

SMART GROWTH FIXES FOR CLIMATE ADAPTATION AND RESILIENCE



*CHANGING LAND USE AND BUILDING CODES AND POLICIES
TO PREPARE FOR CLIMATE CHANGE*

Acknowledgments

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To explore the smart growth code and policy changes that can help communities prepare for and adapt to climate change, EPA's contractors, CH2M and Farr Associates, convened a panel of national smart growth and climate adaptation experts in February 2013. This panel identified topics related to local zoning and building codes that are essential to supporting resilience. Under another contract, MC Consulting, Inc. and Farr Associates developed an initial draft of this publication.

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Executive Summary

Municipalities are seeking ways to adapt to current and projected climate change impacts to better protect lives and property and ensure they can continue to offer a good quality of life and a thriving economy now and in the future. This publication can help local government officials, staff, and boards find strategies to prepare for climate change impacts through land use and building policies. The policy options described here bring multiple short- and long-term environmental, economic, health, and societal benefits that can not only prepare a community and its residents and businesses for the impacts of climate change, but also improve everyday life.

This publication aims to help communities address at least some of the expenses and political challenges of preparing for and adapting to climate change. The strategies outlined here can be worked into a community's regular processes and policies—for example, through scheduled updates to zoning and building codes. This approach allows incremental change, which might be easier for some communities because it costs little or nothing extra compared to “business as usual,” and gives communities the opportunity to adjust codes based on the most up-to-date climate observations and projections.

The effort and political will to make policy and regulatory changes vary by community, and some communities are already implementing smart growth strategies and/or preparing for climate change. To help readers determine which policy and code changes might be appropriate for their community's capacity, desire, and need to make changes, the options in each chapter are categorized as modest adjustments, major modifications, and wholesale changes. These categorizations are meant as basic guidance on the effort needed to implement a policy, but conditions will be different in different communities. What might be a modest adjustment for one town could be a major modification in another.

Many of the strategies in this document can help with multiple climate change impacts. To avoid redundancy, strategies are generally discussed in one place. Because an important question to determine in building resilience is *resilience of what to what*, the publication is divided by impacts that communities are likely to face as the climate continues to change:

- **Chapter 2: Overcoming Barriers to Climate Adaptation** discusses potential social and legal barriers.
- **Chapter 3: Overall Strategies** discusses smart growth strategies that help adapt to multiple climate change impacts and that can be a foundation for the policies in subsequent chapters.
- **Chapter 4: Adapting to Flooding and Extreme Precipitation** includes code and policy options that deal mainly with riverine flooding and managing stormwater to prevent flooding and water pollution. This chapter includes green infrastructure strategies that can also help communities cope with extreme heat and other policy options that are relevant to sea level rise.
- **Chapter 5: Adapting to Sea Level Rise** includes strategies that are specifically related to higher storm surges and other impacts from sea level rise.
- **Chapter 6: Adapting to Extreme Heat** discusses strategies to protect people from heat waves, including green building and energy efficiency.
- **Chapter 7: Adapting to Drought** includes water conservation strategies for individual buildings as well as entire communities.
- **Chapter 8: Adapting to Wildfire** focuses on smart growth and green building strategies to protect neighborhoods from fire damage.

Most chapters include quick tips called “practice pointers”; examples of communities implementing the policies; resources; and a “Guidance and Metrics” section, which references relevant credit summary language and metrics from up to three community-scale sustainability rating systems.

The table below summarizes the strategies discussed in the publication, categorizes them by type of policy or regulatory change, and indicates other impacts to which a strategy might be relevant. See <https://www.epa.gov/smartgrowth/smart-growth-fixes-climate-adaptation-and-resilience> for a sortable version of this table.

Level	Type of Policy Change	Policy Change Actions	Flooding and precipitation	Sea level rise	Extreme heat	Drought	Wildfire
OVERALL STRATEGIES							
Modest Adjustment	Planning/ Mapping	Use regional climate change, population demographics, transportation demand, and related projections to understand where community assets could be vulnerable. <ul style="list-style-type: none"> • Incorporate projections into the comprehensive plan to show climate adaptation is a priority. • Mainstream climate change and smart growth into comprehensive, master, capital improvement, and hazard mitigation plans. • Update land use maps to identify vulnerable lands. Designate less-vulnerable areas and encourage development there. • Require new municipal buildings to be in well-connected, safer areas. • Establish clear annexation policies that take climate change projections into account. 	✓	✓		✓	✓
Modest Adjustment	Planning/ Mapping	Align land use, hazard mitigation, transportation, capital improvement, and other plans so all plans are working toward the same goals.	✓	✓	✓	✓	✓
Modest Adjustment	Incentives, Regulatory	Create a list of desired development elements in more-vulnerable areas, and encourage or require developers to implement a certain number of them.	✓	✓	✓	✓	✓
Modest Adjustment	Incentives	Evaluate development incentives to see if they encourage development in particularly vulnerable areas.	✓	✓		✓	✓
Modest Adjustment	Planning/ Mapping	Conduct a safe growth audit.	✓	✓		✓	✓
Modest Adjustment	Education/ Outreach	Improve public education about the risks of developing in sensitive areas.	✓	✓		✓	✓
Modest Adjustment	Education/ Outreach	Assess and address the needs of people who might be particularly vulnerable and/or are likely to be most affected, especially if they live in higher-risk areas.	✓	✓	✓	✓	✓
Major Modification	Planning/ Mapping	Use scenario planning to inform local planning and policies.	✓	✓	✓	✓	✓
Major Modification	Regulatory	Adopt flexible zoning. <ul style="list-style-type: none"> • Adopt elements of dynamic zoning, or building flexibility into codes. • Adopt a floating zone or overlay zone. 	✓	✓	✓	✓	✓
Major Modification	Planning/ Mapping	Incorporate fiscal impact analysis into development review, and make sure it includes costs related to climate change impacts.	✓	✓	✓	✓	✓

Level	Type of Policy Change	Policy Change Actions	Flooding and precipitation	Sea level rise	Extreme heat	Drought	Wildfire
Major Modification	Regulatory	Allow a mix of uses.	✓	✓	✓	✓	✓
Major Modification	Incentives, Planning/ Mapping	Incorporate into the land use map, comprehensive plan, and economic development plan locations where it makes sense to encourage economic growth. Encourage businesses to locate there.	✓	✓		✓	✓
Major Modification	Collaboration/ Partnership, Regulatory	Encourage on-site renewable energy and storage: <ul style="list-style-type: none"> Amend codes or adopt ordinances to allow renewable energy on individual properties and in communal installations. Use public-private partnerships to promote renewable energy. 	✓	✓	✓	✓	
Wholesale Change	Planning/ Mapping	Incorporate into capital projects features that enhance resilience and bring multiple other benefits.	✓	✓	✓	✓	✓
Wholesale Change	Planning/ Mapping, Regulatory	Plan for post-disaster redevelopment before a disaster strikes. <ul style="list-style-type: none"> Create a post-disaster redevelopment plan. Adopt a post-disaster redevelopment ordinance. 	✓	✓			✓
ADAPTING TO FLOODING AND EXTREME PRECIPITATION							
Modest Adjustment	Pilot Program	Pilot a sustainable streetscape program with green infrastructure features.	Main	✓	✓		
Modest Adjustment	Education/ Outreach, Incentives	Help private property owners better manage stormwater through education and incentives.	Main				
Modest Adjustment	Land Preservation	Design open space in flood plains for multiple amenities.	Main	✓			
Modest Adjustment	Regulatory	Require new development or redevelopment to capture and infiltrate the first 1 or 1.5 inches of rain.	Main				
Modest Adjustment	Regulatory	Update any Clean Water Act Section 402 National Pollution Discharge Elimination System permits to consider climate change.	Main				
Major Modification	Planning/ Mapping	Adopt the 500-year flood plain as the “locally regulated flood plain.”	Main	✓			
Major Modification	Regulatory	Restrict development in areas buffering water bodies or wetlands.	Main	✓			
Major Modification	Regulatory	Adopt green and complete streets design standards.	Main		✓		
Major Modification	Land Preservation	Acquire properties at risk of flooding, use the land for infiltration, and help the property owners resettle in the community.	Main	✓			
Major Modification	Collaboration/ Partnership	Enter into a community-based public-private partnership to install and maintain green infrastructure.	Main		✓		
Wholesale Change	Pilot Program	Create an overarching framework for water-related initiatives.	Main	✓			
Wholesale Change	Regulatory	Adopt a site plan requirement that requires all new development to retain all stormwater on-site.	Main				

Level	Type of Policy Change	Policy Change Actions	Flooding and precipitation	Sea level rise	Extreme heat	Drought	Wildfire
Wholesale Change	Education/ Outreach	Develop a municipal stormwater design manual that illustrates context-appropriate green infrastructure.	Main	✓	✓		
Wholesale Change	Regulatory	Establish elevation requirements with design guidelines for streets and infrastructure.	Main	✓			
Wholesale Change	Regulatory	Create sustainable funding for stormwater infrastructure.	Main				
ADAPTING TO SEA LEVEL RISE							
Modest Adjustment	Planning/ Mapping	Add projected sea level rise to flood zone hazard maps that are based exclusively on historical events.		Main			
Modest Adjustment	Land Preservation	Designate and protect “transition zones” near tidal marshes.		Main			
Modest Adjustment	Regulatory	Change the definition of “normal high water” for land adjacent to tidal waters to change regulatory setbacks.		Main			
Major Modification	Planning/ Mapping, Regulatory	Incorporate sea level rise impacts into all future land use planning and regulations using projections rather than past trends.		Main			
Major Modification	Regulatory	Strengthen building codes in coastal zones by requiring additional adaptation strategies.	✓	Main			
Major Modification	Regulatory	Modify the steep-slope ordinance to account for slopes exposed to increased moisture due to changes in precipitation and sea level rise.	✓	Main			
Major Modification	Regulatory	Create an overlay district where flood regulations and standards would apply, or establish context-sensitive shoreline classifications with appropriate standards.	✓	Main			
Major Modification	Regulatory	Require building-level design for disassembly/ adaptation planning.	✓	Main			✓
Wholesale Change	Pilot Program	Designate and protect working waterfronts.		Main			
Wholesale Change	Regulatory	Implement rolling development restrictions.		Main			
Wholesale Change	Planning/ Mapping	Begin planning for managed retreat from the shoreline.	✓	Main			✓
ADAPTING TO EXTREME HEAT							
Modest Adjustment	Incentives	Offer financial or procedural incentives to use passive survivability.			Main		
Modest Adjustment	Pilot Program, Planning/ Mapping	Map “hot spots,” and conduct pilot programs in these places to reduce heat.			Main		
Modest Adjustment	Education/ Outreach	Support the people and neighborhoods that are most vulnerable and least able to adapt on their own. <ul style="list-style-type: none"> • Designate cooling centers in neighborhoods with particularly vulnerable populations. • Identify vulnerable populations, and develop an outreach plan for them. 			Main		

