and policies that help cities and regions enhance grid resilience and avoid catastrophic failures. Widespread losses in electricity and disruptions in the liquid fuel supply during Hurricane Sandy demonstrated the vulnerability of the electric grid. The smart grid and the resilient grid share many qualities, including energy that is generated close to where it is used, two-way flows of energy and information, fuel switching, and more controls to improve system-wide efficiencies. The U.S. Department of Energy, the Federal Energy Regulatory Commission, the Environmental

Protection Agency, and the Infrastructure Bank should provide additional resources to assess post-Sandy grid resilience projects and to identify both policies and resources that could support the strategic and coordinated transformation of the grid over time.

Fairly distribute costs and responsibility for risks. The reforms enacted under the Biggert-Waters Act are critical to the goals and solvency of the NFIP. People should be well-informed if their homes or businesses are located in hazardous areas or potentially hazardous areas. The RiskMAP program also should identify property in residual risk land and areas that may be subject to sea level rise in the NFIP. Those who do choose to own property in hazardous areas should be responsible for these risks (Association of State Floodplain Managers Foundation 2013). Risk-based pricing and updates to the FIRMs will impact waterfront communities. Low- and moderate-income residents may not be able to absorb increased premium costs or finance the up-front costs of hazard mitigation measures that could lower their insurance rates. Low-income renters may also be priced out of housing units that are flood proof. FEMA and HUD should consider establishing a voucher program or other measure to help low-income households live safely in neighborhoods of their choice or offer means-tested discounts on insurance premiums.

Reward cities for partial mitigation activities. Many FEMA-approved mitigation activities are not well suited for urban contexts. For instance, it is not possible to elevate attached row houses; if it were, homeowners would lose valuable living space. However, it is possible to undertake partial mitigation, such as relocating data centers and heating equipment to higher floors. Working with the Institute of Business and Home Safety,

FEMA should test strategies that would reduce risk and offer credit for these activities under the CRS.

Develop and share data, guidance materials, and decision-support tools to help governments and property owners make forward-looking decisions.

Invest in science and decision-support tools to help both the public sector and the private sector make decisions that support resilience. Coastal resilience must be grounded in sound science. All agencies should require state and local grantees to consider future climate conditions in their plans, such as hazard mitigation and long-range transportation strategies. Existing federally supported regional institutions—such as the National Estuary Program and state CZMPs—can be important vehicles for disseminating these requirements. Under a national strategy for resilience, consistent requirements across federal policies and programs will reinforce shared responsibility and accommodate coastal change. Furthermore, accurate and up-to-date flood hazard maps that include future climate impacts are essential for good decision making. In addition, both public and private actors require tools to help make decisions under conditions of uncertainty. FEMA should develop more complete data about structures within the floodplain to assess risk and apportion costs fairly across those who live in hazardous areas.

Expand the use of new technologies to integrate two-way flows of information.

State and local governments may have data that are more precise, accurate, or updated than federal data. Two-way flows of information can ensure that all levels of government are using the best available intelligence. In developing New York City's sea level rise

maps, the partnership between the New York City Panel on Climate Change and NOAA is one successful model for this type of data integration. Additionally, NOAA, USFWS, and FEMA could take advantage of new technologies, such as LocalData or similar tools that allow users to collect data on a mobile application and export it in convenient formats. Mobile tools can be used to survey parcels of land or to foster citizen science by allowing the public to monitor the relative conditions of natural resources on a regular basis. NOAA, USFWS, and FEMA should partner with Code for America to develop an application that can help generate regular, up-to-date information to promote a better understanding of acute and ongoing stressors and to support resilience. Information can be incorporated into the President's Climate Data Initiative.

Disseminate guidance and best practices across federal programs and use data visualization to effectively communicate risk to the public. First, federal agencies should disseminate guidance and best practices to strengthen underutilized statutes such as the CZMA. Statutes that regulate transportation planning can be important means of advancing best practices. In 2012, the FHWA released a policy memo that outlined the types of mitigation activities that could be reimbursed under its ER program (FHWA 2012). This memo is a good example of the type of clear guidance that state and local governments need. Federal agencies should expand the use of data visualization tools, which are critical for making data accessible for decision makers and for the public. Simple and effective tools are necessary; some point to Smoky the Bear as one example of federal branding that was effectively packaged and disseminated to state and local governments to communicate hazards.



