

# Ten Principles for Building Resilience



## About the Urban Land Institute

The Urban Land Institute is a global, member-driven organization comprising more than 40,000 real estate and urban development professionals dedicated to advancing the Institute's mission of providing leadership in the responsible use of land and in creating and sustaining thriving communities worldwide.

ULI's interdisciplinary membership represents all aspects of the industry, including developers, property owners, investors, architects, urban planners, public officials, real estate brokers, appraisers, attorneys, engineers, financiers, and academics. Established in 1936, the Institute has a presence in the Americas, Europe, and Asia Pacific regions, with members in 76 countries.

The extraordinary impact that ULI makes on land use decision making is based on its members sharing expertise on a variety of factors affecting the built environment, including urbanization, demographic and population changes, new economic drivers, technology advancements, and environmental concerns.

More information is available at [uli.org](http://uli.org). Follow ULI on Twitter, Facebook, LinkedIn, and Instagram.

### Cover photos:

Clockwise from top left:

Solar panels on the roof of Paseo Verde, Philadelphia (Steve Lipofsky)  
Buffalo Bayou Park, Houston (Jonnu Singleton, SWA Group)  
Atlantic Wharf's green roof, Boston (Ed Wonsek)  
CicLAvia kickoff in the Pacoima neighborhood, Los Angeles (ULI Los Angeles).

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## About the Urban Resilience Program

ULI's Urban Resilience Program provides ULI members, the public, and communities across the United States with information on how to be more resilient in the face of climate change. The Urban Resilience Program seeks to build greater community resilience through identifying shared strategies and opportunities that advance community vision, the natural and built environment, real estate investment, multipurpose infrastructure, and long-term vibrancy.

## Acknowledgments

ULI wishes to acknowledge and thank its Urban Resilience Program funding partners—the Kresge Foundation and the New York Community Trust—for supporting this publication, the Ten Principles for Building Resilience workshop, and the associated resilience Advisory Services panels and Technical Assistance Program panels (TAPs).

ULI also wishes to thank the engaged workshop participants for their expertise and wisdom. A special thank-you for chairing the workshop is extended to Marilyn Jordan Taylor, former global chairman of ULI, who facilitated and led the workshop and has demonstrated an extraordinary commitment to community resilience.

This workshop and report build on many prior resilience projects and research initiatives, including ULI Advisory Services panels led by dozens of ULI member volunteers. The workshop participants and the report authors also acknowledge the leadership roles of partner organizations and colleagues such as the White House Task Force on Storm Sandy, the U.S. Department of Housing and Urban Development's National Disaster Rebuilding Competition, Rebuild by Design, and Rockefeller Foundation initiatives such as 100 Resilient Cities and Structures of Coastal Resilience.



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# Ten Principles for Building Resilience

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# About This Report



*The Ten Principles for Building Resilience workshop analyzed ULI's resilience-focused Advisory Services panels and TAPs from 2013 to 2017, which proposed resilient approaches to land use and development for 14 communities and regions across the United States.*

ULI members developed *Ten Principles for Building Resilience* through a 2017 workshop that analyzed the findings of the Institute's ten resilience-focused Advisory Services panels, as well as other resilience-focused projects led by the Urban Resilience program and ULI district councils. The goal of the workshop was to determine the key themes of ULI's resilience work and then succinctly describe these themes within the framework of ten principles, addressing social, environmental, and economic factors. This report is part of a long line of *Ten Principles* documents published by ULI over the past 15 years, including *Ten Principles for Building Healthy Places* and *Ten Principles for Coastal Development*.

Workshop participants included ULI members who participated in the Advisory Services panels, panel sponsors, subject matter experts, and participants from district council resilience activities. The workshop included presentations of each Advisory Services panel's findings, brainstorming, discussion, deliberation, and writing.

The Advisory Services program is one of ULI's longest-running programs, having been established in the 1940s. Between 2013 and 2017, ULI's Urban Resilience and Advisory Services program hosted multiple panels each year explicitly focused on resilient land use and development strategy. These panels have addressed a range of challenges and contexts, including regional planning in Colorado, urban waterfront planning in Maine, urban heat islands in New York City, suburban growth patterns in Louisiana, and climate adaptation planning in Miami-Dade County, Florida. The communities included places that had recently experienced extreme events, such as hurricanes or flash floods, and others seeking to enhance their preparedness for such events.

This report is the output of the workshop. It is designed to serve as a resource for ULI members, including land use professionals, real estate developers, designers, sustainability experts, and policy makers; city officials; community activists; and others involved in building and creating policies to enhance urban resilience.

For more information about ULI's Urban Resilience program, visit <http://www.uli.org/resilience>.

For more information about ULI's Advisory Services program, visit <https://americas.uli.org/programs/advisory-services/>.



LEAH SHEPPARD/ULI

*Panelists at the workshop brainstormed in working groups.*

# Workshop Participants

## Chairman

### **Marilyn Jordan Taylor**

Former Global Chairman, ULI  
Professor of Architecture and Urbanism  
University of Pennsylvania School of Design  
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*Workshop participants included ULI members and staff who have participated in resilience-focused Advisory Services panels and projects across the United States.*

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Intern, Urban Resilience

# Introduction

## Defining Resilience

The Urban Land Institute, in partnership with numerous other organizations active in the built environment such as the American Planning Association, the U.S. Green Building Council, and the American Institute of Architects, defines resilience as **“the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events.”** Central to this definition is the ability to “bounce back” from these events, solving problems and preventing hardship in the future.

As weather events become more frequent and intense due to climate change, disruptions and stressors become a common concern among city officials and residents alike. From sea-level rise to heat waves, from storm surge to drought, the impacts of climate change threaten the built environment in ways that have serious consequences for the health, viability, and economic vitality of our future.

Addressing these issues requires projects and programs that both enhance preparedness and offer other economic, environmental, and social co-benefits. In short, real estate projects, land use strategies, and infrastructure investments should not only make communities less vulnerable, but also strengthen cities overall, enhancing environmental performance, economic opportunity, and social cohesion.

## Chairman’s Message

**W**e are all living at risk. The challenge before us is to determine how we, together, respond to the specific risks that individuals and communities face, including extreme weather events, rising rivers and seas, economic stresses, failing systems of infrastructure, terrorism, political division, fractures in social cohesion, aging populations, and displacement of refugees.

The recent rise in monster hurricanes and devastating earthquakes as well as the persistence of terrorist events have awakened us to an understanding that what is happening to others can also happen to us. Disruptive and destructive events, particularly those related to the impacts of climate change, are likely to be an increasing part of all of our lives. Building resilience in response to these challenges entails recognizing vulnerabilities, identifying community-led initiatives, and formulating and proactively advancing policies, plans, and projects that meet community needs and achieve shared benefits.

Around the globe, many regions, cities, and neighborhoods are doing just that: taking action to acknowledge risks and addressing vulnerabilities with fresh and smarter approaches to engagement, land use and development, and infrastructure and environmental investments. Others have not yet done so. Beginning after Hurricane Katrina in 2005, ULI members have teamed up with experts, advisers, and local public and private leaders to work with threatened communities to create fresh visions and investment strategies for enhancing resilience.

ULI’s work in building resilience, led by its Urban Resilience program, has spread to many communities across North America, where ULI has hosted Advisory Services panels and Technical Assistance Program panels (TAPs) focused on resilient land use and development. These communities have included locations devastated by recent events, such as the New York metropolitan region after Sandy and Louisiana after the 2016 floods, and communities that have not recently experienced extreme events but are nevertheless vulnerable. This report seeks to identify the principles that tie this resilience work together and distill common approaches for success, considering the Institute’s work in locations ranging from Seattle, Washington, to El Paso, Texas; Duluth, Minnesota; and Miami–Dade County, Florida.

Through these efforts, we have shown that real estate, land use, design, and planning leaders have an important contributing role to play in reducing cities’ vulnerabilities by building, and building back, responsibly. The concept of the business case—the proof of return on individual and collective investment—is a powerful tool to guide decision making and to assemble the resources to rebuild homes, businesses, and the infrastructure of water, power, transport, and communication upon which the well-being of communities relies.

In defining our objectives for this report, we set out to assemble a document that is comprehensive and concise, taking a broad view of the “state of play” regarding resilience while also capturing the best view of the work by ULI resilience panels. Our

goal is to analyze ULI's body of work on this topic and share ULI's contributions to the initiatives and partnerships advancing resilience as a foundational characteristic of "vibrant and thriving communities" everywhere. At the same time, this document acknowledges that ULI will focus on the specific contributions we are particularly qualified to make, to complement the strengths and skills of other organizations.

We have organized this document as a "quick read," illustrated with photographs, diagrams, and case studies that make its principles "real." We hope it will be a handy tool for ULI members and others seeking to build resilience in their communities and find broad readership among individuals, professionals in the built environment, land use and real estate professions, community groups, and public leaders.

Learning to live with risk, accepting our vulnerability to shocks and stresses, and crafting a collective approach to risk reduction are among the first steps to becoming more resilient. However, a city cannot become more resilient merely through the actions of high-level decision makers. It is critical that all community members have access to the information they need about a city's vulnerabilities—and how these could directly affect their households, businesses, properties, institutions, and daily lives. Ensuring that those who are most in need have access to information about the risks they face is critical, given low-income communities' often-limited resources to respond to shock events and subsequent heightened vulnerability.



Marilyn Jordan Taylor, FAIA  
Workshop Chairman

Marilyn Jordan Taylor  
Workshop Chairman  
Former Global Chairman, Urban Land Institute

## Locations of ULI's Resilience-Focused Advisory Services Panels and Technical Assistance Panels



# The Urgency behind Resilience and Climate Change

Much of ULI's urban resilience work has focused on how buildings, communities, and cities can be more resilient to the impacts of climate change. Addressing this issue is increasingly urgent: the amount of carbon dioxide in the atmosphere continues to rise to record levels every year due to human activity, and has now risen to levels unseen on the planet in over 800,000 years.<sup>i</sup>

The global climate is changing and impacts are being recorded across a range of observations in the United States.<sup>ii</sup> Global sea level has risen by eight inches (20 cm) since 1880 and is anticipated to rise another one to four feet (0.3 to 1.2 m) by 2100.<sup>iii</sup> Along the coasts, some communities are already experiencing tidal flooding with significant frequency, even on a daily basis. For example, in the 310-year-old community of Annapolis, Maryland, the city dock is anticipated to flood more than once a day by 2045.<sup>iv</sup> In coastal and noncoastal regions alike, flooding from extreme rainfall also is a concern, since heavy downpours have increased particularly in the last several decades.<sup>v</sup> Temperature increases of 1.3°F to 1.9°F have also been recorded in the United States, with the past decade being the warmest on record.<sup>vi</sup> Rising temperatures are leading to an increased likelihood of drought, heatwaves, and wildfires, such as the 2017 wildfires in California.

*The historic core of downtown Annapolis is vulnerable to both sunny-day flooding and flooding from storm events. The city's Weather It Together initiative, which was supported by ULI Baltimore, explored how to enhance resilience through a joint historic preservation and hazard mitigation strategy.*

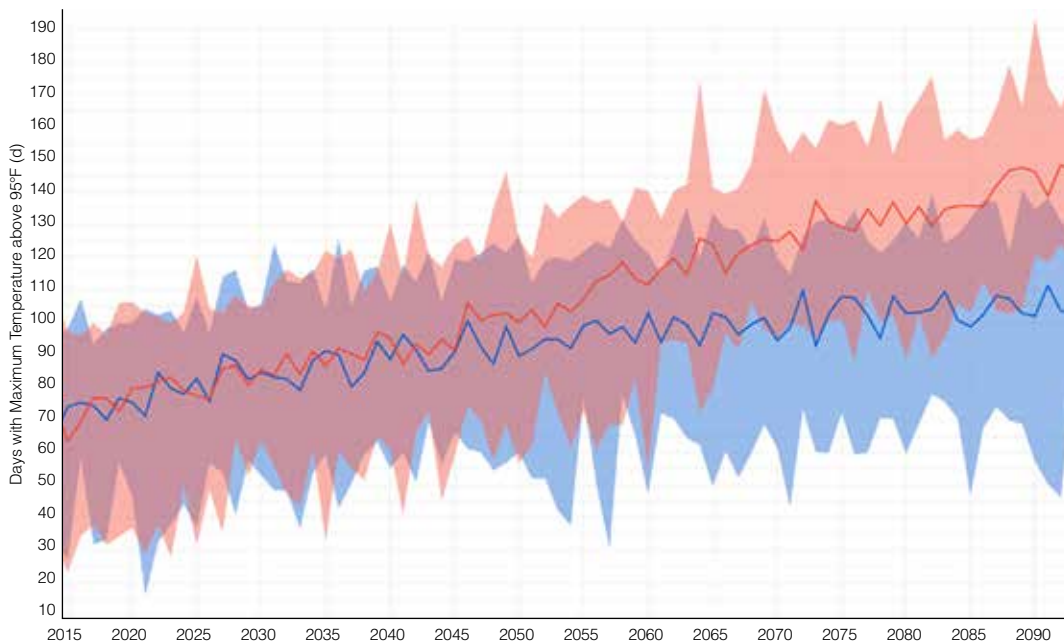


CITY OF ANNAPOLIS



Some of these climate impacts may take the form of severe events that are well covered by the media, such as hurricanes Katrina, Harvey, Irma, and Maria, but many of the effects of a changing climate will be experienced in a more chronic way, such as slightly hotter summers year by year or prolonged droughts. Along with the obvious environmental impacts from a changing climate, such as degradation of natural habitat, there also are clear economic and social impacts. Built infrastructure can be pushed to the brink of its working capacity, such as airport runways closing during heatwaves and coastal flooding forcing cities to redesign their wastewater treatment systems. During extreme climate events, the most vulnerable populations, such as the low income, homeless, sick, elderly, and children, are often most at risk of climate impacts, making climate justice a critical topic.