Level	Type of Policy Change	Policy Change Actions	Flooding and precipitation	Sea level rise	Extreme heat	Drought	Wildfire
Modest Adjustment	Incentives	Offer incentives to plant and protect trees.	✓		Main		
Modest Adjustment	Planning/ Mapping	Include reducing heat island effects as an objective in complete streets projects.			Main		
Major Modification	Incentives, Regulatory	Require or encourage green or reflective roofs on new buildings with little or no roof slope.			Main		
Major Modification	Regulatory	Revise the zoning ordinance to allow urban agriculture.			Main		
Major Modification	Regulatory	Require shade trees in all municipal projects and private parking lots.			Main		
Major Modification	Planning/ Mapping	Adopt a tree canopy or urban forest master plan and implementing ordinances.			Main		
Major Modification	Incentives, Regulatory	Require or offer incentives for using cool paving in municipal capital improvement projects and private parking lots.			Main		
Major Modification	Regulatory	Amend site plan requirements and design guidelines to encourage light or permeable paving, shade, green alleys, vegetation, and tree canopy.			Main		
Wholesale Change	Regulatory	Adopt an energy conservation code to establish minimum requirements for energy efficiency in buildings, or adopt a stretch or reach code.			Main		
Wholesale Change	Regulatory	Incorporate passive survivability into the building code.			Main		
ADAPTING TO DROUGHT							
Modest Adjustment	Regulatory	Encourage compact development policies such as walkable block sizes, transit-supportive density, and high intersection connectivity.			✓	Main	✓
Modest Adjustment	Education/ Outreach	Recommend the use of drought-tolerant plants or xeriscaping as part of water conservation, landscaping, and water waste ordinances.			✓	Main	
Modest Adjustment	Incentives	Promote the use of WaterSense-rated plumbing fixtures through incentives.				Main	
Major Modification	Regulatory	Implement a water impact fee that reflects each property's consumption.				Main	
Major Modification	Incentives	Offer rebates or other incentives to encourage drought-tolerant plants, residential rainwater harvesting, water-efficient fixtures, or other water-saving practices.				Main	
Major Modification	Regulatory	Mandate graywater-ready residential development.				Main	
Major Modification	Pilot Program	Adopt a citywide policy promoting water recycling for nonpotable uses.				Main	
Major Modification	Regulatory	Require use of water-efficient fixtures through the building code.				Main	
Wholesale Change	Regulatory	Enact a building energy and water benchmarking ordinance.				Main	

Level	Type of Policy Change	Policy Change Actions	Flooding and precipitation	Sea level rise	Extreme heat	Drought	Wildfire
Wholesale Change	Regulatory	Enact a water conservation or water waste ordinance to restrict the type of landscaping on new development and public properties.				Main	
Wholesale Change	Regulatory	Mandate rainwater harvesting for all new commercial construction.				Main	
Wholesale Change	Collaboration/ Partnership	Integrate water resource management with land use plans to make sure the community has enough water for planned growth.				Main	
ADAPTING TO WILDFIRE							
Modest Adjustment	Collaboration/ Partnership	Establish a task force to review building codes, development patterns, and other relevant issues.					Main
Modest Adjustment	Planning/ Mapping	Incorporate wildfire scenario planning into local planning.					Main
Modest Adjustment	Regulatory	Strengthen requirements for building and roof materials to be fire-resistant and green.					Main
Modest Adjustment	Regulatory	Require sites for new emergency facilities to be outside of high-risk areas, well-connected, and easy to access.	✓	✓			Main
Modest Adjustment	Regulatory	Require new developments to submit a fire protection plan during site plan review.					Main
Major Modification	Incentives, Regulatory	Encourage or require compact development through comprehensive plans, area plans, and zoning codes.					Main
Major Modification	Regulatory	In subdivision regulations, require clustered development that is well-connected to existing development and walkable.					Main
Major Modification	Regulatory	Adopt wildfire hazard overlay districts with development regulations based on factors like slope, structure, and fuel hazards.					Main
Major Modification	Collaboration/ Partnership	Consider adopting the Firewise Communities Program.					Main
Wholesale Change	Regulatory	Require subdivisions to have a highly connected street network with multiple connection points to the external street network.					Main
Wholesale Change	Land Preservation	Acquire and maintain open space between dense forested areas and residential development.					Main

I. Introduction

Across the country, local governments are responding to more extreme weather events, often unlike any their region has experienced before. Flooding and extreme precipitation, sea level rise, extreme heat, drought, and wildfires put lives at risk and cause billions of dollars in damage every year. These events are expected to continue to increase. The 2014 National Climate Assessment details observed and projected changes in the U.S. climate (Figure 1).

Municipalities are seeking ways to adapt to these changing conditions to better protect lives and property and ensure that they can continue to offer a good quality of life and a thriving economy now and in the future. This publication can help local government officials, staff, and boards find strategies to prepare for climate change impacts through land use and building policies. The smart growth policy options described here bring multiple short- and long-term environmental, economic, health, and societal benefits.

Why Use Smart Growth Strategies?

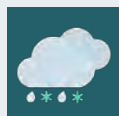
Using the smart growth strategies described in this document can not only prepare a community and its residents and businesses for the impacts of climate change, but also improve everyday life. Smart growth approaches offer multiple benefits in addition to adapting to climate change, including protecting air and water quality, saving people money by using energy more efficiently and offering transportation options, and creating new economic opportunities. Figure 2 lists the principles that underlie smart growth strategies.

Residents and businesses will often see many of these benefits quickly, which can build support for further action.

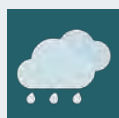
Using smart growth strategies can help communities avoid some common challenges in preparing for climate change. Some conventional solutions, such as building sea walls or elevating buildings, are expensive and solve only one problem—e.g., holding back water or raising structures above it. They bring no other benefits to individuals or the community, they often have drawbacks (e.g., sea walls can increase

Figure 1: Observed and Projected Climate Change

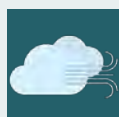
The 2014 National Climate Assessment reviewed climate change research and modeling to summarize observed and project climate change impacts in the United States. Key findings from the assessment include:



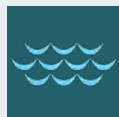
Average precipitation has increased since 1900. Some areas have had increases greater than the national average, and some areas have had decreases.



Heavy downpours are increasing nationally, especially over the last 30 to 50 years. Extreme precipitation events are projected to become more frequent and intense in all U.S. regions.



The intensity, frequency, and duration of North Atlantic hurricanes, as well as the frequency of the strongest hurricanes, have increased since the early 1980s. Hurricane-associated storm intensity and rainfall rates are projected to increase.



Global sea level has risen by about eight inches since 1880. It is projected to rise another one to four feet by 2100.



Average temperature has increased by 1.3°F to 1.9°F since 1895; most of this increase occurred since about 1970. Temperatures are expected to continue to rise.



Heat waves are projected to become more frequent and intense, especially in the West. Droughts in the Southwest are projected to become more intense.



Cold waves have become less frequent and intense, a trend that is projected to continue.

Source: Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds. *Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Change Research Program. 2014.

erosion), and they work only up to a certain level, at which point they fail, often catastrophically. The multiple benefits from smart growth approaches help meet several community goals with each action.

Political constraints can also make it difficult for local governments to implement solutions to climate change-exacerbated challenges. It is frequently hard to garner support for a policy that is intended to prevent some future projected calamity but that might not show any immediate benefits to the people who have to pay for it right now. Approaching climate adaptation through land use and building policies can implement changes through regular community processes.

Many communities already have smart growth policies, but these policies might not make a community more resilient unless they take into account current and projected climate conditions. For example, “direct development toward existing communities” is a smart growth strategy, but it is not a climate adaptation strategy unless it considers projected impacts, such as which parts of an existing community will be less vulnerable to flooding, wildfires, or sea level rise, and directs growth toward areas that are safer but still well-connected to existing development.

Smart growth strategies promote a variety of housing options affordable to people with a wide range of incomes. When seniors can afford to stay in their neighborhoods as they age, friends or relatives can easily check on them during a heat wave or other extreme weather event. Smart growth strategies make walking, bicycling, and transit use easier and safer; these less-polluting transportation choices are often more affordable than driving and help people work regular physical activity into their daily routines. These options also provide redundancy in case of an emergency.

One smart growth principle is community involvement in decision-making, which is essential to help local officials learn who in their community is vulnerable, what their needs and capabilities are, and how to help them improve their lives now while also helping them prepare for climate change impacts.

Figure 2: Smart Growth Principles

The Smart Growth Network, a group of more than 40 national organizations representing government, environmental, real estate, development, historic preservation, affordable housing, and other issues, developed 10 smart growth principles in 1996 based on the experiences of communities around the country:

- Mix land uses.
- Take advantage of compact building design.
- Create a range of housing opportunities and choices.
- Create walkable neighborhoods.
- Foster distinctive, attractive communities with a strong sense of place.
- Preserve open space, farmland, natural beauty, and critical environmental areas.
- Strengthen and direct development towards existing communities.
- Provide a variety of transportation choices.
- Make development decisions predictable, fair, and cost effective.
- Encourage community and stakeholder collaboration in development decisions.



Figure 3: Downtown Saratoga Springs, New York, creates a sense of place by restoring and reusing historic buildings. Its wide sidewalks and tree-lined streets, compact size, and mix of restaurants, shops, offices, and residences encourage people to walk around.

Communities can respond to market demands by using smart growth strategies. Surveys of consumer preferences consistently show that about half the respondents would like to live in a neighborhood where they can walk to places like stores, schools, parks, and other community amenities. Demographic trends suggest that demand for homes in walkable communities will continue to rise.¹ By making sure their smart growth strategies take into account projected climate change, communities can better prepare themselves to meet the needs of future residents and businesses while helping to protect them from climate change-related impacts.

Smart growth strategies can help strengthen and diversify local economies. Companies want to locate offices and shops close to the employees and customers they seek; if the people they want to attract prefer compact, walkable places, that is where the companies want to be as well. Firms around the country have been moving offices from distant locations accessible only by car to central districts where staff and clients can take public transit, walk, or bike.²

Climate change directly affects agriculture and industries that rely on natural resources such as timber, fishing, and recreation. It can indirectly affect many other industries. For example, drought not only reduces water supplies but can affect energy generation. Natural disasters can disrupt or even shut down businesses by damaging property and severing supply chains and transportation networks. Communities that plan for these impacts might have a competitive advantage compared to those that do not. Continuity of operations is very important to most businesses, and a community that can show it understands the risks of climate change and is committed to preparing for them can be attractive to companies seeking safer locations.

Many smart growth strategies, such as providing a wider array of transportation options and encouraging compact development and green building practices that use less energy per capita, reduce the greenhouse gas emissions that cause climate change. Reducing our contribution to climate change ultimately reduces the magnitude of climate change impacts, which makes greenhouse gas reduction an important adaptation strategy as well as a mitigation strategy. Many of the policy options in this document reduce greenhouse gases and other pollutants.