APPENDIX A

Policy Working Session

June 24, 2013

PURPOSE

Regional Plan Association and the Lincoln Institute of Land Policy sponsored a policy working session on June 24, 2013, in New York City. The purpose of this working session was to identify components of a national strategy for climate resilience and to identify the role of federal agencies in supporting climate adaptation.

PROGRAM

Welcome and Introductions

Robert D. Yaro, Regional Plan Association

Opportunities and Challenges for Coastal Adaptation in Metropolitan Areas

Robert Pirani, Regional Plan Association

Review of the Federal Response to Hurricane Sandy

Josh Sawislak and Henk Ovink, Hurricane Sandy Rebuilding Task Force

Hazard Mitigation and Pre-Disaster Planning

William Siembieda, California Polytechnic State University, San Luis Obispo

Federal, State, and Local Policies and Programs for Adaptation

Setting the Agenda for the Policy Forum in Washington, D.C.

Robert Pirani, Regional Plan Association

Participants

Edward Blakely, University of Sydney, Australia

John Boulé, Parsons Brinckerhoff

Armando Carbonell, Lincoln Institute of Land Policy

Sandy Eslinger, NOAA Coastal Services Center

Mike Kangior, Department of Homeland Security

Marjorie Kaplan, New Jersey Climate Adaptation Alliance

Michael Marrella, New York City Department of City Planning

Samantha Medlock, Association of State Floodplain Managers Foundation

Doug Meffert, Audubon Society-Louisiana

Henk Ovink, Hurricane Sandy Rebuilding Task Force

Robert Pirani, Regional Plan Association

Josh Sawislak, Hurricane Sandy Rebuilding Task Force

Catherine Seavitt-Nordenson, CUNY

Howard Slatkin, New York City Department of City Planning

Laura Tolkoff, Regional Plan Association

Robert D. Yaro, Regional Plan Association



APPENDIX B

Forum for Climate-Resilient Coasts

January 14, 2014

PURPOSE

Regional Plan Association and the Lincoln Institute of Land Policy, together with the Association of State Floodplain Managers Foundation, hosted a policy forum at the Carnegie Endowment of International Peace on January 14, 2014. The purpose of this forum was to review the current status of federal rebuilding efforts from Hurricane Sandy, to review the research presented in this report, and to develop a set of policy priorities for federal agencies to consider as they respond to climate change.

PROGRAM

Welcome: *Robert D. Yaro*, Regional Plan Association

Keynote: *Secretary Shaun Donovan*, U.S. Department of Housing and Urban Development

Lightning Round: How are federal agencies responding to Hurricane Sandy?

Moderator: *Armando Carbonell*, Lincoln Institute of Land Policy

Infrastructure Rebuilding Principles

- *Karen Durham-Aguilera*, Director of Contingency Operations & Homeland Security, U.S. Army Corps of Engineers
- *Margaret Davidson*, Acting Director, National Ocean Service Office of Ocean & Coastal Resource Management

North Atlantic Coast Comprehensive Study

- *Roselle Henn*, Deputy Director, National Planning Center of Expertise for Coastal Storm Risk Management, U.S. Army Corps of Engineers

State, Local and Tribal Leaders Task Force on Climate Preparedness and Resilience

- *Susan Ruffo*, Deputy Associate Director for Climate Change Adaptation, White House Council on Environmental Quality

How can federal agencies improve coastal resilience?

- Moderator: *Josh Sawislak*, Senior Advisor to the Secretary for Infrastructure Resilience, U.S. Department of Housing and Urban Development
- *Jo-Ellen Darcy*, Assistant Secretary of the Army, Civil Works, U.S. Army Corps of Engineers
- *Margaret Davidson*, Acting Director, National Ocean Service Office of Ocean & Coastal Resource Management
- *David Miller*, Associate Administrator, Federal Insurance & Mitigation Administration, Federal Emergency Management Agency
- *Susan Ruffo*, Deputy Associate Director for Climate Change Adaptation, White House Council on Environmental Quality

Setting the agenda: What are the priorities for advancing climate resilience with existing federal programs and authorities? (facilitated workshop)

What are the opportunities for strengthening coastal flood policy and protecting natural floodplains?