In the face of these adverse climate impacts, leaders in communities around the world are investing resources in resilience to help their communities recover from extreme events, and to bounce forward and thrive. In the United States, more than 2,500 mayors, governors, business leaders, and others joined the “We Are Still In” movement, pledging to comply with the Paris Climate Accord



*This chart shows the projected increase in the number of days per year with temperatures over 95 degrees Fahrenheit in El Paso, Texas, which hosted a resilience panel in 2016. Indicating a potential doubling of extreme heat days, the blue and red shaded areas show the range in climate model projections for low (RCP4.5) and high (RCP8.5) emission scenarios, respectively. Solid lines represent the median projections for each emission scenario. During the panel, ULI explored how the design of an active transportation infrastructure could address increasing temperatures and drought, among other climate change impacts.*



JOHNU SINGLETON, SWA GROUP

*Buffalo Bayou Park, which won a ULI Global Award for Excellence in 2017, is an example of green infrastructure that also offers flood protection and recreational benefits, including access to the bayou via Texas's longest paddling trail.*

and reduce greenhouse gas emissions to keep global warming below a catastrophic 2°C increase.<sup>vii</sup>

Increasing numbers of communities are also exploring ways to address climate impacts that have multiple benefits, such as green infrastructure, which can help manage increasing precipitation as well as decrease urban heat. Well-planned investments in resilience can improve a community's economic performance and livability, as well as weather the changing climate.

### **The Role of a Chief Resilience Officer**

The chief resilience officer (CRO) is an innovative position in municipal government that was introduced by 100 Resilient Cities, an initiative of the Rockefeller Foundation. A CRO can help shape thinking about how decisions and priorities affect the ability of their city not only to survive a possible disaster, but also to adapt, grow, and thrive no matter what kinds of chronic stresses and acute shocks a city experiences.

A CRO often reports directly to the city's chief executive, and acts as the city's point person for preparing the city for its risks, helping to coordinate all of the city's resilience efforts. The CRO also works to ensure that the city applies resilience thinking to local decision making to achieve multiple goals and deliver

multiple benefits in any policy or project. ULI has worked with CROs to address land use challenges in numerous locations, including Norfolk, Virginia; Miami–Dade County, Florida; and El Paso, Texas.

The exact nature of the CRO position varies from city to city, but the following are fundamental to the role of a CRO, shared by CRO workshop participants Jim Murley (Miami–Dade County) and Christine Morris (city of Norfolk):

1. Working across government departments to help a city improve internal communications, and to address its own complexities. By facilitating communication that reaches across sometimes-significant internal divisions, the CRO promotes new collaboration; makes sure that offices are not wasting resources doing duplicative work; and promotes synergy between the various projects and the plans that agencies are drafting.
2. Bringing together a wide array of stakeholders to learn about the city's challenges and help build support for individual initiatives, and for resilience building in general. These stakeholders include government officials, and it is critical that representatives from the private sector, nonprofit organizations, and community groups also be included.
3. Leading resilience thinking for the city and developing a resilience strategy, to help identify the city's resilience challenges, its capabilities and plans to address them, and then to identify the gaps between these two.
4. Engaging in defining policy and project initiatives, and under some circumstances, leading their implementation of resilience building in their communities.

Effective CROs perform all these functions, helping their cities manage their own complexities to increase the impact of resilience efforts, and collaborating externally to identify and integrate lessons other cities have learned, so that solutions scale globally.

# Ten Principles for Building Resilience

## 1. **Understand Vulnerabilities**

Understanding how shocks and stresses increase risks is the first step toward building resilience.

## 2. **Strengthen Job and Housing Opportunities**

Cities with a diversity of jobs and housing choices are more resilient and better prepared for extreme events and other challenges.

## 3. **Promote Equity**

Pursuing equity means purposefully addressing racial, social, environmental, and economic injustices to build stronger communities and to support the most vulnerable communities in reducing risk.

## 4. **Leverage Community Assets**

Identifying and leveraging existing assets will enable communities to bounce back better.

## 5. **Redefine How and Where to Build**

Building resilience entails identifying and investing in places and infrastructure that are the most likely to endure.

## 6. **Build the Business Case**

Strategies that prepare for and mitigate climate-related risks can create value and provide a strong return on investment.

## 7. **Accurately Price the Cost of Inaction**

Recent extreme weather events suggest that the costs of not investing in resilience and risk reduction are dramatically increasing.

## 8. **Design with Natural Systems**

Designing resilience relies upon an understanding of the function and geography of natural systems and how they can help strengthen manmade systems and communities.

## 9. **Maximize Co-benefits**

Risk reduction initiatives and infrastructure can also include elements that enhance quality of life and economic development potential.

## 10. **Harness Innovation and Technology**

Innovation related to infrastructure, mobility, data, and information tracking can improve response to crisis and strengthen resilience for the long term.

# 1

## Understand Vulnerabilities

Understanding how shocks and stresses increase risks is the first step toward building resilience.

### Defining Shocks and Stresses

The 100 Resilient Cities (100RC) initiative was pioneered by the Rockefeller Foundation, which supports a network of 100 chief resilience officers (CROs) around the world. The initiative is widely credited with popularizing a definition of resilience that focuses on acute shocks and chronic stresses.

**Shocks are sudden and extreme events, or disasters, while stresses are long-term social, economic, and environmental issues that undermine system responses to hazards.** Stresses can increase a community's vulnerability to shocks and limit its ability to bounce back after a major event. Examples of shocks and stresses include the following:

#### Examples of Shocks:

- Coastal flooding
- Earthquakes
- Heat waves
- Hurricanes
- Infrastructure failure
- Landslides
- Rainwater/nuanced flooding
- Riverine flooding
- Terrorist attacks
- Tornadoes
- Wildfires

#### Examples of Stresses:

- Abuse of alcohol and drugs (e.g., opioids)
- Aging or declining population
- Air quality problems
- Crime
- Declining middle class
- Drought
- Failing infrastructure
- Food deserts and lack of food access
- Heat island
- Homelessness
- Insufficient city revenues/financial insecurity
- Insufficient transportation system
- Lack of affordable housing
- Lack of social cohesion
- Potential population influx
- Poverty/inequality
- Sea-level rise, subsidence and coastal erosion
- Unemployment
- Water quality and management problems

Every community, in some way, is vulnerable to hazards, whether natural or manmade. These hazards, or extreme events, can include floods, storms, heat waves, earthquakes, and major infrastructure failures, as well as other crises such as terrorist attacks or economic disruptions. Acknowledging the potential for disruption by, and the cascading consequences from, peak events like these is arguably the first and foremost component of resilience.

The increasing severity and frequency of storms and other natural events is heightening awareness of vulnerability to water, fire, and earthquakes—significant, disruptive occurrences. Violent attacks motivated by terrorism and hatred are challenging our sense of personal security. The Rockefeller Foundation, as part of the 100 Resilient Cities program, popularized the term *shocks* to describe such short-term, erratic events.

Disruption by large-scale hazards can quickly raise awareness regarding a community's vulnerabilities and the critical need to be prepared for future events. However, the risks to human health, the economy, and society in general are far too great to rely on an initial disruption to inspire a desire for change.



ULI Boston's *Living with Water* workshop developed design interventions for Boston's urban neighborhoods to address sea-level rise. First and foremost, the workshop acknowledged the vulnerability of the city's coastal areas, many of which are historically filled-in tidelands, susceptible to both sea-level rise and land subsidence. Some design solutions addressed a potential 7.5 feet (2.3 m) of sea-level rise, as depicted in this aerial view.

#### Key: Flood Depths

- 0–2 feet
- 2–4 feet
- 4–6 feet
- > 6 feet

## Specific Assets in the 100-Year Floodplain in the Portland Region

Asset category	South Portland	Portland
Physical utility infrastructure	Electrical substation and small Peaker Power Plant in Mill Creek Wastewater treatment plant Sanitary pumping stations	Gas primary pumping station
Commercial/Industrial	Oil storage and distribution facilities Marinas Portland Pipeline	Waterfront business on piers Commercial Street retail Elmskip facility New rail line to Elmskip Back Cove businesses
Residential	Willard Beach neighborhood Mill Creek neighborhood Miscellaneous residential units	Condominiums on piers Back Cove neighborhood

*ULI panelists in Portland, Maine, assessed major community assets that are within the 100-year floodplain, and are therefore exposed to damage due to sea-level rise and the increased probability of storms.*

Alongside major shocks, cities face long-term stresses that weaken their capacities. These stresses may arise from climate change, such as more regular intense rain events, increasing temperatures, and drought. Social and economic problems such as crime, poverty, lack of affordable housing, aging infrastructure, and insufficient city revenues also are relevant stresses. These issues not only affect a community's public health, quality of life, and economic development potential, but also make recovery from major shocks more difficult.

Learning to live with risk—to accept vulnerability to shocks and stresses and develop a collective tolerance to risk—is the first step to becoming more resilient. However, a community cannot become more resilient merely through the actions of municipal leadership. The business community, the real estate sector, neighborhood and civic groups, and households all have important perspectives to share and roles to play.

- For the private and real estate sectors, acknowledging vulnerabilities entails understanding the risks to assets and potential costs of recovery.
- For local government, acknowledging vulnerability entails establishing which geographical areas, communities, businesses, infrastructure systems, and other assets are at risk.
- For civic groups, neighborhoods, and households, recognizing vulnerability means exploring how a major event could directly affect families, homes, and livelihoods.

## On Site with Advisory Services: Norfolk, Virginia

**Context and assignment:** Fort Norfolk is a waterfront site on the banks of the Elizabeth River, northwest of downtown Norfolk. The site includes substantial vacant waterfront land, as well as a diverse mix of current uses, including parking, a television station, and offices for the U.S. Army Corps of Engineers, People for the Ethical Treatment of Animals, and the American Red Cross.

The city of Norfolk invited ULI to recommend land use strategies for the site, considering the increased likelihood of coastal and tidal flooding in the future. Norfolk is among the most vulnerable cities to sea-level rise in the country, given its coastal geography and regional subsidence; sea level has risen 14.5 inches (36.8 cm) in the region over the past 80 years.<sup>viii</sup>

**Key finding:** In 2002, a ULI panel had assessed the site and recommended the development of a mixed-use urban residential village, citing its waterfront location as a promising asset. However, the 2014 resilience-focused panel instead proposed pivoting development to a recently opened light-rail station inland. The waterfront space could then offer a site for community space that could both offer protection from storm surge and serve as a neighborhood amenity.

The panel also noted the potential for limited demand for waterfront properties due to their inherent vulnerability. In the two years since the panel, Zillow has indicated a continued decrease in the value of waterfront properties on or near the Fort Norfolk site.<sup>ix</sup>

# 2

## Strengthen Job and Housing Opportunities

Cities with a diversity of jobs and housing choices are more resilient and better prepared for extreme events and other challenges.

Although climate vulnerabilities and the likelihood of natural disasters are often front and center in discussions of resilience, social and economic ecosystems are extremely important contributors to a city's overall ability to recover and bounce back. Notably, long-term stresses related to a lack of jobs and economic opportunities make communities more vulnerable to shocks.

Jobs, and a degree of job security, are important to everyone. Chronic concern about job vulnerability and housing availability makes individuals and households more susceptible to shocks, such as extreme weather events, and stresses, such as a lack of education opportunities and expensive health care.

To recover quickly from shocks, cities must have healthy economies that can withstand crises affecting a single industry. Coastal communities, which can be particularly vulnerable to major storms and often rely on tourism, offer one clear illustration of the potential for economic loss. For example, Superstorm Sandy is estimated to have caused a loss of \$950 million worth of tourism spending in New Jersey in 2013, and to have reduced employment for more than 11,000 hotel, food service, retail, amusement, and transportation sector employees.<sup>x</sup>

Having a diverse economy, without reliance on a single industry vulnerable to the trends of globalization or potential adverse events, has obvious, myriad benefits beyond enhanced resilience. Similarly, cities require systems redundancies and emergency preparedness plans to maintain business continuity in the face of major crises.