What This Publication Is—and Is Not

This publication aims to help communities address some of the expenses and political challenges of preparing for and adapting to climate change. The strategies outlined here can be worked into a community's regular processes and policies—for example, through regular updates to zoning and building codes. This approach allows incremental change, which might be easier for some communities because it costs little or nothing extra compared to “business as usual,” and regular code updates give communities the opportunity to adjust codes based on the most up-to-date climate observations and projections.

The information here can help communities evaluate their existing codes and ordinances and apply the information to better prepare themselves for climate-related impacts. This publication does not include model language, nor is it intended to provide model codes or ordinances.

This publication is not a compilation of general climate adaptation strategies. It discusses only zoning and building code changes and related policies that adhere to smart growth and/or green building principles and bring multiple benefits. These code and policy changes are not sufficient on their own to prepare a community for the impacts of climate change; communities will still need an overall climate

¹ EPA. *Smart Growth and Economic Success: Investing in Infill Development*. 2014. <https://www.epa.gov/smartgrowth/smart-growth-and-economic-success-investing-infill-development>.

² For more on how smart growth strategies can help businesses, see: EPA. *Smart Growth and Economic Success: The Business Case*. 2013. <https://www.epa.gov/smartgrowth/smart-growth-and-economic-success-business-case>.

adaptation strategy. Once a community has determined its vulnerabilities³ and priorities, this guide can help it achieve some of its goals.

Nor is this publication a hazard mitigation tool; many guides exist to help communities, developers, and builders prepare for tornadoes, earthquakes, and other natural hazards. This guide is intended for communities facing changing conditions and covers natural hazards that are projected to become more frequent, severe, and/or widespread as the climate changes.

How to Use This Publication

This document is meant for local government staff and officials who are looking for options that will help them make their communities more efficient, economically stronger, environmentally responsible, and better prepared for the impacts of climate change. The effort and political will to make policy and regulatory changes vary by community, and some communities are already implementing smart growth strategies and/or preparing for climate change. To help readers determine which policy and code changes might be appropriate for their community's capacity, desire, and need to make changes, the options in each chapter are categorized as:

- **Modest Adjustments:** Options in this category assume the local government will keep its existing regulations and policies and is looking for relatively modest revisions (e.g., changing minimum setbacks to maximums) that will help it remove barriers to smart growth development and climate change adaptation strategies.
- **Major Modifications:** Options in this category assume the local government is looking to change the structure of the existing code or make significant changes to policies. Examples include creating incentives for smart growth development or creating overlay zones.
- **Wholesale Changes:** Options in this category assume the local government wants to create a new regulatory framework or a new policy.

These categorizations are meant as basic guidance on the effort needed to implement a policy, but conditions will be different in different communities. What might be a modest adjustment for one town could be a major modification in another.

Most chapters include a "Guidance and Metrics" section, which references relevant credit summary language and metrics from up to three community-scale sustainability rating systems: LEED for Neighborhood Development, STAR Community Rating System, and the Living Community Challenge (Figure 4). These systems were chosen because they can be applied to entire neighborhoods or communities, and they cover a wide range of elements, including development location and design, transportation, and water and energy use. This information is a starting point to consider best practices and industry-standard metrics. While these rating systems are not code language, their metrics can define terms such as "walkability" in a community's plans and codes.

³ *Vulnerability* in the climate change context means "the degree to which geophysical, biological and socio-economic systems are susceptible to, and unable to cope with, adverse impacts of climate change." Parry, M.L., O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (eds). "Section 19.1.2.1 Meaning of 'key vulnerability'." *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007*. Cambridge University Press, Cambridge, UK, and New York. 2007. https://www.ipcc.ch/publications_and_data/ar4/wg2/en/ch19s19-1-2.html.

Figure 4: Rating Systems Used in “Guidance and Metrics” Section

These rating systems include many more elements that are listed in this publication. Some of the text from these systems is used verbatim, and some is edited to focus on the most relevant aspects. Please refer to each rating system for the complete text.

LEED for Neighborhood Development applies to neighborhood-scale development and redevelopment projects. Text in the “Guidance and Metrics” sections is adapted from *LEED v4 for Neighborhood Development*, updated April 5, 2016, available at www.usgbc.org/resources/leed-v4-neighborhood-development-current-version. In addition, the U.S. Green Building Council has a tool that identifies elements in LEED rating systems that can build resilience: www.usgbc.org/resources/leed-climate-resilience-screening-tool-leed-v4-projects. The tool estimates that 76 percent of the credits in *LEED v4 for Neighborhood Development* present opportunities for adaptation.

The **STAR Community Rating System**, a certification program for sustainable communities, lets communities “assess their sustainability, set targets for moving forward, and measure progress along the way.” Each objective includes several outcomes and actions that can earn a community points toward certification. This publication lists only the most relevant ones. Text is adapted from *STAR Community Rating System*, Version 2.0, published October 2016, available at www.starcommunities.org/rating-system.

The **Living Community Challenge** is a certification process that planners and developers can use for projects ranging from a single site to an entire neighborhood. Text is adapted from *Living Community Challenge*SM 1.1, published 2016, available at living-future.org/lcc.

Most chapters include resources specific to the topics discussed in that chapter. The Additional Resources appendix lists publications and tools that are more generally about smart growth and green building strategies, social equity, climate adaptation, and identifying potential climate change impacts.

Many of the strategies can help with multiple climate change impacts. For example, green infrastructure elements can increase water supplies, absorb precipitation to reduce localized flooding, and lower ambient air temperatures. To avoid redundancy, strategies are generally discussed in one place. Because an important question to determine in building resilience is *resilience of what to what*, the publication is divided by impacts that communities are likely to face as the climate continues to change:

- **Chapter 2: Overcoming Barriers to Climate Adaptation** discusses potential social and legal barriers.
- **Chapter 3: Overall Strategies** discusses smart growth strategies that help adapt to multiple climate change impacts and that can be a foundation for the policies in subsequent chapters.
- **Chapter 4: Adapting to Flooding and Extreme Precipitation** includes code and policy options that deal mainly with riverine flooding and managing stormwater to prevent flooding and water pollution. This chapter includes green infrastructure strategies that can also help communities cope with extreme heat and other policy options that are relevant to sea level rise.
- **Chapter 5: Adapting to Sea Level Rise** includes strategies that are specifically related to higher storm surges and other impacts from sea level rise.
- **Chapter 6: Adapting to Extreme Heat** discusses strategies to keep people safe during heat waves, including green building and energy efficiency.
- **Chapter 7: Adapting to Drought** includes water conservation strategies for individual buildings as well as entire communities.
- **Chapter 8: Adapting to Wildfire** focuses on smart growth and green building strategies to protect neighborhoods from fire damage.

2. Overcoming Barriers to Climate Adaptation

Introduction

Barriers to implementing climate adaptation strategies can arise from many sources. They might be specific regulations, fiscal challenges, uncertainty over how to determine the best strategies to pursue, societal disparities, or differing perceptions about the timeframe of climate change impacts.

The legal framework under which the community governs itself might also present challenges. This chapter lists some of the primary legal considerations for local governments deciding on land use policy changes related to climate adaptation.

Regulatory and policy barriers: Communities might have regulations or policies that either do not take climate change projections into account or actually hinder adaptation to current and future conditions. Overcoming regulatory barriers requires not just finding the right fix to the regulation, but also working with stakeholders and the public to educate them about why a fix is needed and get their input on what the fix should be.

Fiscal barriers: Seeking much-needed tax revenue could be another barrier to adaptation. Communities might annex unincorporated territories for policy or budget-related reasons, but these annexations could include land that is more vulnerable to natural hazards. The municipality might unwittingly be taking on major costs for responding to or rebuilding after a severe event. This publication includes policy options to help communities make more informed choices about annexation (see Chapter 3).

Communities can use this publication to find strategies that can help them prepare for climate change incrementally, through many municipal programs and projects, and often less expensively than undertaking a single major project. While these incremental changes might not be sufficient on their own to prepare the community for the worst of the projected impacts, they could buy time to pay for larger projects over a longer period. Smart growth strategies can also use public funds more efficiently—for example, each increment of infrastructure costs less to build, maintain, and serve in a compactly developed neighborhood than in a more spread-out one—and they bring multiple benefits, which could save money by meeting several goals with a single project. These savings could be used to pay for other climate adaptation projects.

Uncertainty: Climate change projections can be confusing for people who do not work in climate science. Many people perceive more uncertainty about climate change than actually exists. And, as one study noted, “politicization of climate change can be directly related to scientific uncertainty.”⁴ In addition to potential political ramifications, local government staff might simply not be sure how to get data on projected impacts that are reliable enough to be a basis for regulatory and policy decisions. One way to overcome the politicization of the science is to engage scientists to advise policy makers. Data resources from federal agencies and respected, nonpartisan nonprofit groups can help create a foundation for decision-making (see the Additional Resources appendix for some helpful resources).

Communities might also think that they need more precise, “higher resolution” climate change projections than are actually required. However, these higher-resolution projections can increase the range of potential impacts that have to be considered. Rather than seeking highly precise projections, local governments can generally use broader models developed by their state, a reputable nongovernmental organization, or the federal government to get a range of plausible future climate conditions. Local governments frequently use demographic, market, and economic estimates for planning future growth, and this range of plausible climate conditions is similar to those estimates. Putting these projections into a

⁴ Carlson, Kathleen, and Sabrina McCormick. “American Adaptation: Social Factors Affecting New Developments to Address Climate Change.” *Global Environmental Change* 35 (2015): 360-367. p. 366.

decision-making framework that includes the community's vulnerabilities, strengths, and resources helps identify policy options that would work reasonably well within this range of future conditions.⁵

The policy options described in this publication are, for the most part, "no-regrets" strategies—actions that cost little or nothing more than business as usual, bring benefits regardless of the extent of climate change impacts, and often have both short- and long-term benefits. One study of U.S. adaptation plans noted that, "Considering multiple futures and including no-regret strategies in planning are easy ways to begin managing climate-related uncertainty," adding that when local governments establish a way to incorporate lessons learned into future planning and implementation, they can ensure that "planning is adjusting to real-time changes in science and policy."⁶

Societal disparities: The people who are most vulnerable to and hardest hit by climate change impacts—because they are elderly, very young, low income, chronically ill or disabled, socially isolated, or suffering from other health and economic disparities—are also frequently the least able to adapt. Other populations, such as renters, might be unable to better protect their homes against impacts. Communities that are predominantly low-income, overburdened,⁷ and minority have more immediate challenges and might not have the capacity to plan for climate adaptation.⁸ Moreover, many people have more urgent priorities in their daily lives than thinking about how to prepare for projected changes, the worst of which might not happen for years to come.

To gain public support, one approach is to highlight cost savings, economic development potential, health benefits, or other tangible benefits of strategies that promote climate resilience and other community goals. Using a carrot rather than a stick can create support. For example, Albuquerque, New Mexico, offers incentives to encourage residents and businesses to conserve water (see the case study in Chapter 7 for more details).