- Moderator: *Samantha Medlock*, Policy Counsel, Association of State Floodplain Managers Foundation
- *Jessica Grannis*, Staff Attorney, Georgetown Climate Center
- *Mark Mauriello*, Past Commissioner, New Jersey Department of Environmental Protection, Mark Mauriello Consulting, LLC
- *Sarah Woodhouse Murdock*, Director, U.S. Climate Change Adaptation Policy, The Nature Conservancy
- *Dan Zarrilli*, Director of Resiliency, City of New York

Innovating together for resilience: How can we link disaster recovery and climate adaptation?

- Moderator: *Robert Pirani*, Vice President for Energy and Environmental Programs, Regional Plan Association
- *John Boulé*, Vice President, Parsons Brinckerhoff
- *Guy Nordenson*, Guy Nordenson and Associates; Princeton University
- *Henk Ovink*, Dutch Government Liaison to the Hurricane Sandy Rebuilding Task Force and the U.S. Department of Housing and Urban Development; Principal, Rebuild by Design
- *Mary Rowe*, Vice President, Municipal Art Society of New York City

PARTICIPANTS

Brian Balukonis, GZA Environmental Inc.

Louise Bedsworth, Office of the Governor-California

Doug Bellomo, Federal Emergency Management Agency (DHS)

Kai-Uwe Bergmann, BIG Architects

Edward Blakeley, University of Sydney, Australia

John Boulé, Parsons Brinckerhoff

Kevin Bush, U.S. Department of Housing and Urban Development

Mayor Robert Campbell, Downe Township, New Jersey

Armando Carbonell, Lincoln Institute of Land Policy

Nicole Carter, Congressional Research Services

James Chang, Office of Senator Brian Schatz

Wayne Cobleigh, GZA Environmental Inc.

Jad Daley, Trust for Public Land

Jo-Ellen Darcy, Assistant Secretary, U.S. Army Corps of Engineers

Kamer Davis, FloodSmart Campaign

Margaret Davidson, National Ocean Service Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration

Scott Davis, U.S. Department of Housing and Urban Development

Elizabeth Demetrius, Southwest Brooklyn Industrial Development Corporation

Secretary Shaun Donovan, U.S. Department of Housing and Urban Development

Karen Durham-Aguilera, U.S. Army Corps of Engineers

Michael Flood, Parsons Brinckerhoff

Maggie Glowacki, City of Seattle, Department of Planning and Development

Bill Golden, National Institute for Coasts and Harbor Infrastructure

Miriam Goldstein, Office of Senator Edward Markey

Mark Gorman, Northeast-Midwest Institute

Jessica Grannis, Georgetown Climate Center

Jason Hartke, U.S. Green Buildings Council

Tomer Hasson, Office of Management and Budget

Roselle Henn, U.S. Army Corps of Engineers

Maria Honeycutt, National Oceanic and Atmospheric Administration Coastal Services Center

Christine Hsu, Regional Plan Association

Jeff Jacobs, National Research Council

Jennifer Itri, Parsons Brinckerhoff
Marjorie Kaplan, Rutgers Climate Institute
Carolyn Kousky, Resources for the Future
Lindsey Kraatz, Coastal States Organization
Stephanie Krueel, Climate Adaptation Knowledge Exchange
Anna-Maria Laura, Office of Senator Sheldon Whitehouse
Lauren Leuck, U.S. Army Corps of Engineers, Institute for Water Resources
Paul Lewis, LTL Architects
Sharai Lewis-Gruss, Regional Plan Association
Ed Link, University of Maryland
Helen Lothead, Harvard Loeb Fellow, Sydney Harbour Foreshore Authority
Elaine Mahoney, Federal Emergency Management Agency
Mark Mauriello, New Jersey Department of Environmental Protection; Mark Mauriello Consulting, LLC
Brian McMahon, Parsons Brinckerhoff
John McShane, Environmental Protection Agency
Samantha Medlock, Association of State Floodplain Managers Foundation
Dave Miller, Federal Emergency Management Agency (DHS)
John Miller, Association of State Floodplain Managers-New Jersey
April Mims, National Parks Conservation Association
Lucrecia Montemayor, Regional Plan Association
Brian Moore, Audubon Society
Dale Morris, Royal Netherlands Society
Mary Munson, Coastal States Organization
Sarah Woodhouse Murdock, The Nature Conservancy
Erin Musiol, American Planning Association
William Nechamen, New York State Department of Environmental Conservation
Guy Nordenson, Guy Nordenson and Associates, Princeton University
Alexa Noruk, Senate Homeland Security and Governmental Affairs Subcommittee on Emergency Management, Intergovernmental Affairs
Henk Ovink, Principal, Rebuild by Design
Jonathan Phinney, U.S. Fish and Wildlife Service
Robert Pirani, Regional Plan Association
Wendy Pollack, Regional Plan Association