A diverse housing stock and housing affordability also are key components of a resilient community. According to a 2015 study published by the Joint Center for Housing Studies at Harvard University, high-priced housing is not just a large-

*ULI panelists in Portland and South Portland, Maine, observed that the towns' maritime economy could be dramatically affected by changing sea temperatures arising from climate change. This would ultimately affect not only the maritime industries but also the tourism and heritage industries, which rely on the charm of a visible working waterfront. As a result, some of the panel's recommendations focused on how to diversify the local economy and attract employers that would support the existing maritime and tourism industries.*



STEVE LIPOFSKY, WATERFRONTS OF PORTLAND AND SOUTH PORTLAND, MAINE (2014)



city problem.<sup>xi</sup> In fact, many U.S. cities are experiencing housing affordability crises, with few lower- or middle-income families, including service and support professionals, able to afford to live close to their places of work. Diversity within the housing supply, including housing for a diversified workforce and workers essential in emergencies, will help build the ability to “bounce back” from a severe weather event as well as long-term economic strength. Affordable housing also provides stability by increasing discretionary income for vulnerable families and helps prevent homelessness.

Most critical of all, workforce housing is essential to a city's ability to recover after a major event. Emergency responders, nurses, and construction workers are typically those who supply the skills and the labor to respond to shocks such as severe storms, floods, heat waves, and droughts. These low- and middle-income professionals often struggle to return or continue their professional lives after major events, a trajectory that can be exaggerated when a city lacks affordable housing. For example, New Orleans, a city that did not suffer from high cost of living in 2005, experienced a severe shortage of contractors after Katrina, delaying homeowners from rebuilding and leaving many vulnerable to price gouging or unreliable service.<sup>xii</sup>

In short, when one is speaking of resilience, all types of housing are important to building a city's capacity to respond to shocks and stresses, but workforce housing is of paramount importance. Implementing affordable housing policies, especially policies targeting housing for key workers and emergency personnel, offers one key strategy for enhancing resilience.

### Estimated Number of Low-Income Renter Households in Larimer County, 2009

HUD designation	Households	Number of cost-burdened households	Percentage cost burdened
Low income	7,788	2,336	30
Very low income	8,651	6,629	77
Extremely low income	13,918	11,065	80

*Note: Cost-burdened households pay 30 percent or more of income on rent.*

*ULI panelists in northern Colorado observed a significant housing affordability gap in Larimer County, which has a population of roughly 300,000 people. To address this gap, the panel recommended developing a range of unit types at various affordability levels, including smaller efficiency units suitable for seasonal workers, mixed-income multifamily units, and single-family starter homes.*

### On Site with Advisory Services: Northern Colorado

**Context and assignment:** In 2013, northern Colorado experienced devastating flooding, which made major roads between towns impassable. One year later, the towns of Fort Collins, Loveland, and Estes Park invited ULI to explore how to enhance resilience through a regional land use and development strategy covering a 50-mile (80 km) study area, considering preparedness for extreme events such as floods and wildfires.

The region has a severe lack of affordable housing. Many essential workers had daily commutes of 60 to 80 miles (96 to 129 km), and rental properties in Estes Park had a mere 2 percent vacancy rate over the two years prior to the panel.

**Key finding:** ULI's panel recognized that this lack of accessible housing led to significant costs and barriers to recovery after the floods. When roads were impassable due to flooding, some Estes Park hospital staff faced three-and-a-half-hour drives to work. As a result, the hospital was forced to send in staff by helicopter, providing housing and meal per diems, which ultimately cost about \$700,000 in a single month.

**Strategies and tools:** The panel recommended that the three towns consider housing diversity as a key component of resilience and make proactive choices to increase the availability of affordable housing. This was particularly critical for key workers, including medical and emergency management professionals. Recommendations to encourage housing diversity included the following:

- Conduct a housing needs assessment for essential workers; and
- Establish a housing fund to develop affordable multifamily housing for key workers, ensuring they can better access the communities they serve during both peak events and regularly. A \$3 million investment could result in 25,000 square feet (2,300 sq m) of multifamily housing, or 29,850-square-foot (2,800 sq m) two-bedroom apartments.

# 3

## Promote Equity

Pursuing equity means purposefully addressing racial, social, environmental, and economic injustices to build stronger communities and to support the most vulnerable communities in reducing risk.

### Defining and Applying Equity

Embedding equity into land use decision making is a multifaceted, nonlinear process. The U.S. Sustainability Directors Network has proposed the following framework for better embedding equity into urban sustainability work:

- **Procedural equity:** “Inclusive, accessible, authentic engagement and representation in processes to develop or implement sustainability programs and policies.”
- **Distributional equity:** “Programs and policies result in fair distribution of benefits and burdens across all segments of a community, prioritizing those with the highest need.”
- **Structural equity:** “Decision makers institutionalize accountability; decisions are made with a recognition of historical, cultural, and institutional dynamics and structures that have routinely advantaged privileged groups in society and resulted in chronic, cumulative disadvantages for subordinated groups.”
- **Transgenerational equity:** “Decisions consider generational impacts and don’t result in unfair burdens on future generations.”<sup>xvi</sup>

Increasing equity is critical to achieving resilience. Communities with the least financial resources are typically most at risk in times of extreme events: they are the least likely to have sufficient resources to support needs after an extreme event, and have the least job security, which can often affect decision making and preparedness before an event. Forty-six percent of Americans do not feel that they would be able to handle an unexpected \$400 expense—a figure far below the likely recovery cost per household after a major storm event.<sup>xiii</sup> Even with subsequent federal aid or support from community organizations and recovery programs, property losses and delays due to home inspections, insurance payments, and work interruptions can be debilitating.

A resilient community therefore either has a more equitable distribution of resources, or ensures that those with fewer resources are better protected from peak events that could lead to damages. If vulnerable communities cannot bounce back after a shock, a city’s economic, social, and services ecosystems will be strained. Similarly, unemployment, lack of job security, and lack of affordable housing are major stressors to a city in good times and after extreme events.

Research institute PolicyLink defines *equity* as “just and fair inclusion. An equitable society is one in which all can participate and prosper. The goal of equity must be to create conditions that allow all to reach their full potential.”<sup>xiv</sup> An equitable society considers the needs of and opportunities for all residents, including people of all income levels, races, ages, and levels of physical ability, seeking to strengthen local capacities. An equitable society also seeks to ensure that all communities share and receive access to the benefits of investments in infrastructure, land use, and development. As Mayor Bill Peduto of Pittsburgh succinctly stated, “If it’s not for all, it’s not for us.”<sup>xv</sup>

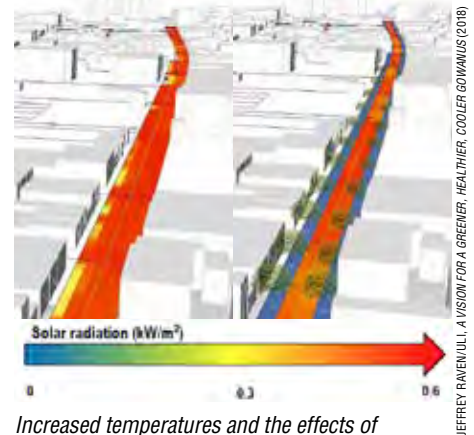
Low-income communities are often particularly vulnerable to the impacts of climate change, due to the likelihood that low-income neighborhoods are located in geographically at-risk parts of cities. For flood-vulnerable communities, low-income residents are often prone to nuisance flooding and are in harm’s way during storms and hurricanes. Moreover, “climate gentrification,” or the process by which affluent populations move away from historically high-value yet vulnerable areas and move inland, is becoming a concern among low-income communities that are not located in vulnerable parts of cities. For example, many inland communities in Miami-Dade County have expressed concern about the prospect of displacement if residents of beachfront neighborhoods decide to move inland. In cases like this, fears of displacement—both physical and cultural—are part of a larger conversation about preparedness, climate change, and housing affordability.



ULI’s workshop in St. Petersburg, Florida, proposed strategies for the city to engage local communities in resilience planning and enhance emergency preparedness. Catalyst Miami’s Clear Program was one best practice shared; the 12-week training program on climate resilience provides graduates with grounding to become community leaders and organizers.

As vulnerable and low-income communities face unprecedented risk of impact from extreme events, a variety of strategies enhance equity and build resilience:

- **Earlier dialogue.** Vulnerable and low-income community members should be a key part of resilience conversations from the very beginning of the resilience planning and decision-making process. Their input can help community leaders and public decision makers define the full extent of the vulnerabilities faced, and craft realistic solutions.
- **Inclusive decision making.** When decision makers are representative of the communities they serve, disadvantaged and low-income communities are more likely to receive solutions that accurately respond to their needs.
- **Additional resources.** Planning for extreme events should assume that low-income and disadvantaged communities will need additional resources to cover preventative measures that should be taken prior to extreme events, such as preparing homes for incoming storms, and higher-than-average resources to recover from the impacts of extreme events.
- **Prioritized investments.** Investments in infrastructure and mitigation should prioritize the safety and security of low-income individuals and communities of color that are most in harm's way.
- **Double-bottom-line solutions.** Resilience resource allocations and investments should affirmatively seek to provide other quality-of-life or economic development opportunities, or co-benefits, in addition to their resilience benefits.



JEFFREY RAVENHILL, A VISION FOR A GREENER, HEALTHIER, COOLER GOWANUS (2018)

*Increased temperatures and the effects of urban heat islands are a major concern for Gowanus, given the Brooklyn neighborhood's lack of green spaces, heavy traffic, and lower air and water quality. During a ULI New York TAP, panelists noted how the urban heat islands have a disproportional impact on the disadvantaged, including the elderly and low-income households unable to afford air conditioning. This image indicates the existing heat corridor along Third Avenue, which could be improved by planting trees and implementing other types of green infrastructure.*

## On Site with Advisory Services: Seattle, Washington

**Context and assignment:** The South Park, Georgetown, Port of Seattle, and SoDo (South of Downtown) areas along the Duwamish River are Seattle's most vulnerable areas for flooding induced by sea-level rise. The areas are also home to a larger group of minority and low-income families in comparison to the surrounding counties.

In 2015, the city of Seattle invited ULI to study how the neighborhoods of the Duwamish Valley could be more resilient to flooding caused by sea-level rise and changes in precipitation. The city was particularly interested in understanding potential public/private partnership models for funding infrastructure such as levees or sea walls, opportunities for modified building and zoning codes, and best practices for engaging residents in the decision-making process.

**Key finding:** The panel observed that a more resilient Duwamish Valley would not only be more physically prepared for floods but also exhibit other conditions

related to social and economic systems. The panel proposed "ideal conditions" for resilience in Duwamish, including high internal cohesion and external connectivity; improved welfare, health, and economy; a diversified portfolio of land uses; and increased self-reliance and internal investment. Social equity, cohesion, and investment in social networks were central to many of these conditions. As a result, the panel's recommendations focused on how to support the local communities in Duwamish and engage them most effectively.

**Strategies and tools:** Recommendations made by the panel include the following:

- Creating programs, including in-kind and financial assistance, to help low-income residents work toward personal resilience through home elevation and relocation assistance, transit access, and workforce opportunities.
- Planning inclusive community-wide events to cohesively communicate trends, development,

and concerns, including an annual "state of the Duwamish" summit. A summit would communicate critical information about environmental remediation, development prospects, future engagement opportunities, and more, at a time and place sensitive to child care, work, and accessibility needs, and with information provided in multiple languages. The city has since implemented this recommendation.

- Tailoring outreach strategies through Seattle's Department of Neighborhoods, including providing interpreters, leveraging existing community groups, and offering meetings at multiple times of day.
- Formally engaging in the existing network of non-profit organizations.
- Producing a strategy to engage philanthropic organizations in order to better familiarize foundations with the needs of the area.

# 4

## Leverage Community Assets

Identifying and leveraging existing assets will enable communities to bounce back better.

To be ready to bounce back from extreme events, communities must first identify their assets. Strengthening, leveraging, and protecting these assets will present opportunities to be more prepared for eventual shocks, as well as otherwise improve a local economy and quality of life.

Community assets may relate to geographical location, economy, culture, or skills of the local population. Categorizing these assets, alongside relevant vulnerabilities, is a critical early step for any resilience planning process, whether at the community or site scale. For example, the RAND Corporation's Community Resilience Action Checklist recommends an initial focus on assets, considering competencies, infrastructure, equipment, money, services, relationships, and data.<sup>xvii</sup>

Advancing a scan of assets into an action plan relevant to resilience requires an understanding of how vulnerabilities and assets fit together; an appreciation of the changing roles of the players within the government, resident, and business community; and the resources available for investment.

Valuable and distinctive assets relevant at the city or community scale could include the following:

- Economic drivers
- Environmental qualities
- Location
- Workforce
- Community leadership
- Social networks
- Culture and history.