Many strategies to help prepare vulnerable populations for climate change can also help improve their lives now, if designed with their input. Working with trusted messengers in neighborhoods (which might include houses of worship, local activists, health care facilities, or other community fixtures), municipalities can learn about the problems residents are facing and the solutions they would like to see while educating people about why and how they can prepare themselves and their homes. The municipality and residents can work together to find solutions that improve people's health, create more jobs and entrepreneurial opportunities, and provide affordable and energy-efficient housing—all things that make residents' lives better now and will help them prepare for sudden events like a severe storm or longer-term changes like rising summer temperatures.

Timeframe of impacts: The (perceived) long timeframe of climate change impacts can make it seem less urgent to many stakeholders who have competing priorities. Elected officials might not see much upside to taking action now for benefits that might not become apparent during their term in office. Businesses, particularly small businesses, might be planning their investments on a very different time scale, perhaps five or 10 years out, and might not see the relevance of long-range projections.

⁵ Weaver, C.P., R.J. Lempert, C. Brown, J.A. Hall, D. Revell, and D. Sarewitz. "Improving the Contribution of Climate Model Information to Decision Making: The Value and Demands of Robust Decision Frameworks." *WIREs Climate Change* 4 (2013): 39-60.

⁶ Woodruff, Sierra C., and Missy Stults. "Numerous Strategies but Limited Implementation Guidance in US Local Adaptation Plans." *Nature Climate Change*. Published online May 2, 2016. p. 4.

⁷ *Overburdened communities* are, "Minority, low-income, tribal, or indigenous populations or geographic locations in the United States that potentially experience disproportionate environmental harms and risks. This disproportionality can be as a result of greater vulnerability to environmental hazards, lack of opportunity for public participation, or other factors." EPA. *EJ 2020 Action Agenda*. 2016. <https://www.epa.gov/environmentaljustice/environmental-justice-2020-action-agenda>. p. 55.

⁸ Kaswan, Alice. "Seven Principles for Equitable Adaptation." University of San Francisco Law Research Paper No. 2013-18. 2013.

The private sector can be a leader and strong partner in spurring adaptation. Major multinational companies are preparing for climate change impacts, to both avoid disruption and take advantage of new economic opportunities, and often their actions extend down their supply chains to smaller companies.⁹

Development investors are awakening to climate change's potential impacts on their portfolios. CBRE Research, a real estate market research firm, estimated that commercial property owners could see more than \$1.2 billion in flood damage annually by 2050—well within the lifetime of buildings being constructed today.¹⁰ The annual *Emerging Trends in Real Estate* survey of property owners, developers, investors, and others involved in real estate found that some respondents were taking action to reduce their risk, including “installing backup and on-site power; investing in higher-quality construction to withstand risks (often above code); avoiding construction in high-risk areas; [and] conducting risk assessments that incorporate severe weather impacts.”¹¹

What Legal Issues Should Communities Consider?¹²

When a local government seeks to change its policies, zoning ordinances, or other regulations, it should understand the potential for litigation resulting from its actions. Knowing the legal limits of action can help a local government decide on policy options.¹³ Some of the prevailing considerations that can help communities be aware of the potential for litigation include:

1. Under what type of authority is the municipality acting?
2. Is there an existing state or federal law that could preempt local efforts?
3. When would a zoning ordinance constitute a “taking” of private property?
4. Will the local action raise issues related to the Americans With Disabilities Act?

1. Under what type of authority is the municipality acting?

Knowing the source of the local government's authority to legislate is key in evaluating the potential for litigation related to legislation.

- In Dillon Rule states, a local government has authority to act only if the state legislature expressly grants such authority or such authority can be implied as incident to other powers granted to the local government. Local governments in a Dillon Rule state often get authority to act independently through state-issued enabling statutes, which “permit what was previously prohibited or that [create] new powers.”¹⁴

For example, the commonwealth of Virginia operates under the Dillon Rule, but local governments can still zone for some climate change impacts because the Virginia Code grants broad authority to local governments to consider flood risks in planning and zoning. One analysis noted, “Localities are urged to consider the ‘future requirements of the community’ and the ‘conservation of natural resources’ when drawing zoning ordinances. Sea level rise will increase flooding, storm surge, and erosion, so considering future projections of sea level rise when

⁹ Crawford, Meg, and Stephen Seidel. *Weathering the Storm: Building Business Resilience to Climate Change*. Center for Climate and Energy Solutions. 2013. <http://www.c2es.org/publications/weathering-storm-building-business-resilience-climate-change>.

¹⁰ Eddins, Quinn W. “Rising Vulnerability to Floods Risks Devastating Property Losses in U.S. Cities.” CBRE Research. Oct. 22, 2015. [http://f.tlcollect.com/fr2/015/47568/Rising_vulnerability_ARE_Eddins_151022_\(1\).pdf](http://f.tlcollect.com/fr2/015/47568/Rising_vulnerability_ARE_Eddins_151022_(1).pdf).

¹¹ PwC and the Urban Land Institute. *Emerging Trends in Real Estate*® 2016. 2015. p. 13.

¹² The material in this section is included for information only and should not be taken as legal advice. For specific questions about any legal matter, local governments should consult their attorneys or other legal services providers.

¹³ Byrne, J. Peter. “The Cathedral Engulfed: Sea-Level Rise, Property Rights, and Time.” *Louisiana Law Review* Vol. 73 (2012):69-118.

¹⁴ The Harvard Law School Food and Policy Clinic. “Good Laws, Good Food: Putting Local Food Policy to Work for Our Communities.” 2012. <http://www.chlpi.org/wp-content/uploads/2013/12/FINAL-LOCAL-TOOLKIT2.pdf>.

exercising zoning powers is consistent with the legislature's intent to 'promote the health, safety, [and] general welfare of the public.'"¹⁵

- States that follow Home Rule grant municipalities broad authority to decide local matters, as long as the local government's actions do not directly conflict with state law. Local governments' powers are limited to those granted to them in their state's constitution or by the legislature. Generally, the powers delegated to the local level are listed in a Home Rule Charter.

For example, a court confirmed that Lafourche Parish, Louisiana, could adopt FEMA-recommended advisory base flood elevations because it had the authority under a broad Home Rule grant to pass zoning ordinances that "promote, protect, and preserve the general welfare, safety, health, peace, and good order of the Parish...". Revising the flood maps was seen as an act undertaken to protect its residents' future welfare and safety.¹⁶

2. Is there an existing state or federal law that could preempt local efforts?

Even in states where Home Rule authority has been granted to a local government, the state and federal governments still have preemptive power. Preemption law acts as a tier system, with the federal government occupying the top tier, followed by state government, then local government.¹⁷ Between the state and local governments, state laws generally act as a floor rather than a ceiling, meaning local governments might be able to exceed the state law's requirements, but they cannot go below them. A local government can adopt flood plain regulations that exceed state or federal FEMA standards without raising an issue of preemption.¹⁸

3. When would a zoning ordinance constitute a "taking" of private property?

Any regulation passed by a local government that changes the zoning of an area, and in so doing might affect the owners' present enjoyment of the land, must be defensible. If a regulation diminishes the land's value, the landowner could claim that it is a taking. A regulation that reduces a parcel's economic value is not automatically a taking; the extent of the reduction is a factor to be considered case by case. Diminished value would not necessarily render the new regulation or zoning ordinance invalid, but it might require just compensation to be paid to an owner whose land lost substantial value as a result of the local government's action.

Regulations adopted in preparation for and as protection from climate change-related impacts are more likely to be defensible if they can be shown to be rationally related to protecting a genuine public purpose. Tools such as FEMA mapping and climate change vulnerability assessments can demonstrate the likelihood of hazards to which at-risk areas might or will be exposed. The information these tools provide, coupled with the goals of reducing human exposure to climate change-related risks and reducing the economic toll from climate change impacts, can be used to demonstrate the legitimacy of the new regulations or zoning ordinances.¹⁹

The National Flood Insurance Program (NFIP) seeks to mitigate the socioeconomic impacts caused by flooding by encouraging communities to adopt and enforce flood plain management regulations, and by providing affordable insurance to property owners.²⁰ Some landowners are concerned that determinations

¹⁵ Gill, Lauren, J.D. *The Dillon Rule and Sea Level Rise: An Analysis of the Impact of the Dillon Rule on Potential Adaptation Measures*. Virginia Coastal Policy Clinic at William and Mary Law School. 2013.

<http://law.wm.edu/academics/programs/jd/electives/clinics/vacoastal/documents/march2014reports/dillonrulessealevel.pdf>.

¹⁶ Colvan Cattle Co. L.L.C. v. Lafourche Parish Government. Case 2:08-cv-00907-EEF-SS Document 41. U.S. District Court, Eastern District of Louisiana. 2009.

¹⁷ Nelson, Caleb. "Preemption." *Virginia Law Review* Vol. 86 (2000):225-305.

¹⁸ Kusler, Jon A. *Common Legal Questions about Floodplain Regulations in the Courts: 2003 Update*. Association of State Floodplain Managers. 2004. http://www.floods.org/NoAdverseImpact/FLOODPLAIN_REG_IN_COURTS_050604.pdf.

¹⁹ Grannis, Jessica, et al. *A Model Sea-Level Rise Overlay Zone for Maryland Local Governments*. Georgetown Climate Center. 2011. http://dnr2.maryland.gov/ccs/Publication/GCC_MD-SLROrdRpt_FINALv3_11-2011.pdf.

²⁰ FEMA. "The National Flood Insurance Program." <https://www.fema.gov/national-flood-insurance-program>. Accessed Dec. 11, 2015.

and rezonings made as a result of the NFIP could decrease their properties' value to the extent that an unconstitutional taking has occurred. However, courts have "unanimously rejected takings suits based on NFIP-inspired floodplain ordinances, or similar non-NFIP floodplain ordinances."²¹

4. Will the local action raise issues related to the Americans with Disabilities Act?

The Americans with Disabilities Act (ADA) prohibits discrimination and guarantees that people with disabilities have the same opportunities as everyone else to participate in the mainstream of American life—to enjoy employment opportunities, buy goods and services, and participate in state and local government programs and services.²² It relates to zoning because a municipality might pass zoning ordinances that have unintended discriminatory effects on disabled persons. For example, if an ordinance mandates that new construction projects in a flood zone be elevated, it could have the effect of limiting disabled people's access (unless it also requires modifications such as elevators, ramps, or other ways to allow disabled people to get into the building).

To combat such unintentional discrimination, the ADA requires local governments to "make reasonable modifications to policies, practices, or procedures to prevent discrimination on the basis of disability."²³ Because "making zoning decisions is a normal function of a governmental entity.... when a local government takes an action under its zoning (e.g., reviewing a permit application or taking an enforcement action), this action triggers an obligation to comply with the ADA."²⁴ Therefore, considering how any zoning action might affect disabled persons can help ensure compliance with ADA.

²¹ Meltz, Robert. *Climate Change and Existing Law: A Survey of Legal Issues Past, Present, and Future*. Congressional Research Service. 2013. p. 31.