Sam Ricketts, Office of Governor-Washington
Kate Roetzer, Office of Congressman David Price
Jay Rojas, Office of the Governor-Guam
Joyce Rosenthal, Harvard Graduate School of Design
David Rouse, American Planning Association
Mary Rowe, Municipal Art Society of the City of New York
Susan Ruffo, White House Council on Environmental Quality
Gabrielle Saluta, Virginia Institute of Marine Science
Josh Sawislak, U.S. Department of Housing and Urban Development
Judd Schechtman, Edward J. Bloustein School of Planning and Public Policy
Dan Schned, Regional Plan Association
Jeremy Seigel, BIG Architects
Janani Shankaran, Regional Plan Association
Livia Shmavonian, Office of Representative Jim Langevin
Elizabeth Silver, Michael Van Valkenburgh Associates
Rachel Silverstein, U.S. Senate Committee on Homeland Security and Governmental Affairs
Courtney Smith, Municipal Art Society of the City of New York
Lilo Stainton, New York-New Jersey Harbor Coalition
Tyler Sylvestro, WXY Studios
Nicole Marie Teutschel, Office of Senator Maria Cantwell
Laura Tolkoff, Regional Plan Association
Shana Udvardy, Center for Clean Air Policy
John Vocino, U.S. Senate Committee on Homeland Security and Governmental Affairs
Mary Jo Vrem, Federal Emergency Management Agency (DHS)
Michael Walsh, U.S. Army Corps of Engineers (emeritus)
David Wegner, U.S. Senate Subcommittee on Water Resources and Environment, Committee on Transportation and Infrastructure
Jack Wiggin, Urban Harbors Institute
Thomas K. Wright, Regional Plan Association
Robert D. Yaro, Regional Plan Association
Dan Zarrilli, City of New York



APPENDIX C

Glossary of Acronyms

ABFE	Advisory Base Flood Elevation
BFE	Base Flood Elevation
CBRA	Coastal Barrier Resources Act
CBRS	Coastal Barrier Resource System (formerly known as the John H. Chafee Coastal Barrier Resources System)
CEQ	White House Council on Environmental Quality
CZMA	Coastal Zone Management Act
CZMP	Coastal Zone Management Program
CDBG-DR	Community Development Block Grant-Disaster Recovery
CRS	Community Rating System
DRF	Disaster Relief Fund
EIS	environmental impact statement
ER	Emergency Relief
FEMA	Federal Emergency Management Agency
FHA	Federal Housing Administration
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HUD	U.S. Department of Housing and Urban Development
LRTP	Long-Range Transportation Plans
MPO	Metropolitan Planning Organization
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NSF	National Science Foundation
OMB	Office of Management and Budget
SBA	Small Business Administration
SRIA	Sandy Recovery Improvement Act
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
WRDA	Water Resources Development Act



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Lessons from Sandy

Federal Policies to Build Climate-Resilient Coastal Regions

Hurricane Sandy was a wakeup call that elevated the discussion about disasters and climate change at all levels of government. The regional reach of the storm demanded a new approach to disaster relief and recovery. This report identifies a set of policies, regulations, and administrative practices that federal agencies can adopt to help coastal metropolitan regions become more resilient—able to recover quickly from shocks and stressors while at the same time reducing future risk in the face of climate change. These recommendations can help advance a national strategy for disaster recovery that helps coastal regions adapt to future conditions by integrating hazard mitigation and risk management approaches into federal policies. They include the following overarching strategies:

- **Anticipate future climate impacts during the disaster recovery and rebuilding processes.**
- **Enable effective urban infrastructure and development patterns.**
- **Align federal policies and programs to reduce risk and restore the health and productivity of coastal resources over the long term.**
- **Develop and share data, guidance materials, and decision-support tools to help governments and property owners make forward-thinking decisions.**