Valuable and distinctive assets relevant at the site scale could include:

- Location and connectivity
- Geographical, topographical, and natural features
- Infrastructure
- Current and future community.

In local government, interdisciplinary and cross-agency collaboration is essential to both identifying assets and understanding ways to leverage them and attract funding from the federal, state, private, and philanthropic sectors. Municipal and business leaders should encourage the sharing and exchange of resources across city agencies to understand the multifaceted character of community assets and find efficient strategies to invest and build from these opportunities.

Community involvement is also key for any municipality or other entity seeking to initiate an asset-mapping exercise. Involvement from and engagement with local business, resident, and civic communities are critical to fully mapping and understanding assets and opportunities and developing locally appropriate solutions. Groups that may contribute to any asset mapping or planning exercise could include civic leaders, businesses, community organizations, community development corporations, public health leaders, and others.



KATHARINE BURGESS/ULI

*A Rose Center study visit, hosted by ULI and the National League of Cities, focused on building resilience in the Mountain View neighborhood of Anchorage, Alaska, which is the most diverse zip code in the United States. The panel noted the many existing assets in the neighborhood that serve as well-used social resources and hubs, such as the Mountain View library.*

## On Site with Advisory Services: Lafayette, Louisiana



KATHARINE BURGESS/ULI, DOWNTOWN LAFAYETTE, LOUISIANA (2017)



LEAH SHEPPARD/ULI, DOWNTOWN LAFAYETTE, LOUISIANA (2017)

*ULI's panel in Lafayette focused on how to encourage more resilient development patterns, including residential development downtown. The panel found that the downtown already had many local assets that could be leveraged to create a more lively and unique destination, such as historic architecture, independent retailers, and Parc Sans Souci, which hosts a popular annual festival.*

**Context and assignment:** In August 2016, Lafayette, Louisiana, experienced a 1,000-year rain event, during which 24 inches (61 cm) of rain fell over a three-day period. The flood damaged approximately 3,500 homes, requiring an estimated \$100 million in repairs. This flood significantly raised local awareness about the region's vulnerability to major storms, particularly in low-lying parts of the parish, and led the Lafayette Consolidated Government to invite ULI to study how the city could encourage more resilient land use patterns.

**Key finding:** The panel found that resilient development would entail a focus on downtown Lafayette. The downtown offers abundant assets, including a relatively high-ground location, a rail and public transit center with direct access to New Orleans, an adjacent university, historic architecture, and cultural facilities. However, the downtown does not yet have significant residential development. The panel recommended that the city encourage and incentivize downtown growth to foster a more vibrant downtown that would not only be less vulnerable to future flooding but also offer numerous opportunities in terms of economic development and expansion of the local tax base.

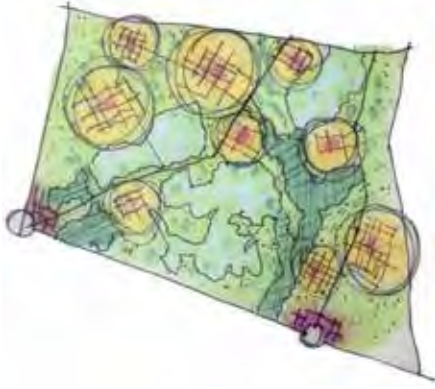
**Tools and strategies:** Leveraging downtown's assets was a key theme of the panel. Strategies to achieve this included the following:

- Capitalizing on historic building stock to reinforce downtown's unique character through infill and adaptive use, thus differentiating it from other areas of the city and parish, as well as incorporating public art specific to the city and region in future downtown management plans;
- Embracing an entrepreneurial approach to downtown development by using tools like tax increment financing, bonds, and tax credits and being proactive in efforts to attract private sector partnerships;
- Retrofitting existing spaces to incorporate green infrastructure and other techniques to manage stormwater and flooding. For example, the current coulee system could be transformed into a recreational corridor, featuring a waterway and trail system; and
- Building resilience into everyday development practice and making investments to better manage water through new funding streams such as a potential stormwater fee.

# 5

## Redefine How and Where to Build

Building resilience entails identifying and investing in places and infrastructure that are the most likely to endure.



*In St. Tammany Parish, Louisiana, a ULI panel recommended accommodating projected population growth by encouraging a “village-in-the-woods” strategy, which uses smart growth techniques to concentrate development and retain local natural resources.*

If the locations of homes, businesses, and government are vulnerable to major events, a city must be ready for potential impacts to the economy and to residents' safety, health, and welfare. Building resilience entails recognizing which physical areas are most vulnerable and making strategic decisions to both protect those in harm's way and foster a long-term culture shift toward investing in places and infrastructure that are more likely to endure.

While cities are increasingly acknowledging climate risks and vulnerabilities, many have yet to do so in the context of their approaches to land use, development, and the growth and change of the built environment. Zoning, building codes, standards, overlays, incentives, and infrastructural investments are among the tools that can be deployed to address the challenges at multiple scales, ranging from the individual building and the neighborhood to the city and the region. These approaches should be shaped in response to the conditions, expectations, and goals of each community. Sometimes, relocation may be a component of the strategy.

To enhance resilience, cities should support and incentivize development in locations that are most likely to be secure for the longest period of time. If lucrative development conditions are in place, the real estate sector is likely to respond, leading development patterns to shift over the long term to locations that are less vulnerable. For example, cities that are vulnerable to sea-level rise may focus on encouraging development on high-ground sites less likely to be affected by rising sea levels or storm surges.

These land use strategies and investments should ultimately encourage a higher density of people, activities, and business in parts of a city that have the infrastructure to thrive in changing conditions. Strategies for beginning such a shift could include the following:

- Introduce density bonuses, opportunities for increased floor/area ratios, or other incentives, such as streamlined permitting, in parts of a city projected to be least vulnerable to long-term climate risk.
- Prioritize municipal investment in transportation and other infrastructure in parts of a city least vulnerable to long-term climate risk.
- Introduce zoning incentives for modifications to existing buildings and infrastructure that reflect effective, long-term climate resilience.
- Modify zoning to allow for the relocation of building systems above projected flood elevations whenever permits are issued for open space, building, street, or infrastructure renovations.
- Incorporate zoning and code relief to allow upward expansion to offset the loss of the lower-level uses and revenue where flooding is an issue.
- Fortify buildings and infrastructure in locations that are not practical or cost-effective to relocate.

Resilient design also entails recognizing how vulnerabilities can be addressed at the building scale, incorporating technologies enabling more efficient use of water and energy, and allowing for quick response to peak events. Numerous design standards, such as LEED, RELi, the Sustainable SITES Initiative, REDi, the Waterfront Edge Design Guidelines (WEDG), and Fortified, explore how this could translate for individual buildings or development projects. For example:

- Incorporating renewable-energy systems, backup power systems, and the ability to “island” (i.e., operate off-grid for a period of time) will make properties better able to manage the impact of major storms.
- Design strategies can directly address vulnerabilities to rising waters, such as increased elevation, the elevation of mechanical features such as boilers and chillers, and stormwater management best practices.
- In regions prone to drought, redefining how and where to build may mean identifying opportunities for graywater recycling and drought-tolerant landscapes.

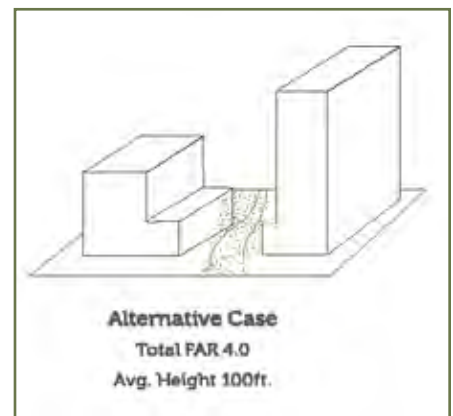
However, redefining how and where to build entails not only proactive investment in the future, but also an acknowledgment of the inherent risks in cities' current development patterns. Merely supporting parts of a city that have the potential for long-term growth presents a major risk: that those living and working in vulnerable areas will be forgotten. Providing support to these communities, and ensuring that all people have the social networks and physical infrastructure needed to stay safe and reach their potential, are also critical facets of building resilience.

Cities will need to establish fair approaches for supporting communities in places that are physically vulnerable to climate impacts and major events. Thoughtful relocation strategies, which seek to maintain community fabric and networks and include residents in the decision-making process, may be part of the solution. If communities or residents ultimately need to relocate, they should be provided fair compensation and offered alternatives in nearby neighborhoods, which preserve access to jobs, civic facilities, and social networks.

Pivoting land use patterns and municipal investment strategies to acknowledge vulnerabilities and enhance resilience will be a long-term process, and it may take decades for land use patterns encouraged by new policies to come to fruition. In the interim, developers, investors, and others who anticipate this potential shift are likely to see long-term potential in investments that are out of harm's way.



A VISION FOR A GREENER, HEALTHIER, AND COOLER GOWANUS (2018)

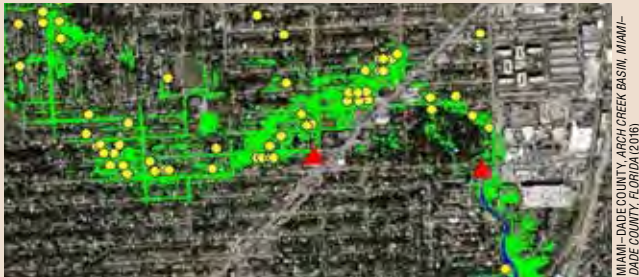


A VISION FOR A GREENER, HEALTHIER, AND COOLER GOWANUS (2018)

*During the Gowanus TAP, panelists recommended adjusting height limits, or offering site-specific zoning bonuses for design approaches that would open up green spaces in new development, particularly when aligned with the area's prevailing winds. Here, two buildings with identical floor/area ratios (FARs) are shown; the alternative case has potential to mitigate the urban heat island effect.*

## On Site with Advisory Services: Arch Creek Basin, Miami–Dade County, Florida

**Context and assignment:** With over 84 miles (135 km) of coastline and a population of 2.6 million people, Miami–Dade County is one of the most vulnerable areas to sea-level rise in the United States. Many parts of the county are already regularly experiencing flooding due to low elevations and drainage problems, and the county is vulnerable to extreme weather events that could include catastrophic winds and storm surge. South Florida’s porous substrate also makes traditional defenses, such as levees, less effective for managing groundwater levels and flooding.



MIAMI-DADE COUNTY, ARCH CREEK BASIN, MIAMI-DADE COUNTY, FLORIDA (2016)

*Chronic flooding and repetitive losses (indicated by yellow dots) affect properties in the Arch Creek Basin, many of which overlap with the contours of the historic creek (green). Some residents in this area have resorted to applying for FEMA buyouts.*

Miami–Dade County invited ULI to study the Arch Creek Basin area, a multijurisdictional area that comprises approximately 2,838 acres (1,148 ha) and four municipalities, as well as unincorporated county land. The area is economically diverse and includes sites that have experienced repetitive losses due to routine flooding, where households had unsuccessfully applied for Federal Emergency Management Agency (FEMA) buyouts. The area is also likely to experience development and change, as a future commuter-rail station will provide an opportunity for transit-oriented development. The panel sought to address the question of how long-term development and land use patterns in Arch Creek could pivot to enhance resilience, reversing decades of past development that advanced regardless of flood vulnerability.



ARCH CREEK BASIN, MIAMI-DADE COUNTY, FLORIDA (2016)

**Key finding:** The long-term solution that the panel proposed concentrated development in the area that would ultimately be the least vulnerable, along a ridge that would soon offer transit connectivity. The plan also proposed long-term options for relocation for households that had experienced repetitive losses due to flooding. If these residents opted to relocate, the flood-prone area, or parts of it, could transition into regional park and flood preparedness infrastructure along the contours of the historic creek.

**Strategies and tools:** The recommendations included the following:

- **Concentrate development in transit-ready sites along the coastal ridge,** including at a new station proposed for NE 125th Street, described as the Transit Opportunity Area. This promising opportunity area offers relatively high ground, future transit connectivity, and the opportunity for a considered mixed-income development approach including dedicated relocation housing for flood-vulnerable households.
- **Restore natural systems through the development of a park along the historic contours of Arch Creek:** The panel proposed a long-term strategy to implement green infrastructure in the areas experiencing repetitive losses, particularly where households had expressed an interest in relocation through FEMA buyouts. If these households chose to relocate and ample relocation housing was provided in the transit-opportunity area, flood-vulnerable sites could ultimately become a “city slough” park designed to manage water during peak events. The slough would be a long-term acquisition, and built with an alternative safe housing project, which would strategically implement parkland along the historic creek contours.