²² U.S. Department of Justice. "Information and Technical Assistance on the Americans With Disabilities Act." https://www.ada.gov/ada_intro.htm. Accessed Dec. 11, 2015.

²³ U.S. Department of Justice. "The ADA and City Governments: Common Problems." <https://www.ada.gov/comprob.htm>. Accessed Dec. 11, 2015.

²⁴ Vermont League of Cities and Towns. "Ask the League: Americans With Disabilities Act and Zoning." *VLCT News*, Jul. 2002. http://vlct.org/assets/News/Newsletter/2002/vlctnews_2002-07.pdf.

3. Overall Strategies

Introduction

The strategies discussed in this chapter can help communities adapt to multiple climate change impacts. They could be useful as a foundation to which communities can add other policies that address specific impacts such as flooding, heat, or wildfires. Communities can consider each strategy in the context of other adaptation, land use, and related efforts.

Response to the Problem

Developing and implementing land use and building codes and practices that take climate change into account can promote climate adaptation even in communities where reaching consensus on climate action can be challenging. Making climate adaptation part of regular processes such as code updates helps incrementally prepare for climate change. Financial and procedural incentives for individuals, commercial enterprises, and public entities can be incorporated into policy tools to encourage climate-resilient development.

Keeping people safe and securing the community's future prosperity are not partisan issues. However, it can be hard to build political will for adaptation actions, particularly in places where climate change impacts are not being immediately felt or where climate science is doubted or mistrusted. Understanding a community's underlying needs and communicating an initiative's multiple benefits that respond to those needs could help achieve climate resilience without resilience being the primary driver for the initiative.



Figure 5: Atlanta's Historic Fourth Ward Park (left) was designed to capture excess rainfall and reduce downstream flooding. It saved the city \$15 million in infrastructure costs compared to a conventional stormwater facility. Lines on the park's walls mark the 100-year and 500-year flood heights to help educate residents (right). The park is a beautiful amenity for the neighborhood, spurring new development nearby.²⁵

²⁵ EPA. 2013 National Award for Smart Growth Achievement. 2013. <https://www.epa.gov/smartgrowth/2013-national-award-smart-growth-achievement-booklet>.

Energy conservation and distributed generation²⁶ strategies not only reduce greenhouse gas emissions, they can also reduce the number and severity of catastrophic power outages by lowering grid loads. Reducing greenhouse gases also reduces the potential devastation of flooding, fire, and extreme weather events, which translates to lower recovery costs and less disruption to people's lives. Finally, climate-sensitive strategies such as smart growth policies can attract people drawn to vibrant, walkable communities close to cultural attractions, recreation, and natural beauty as well as their jobs.

Communities are also seeing economic successes by implementing adaptation and resilience projects with multiple benefits, such as an open space project that creates a new park, uses green infrastructure to reduce stormwater runoff, reduces ambient air temperatures, and lessens the threat of flooding, which can encourage private investment in nearby properties.

Potential Benefits

- Protecting residents' health, safety, property, and livelihoods in the short and long terms.
- Strengthening the local economy against disruption by helping to protect businesses' property and continuity of operations, as well as helping individuals and businesses explore new economic opportunities related to climate change adaptation.
- Reducing the need to rebuild or the cost of rebuilding after disasters by making properties less likely to be damaged.
- Providing predictability for developers, businesses, investors, and property owners by planning for changing conditions.
- Using public services (e.g., fire, rescue, police) more efficiently and conserving emergency and recovery response resources.
- Creating jobs designing, building, and maintaining adaptation-related elements such as green infrastructure and energy-efficiency upgrades.

²⁶ *Distributed generation* refers to technologies that generate electricity close to where it will be used. Distributed generation systems can include solar panels, wind turbines, and combined heat and power systems. For more information, see: EPA. "Distributed Generation." <https://www.epa.gov/energy/distributed-generation>.

Implementation Approaches

I. Modest Adjustments

- **Use regional climate change projections from a metropolitan planning organization or council of governments, as well as projected population demographics, transportation demand, and other relevant data, to understand where housing, transportation, businesses, and services could be vulnerable to floods, sea level rise, drought, or wildfire.**
 - **Incorporate the projections into the comprehensive or master plan to ensure that climate adaptation is a clear community priority** that should be included in policies and regulations that implement the comprehensive plan.
 - **Mainstream climate change considerations and smart growth into comprehensive plans, master plans, capital improvement plans, and hazard mitigation plans.**
 - Keene, New Hampshire, developed a climate adaptation action plan and used it to incorporate climate change considerations into all municipal departments' planning and operations. See the case study in this chapter for more information.
 - **Update land use maps to identify land that is currently vulnerable, or projected to become more vulnerable, to climate-related hazards** such as fire, flooding, storm surge, and sea level rise. Consider also designating areas that are both less vulnerable and well-connected to existing development as places where the community wants to encourage development. Communities could use these more vulnerable areas as “sending” zones in a transfer of development rights program, with the safer, well-connected areas being the “receiving” zone.
 - The Southeast Florida Climate Compact suggested that municipal and county comprehensive plans designate Adaptation Action Areas (the areas most vulnerable to sea level rise and other impacts and prioritized for investment to reduce their risk), Restoration Areas (undeveloped areas that are vulnerable to climate change impacts and that should be prioritized for acquisition to keep

Practice Pointer

Basing policy changes on publicly available data such as federally provided climate projections makes the decision-making process transparent and helps people understand the need for changes.

Practice Pointer

Engage partners to help gather data, develop strategies, and reach out to the public and key stakeholders. Local colleges and universities, councils of governments and other regional entities, regional staff of federal agencies, and nonprofit groups can be helpful partners who add credibility and reach different audiences.

Practice Pointer

Incorporate smart growth strategies and climate change projections into planning for large development or redevelopment projects, including brownfields redevelopment, from the start to help ensure that development is located in areas that are less vulnerable to hazards now and in the future. It can also help developers and communities determine the most appropriate type of development for parts of the site that might be more vulnerable to hazards.

them undeveloped), and Growth Areas (areas that are at a higher elevation and already have infrastructure, where growth should be directed).²⁷

- **Require new municipal buildings to be sited in locations that are close to the people they serve; easy for people to access on foot, by bike, by public transit, or by car; and in less-vulnerable areas** (unless they absolutely must be located in more-vulnerable areas).
- **Establish clear annexation policies or requirements that take into account climate projections and areas that currently are or are projected to become particularly vulnerable.** These policies can help municipalities better assess the potential costs and benefits of annexing land, particularly if that land is significantly more or less vulnerable to climate impacts. Municipalities can also create boundary agreements with adjacent jurisdictions to outline clear plans for future annexations. Boundary agreements help neighboring municipalities manage their growth collaboratively and set clear expectations about the effects of development that can spill over into surrounding areas. They help ensure efficient capital improvements and infrastructure investments.²⁸
 - Austin, Texas, shares with surrounding Travis County design review authority for new development that is outside of the city limits. Because it might someday annex some of this land, the city wants to make sure that the development is planned in a way that makes it less vulnerable to wildfires.²⁹
- **Align land use, hazard mitigation, transportation, capital improvement, economic development, and other relevant plans.** All of the community's plans should be working toward the same goals, and their performance measures, indicators, and policy recommendations should be aligned. Engaging staff and other experts from different municipal entities to participate in planning efforts—for example, involving hazard mitigation staff in developing the comprehensive plan—helps make sure that the plans reinforce each other.
 - Albuquerque aligns its Water Resources Management Strategy with its comprehensive plan and other plans to make sure that new development has adequate water supply and infrastructure. For more information, see the case study in Chapter 7.
- **Create a list of desired development elements in more-vulnerable areas, and encourage or require developers to implement a certain number of these elements.** Elements would be based on the specific hazard; for example, for buildings in a highly impervious area, the municipality might want new development to include elements to mitigate the heat island effect and localized flooding. To ensure these elements fit with the context and achieve the desired results, the community could create design guidelines illustrating acceptable designs, plant species, and other specifications. Engaging the public and key stakeholders in selecting desired elements can help

Practice Pointer

Solicit input from residents on desirable neighborhood amenities. Make particular efforts to engage low-income, minority, and overburdened communities, as well as people at different stages of life, from those just starting out to families to those who have retired.

²⁷ Southeast Florida Regional Climate Change Compact Counties. *A Region Responds to a Changing Climate*. 2012.

<http://www.southeastfloridacclimatecompact.org/wp-content/uploads/2014/09/regional-climate-action-plan-final-ada-compliant.pdf>.

²⁸ For more on smart growth annexation policies, see: EPA. *Essential Smart Growth Fixes for Rural Planning, Zoning, and Development Codes*. 2012.

EPA. *Essential Smart Growth Fixes for Urban and Suburban Zoning Codes*. 2009.

<https://www.epa.gov/smartgrowth/essential-smart-growth-fixes-communities>.

²⁹ Headwaters Economics. "Austin, Texas: Managing for Growth, Healthy Landscapes, and Wildfire Risk Reduction." 2016.

<https://headwaterseconomics.org/wildfire/solutions/lessons-five-cities>.

make sure that what the community wants is feasible and responds to the concerns of residents and businesses.

- Seattle created Seattle Green Factor, a code requirement that applies in certain districts, to increase and improve landscaping in new development projects (Figure 6). Developers have to attain a minimum score but can select from several options, such as installing rain gardens, planting trees, or installing a green roof, to meet the requirement.³⁰ The city offers educational materials and Green Factor worksheets from approved projects.³¹
- **Evaluate development incentives to determine if they are encouraging development in areas that are particularly vulnerable to floods, wildfire, and other hazards.** Incentives might be financial, such as tax abatements or publicly funded infrastructure, or regulatory, such as expedited approval processes or density bonuses. If it is not possible to limit development in particularly vulnerable areas, the local government can at least remove the incentives that are encouraging growth there and redirect those incentives to promote development in safer areas.³²
- **Conduct a “safe growth audit” to determine if the community’s current development policies such as the comprehensive plan, zoning, subdivision regulations, and other policies are allowing growth in hazardous areas.**
 - The American Planning Association offers a basic safe growth audit. Sample questions are:
 - Does the comprehensive plan provide enough space for expected growth outside natural hazard areas?
 - Is transportation policy used to guide growth to safe locations?
 - Do subdivision regulations allow density transfers where hazard areas exist?
 - Do economic development strategies include provisions for mitigating natural hazards?³³



Seattle Dept. of Construction and Inspections

Figure 6: Chloe Apartments, a 7-story mixed-use building in Seattle, got Green Factor credits for preserving mature trees along the street, among other elements.

³⁰ City of Seattle. “Seattle Green Factor: What Is the Seattle Green Factor?”

<http://www.seattle.gov/dpd/codesrules/changestocode/greenfactor/whatwhy>. Accessed Jun. 17, 2015.

³¹ City of Seattle. “Seattle Green Factor: Case Studies.”

<http://www.seattle.gov/dpd/codesrules/changestocode/greenfactor/background/default.htm>. Accessed Jun. 17, 2015.