WALTER MEYER/ULI, ARCH CREEK BASIN, MIAMI-DADE COUNTY, FLORIDA (2016)

*The Arch Creek Basin panel recommended a long-term transformation of the Arch Creek Estates neighborhood to include a “city slough” to both provide recreation space and manage water, with higher residential density on either side.*

- **Implement this vision through an Adaptation Action Area:** Inter-governmental cooperation, and even the establishment of regional authorities or partnerships such as the Southeast Florida Climate Compact, may be required to propose and implement resilient land use approaches. The panel recommended the implementation of an Adaptation Action Area and Steering Committee, which would include representation from all the municipalities as well as neighborhood residents.

*The Arch Creek Basin long-term master plan envisions transit-oriented development including affordable relocation housing units around the proposed new rail station in North Miami.*



## Key Tools for Resilient Land Use

ULI's resilience panels have recommended that cities follow a range of strategies to embed resilience into land use planning. The approaches that generate the highest level of impact vary depending on local market context, climate conditions, and regulatory options, but some key themes have resonated in many different communities. The following strategies and tools proposed by various advisory panels offer opportunities to both embed resilience thinking into long-term development and advance quick wins on the ground.

Resilience building strategy	Rationale	Example from a panel
Incorporate resilience thinking into existing land use tools, such as zoning and comprehensive planning.	Embedding resilience into existing planning or zoning policy eliminates redundancy and the potential for community fatigue associated with a new planning initiative.	The St. Tammany Parish panel recommended embedding resilience thinking into updated land use plans, such as the Unified Development Code. The city of Norfolk also offers an implemented example of this approach; resilience and analysis of vulnerabilities are fundamental topics in the recent zoning ordinance rewrite.
Build resilience thinking into existing capital improvement planning and municipal budgets.	Municipal budgeting and capital improvement plans offer the best possible route for implementation of resilient infrastructure, as opposed to dedicated resilience funds, which are unlikely to address the scope of the problems sufficiently.	In St. Petersburg, Florida, panelists suggested that the city align goals in the city's capital budget with opportunities to build resilience. Miami-Dade County currently takes this approach with its budget, considering four pillars of resilience relevant to capital projects: health and well-being, economy and society, infrastructure and environment, and leadership and strategy.
Initiate multijurisdictional or cross-jurisdictional planning approaches.	Planning across borders enables resilience planning to build from natural systems and more comprehensively address vulnerabilities regionally.	In Miami-Dade County, panelists recommended using an adaptation action area framework to plan for resilience in a 2,800-acre (1,133 ha) flood basin, including four jurisdictions and unincorporated county land.
Plan at the district scale, considering opportunities for alternative infrastructure funding, increased efficiencies, and district-wide value capture.	District-scale planning offers the opportunity for resource efficiencies with energy and water systems, as well as the chance to establish new funding structures and delivery vehicles.	The Seattle panel proposed the creation of a resilience district for the Duwamish area, including strategies for funding resilience investments via a resilience enhancement fund. Although the state of Washington does not allow tax increment financing in its standard form, the panel proposed alternative funding strategies for this district-scale initiative.
Forge new financial partnerships, including with the private sector.	Many resilient infrastructure projects present opportunities for both the public and private sectors, and are therefore natural fits for PPPs.	In Anchorage, the Rose Center Study Visit recommended that the city seek partnerships with the private sector to invest in resilient infrastructure and development, including the local Tribal Corporations.
Harness value creation from new development or policy change to invest in building resilience.	An upcoming neighborhood redevelopment can present the opportunity to realize and/or fund improvements that will benefit both long-term and new residents to an area.	In the Gowanus neighborhood of Brooklyn, the panel proposed implementing policies that would capture some of the real estate value generated by a rezoning to implement urban heat island mitigation measures such as parks, green infrastructure, and cool roofs.
Use pilot projects to demonstrate new approaches and inspire the local community.	Pilot projects offer the opportunity to test and prototype new approaches to infrastructure and design, and can also be eligible for alternative funding sources.	Numerous ULI panels, such as in St. Tammany Parish, proposed pilot projects related to park design, green infrastructure, and other resilience topics.

# 6

## Build the Business Case

Strategies that prepare for and mitigate climate-related risks can create value and provide a strong return on investment.



ROBIN HILL, RETURNS ON RESILIENCE: THE BUSINESS CASE (2015)

*A view of the green roof at 1450 Brickell, Miami, Florida, which was profiled in Returns on Resilience: The Business Case.*

**M**aking cities, communities, and buildings more resilient will require significant investment from the public, private, and philanthropic sectors. Developers and finance, insurance, and other private sector parties are likely to play a key role in building a more resilient city if they see tangible economic benefits from improving the resilience of buildings and infrastructure. To build the business case for this investment, cities and other parties dedicated to resilience need to look at the economic costs of “business as usual” development versus the cost savings and revenue generation that would come through a dedicated investment in resilience.

As cities work to recover from increasingly frequent and intense weather events, the business case for public investments in resilience becomes more and more compelling. Local, municipal, and state governments bear the biggest economic impacts as they work to rebuild damaged infrastructure and public buildings, and cope with the loss of tax revenue from disrupted economic activity and stranded assets. Municipalities are also finding that investments in resilience can serve as a cost-effective alternative to substantial investments in increased capacity for wastewater and energy infrastructure. For example, capturing stormwater before it reaches a combined outflow sewage system becomes more cost-effective than increasing the capacity of sewage treatment facilities.

There can be many different quantifiable “returns on resilience” for developers as well. For example:

- Investments in resilient energy and water systems can introduce short-term benefits, such as reduced construction costs and/or reduced building operating expenses.
- Resilient design can lead to lower insurance premiums, or better access to insurance coverage.
- Resilience may offer marketing or branding benefits, particularly for future tenants and owners concerned about a building’s vulnerability to major events like storms and long-term stresses like sea-level rise.
- Future tenants and owners may also see investment in resilience as a proxy for quality or environmental responsibility.
- Long-term benefits can include reduced risk of major damage or disruption from extreme weather events, improving long-term asset viability and enhancing property values.
- If developers partner with cities to co-develop more resilient infrastructure that increases access and the likelihood of occupant safety and business continuity, buildings are likely to be more attractive to future tenants.

While a compelling business case exists for both cities and developers to invest in resilience, these returns must be better defined to help all decision makers decide to invest in resilience initiatives at the community-wide scale and building scale. A better-defined business case will ultimately engage a broader range of investors in resilience, including businesses and enterprises, real estate developers, banks, and insurance funds. Municipalities, community development organizations, governments, philanthropists, and foundations would also benefit from understanding the business case for investing in resilience, whether that translates to physical infrastructure, individual facilities, economic development tools, or capacity-building initiatives. Without the commitment of additional capital to both private and public projects that incorporate resilient design, communities will not see tangible progress.



*Fortified Home Building Standards were profiled in Returns on Resilience: The Business Case.*

## Case Studies for the Business Case

*Returns on Resilience: The Business Case* is a ULI report and ongoing research project showcasing real estate developments that exhibit best practices in resilient design, from the building to the neighborhood scale, with positive financial, operational, and other business outcomes. The projects profiled have achieved measurable returns such as increased real estate value, discounted insurance premiums, marketing value, cost savings from prevented damages, reduced operating costs, and more, on account of the decision to invest in resilient design.

**Spaulding Rehabilitation Hospital:** Located on a waterfront site at the Charlestown Navy Yard, Spaulding Rehabilitation Hospital in Boston is designed to keep patients and their families safe from coastal storms, storm surge, and future impacts of sea-level rise despite its vulnerable site. The hospital is built 30 inches (76 cm) above the 500-year floodplain, with elevated mechanical elements (e.g., boilers, chillers, and air handlers for ventilation) on the top level, and is super-insulated with triple-paned operable windows, includes an extensive landscape berm system, and is designed to last four days in “island mode” in case of a disaster, thanks to an on-site cogeneration plant. The hospital designers esti-

ated that the resilience investments cost roughly \$1.5 million within the \$160 million construction cost, with about half of this cost contributing to the encasing of the high-voltage riser to the elevated mechanicals and the other half covering systems upgrades for high-efficiency pumps and chillers. The cogeneration was an additional cost that the hospital anticipates recouping in an eight-year payback period, having saved \$400,000 on the first year of operating costs and an anticipated \$500,000 per year after system optimization. The investment in resilience also enhanced the hospital's reputation, elevating Spaulding's position in the marketplace.

**1450 Brickell:** Located in Miami, 1450 Brickell is a commercial/mixed-use Class A office tower that includes several resilient design aspects to address risks of hurricanes, tropical storms, and storm surge. Resilient design features include high-impact-resistant windows for the entire building, the inclusion of a backup emergency generator, and elevated ground floors eight feet (2.4 m) above grade. At the time of construction, 1450 Brickell's curtain wall window system was the strongest of any commercial building in the United States, far above and beyond the standards of the already stringent local building code. These investments in resilience

differentiated the project, leading it to fully lease up in 2013, compared with 40 percent lease-up rates for two comparable office properties. The developer attributed this to the interest in business continuity from tenants such as J.P. Morgan Chase & Company, H.J. Heinz Company, American Express, and Bank of New York Mellon.

**Fortified Home Building Standards:** Fortified Home Building Standards are a set of performance-based engineering and building standards that protect homes from rain, hail, wildfire, and winds up to 130 miles (209 km) per hour. A study of the marginal effect of Fortified construction standards on home resale value found a 7 percent increase in resale value from a sample of 321 homes, about half of which were built or retrofitted to the Fortified standard. This consumer recognition of the standard can be at least partially attributed to correlated insurance savings. The state of Alabama passed legislation that requires insurers to offer discounts to owners of homes that meet the Fortified standard, to create a program that offers financial incentives to building new construction using Fortified, and to provide grants for retrofitting existing homes.

**Link to report:** <https://americas.uli.org/returns-on-resilience>.

# 7

## Accurately Price the Cost of Inaction

Recent extreme weather events suggest that the costs of not investing in resilience and risk reduction are dramatically increasing.

A compelling qualitative business case exists for developers and their customers to mitigate risk from extreme weather events. As climate change leads to more frequent and intense flooding, fire, and drought, more and more development assets that do not incorporate resilience strategies have the potential to lose long-term value, face higher insurance premiums (or be unable to secure any coverage), and could even become obsolete in the not-so-distant future. Properly pricing risks and quantifying the cost of not investing in resilience will help move the market to better incorporate resilience into real estate development decisions.

For some investors and developers, the current “cost” of not being prepared for natural disasters is not perceived to be large enough to meaningfully influence development decisions. Many owners of existing assets do not expect disasters to have a meaningful impact on their development during their investment horizon. Or, if they do, they may believe that their insurance will protect them against any significant long-term losses, or the federal government will pay for rebuilding after a major disaster. For many, the current cost of addressing long-term climate threats exceeds the potential return on investment for taking preemptive action.

For real estate end users—such as homeowners, or commercial, retail, or industrial tenants—the financial benefit associated with proactively preparing for resilience is often difficult to quantify. In the case of tenants, most do not know how to meaningfully drive resilience in properties that they did not build and do not own. The challenges of the current cost/benefit analysis are exacerbated by public policy that (in many cases) will reimburse owners for some or most of the cost of rebuilding, and insurance rates and coverage that either do not reflect the actual risk, are too inexpensive to drive investments in resilience, or are too opaque to provide meaningful input in a cost/benefit analysis.

There is likely to be increased interest in investing in resilience if today’s model for federal support after disasters shifts, with reduced support provided for building owners after storms, particularly those in flood-vulnerable areas that have experienced repetitive losses. A November 2017 Congressional Budget Office (CBO) report noted that the share of the U.S. population facing substantial damages from hurricanes is likely to grow fivefold by 2075, due to climate change and coastal development patterns.<sup>xviii</sup> In response, the report recommended a shift of recovery costs from the federal government to states, cities, and the private sector. A change like this could radically shift how or whether property owners invest in preparedness upfront.

The cost/benefit analysis of extreme weather events to the real estate industry is changing, both due to these potential policy shifts and the frequent extreme weather events that have damaged property and disrupted business continuity.