³² For more on this policy, see section 3-A in EPA. *Using Smart Growth Strategies to Create More Resilient Communities in the Washington, D.C., Region*. 2013. <http://www.epa.gov/smartgrowth/using-smart-growth-strategies-create-more-resilient-communities-washington-dc-region>.

³³ Godschalk, David R., FAICP. “Safe Growth Audits.” *Zoning Practice*, Issue 10, Oct. 2009. American Planning Association. https://planning-org-uploaded-media.s3.amazonaws.com/legacy_resources/zoningpractice/open/pdf/oct09.pdf.

- **Improve public education about the risks of developing in sensitive areas.** Residents, particularly people who have recently moved to a more-vulnerable area, might have unreasonable expectations that their property will be safe or that they will be swiftly rescued in case of an emergency. Being clear about the risks of living in more-hazardous areas and the limitations of the local government's ability to help mitigate those risks can help temper expectations. In addition, when people better understand the reasons for proposed policies, they are more likely to support action. For example, when talking about wildfire risks in Missoula, Montana, local officials focus on saving people's lives instead of on the need for regulations.³⁴
 - The University of Rhode Island's Coastal Resources Center and Rhode Island Sea Grant developed a guide for coastal property owners to help them get answers to 10 key questions. The guide includes information on how to find out if the property is in a flood zone according to FEMA maps; whether the property owner has to buy flood insurance and how much it might cost; how erosion, sea level rise, coastal storms, and flooding might affect the property; whether the owner will be allowed to rebuild a damaged or destroyed structure; whether the building meets current design and construction standards; and how to make the building more resilient.³⁵
 - The fire department in Teton County, Wyoming, tells residents of certain subdivisions that have only one road in and out that it could be too dangerous to fight a fire in those subdivisions because of the poor access and warns, "If we can defend your home, we will, but if it is too dangerous, we won't."³⁶
- **Assess and address the needs of people who might be particularly vulnerable and/or are likely to be most affected, especially if they live in areas that are at higher risk.** Those who might be especially vulnerable include renters who cannot make changes to their homes, people who do not speak English well, low-income people, children and pregnant women, and people who do not have a vehicle for evacuations. Specific strategies related to flooding and extreme heat are discussed in the relevant chapters, but generally, local governments can work with communities that are geographically and/or socially vulnerable to make sure that their plans for hazard mitigation and climate adaptation include provisions for people who need different types of assistance. In neighborhoods with many particularly vulnerable residents, the community could designate locations as emergency shelters or as meeting points for buses that will help evacuate. The local government could distribute vital information and learn about the residents' needs by working with messengers trusted by different populations, which might include houses of worship; community associations; nonprofit groups that work with homeless, low-income, immigrant, elderly, mothers-to-be, children, and other vulnerable people; and even private businesses that are popular gathering places for residents. Getting feedback can help the local government ensure that it knows who is likely to need help in an emergency, what kind of help they need, and who can provide that help. For example, if some residents cannot travel without assistance, this engagement lets the government and its partners know where to provide paratransit services or other transportation.

Practice Pointer

Finding the right, trusted messengers to reach vulnerable populations is particularly important for people who might mistrust government entities.

³⁴ Headwaters Economics. *Local Responses to Wildfire Risks and Costs: Case Studies and Lessons Learned*. 2014. https://headwaterseconomics.org/wp-content/uploads/western_case_studies_report.pdf.

³⁵ Manning, Helen, Michelle Carnevale, and Pamela Rubinoff. *Rhode Island Coastal Property Guide*. Rhode Island Coastal Resources Council. 2014. <http://www.beachsamp.org/resources/coastalpropertyguide>.

³⁶ Headwaters Economics, *Local Responses to Wildfire Risks and Costs*.

- During Hurricane Katrina in 2005, about 100,000 New Orleans residents could not obey the mandatory evacuation order, in some cases because they did not have their own vehicle or had special needs. Subsequently, the city arranged to make transportation available for people who need it.³⁷ In a mandatory evacuation, residents and visitors who cannot leave on their own can meet at Evacuspots, marked with a distinctive statue, to get city transportation to and from shelters (Figure 7).³⁸



Evacutest.org

Figure 7: Evacuspot statues in New Orleans show residents and visitors where to meet if they cannot self-evacuate when the city orders a mandatory evacuation. The city will transport people to shelters and bring them back when the emergency is over.

- Fire emergency response vehicles in Kinston, North Carolina, have laptop computers with GIS data that gives critical information to emergency responders rescuing people from flooded homes, including how many people live in the home and if any of them need special assistance.³⁹

2. Major Modifications

- **Use scenario planning to inform local planning and policy development.** Scenario planning lets communities evaluate alternative growth scenarios and their projected environmental and community impacts. Incorporating a plausible range of climate change scenarios into the growth scenarios can help a municipality explore how its growth patterns might affect or be affected by its vulnerability to various climate change impacts.⁴⁰ Include a “do nothing” scenario that demonstrates the results of maintaining the status quo.
 - The Albuquerque, New Mexico, Mid Region Council of Governments worked with federal partners to incorporate analysis of strategies to improve resilience to climate change impacts and reduce greenhouse gas emissions into its transportation and land use scenario planning. The Climate Change Scenario Planning Project “resulted in a preferred land use and transportation scenario for the region that accommodates anticipated growth. By considering future climate change impacts and GHG emission reduction strategies, the scenario is more resilient and sustainable than the trend or status quo.”⁴¹ The project

³⁷ Reckdahl, Katie. “Why New Orleans’ Katrina Evacuation Debacle Will Never Happen Again.” *Next City*, Jul. 9, 2014.

<https://nextcity.org/daily/entry/new-orleans-evacuation-hurricane-katrina-will-never-happen-again>.

³⁸ City of New Orleans. “Do You Know Where Your Evacuspot Is?” <http://www.nola.gov/ready/evacuspots>. Accessed Oct. 6, 2016.

³⁹ FEMA. “Innovative Floodplain Management: Kinston, North Carolina.” FEMA Mitigation Case Studies. 2013.

https://www.fema.gov/media-library-data/20130726-1515-20490-7614/kinston_cs.pdf.

⁴⁰ Few land use scenario planning tools that also incorporate climate change projections exist, but the Open Planning Tools Group (www.openplanningtoolsgroup.org) could be helpful to either find suitable tools or learn how to add climate change projections to an existing tool.

⁴¹ Rasmussen, Benjamin K., et al. *Integrating Climate Change in Transportation and Land Use Scenario Planning: An Example from Central New Mexico*. Federal Highway Administration. 2015.

https://www.fhwa.dot.gov/environment/climate_change/adaptation/publications/scenario. p. i.

report also noted, “By integrating climate analysis into the [master transportation plan], [the council] mainstreamed climate analysis into its transportation planning. Experience suggests that this is more efficient and effective in meeting climate change-related goals.”⁴²

- **Adopt flexible zoning**, which could include dynamic zoning or a floating zone.
 - **Adopt elements of dynamic zoning, or building flexibility into codes to cope with changing conditions without formal revision.**⁴³ With dynamic zoning, the zoning code includes “triggers” that, when activated, change the code requirements automatically. The nature of dynamic zoning might be particularly helpful for climate change-related impacts. Dynamic provisions would let a community pass regulations that fit its current conditions but will change based on some empirical future condition. One law expert notes that, “gradual and adaptive regulations... can minimize harms and takings compensation requirements” while giving property owners some certainty about how they can expect to use their property once certain thresholds are passed.⁴⁴
 - **Adopt in the zoning code a “floating zone” that describes the resilience characteristics that the community would like to see in new development.** The floating zone is “a zone classification... authorized for future use, but not placed on the zoning map. Rather, developers of compliant parcels are invited to make an application to have the zone applied in a particular location.”⁴⁵ The Land Use Law Center at Pace Law School and the U.S. Green Building Council, which developed the floating zone concept, note that it is “meant for local governments that desire green development but that are faced with limited staff, time, and resources. The floating zone approach saves a more limited municipality time and money, while still creating an incentive mechanism to further greener, more socially and environmentally responsible development, and while still allowing the local government to have significant control over the approval process.”⁴⁶ While the model floating zone focuses on environmentally sustainable development, communities could include resilience-focused aspects as well.

Communities can also use a standard overlay zone that incorporates resilience features. For example, Keene, New Hampshire, has a Sustainable Design and Energy Efficient Development (SEED) overlay zone that promotes compact development and energy efficiency. See the case study in this chapter for more information.

- **Incorporate fiscal impact analysis into the development review process, and ensure that the analysis includes the cost of providing services related to extreme weather and how those costs are likely to change based on projected climate change.** For example, if a new development is proposed for a flood plain, the fiscal impact analysis ought to take into account not only the standard costs and benefits—the number of residents or employees in the development, the costs of the public services (e.g., roads, schools, emergency response) they are likely to need, the tax and other revenue the growth will generate—but also the costs of strengthening the infrastructure to withstand flooding or repairing it if it is damaged, rescuing or

⁴² Ibid, p. vi.

⁴³ Elliot, Don. “Towards Dynamic Zoning.” Planetizen. Feb. 9, 2009. <http://www.planetizen.com/node/36937>.

⁴⁴ Byrne, “The Cathedral Engulfed,” pp. 72-73.

⁴⁵ Blanchard, Jennie Nolon, and John R. Nolon. *Neighborhood Development Floating Zone*. Land Use Law Center at Pace Law School and U.S. Green Building Council. 2013. <http://www.smartgrowthamerica.org/documents/Neighborhood-Development-Floating-Zone-2012.pdf>. p. 6.

⁴⁶ Ibid, p. 5.

sheltering residents forced from their homes by flooding, and lost revenue if businesses in the development are shut down by a flood.⁴⁷

- **Allow a mix of uses in appropriate zoning districts**, such as downtowns, town centers, around transit stations, and in other places where appropriate.⁴⁸ Having a mix of uses close together makes it easier for people to walk, bike, take transit, or drive shorter distances. These transportation options reduce greenhouse gas emissions and give a neighborhood critical redundancy if an emergency cuts off a major transportation route.
- **Incorporate into the land use map, comprehensive plan, and economic development plan locations where it makes sense to encourage economic growth.** As part of an overall strategy to promote growth in safer, well-connected locations, encourage businesses to expand or locate away from particularly vulnerable areas by offering incentives, whether financial or procedural. For vital industrial and job centers in areas that might experience increased threats from severe climate-related events, such as a working waterfront, engage with businesses to create resilience strategies that prevent or minimize interruption of services and help them find solutions for proper storage of goods and transportation needs such as supply chains and getting workers and customers to and from the business.⁴⁹ This type of resilience planning is especially important in areas where a major industry must be in a specific location for infrastructure or geographic reasons, such as ports, or where locally serving businesses are vital to a neighborhood.



Figure 8: In Boise, Idaho, the mix of stores, restaurants, services, and homes downtown lets people walk, bike, or take buses to get around.

Figure 9: Climate Resilience for Water Utilities

Ensuring that water infrastructure is prepared for climate-related impacts is a critical part of planning for economic resilience. EPA's Climate Resilience Evaluation and Awareness Tool (CREAT) is a climate risk assessment and planning application for water, wastewater, and stormwater utilities. CREAT helps water utilities understand and adapt to climate change. The tool helps users:

1. Find out which extreme weather events pose significant challenges to the utility and build scenarios to identify potential impacts.
2. Identify critical assets and the actions the utility can take to protect them from the consequences of climate change on utility operations.
3. Generate reports describing the costs and benefits of risk-reduction strategies for decision-makers and shareholders.

Find the tool at <https://www.epa.gov/crwu/build-climate-resilience-your-utility>.

⁴⁷ For more on fiscal impact analyses that is particularly relevant to small towns and rural places, see: EPA, *Essential Smart Growth Fixes for Rural Planning, Zoning, and Development Codes*.

⁴⁸ For specific actions to promote a mix of uses, see: EPA, *Essential Smart Growth Fixes for Urban and Suburban Zoning Codes*.

⁴⁹ For strategies to help businesses build resilience, see: EPA, *Planning Framework for a Climate-Resilient Economy*. 2016. <https://www.epa.gov/smartgrowth/planning-framework-climate-resilient-economy>.

- **Encourage on-site renewable energy generation and storage** to reduce greenhouse gas emissions and provide backup power in case of a power outage.
 - **Amend codes or adopt ordinances to allow solar, solar thermal, wind, and geothermal energy production on individual properties and in communal installations.** These kinds of ordinances give property owners clear direction on what is permitted and prohibited, providing them peace of mind that their investment is legal and alleviating protests from neighbors.

Under the SunShot Solar Outreach Partnership, the U.S. Department of Energy worked with several partners to develop tools and training to local governments to make it easier for residents and businesses to use solar energy.⁵⁰ As part of this initiative, the American Planning Association developed *Planning for Solar Energy*, which includes guidance on how to incorporate solar-friendly provisions into various planning documents and regulations, examples of places that have solar-supportive plans and regulations, and a framework to help local governments develop solar regulations that “that meet the unique needs of each community and are fully integrated within a community’s existing regulations.”⁵¹

- Aurora, Illinois’ Alternative Energy Systems Ordinance clearly defines solar, wind, and geothermal system generation limits, required setbacks, permitted system heights, and noise limits for both residential and non-residential parcels. The ordinance includes easy-to-understand illustrations of these requirements.⁵²

Solar gardens, small community installations that serve local customers who buy or lease shares, can make good use of lots that would otherwise be difficult to develop.

Community installations like these let residents who cannot install photovoltaic panels on their homes—for example, because they rent, they live in a multifamily building, their roofs are unsuitable for solar panels, or the upfront cost of panels is too high—buy solar power.⁵³ The National Renewable Energy Laboratory estimates that about half of households and businesses cannot install rooftop solar systems.⁵⁴ Local governments can make solar gardens easier to build by defining them as a specific use in the zoning code, but communities do not necessarily need zoning changes to build solar gardens.⁵⁵

- Fort Collins, Colorado, used a power purchase agreement with Clean Energy Collective to build a solar garden on the city-owned site of a demolished former pickle plant (Figure 10). The site lies at the edge of a compact residential neighborhood, but a railroad running through it as well as contamination from its industrial past made it impractical to develop.⁵⁶ The city is incorporating public art into the installation, known as the Riverside Community Solar Array, to make

⁵⁰ For materials developed under this initiative, see: Solar Outreach Partnership. <http://solaroutreach.org>. Accessed Dec. 10, 2015.

⁵¹ Morley, David, AICP, ed. *Planning for Solar Energy*. American Planning Association. Planning Advisory Service Report 575. 2014.

⁵² City of Aurora. *Zoning Ordinance*. Section 4.4-9: Alternative Energy Systems. 2014. https://www.aurora-il.org/documents/planning/ordinance/appendix_a_zoning.pdf.

⁵³ Morley, David. “Planning and Zoning for Solar Gardens.” American Planning Association National Planning Conference, Apr. 20, 2015. <http://narc.org/wp-content/uploads/APA-2015-Planning-and-Zoning-for-Solar-Gardens.compressed.pdf>.

⁵⁴ Feldman, David, et al. *Shared Solar: Current Landscape, Market Potential, and the Impact of Federal Securities Regulation*. National Renewable Energy Laboratory. 2015. <http://www.nrel.gov/docs/fy15osti/63892.pdf>.

⁵⁵ Morley, “Planning and Zoning for Solar Gardens.”

⁵⁶ Hois, Emily. “Fort Collins Residents Help City Reach Climate Targets While Saving on Electricity.” Clean Energy Collective blog. Jul. 24, 2015. <http://cleanenergyco.com/blog/fort-collins-residents-help-city-reach-climate-targets-while-saving-on-electricity>.

it a gateway welcoming people to Fort Collins.⁵⁷ Before ground was even broken on the array, it was sold out, and its capacity was doubled to meet demand.⁵⁸



Source: City of Fort Collins
Designer: Logan Simpson
Landscape Architect

Figure 10: Fort Collins' Riverside Solar Array uses a former industrial site that would have been difficult to develop otherwise.

- **Use public-private partnerships to promote renewable energy use.** For example, a purchase power agreement is a financing tool that connects a developer who owns, operates, and maintains an energy system to a customer who agrees to site the system on its property and purchase the system's energy output from the provider for a predetermined period. With any public-private project, it is important to conduct a transparent selection process through a request for proposals or other procurement mechanism.
 - Partnering with a private solar company, the town of Carver, Massachusetts, installed a 99-kilowatt solar array along a highway easement that provides 100 percent of the energy required for the town's water treatment plant. A 20-year power purchase agreement between the town and SolareAmerica made the project economically viable for both sides. The project gave the town a reliable clean energy source and the provider an entry to the Massachusetts solar market.⁵⁹

3. Wholesale Changes

- **Incorporate into capital projects features that enhance resilience and bring multiple other benefits.** For example, adding trees and rain gardens along a street beautifies the neighborhood, cools the air, and makes the street safer for walking and biking as well as driving. New or upgraded streets, sidewalks, and public spaces that are attractive and distinctive draw people, which in turns draws private investment.
 - In 2009, the town of Normal, Illinois, built the Uptown Circle, a traffic circle with a park at its center featuring seating, a water feature, and an open plaza (Figure 11). The circle's water feature doubles as sustainable stormwater



Scott Shigley, Shigley Photo

Figure 11: Normal, Illinois' Uptown Circle has become a vibrant public space, winning EPA's 2011 National Award for Smart Growth Achievement in the Civic Places category.

⁵⁷ Gloss, Cameron. "Planning and Zoning for Solar Gardens." American Planning Association National Planning Conference, Apr. 20, 2015. <http://narc.org/wp-content/uploads/APA-2015-Planning-and-Zoning-for-Solar-Gardens.compressed.pdf>.

⁵⁸ Hois, "Fort Collins Residents Help City Reach Climate Targets While Saving on Electricity."

⁵⁹ Knox, Rob. "Array Gives Carver Clear Shot at Savings." *Boston Globe*, Aug. 30, 2012.

treatment for rainwater that falls in the area, making water treatment visible, tangible, and educational. It prevents 1.4 million gallons of stormwater from entering the municipal storm sewer each year. The project's success has generated \$140 million in private development in the area to date, including two hotels, new mixed-use buildings, commercial infill, a museum, and investment from a nearby university. Property values in the Uptown tax increment financing district increased by \$1.5 million (or 9 percent) from 2009 to 2010, a 31 percent increase from 2004, when planning work started on the project.⁶⁰

- **Plan for post-disaster redevelopment before a disaster strikes.**

- **Create a post-disaster redevelopment plan.** This plan can help communities recover faster and more efficiently and can lay out a vision to help the community build back better than before. It also helps set expectations and avoid making rebuilding decisions under duress in the immediate wake of a disaster.

Integrate the post-disaster redevelopment plan with other major governing documents such as the comprehensive plan and the hazard mitigation plan. Review the plan regularly; a guide developed by the state of Florida⁶¹ suggests an annual review before hurricane season each year and a major update every five years. Engaging the public in the initial development of the plan, as well as reviews and updates, helps make sure that the plan takes into account the needs of the entire community. The guide encourages communities, when thinking about post-disaster redevelopment opportunities, to consider how to promote:

- “Disaster-resilient land use patterns
- Hazard mitigation construction techniques
- Energy-efficient buildings
- Healthy community design
- Affordable or workforce housing
- Alternative transportation networks
- Environmental preservation and habitat restoration
- Sustainable industry recruitment”⁶²

The Palm Beach County Post-Disaster Redevelopment Plan, for instance, notes the need to have temporary housing and long-term shelters, particularly for low-income residents, to ensure that people can stay in the neighborhood if they want and to make sure businesses have employees and customers after a disaster. Actions to meet this goal include allowing businesses to apply for a permit to let employees live on-site temporarily, making sure temporary housing sites are near the areas with the most vulnerable housing stock, and setting up a website to help renters find undamaged rental units.

The plan also emphasizes including affordable housing in redevelopment projects, noting, “Palm Beach County developed a vision for its land use planning efforts many years back that revolved around maintaining a diverse community that included urban and rural communities and all levels of income households. To maintain that vision after a disaster

⁶⁰ Hoerr Schaudt Landscape Architects. “The New Normal: Sustainability as a Catalyst.” Undated. <http://70.32.79.30/files/pdfs/Normal-Landscape-Benefits.pdf>. Accessed Nov. 16, 2016.

⁶¹ Florida Department of Community Affairs and Florida Division of Emergency Management. *Post-Disaster Redevelopment Planning: A Guide for Florida Communities*. 2010. <http://www.floridajobs.org/docs/default-source/2015-community-development/community-planning/pdr/pdrpguide.pdf?sfvrsn=2>.

⁶² Ibid, p. 4.

means that affordable housing must be seriously addressed.”⁶³ Actions could include incorporating post-disaster redevelopment into the county’s workforce housing program to require residential developments and multifamily buildings with significant damage to include workforce housing when they rebuild.

The guide also suggests convening local staff and stakeholders one year after a major disaster for an “after-action” assessment of how well the plan worked. Indicators—such as home occupancy and rental rates, employment resumption statistics, public engagement measures, and the number of projects started and completed and an estimate of the number of people who have benefited from these projects—can help communities assess how well the plan worked.⁶⁴

- **Adopt a post-disaster redevelopment ordinance** that sets up temporary post-disaster regulations, such as building moratoria⁶⁵ and permits for repairs, and establishes a redevelopment task force or advisory board.
 - Hillsborough County, Florida’s ordinance sets up a redevelopment task force to oversee post-disaster reconstruction, advise the county board on redevelopment, and “identify opportunities to mitigate future damages through the management of recovery and redevelopment.” The task force can also advise the county board on actions to enhance open space, restore local ecosystems, reduce traffic congestion, and improve “the long-term economic vitality of the local commercial and industrial base.” The task force includes county staff from a variety of departments and representatives from cities in the county, the chamber of commerce, utilities, and trade associations for the building and development industries. The ordinance also outlines specific guidance on emergency post-disaster repairs, building moratoria, and requirements for rebuilding damaged structures.⁶⁶

⁶³ Palm Beach County Division of Emergency Management. *Countywide Post-Disaster Redevelopment Plan: Palm Beach County, Florida*. 2006. p. 2-19. <http://discover.pbcgov.org/publicsafety/dem/Publications/Post-Disaster-Redevelopment-Plan.pdf>.