BETH SILVERMAN/ULLI, NORTHERN COLORADO, ESTES PARK, LOVELAND, AND FORT COLLINS (2014)



BETH SILVERMAN/ULLI, NORTHERN COLORADO, ESTES PARK, LOVELAND, AND FORT COLLINS (2014)



BETH SILVERMAN/ULLI, NORTHERN COLORADO, ESTES PARK, LOVELAND, AND FORT COLLINS (2014)

*Damages observed after the 2013 floods in northern Colorado.*

Forward-thinking developers, insurers, policy makers, and the real estate finance community are beginning to recognize that preventative strategies to mitigate the risk of extreme events make business sense, and are incorporating risk into their cost/benefit analyses. For example:

- Because insurers often have the longest-term interest in effectively pricing risk, this industry is likely to lead the way. More insurers are refusing to issue coverage in expanding “high risk” areas prone to frequent flooding and in some cases potential sea-level rise. Insurers are also starting to incentivize preparation and mitigation for extreme events—this has started through earthquake standards, such as REDI, that address earthquake preparedness. Retail policy adjustments also could reward developments that mitigate flooding risks. As the insurance industry increasingly offers meaningful discounts in premiums or a greater level of coverage for real estate assets that take specific steps to improve their resilience, these mitigation and adaptation strategies will see greater adoption across the real estate industry.
- Capital markets may soon also price risk better, possibly by offering more favorable bond pricing to cities and developers integrating resilience strategies into their projects, or better mortgage terms for buildings that are better prepared for extreme weather events. In December 2017, Moody’s Investors Service released a report indicating that future credit rating assessments will consider cities’ preparedness for climate change, and adaptation and mitigation actions.<sup>xix</sup> The emergence of “resilience bonds” and environmental bonds targeting projects with resilience co-benefits suggests that capital markets are developing a more refined pricing approach to resilience.
- Local governments may create increasingly favorable development conditions—whether through policies or incentives such as density bonuses—for real estate projects incorporating resilience and minimizing the risk to future occupants. Government investment in resilient infrastructure can also affect future development patterns, with developers leveraging these public investments.
- While developers and owners may have shorter investment time horizons, price signals from the insurance industry and capital markets, and incentives from local governments will strengthen the business case for resilience investments and help drive uptake from the development community. Longer-term real estate owners, such as institutional investors and mortgage lenders, may drive this.
- As tenants and property buyers get better information on risks that climate-vulnerable properties face and value the prospects of enhanced security, reduced losses, and enhanced business continuity, they will begin moving to more resilient properties. This preference for resilient buildings would deliver a clear market signal through increased rents and decreased vacancy rates.



*The 2014 Flood Insurance Rate Map shows much of the study area in Fort Norfolk, Virginia, exposed to a 1 percent annual chance of flood in blue (top). However, the current Flood Insurance Rate Map shows even more land exposed to flood risk in light green (bottom).*

# 8

## Design with Natural Systems

Designing resilience relies upon an understanding of the function and geography of natural systems and how they can help strengthen manmade systems and communities.

### Addressing Resilient Design and Natural Systems at Different Scales

Nature does not respect the borders that humans have placed on the landscape, whether these boundaries are jurisdictional or physical. Strategies for implementing resilient land use, development, and infrastructure projects across boundaries at different scales include the following:

**Regional scale:** Create a collaborative resilience consortium including local counties and municipalities. Determine the scientific consensus on regional climate change hazards, assess the vulnerability of current and planned assets, and determine the potential for regional solutions, including investments in infrastructure and coordinated policy approaches. Regularly solicit input from the local business and residential communities, as well as other stakeholders. A regional group will have the unique ability to understand the economic value that infrastructural solutions would protect and establish the likely costs, and how to identify funding. The Southeast Florida Climate Change Compact provides one excellent example of this type of regional collaboration.<sup>xxiv</sup>

**City scale:** Assess the vulnerability and associated risks from the range of impacts from climate change throughout the municipality. Implement zoning, hazard mitigation, and other policies to address these risks comprehensively. Consider the range of natural conditions across the city, including flood elevations and vulnerability to flooding, storm surge, and extreme heat. Plan for infrastructure improvements and protections that are built on the understanding of the natural systems and forces at work, including an integrated approach to green and gray infrastructure.

**Neighborhood scale:** To consider resilience at the neighborhood scale, planning should address both physical vulnerabilities and assets, and the supporting social and civic networks. Social connections and the shared use of commercial and civic facilities bind a neighborhood together, in daily life and during peak or extreme events.

and use patterns developed over time as people settled along coastlines, rivers, and fertile lands where resources were rich, commerce was vibrant, and the climate was stable. However, many of the resources that attracted people initially and supported communities for centuries have become threats in the era of climate change. As the air warms, seas rise, and storms become more intense, climate change generally intensifies existing regional conditions. Dry regions become drier, hot regions become hotter, and wet regions become wetter. These exacerbations emphasize how important it is to embrace the natural conditions and flows of a site, community, and region and to design accordingly.

Fifty years ago, in his book *Design with Nature*, landscape architect Ian McHarg popularized the concept of embracing ecological function to create beautiful and resource-efficient environments. Planning and designing in concert with nature not only builds for resilience, but also provides amenities for communities and value for investors in development. Parks, green spaces, and stormwater management features can enrich the quality of a development or neighborhood, and potentially enhance resilience, community cohesion, and public health. The quality of concept, design, and execution of these resilient solutions is essential to creating their shared value.

Designing with natural systems should entail looking beyond municipal or site territories to address the geography of the site in a holistic way. It is also critical to understand the history of natural systems, resources, and use of the site, particularly considering natural resources that may have been ignored or squandered in recent years. While jurisdictional or site boundaries sometimes follow geographic boundaries such as rivers or coasts, in other cases they ignore natural systems, such as flood basins. Flooding, heat, and the other cascading impacts of climate change will not respect jurisdictional boundaries.

Accordingly, resilient development and land use policies identify ways to build from natural systems, whether at the site, block, neighborhood, city, or regional scale. Natural systems that could feature, depending on the context and climate conditions of the area, include:

- Green infrastructure, such as rain gardens, constructed wetlands, and bioswales;
- Native landscaping, including drought-tolerant plantings;
- Natural coastal and riparian systems, such as mangroves and oyster habitats, and the restoration of degraded coastal, bayou, marshland, or riverine natural habitats; and
- Flood mitigation infrastructure designed to address risk beyond the boundaries of a site.

*ULI Boston's Living with Water report and workshop envisioned the Harborwalk in Dune Park, Boston, with a dynamic natural landscape, which assumes daily tidal fluctuations and the onset of rising water levels. The design includes gradually increasing aquatic vegetation, which allows the "occupiable sea wall" to protect against rising sea levels and storm surges while creating a public recreation space.*



ARROWSTREET AND HALVORSON DESIGN PARTNERSHIP, THE URBAN IMPLICATIONS OF LIVING WITH WATER (2014)

## Designing for Natural Hazards

Thoughtful approaches to site selection, density and building massing, sustainable technologies, and architectural design can address the risks arising from natural hazards and the impacts of climate change.

**Sea-level rise and storm surge:** Developments in areas vulnerable to sea-level rise should not only ensure preparedness for rising water levels but also consider peak and storm surge conditions. Practically, this should entail thoughtful site selection, design above FEMA base elevation requirements, preparedness at the building level, and inclusion of stormwater management systems to handle water during peak and routine events. First and foremost, placement of buildings on waterfront sites must be carefully considered, given the likelihood of inundation within the development project's lifetime, or even the initial mortgage cycle. Buildings close to the waterfront should then be prepared to "get wet," with mechanical elements elevated out of harm's way and entryways and frontage that will remain accessible for the long term. In the public realm, green infrastructure and stormwater management mechanisms such as bioswales, rain gardens, and green roofs can both improve the quality of the outdoor environment and help slow water during rain events.

**Riverine flooding:** Many cities are situated on historic commerce hubs along major rivers and waterways, putting development at risk of flooding after significant rain events. Like properties in areas vulnerable to sea-level rise and storm surge, riverfront development should be designed to be prepared for rising water levels, which would affect building placement, location of mechanicals, and elements of the public realm.

**Heat:** Urban areas experience elevated temperatures compared with their surrounding areas due to the paved surfaces, loss of vegetation, and waste heat emitted from buildings and vehicles. According to the U.S. Environmental Protection Agency's Heat Island Compendium, the annual mean temperature of a city of 1 million or more can be 1.8 to 5.4 degrees Fahrenheit more than its immediate surroundings, with differences of up to 22 degrees Fahrenheit on a clear evening.<sup>xx</sup> Designing to address increased heat can include the use of green and blue roofs, reflective surfaces, and increased vegetative cover. Many of these strategies are increasingly incentivized or required in cities struggling with water management and rising temperatures.

**Wind:** Hurricanes, tornadoes, and other extreme events put buildings and people in harm's way due to peak wind conditions. During high-wind events, each structure experiences a different level of risk due to its unique shape, location, and strength. Particularly in urban areas, wind will flow around buildings, causing different pressures and impacts on other developments and pedestrian comfort and safety. Designs that are intended to build up massing minimize these micro-climate impacts. Numerous hurricane-prone municipalities release design guidelines and codes addressing wind pressure, such as Miami-Dade County. Design standards such as Fortified also propose strategies to protect roofs and building enclosures, such as doors and windows, as well as strengthen buildings' continuous load path.<sup>xxi</sup>

**Drought:** Development in drought-prone areas requires a focus on water consciousness and efficiency. In addition to concerns about water availability, hard-packed soil in these areas can lead to its inability to absorb water, increasing the likelihood of flash flooding. Resilient design strategies could incorporate rainwater harvesting and recycling systems to capture precipitation during infrequent weather events, conserving this limited resource. Equally important to design is behavior change; the American Society of Landscape Architects notes that "communities can spur needed changes in behavior, encouraging greater conservation through smart regulations."<sup>xxii</sup>

**Wildfire:** Wildfire suppression and protection costs have tripled in the United States since the 1990s, recently surpassing \$3 billion annually, due to rising temperatures, reduced moisture in the air, and development in areas where fire is a risk and a "natural part of the ecosystem."<sup>xxiii</sup> The 2017 California wildfires, including fires in Sonoma, Napa, Los Angeles, and San Bernardino counties, among others, caused extensive damage and drew national attention to this risk. Land use and smart land management is critical to decreasing wildfire risk; some areas may not be suitable to development due to fire risk and the likely costs of rebuilding. For developments in areas with some wildfire vulnerability, built areas should be designed to avoid wind corridors and to remain separated from fuel sources, like cars. Building material decisions can be made with an eye toward reducing wildfire risk; for example, roofing made of noncombustible materials, such as clay or tile, will also deter building ignition. Site design and landscape planning also should consider this vulnerability, ensuring access to water and keeping spaces between structures and any combustible debris, tall grasses, and trees.

Climate risks and vulnerabilities are an important frame for work with natural systems, particularly given that the impact of natural disasters can be exacerbated by climate change. Project design should consider the climate change projections for the lifetime of the development considered, or, at the very least, for the initial mortgage cycle.

Managing water, particularly during peak conditions, presents a primary concern and opportunity for incorporation of natural systems. The need for new development to better manage water is twofold: On one hand, development over time has intensified rainwater runoff in watersheds through paving and building construction. On the other hand, storm intensity in many areas is increasing from climate change. Incorporating natural systems can address both of these factors, and as a result, will build resilience when implemented in conjunction with bigger-picture land use strategies.



KATHARINE BURGESS/ULI, DOWNTOWN LAFAYETTE, LOUISIANA (2017)

*Lafayette, Louisiana, currently has a number of concrete-based coulees (above) throughout the city, which are designed to move water quickly and can exacerbate flooding conditions. ULI panelists recommended converting a coulee into an attractive green corridor (right), to continue to manage flooding while creating a recreational space that would enhance local quality of life.*



SUMIRTI GHOSH/ULI, DOWNTOWN LAFAYETTE, LOUISIANA (2017)



## On Site with Advisory Services: Duluth, Minnesota

**Context and assignment:** Straddling the shores of Lake Superior for 26 miles (42 km), Duluth has tremendous natural resources. More than 47 creeks run down from the top of the bluffs, often dropping more than 650 feet (198 m) in less than a mile (1.6 km), into the St. Louis River and Lake Superior.

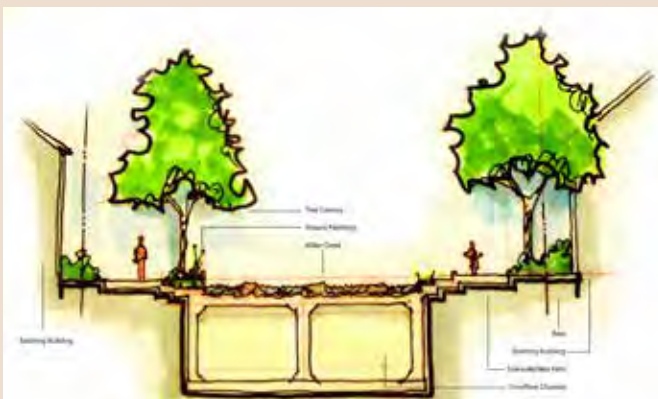
In June 2012, between eight to ten inches (20 to 25 cm) of rain fell, causing severe riverine and flash flooding. Within the Lincoln Park neighborhood, Miller Creek overflowed into homes and turned the steep streets into rivers. The ULI panel, hosted in 2015, focused on how to build resilience, decrease flood risk, invest in infrastructure, and apply lessons learned beyond this watershed. The panel also coincided with the development of the local application for the U.S. Department of Housing and Urban Development's National Disaster Resilience Competition.

**Key finding:** Duluth's complex geography and geology, including steep, rocky slopes and poor soils, can make for difficult building and transportation conditions. The auto-centric, suburban development patterns of Duluth and adjacent counties had also led to the destruction of the natural wetlands at the top of the bluff, contributing to the flash flooding along with the channelization of the creek. In contrast, the panel proposed flood mitigation strategies that would build from the city's natural systems, including its network of creeks and waterways.

**Strategies and tools:** ULI's panel focused on mitigation in the Miller Creek watershed, recommending the following strategies to design with nature in mind and enhance resilience:

□ *Enhance and reforest the headwaters east of the airport.* The headwaters of streams are the most fragile portions of the entire stream system. Protecting the headwaters should be a priority and could be done by planting additional trees to protect the stream, providing cover for the stream from solar exposure, and providing for quantity and quality control of the water.

- *Improve the affected stream valley.* Relocated and channeled stream segments and denuded stream banks along with eroded side slopes are just some of the results occurring in the affected stream valley. Variable stream valley buffers should be applied to all portions of the creek that have not yet been developed.
- *Rechannel the streams.* Streams that have been channeled have diminished natural capacity to store and infiltrate water, to absorb storm flows, and to provide habitat for wildlife. Such a restoration will return the natural sinuosity of the creek and will improve the creek's ability to absorb and detain storm flows.
- *Reduce the effect of large impervious areas on roofs and parking lots.* The panel recommends against overbuilding parking lots and roadways, and calls for constructing multistory buildings on reduced footprints instead of large single-story buildings. Bioswales, enhanced tree grates, and subsurface water storage also should be added wherever possible to infiltrate water to improve its quality and quantity.
- *Remove built choke points.* Multiple choke points in the form of culverts restrict the flow of stormwater during heavy rainstorms. These culverts should be replaced with either a larger culvert or, preferably, a bridge that would reduce or eliminate the constriction and allow fish to move unimpeded through streams.
- *Incorporate complete reconstruction of Miller Creek from Second Street to beyond Michigan Street.* Miller Creek can be daylighted down to the lake to provide a water amenity throughout the Lincoln Park neighborhood, to increase property value, and to provide another avenue for piping out stormwater.



DANIEL ANDERTON/ULI, DULUTH, MINNESOTA (2015)

After looking at a series of design options for Miller Creek, the panel recommended implementing a hybrid open channel and a natural stream design because it minimally affects adjacent private properties, adds aesthetic and functional value, and safely conveys the flow of water.

# 9

## Maximize Co-benefits

Risk reduction initiatives and infrastructure can include elements that enhance quality of life and economic development potential.

### Examples of Co-benefits

Co-benefits that can be derived from resilient infrastructure projects include improvements in the following:

- Public health
- Quality of life
- Access to green space and recreation
- Placemaking
- Improved air quality
- Improved water quality
- Ecosystem services
- Transportation capacity
- Economic development
- Tax revenue generation
- Job creation.

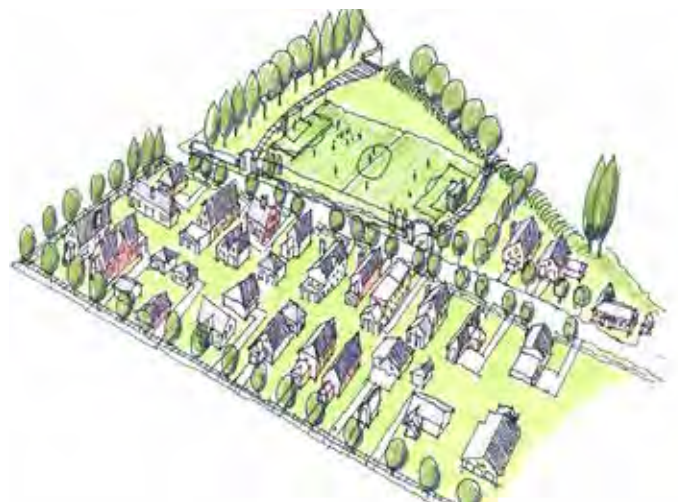
Co-benefits, which can include social, environmental, and economic outcomes, define resilient investments. Physical infrastructure intended to protect a community from hazards should both strengthen a community against potential shocks and contribute to addressing stresses, enhancing a community's environmental performance, economic development potential, or social cohesion. For example, a riverfront park designed to incorporate flood storage offers far greater chances for public benefits such as enhanced recreation, public health, and green space than gray infrastructure investments like sea walls.

Opportunities to build resilience and achieve co-benefits such as improved quality of life, public health, open space, and environmental justice often exist within the scope of an existing capital improvement program. For example, infrastructural investments addressing water treatment and street capacity have the opportunity to also build resilience and provide other meaningful environmental and social benefits.

The U.S. Department of Housing and Urban Development's Rebuild by Design competition after Sandy sought to identify infrastructural investments with the capacity for both better protecting the New York metropolitan area and providing co-benefits. These major projects in the Sandy-impacted region, which received \$920 million in financial support, would not only mitigate against future extreme events but also improve "physical, ecological, and economic resilience."<sup>xxv</sup> One winning project included berms and marshland restorations that would both protect against ocean surge, improve water quality, and create new recreational zones. Another proposed flood protection system would double as public amenities along an underused waterfront.



BING MAPS



ANGELO CARUSI/ULI, SEATTLE, WASHINGTON (2015)

*In Seattle, the ULI panel recommended altering the residential area in the South Park neighborhood to include a soccer field, which not only is a neighborhood amenity, but also acts as a flood protection buffer between the Duwamish River and the neighborhood.*

## On Site with Advisory Services: El Paso, Texas



KATHARINE BURGESS/ULI, ACTIVE TRANSPORTATION SYSTEM, EL PASO, TEXAS (2016)



CARLOS PEREZ/ULI, ACTIVE TRANSPORTATION SYSTEM, EL PASO, TEXAS (2016)

*El Paso's Franklin Canal (top) is largely inaccessible at present, although it offers a potentially convenient route between two employment hubs and borders two multifamily housing developments that could benefit from green space. A resilient active transportation system (above) would not only provide a trail, but also connect the two housing developments, offering amenities such as attractive landscaping, community art, and water management features potentially using reclaimed water for recreational use.*

**Context and assignment:** ULI's panel in El Paso, Texas, proposed a resilient land use strategy for a new active transportation system (ATS), a citywide cyclist and pedestrian network funded by the El Paso Metropolitan Planning Organization (MPO). Co-benefits were a primary focus for the panel: by taking a resilient design approach, the ATS could ultimately accomplish more than its transportation-related goals.

**Key finding:** A resilient ATS would not only be an attractive, convenient place for biking and walking, but also:

- Address local climate risks such as extreme heat and flash flooding;
- Connect residents with jobs and present new economic development opportunities;
- Provide community-building opportunities in an underserved neighborhood;
- Improve public health; and
- Provide new recreational opportunities and enhance quality of life.

Accordingly, the panel developed a proposal for the design, planning, and delivery of an ATS that would seek to accomplish the above goals through design and an integrated planning process. The outcome is an example of a resilient development project not only because of its integration of climate concerns but also because of the process to engage a range of stakeholders and build from the strengths of the local community.

The ATS also presented an interesting opportunity for co-benefits due to the proposed location for the network, along a dis-used and abandoned irrigation canal, directly adjacent to two local Housing Authority sites under redevelopment. This location offered opportunities to leverage an existing asset—a previously attractive canal and path—and to increase community access by integrating trail design into site planning for the adjacent Housing Authority sites. The panel's final recommendations encouraged the MPO not only to plan for the ATS, but also to integrate the ATS plans into strategies for Housing Authority site redevelopment and for addressing local land contamination. Incorporating these adjacent sites and involving these different agencies and stakeholders would help the MPO better identify potential co-benefits and create a facility likely to provide the greatest value for the local communities.

To maximize the opportunity to identify co-benefits, planning and design processes should seek input from multiple sources to understand local needs and the interactions among systems and the people they support. This input should then find opportunities for infrastructure, development, or policies to enhance social, environmental, and economic outcomes. Establishing opportunities to achieve co-benefits is particularly critical for projects located in under-resourced communities.

Identifying potential co-benefits that respond to a community's needs requires interdisciplinary thinking and a commitment from the beginning of project planning. The design process should not only work across different agencies but also seek input from the community members involved, and

others outside of the land use and policy fields to understand the interactions among systems and the people they serve. Working with the relevant local communities is the most critical aspect of the process, and should have the bonus of raising awareness about municipal investments and resources.

Local governments may require more collaborative approaches to deliver these types of projects, particularly if they require interagency financial contributions and an integrated consultation process. Launching early infrastructural investments as pilot projects may provide opportunities to prototype new approaches and assess outcomes before establishing new municipal processes and funding streams.

# 10

## Harness Innovation and Technology

Innovation related to the infrastructure, mobility, and data and information tracking can improve response to crisis and strengthen resilience for the long term.

### On Site with Advisory Services: Waterfronts of Portland and South Portland, Maine

**Context and assignment:** In 2014, the cities of Portland and South Portland invited ULI to advise them on how to be prepared for the impacts of climate change, including as relevant to historic preservation, economic development, land use planning, and risk mitigation.

**Key finding:** Alongside addressing land use issues, the panel explored how the cities could better manage data related to climate change and coastal risk. The panel noted the challenges related to both data management and communicating about potential policy implications to the public and individual constituencies. In response, the panel proposed a shared-governance strategy around sea-level-rise data, including separate groups managing data collection and dissemination.

**Strategy and tools:** Panelists proposed creating a risk data group charged with obtaining data on sea-level rise and climate impacts, and acting as a clearinghouse for information for local municipalities, businesses, and the community. A second data group would then be charged with developing models to incorporate these data into municipal decision making.

**R**esilience refers to the ability to anticipate and be ready for change. Change is a result of a broad range of shocks and stresses that communities face, but also occurs as promising new technologies are created and deployed. Among them will be technologies related to:

- Renewable energy
- District-scale utilities
- On-demand transportation
- Climate change preparedness
- Communications
- Public health
- Open data sharing, sensors, and real-time information tracking
- Enhanced project delivery and performance measurement
- Dynamic logistics for delivery of goods and supplies.

Innovations are particularly important to cities seeking to optimize municipal services and understand real-time needs during peak events. Open data and technology make information more easily available and actionable for users including municipal governments, corporations, enterprises, communities, and individuals. For example, technologies such as off-grid power, district energy, and demand-response electricity management have an important role to play in the response period after sudden shocks. By creating efficient redundancies, these technologies can improve the likelihood of security and business continuity after a major event, also presenting opportunities to conserve resources and reduce costs and environmental impact along the way.

Open data and technology will soon offer more accurate predictions about when extreme events could occur, and mapping of the areas likely to be affected. These innovations also provide opportunities to better understand resource needs and leverage third-party input on a day-to-day basis as well as during peak events. These technologies will become increasingly important tools for cities, businesses, institutions, and others to be more resource-efficient and responsive to changed circumstances and needs of their users.

As the nature of work changes with the onset of globalization and changing technologies, cities that have been more proactive and responsive to change will also offer the most opportunities for their residents. For example, the increasing prevalence of the shared economy as relevant to transportation, housing, and logistics has introduced many opportunities for investment and efficient use of resources. Many of these innovations are directly relevant to resilience, such as opportunities for decreased emissions through reduced car use and flexible approaches to housing, transportation, and other services after peak events. Cities that have not proactively recognized these opportunities and implemented relevant policies or incentives have missed out on opportunities to grow this sector in their local markets, providing consumers with value and services they have come to expect, and local workers with opportunities for skills development.

Strategies for cities to stimulate growth and investment in new technologies and emerging industries could include the following:

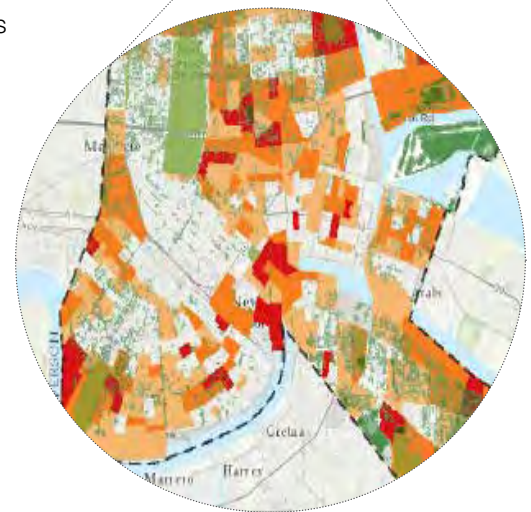
- Taking steps to recruit and support businesses of the future, through incentives, subsidies, and cultivation of an economic ecosystem and a supportive environment for new businesses and entrepreneurs;
- Implementing incentives for private sector and real estate sector implementation of technologies related to resilience, climate adaptation, and mitigation, including clean technologies; and
- Investing in a variety of education and training opportunities for all age groups to support the changing skill sets needed.

Resilience and climate adaptation technologies also offer economic development and investment opportunities. As a result, numerous communities are currently positioning themselves to attract and retain industries related to resilience and climate change, in hopes of establishing industry clusters including innovation, knowledge generation, and service providers. Potential areas of growth include the construction and maintenance of green infrastructure, renewable energy and clean technologies, and technologies relevant to sea-level rise and coastal construction mitigation. These industries offer the potential for job opportunities in research and development as well as systems deployment and maintenance.

Innovation districts focused on resilient technologies could be physically centered on the mitigation technologies addressing their local sites' vulnerabilities. For example, a waterfront resilience innovation district could include the investments in green infrastructure and coastal construction mitigation that would make the site more secure and appropriate for long-term mixed-use or commercial development.



THE TRUST FOR PUBLIC LAND'S CLIMATE-SMART CITIES™ PROGRAM, "REALIZING RESILIENCE" (2016)



*The Trust for Public Land's Climate-Smart Cities tool, pictured here for New Orleans, helps decision makers identify key locations for green infrastructure installation based on environmental vulnerabilities. ULI Boston is collaborating with the Trust for Public Land to add an additional layer of data points to the tool to support the real estate industry's need to evaluate points of interest at the parcel level.*

## On Site with Advisory Services: Norfolk, Virginia

**Context and assignment:** ULI's panel in Norfolk developed a strategy for a waterfront site and proposed broader strategies for the city's land use, real estate, and economic development efforts given the city's vulnerability to sea-level rise.

**Key finding:** Given Norfolk's well-known vulnerability to sea-level rise, the panel recommended "flipping" this and instead cultivating the image and knowledge that the city is prepared for the risks it faces. Technologies related to climate adaptation and sea-level rise are an important opportunity area, and should be a cluster that the city actively pursues as it seeks to diversify its economy.

**Strategy and tools:** The panel proposed the establishment of a Coastal Urban Resilience Venture Enterprise, or CURVE. CURVE would build from the work already done by partners in the region, such as Old Dominion University and the U.S. Navy. The panel proposed the study area waterfront site as a potential physical location for a CURVE innovation center, which would be a testing ground for new technologies. Such a center could ultimately lead to the development of a local cottage industry in Norfolk for businesses related to resilience, risk transfer, and floodproofing, an opportunity already aligned with the workforce in the region.

# Conclusion

The devastation wrought by hurricanes Katrina, Harvey, Irma, and Maria and the recent California wildfires drew international attention to the vulnerability of cities and the need for more resilient land use and development. Today, city leaders are increasingly focused on how to prepare and plan for, withstand, recover from, and more successfully adapt to adverse events. Equally important is addressing the stresses that affect both daily life and the ability to recover from peak events. For example, the stresses arising from the impacts of climate change, such as increased heat and sea-level rise, will have serious consequences for cities and affect public health, quality of life, and economic opportunity.

Building resilience entails identifying these vulnerabilities and proactively addressing them, considering environmental, social, and economic factors. This *Ten Principles* report introduces these many components of resilience, including factors relevant to housing, social equity, land use, finance, design, and other topics. These principles offer a framework that decision makers can use when exploring how to enhance resilience at the city, district, or neighborhood scale, and what roles the land use, real estate development, and community sectors can play. Many of these principles also apply when considering how to enhance building- or asset-level resilience at the site scale.



MICHAEL WANG, ARLEN STAWASZ, AND DENNIS CARLBERG, THE URBAN IMPLICATIONS OF LIVING WITH WATER (2014)

*Resilience can entail reenvisioning the use of existing assets. For example, ULI Boston's Living with Water workshop imagined Back Bay streets transformed into canals to enhance preparedness for sea-level rise.*

Ultimately, investing in resilience should not only reduce risk from peak events, but also introduce strategies for improved environmental performance, economic development, and social cohesion. The cities profiled in this *Ten Principles* report sought ULI input on how to reduce their vulnerabilities and enhance resilience. The proposed infrastructural investments, building design best practices, and policy approaches also introduced other opportunities to thrive, whether by creating multifunctional green spaces, developing a more vibrant downtown, or investing in new sectors for economic development. Real estate projects that have incorporated resilient design at the building scale have also seen demonstrable returns on investment, as well as opportunities to enhance business continuity and improve building user experience.

ULI's recent reports addressing resilience topics, which are listed at right, share these examples of best practices in building resilience from cities, communities, and real estate projects. Over the upcoming years, ULI's Urban Resilience program will continue this work. To learn more about this work, identify ways to get involved, or request technical assistance for your community, visit <https://americas.uli.org/resilience>.

# ULI Resilience Resources

## Advisory Services Panels

The Urban Land Institute has run many resilience-focused Advisory Services panels and Technical Assistance Program panels since the establishment of the Urban Resilience program in 2014, including the projects below and others. This *Ten Principles* report analyzed the following panels, alongside other recent district council projects and research projects:

### **Active Transportation System, El Paso, Texas: Downtown–Chamizal–Medical Center.**

Considering an arid and drought-prone climate, the El Paso Advisory Services Panel explored how a new active transportation system (ATS) could serve as a model for resilience planning. The panelists identified a site for a future ATS route, creating concepts for the reuse of an abandoned canal and proposing design approaches that would integrate the trail with adjacent affordable housing redevelopments.

**After Sandy: Advancing Strategies for Long-Term Resilience and Adaptability.** This post-Sandy panel brought together a large team of ULI members to develop strategies for long-term resilience and adaptability in the New York City region. Tasked with a remit broader than that of a “typical” Advisory Services panel, the group visited sites across New York and New Jersey and developed recommendations applicable to the region, rather than exploring resilient land use strategies for a single site.

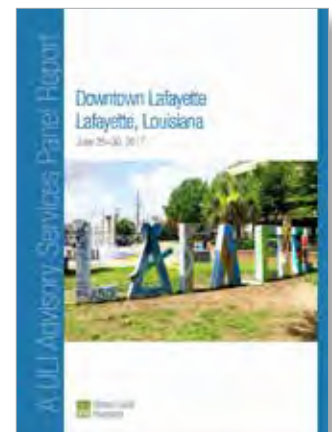
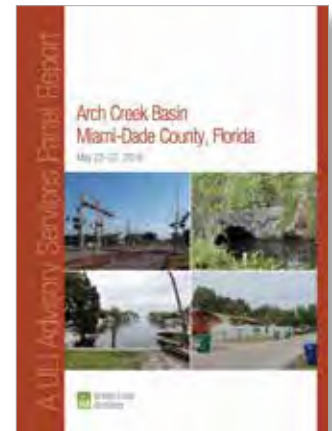
**Anchorage, Alaska.** ULI and the National League of Cities’ Rose Center for Public Leadership hosted a three-day study visit to explore how two neighborhoods—Mountain View, the most ethnically diverse zip code in America with significant communities of refugees, and Muldoon, a redeveloping neighborhood with a recent investment stormwater infrastructure—could be developed as pilot “resilience districts.” The panel considered how to engage the members of these communities and what resilience could mean to two urban areas in Alaska, addressing land use, design, community facilities, energy, and housing.

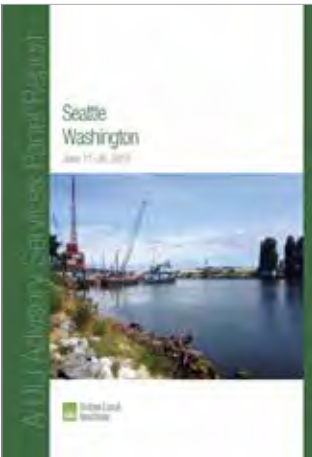
**Arch Creek Basin, Miami–Dade County, Florida: Addressing Climate Vulnerabilities and Social Equity with an Adaptation Action Area Framework.** The Arch Creek Basin panel focused on a 2,800-acre (1,133 ha) multijurisdictional site that functions as a flood basin, and which includes both a future rail line and low-lying areas whose residents have applied for FEMA buyouts due to repetitive flooding losses. The panel developed a long-term vision to create a high-density TOD, including affordable relocation housing, as well as new green infrastructure and park space in the low-lying areas.

**Downtown Lafayette, Louisiana: Strategies for Resilient Land Use, Development, and Implementation.** This panel explored resilient land use strategies, with a focus on short- and long-term downtown redevelopment approaches. The panel recommended encouraging catalytic mixed-use and residential projects in Lafayette’s urban core and identified financing vehicles to support a vibrant and ultimately more resilient downtown, in light of a major rain event in 2016 that caused extensive damage and flooding. The panel also recommended implementing green infrastructure projects, updating development-related standards with green practices, and implementing a stormwater utility fee.

**Duluth, Minnesota: Strategic Advice for Lincoln Park and the Miller Creek Watershed.** Having experienced riverine and flash flooding due to an extreme rain event in 2012, the city of Duluth sought land use strategies that would make the city less prone to flooding while also improving downstream water quality, economic opportunity, and quality of life. The panel recommended enhancing stormwater management and watershed planning initiatives, government and community programming, as well as implementing districts that foster economic growth.

**Northern Colorado, Estes Park, Fort Collins, and Loveland: Connected Systems, Connected Futures: Building for Resilience and Prosperity.** Larimer County, located north of Denver, sought regional resilience strategies from the panel considering risk of natural disasters like extreme flooding. The panel recommended coordinating regional economic plans in line with updated floodplain and natural landscape maps and strengthening communication systems to foster public awareness.



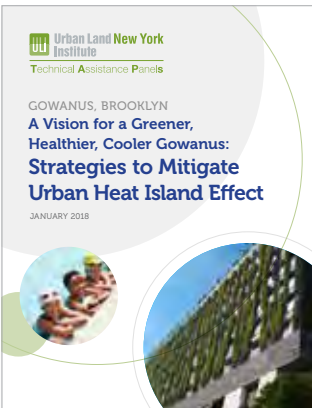


**Norfolk, Virginia: Assessing Risk and Protecting Value.** A ULI panel was invited to Norfolk, one of the U.S. cities most at risk of sea-level rise and subsidence, to assess the market value and potential of the Fort Norfolk study area and consider how to assess environmental risks and protect the study area's value, while creating a more vibrant and livable community for its residents.

**Seattle, Washington: Strategic Advice for Urban Resilience on the Lower Duwamish River.** Georgetown and South Park are two coastal neighborhoods in Seattle that are extremely diverse and home to both low-income communities and industrial development. The panel was tasked with providing recommendations for enhancing the resilience of these neighborhoods to sea-level rise and increasing stormwater, while also addressing economic challenges associated with physical connectivity, socially disadvantaged populations, and encroaching land use changes.

**St. Tammany Parish, Louisiana: Bridging the Divide with the South Central Study Area through Resilience.** St. Tammany Parish experienced a sudden influx of residents and businesses following Hurricane Katrina, in addition to the impacts of four major hurricanes and the BP oil spill. The parish requested that the panel assess the parish's local resilience philosophy and explore how projected growth should occur within the panel's study area, a predominantly vacant, flat, and low-lying site. The panel recommended that the parish use the site as a pilot area for more resilient land use patterns, encouraging the development of a range of housing choices and public transportation.

**Waterfronts of Portland and South Portland, Maine: Regional Strategies for Creating Resilient Waterfronts.** The panel explored the opportunities for the waterfronts of Portland and South Portland and outlined dilemmas facing the two waterfronts that largely support commercial vessels and institutional land uses. The recommendations focused on addressing risks from sea-level rise and storm surge, in the context of historic preservation, economic development, and land use planning.



## Technical Assistance Program Panels and District Council Projects

**A Vision for a Greener, Healthier, Cooler Gowanus: Strategies to Mitigate Urban Heat Island Effect.** ULI New York partnered with the Urban Resilience program and south Brooklyn community-based nonprofit and advocacy group, the Fifth Avenue Committee, to explore how a potential rezoning in the Gowanus neighborhood, which was developed as an industrial area and was New York City's first Superfund site, could address urban heat island mitigation.

**Realizing Resilience: Social Equity and Economic Opportunity, St. Petersburg, Florida.** ULI's Tampa Bay District Council partnered with the Urban Resilience program and the city of St. Petersburg to host a workshop to inform the city's plan to address climate change. The workshop primarily focused on economic development and social equity in the face of environmental vulnerabilities.

**The Urban Implications of Living with Water.** This report, which was developed through a charrette hosted by ULI Boston, looked at resilience solutions for four neighborhoods in the Boston region, envisioning how their built environments could adapt to sea-level rise. The East Boston TAP report, *Advancing Resiliency in East Boston*, also addressed sea-level rise and other resilience issues.



## Other Urban Resilience Program Resources

**Harvesting the Value of Water: Stormwater, Green Infrastructure, and Real Estate.** This report explores the real estate sector's increased participation in stormwater management through the incorporation of green infrastructure and other water management mechanisms. Highlighting a series of case studies, the report provides an overview of how stormwater management can introduce operational efficiencies, improve building user experience, enhance aesthetics, and otherwise differentiate a real estate project.

**Returns on Resilience: The Business Case.** This report showcases real estate developments that exhibit best practices in resilient design and have experienced positive financial, operational, and other business outcomes.



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