⁶⁴ Florida Department of Community Affairs and Florida Division of Emergency Management, *Post-Disaster Redevelopment Planning*.

⁶⁵ A post-disaster building moratorium can give a community a chance to consider where and how to rebuild, instead of rebuilding exactly what existed before the disaster.

⁶⁶ Hillsborough County. Ordinance Number 93-20. Adopted Jul. 29, 1993. <https://fl-hillsboroughcounty.civicplus.com/DocumentCenter/Home/View/1051>.

Resources

- FEMA's *Plan Integration: Linking Local Planning Efforts* (2015) demonstrates how to link hazard mitigation plans to other community planning efforts. The guide includes specific steps, examples, and checklists: <https://www.fema.gov/media-library/assets/documents/108893>
- EPA's "Clean Energy Financing Programs" webpage offers resources to help local governments find financing for clean and renewable energy projects: <https://www.epa.gov/statelocalclimate/clean-energy-financing-programs>
- EPA's *Local Climate Action Framework: A Step-by-Step Implementation Guide* has case studies, tools, and other resources to help local governments plan, implement, and evaluate climate, energy, and sustainability projects and programs. The framework's implementation phases include communications, setting goals and selecting actions, obtaining resources, and tracking and reporting: <https://www.epa.gov/statelocalclimate/local-climate-action-framework-step-step-implementation-guide>
- EPA's Local Government Climate and Energy Strategy Series offers greenhouse gas reduction strategies related to energy efficiency, transportation, community planning and design, solid waste and materials management, and renewable energy: <https://www.epa.gov/statelocalclimate/local-government-climate-and-energy-strategy-series>
- EPA's RE-Powering America's Land initiative offers tools to help site renewable energy projects on contaminated land: <https://www.epa.gov/re-powering>
- EPA's *Climate Smart Brownfields Manual* (2016) helps communities consider climate change when assessing, cleaning up, or redeveloping brownfield sites. It includes case studies and links to resources that communities can use as they develop brownfields project plans: <https://www.epa.gov/land-revitalization/climate-smart-brownfields-manual>
- FEMA's "Public Private Partnerships: Building Better Resiliency Together" offers tools to help start resilience-related public-private partnerships that can take advantage of multiple sectors' resources: <https://www.fema.gov/public-private-partnerships>
- The American Public Health Association has many resources on the health impacts of climate change: <https://www.apha.org/topics-and-issues/climate-change>
- Open Planning Tools Group is a group of scenario planning tool experts who work together to improve tools and techniques: <http://www.openplanningtoolsgroup.org>
- Envision Tomorrow is an open-access scenario planning package of tools that lets users analyze how current growth patterns and decisions about growth will affect health, environmental, and fiscal measures: <http://envisiontomorrow.org>
- The Federal Highway Administration's 2015 report on *Integrating Climate Change in Transportation and Land Use Scenario Planning: An Example from Central New Mexico* includes guidance that can help other regions integrate climate change considerations into land use and transportation scenario planning: https://www.fhwa.dot.gov/environment/climate_change/adaptation/publications/scenario

Guidance and Metrics

LEED for Neighborhood Development

Smart Location and Linkage Prerequisite: Smart Location

Locate the project on an infill site, next to already-developed land that has at least 90 intersections per square mile within one-half mile of the project, on a site with existing or planned transit service, or near a variety of existing uses. Locate the project on a site served by existing water and wastewater infrastructure, or locate it within a planned water and wastewater service area and provide new infrastructure.

Neighborhood Pattern and Design Prerequisite: Compact Development

Build residential components at a density of at least seven dwelling units per acre and nonresidential components at a density of 0.50 or higher floor-area ratio (FAR) for the available land, with higher densities within walking distance of transit service.

Neighborhood Pattern and Design Prerequisite: Mixed-Use Neighborhoods

Ensure that at least half of the project's dwelling units are within 0.25 miles walking distance of a variety of uses.

Green Infrastructure and Buildings Credit: Solar Orientation

Orient blocks and buildings for optimal solar exposure.

Green Infrastructure and Buildings Credit: Renewable Energy Production

Incorporate on the site nonpolluting, renewable energy generation with capacity to provide at least 5 percent of the project's annual electrical and thermal energy.

STAR Community Rating System

Built Environment Objective 3: Compact & Complete Communities

Demonstrate that the community achieves thresholds for residential and nonresidential density, diverse uses, public transit availability, and walkability. Demonstrate that plans and policies support compact, mixed-use development. Identify areas appropriate for compact, mixed-use development on the future land use map.

Climate & Energy Objective 1: Climate Adaptation

Conduct a local climate risk and vulnerability assessment. Adopt building or land use codes or ordinances that address specific climate impacts in the community. Require or encourage residents and businesses to change behaviors to prepare for climate change impacts. Prepare infrastructure throughout the community for climate change impacts.

Climate & Energy Objective 2: Greenhouse Gas Mitigation

Demonstrate incremental progress toward reducing communitywide greenhouse gas emissions by 28 percent by 2025 and/or 80 percent by 2050.

Climate & Energy Objective 3: Greening the Energy Supply

Demonstrate that the community gets some of its electricity from renewable energy sources. Remove restrictions on residential and small business renewable energy installations.

Equity & Empowerment Objective 1: Civic Engagement

Work with businesses, nonprofits, and neighborhood organizations to improve community engagement in decision-making. Establish regular opportunities for local government staff and officials to meet with residents to answer questions and listen to concerns.

Equity & Empowerment Objective 4: Equitable Services & Access

Demonstrate that neighborhoods with the highest percentage of low-income residents and people of color have increased access to community facilities, services, and infrastructure.

Health & Safety Objective 3: Emergency Management & Response

Encourage residents to develop emergency kits and evacuation plans, or distribute kits or supplies to low-income and vulnerable residents.

Health & Safety Objective 6: Hazard Mitigation

Reduce over time the number of homes below code standards that are in high-risk areas or the percentage of residents living in high-risk areas. Develop a post-disaster plan that covers long-term redevelopment. Adopt land use regulations that limit development in areas highly vulnerable to hazards.

Living Community Challenge*Imperative 1: Limits to Growth*

Projects can be built only on previously developed sites that are not on or adjacent to sensitive ecological habitats, including wetlands or the 100-year flood plain.

Imperative 6: Net Positive Energy

Supply 105 percent of the community's energy needs by renewable energy generated in the community, do not use combustion-based energy, and provide local energy storage for resilience.

Imperative 10: Resilient Community Connections

Incorporate design features, strategies, and community-based programs to ensure resilience through infrastructure, community resources, and social interactions, including: creating, annually maintaining, and disseminating to all residents a disaster response plan that identifies emergency contacts and shelter locations and gives guidance on what to do in specific types of emergencies; designating local block or building captains trained in emergency response; depending on the community context, providing places out of the flood plain where residents can safely gather; requiring all facilities except single-family homes to have a generator or battery backup for emergency power located above the flood plain; and ensuring that critical infrastructure and facilities are out of the flood plain.

Imperative 16: Universal Access to Community Services

Incorporate access to basic community services and amenities that support the health, dignity, and rights of all people.

Case Study: Keene, New Hampshire

In 2005, Keene, New Hampshire, received more than 11.5 inches of rain in less than 48 hours.⁶⁷ The rain caused Keene's brooks to overflow, flooding some homes with as much as 7 feet of water.⁶⁸ In response to the floods and other observed climate change effects, Keene, working with ICLEI–Local Governments for Sustainability, developed a Climate Adaptation Action Plan, which the city council approved in 2007.

The plan, one of the first of its kind adopted in the United States, presented land use planning and design recommendations to reduce the city's vulnerability to extreme weather events. The plan outlined potential impacts of climate change on three sectors: the built environment, the natural environment, and the social environment. For each sector, the plan developed adaptation goals and recommended actions to achieve those goals.

- Built environment:** Goals included increasing buildings' resilience to extreme weather events and promoting smart growth initiatives. Strategies included creating new design standards for buildings to fit projected climate conditions, identifying a 200-year flood plain and managing development in that area, offering incentives to developers and homeowners to update buildings, and adopting smart growth principles to encourage infill development. Stormwater management strategies included developing a regional stormwater management plan, implementing green and complete streets programs, incorporating sustainable stormwater design in all new development plans, and adopting a net zero runoff site plan requirement for all new development.
- Natural environment:** Goals included protecting wetlands that naturally recharge aquifers and absorb stormwater runoff and increasing the city's water storage to guard against drought. Strategies included educating the public about the benefits of wetlands, preserving wetlands through the comprehensive plan and a wetlands management strategy, creating a watershed management plan, and using graywater systems. The plan also discussed protecting agricultural land, creating local markets and business opportunities for agricultural products, and developing a food security plan.
- Social environment:** Goals included helping people who lose their jobs because of climate change, educating the public about health impacts of climate change, improving emergency services, and creating a climate-appropriate local economy. Strategies included creating loan programs for residents to adapt their businesses, preparing for people migrating to Keene from coastal areas because of sea level rise, and making it easier for people to find and get to emergency shelters even if they do not have a car.⁶⁹

Following city council's adoption of the plan, the city institutionalized adaptation efforts by putting a "climate lens" over all departments' operations.⁷⁰ In 2009, the council passed a hillside development ordinance, amending the zoning ordinance to better protect ridgelines, slopes, and other sensitive land areas from development. The ordinance also adopted low-impact development site plan regulations to lessen stormwater impacts.⁷¹

⁶⁷ Personal communication with Rhett Lamb, Planning Department, City of Keene, on Sep. 20, 2016.

⁶⁸ Quinton, Amy. "Keene Plans for Climate Change." NHPR, May 30, 2007. <http://info.nhpr.org/node/13005>.

⁶⁹ City of Keene. *Adapting to Climate Change: Planning a Climate-Resilient Community*. 2007. http://www.ci.keene.nh.us/sites/default/files/Keene%20Report_ICLEI_FINAL_v2_1.pdf.

⁷⁰ Byrne, Kristina. "Spotlight: Sustainable City Planning." Security & Sustainability Forum, Jun. 1, 2012. <http://securityandsustainabilityforum.org/spotlight-sustainable-city-planning-2808>.

⁷¹ City of Keene. *Code of Ordinances*. Chapter 102, Zoning Ordinance. 2009.

The city also incorporated climate change issues in its comprehensive master plan, which the city council unanimously adopted in 2010.⁷² The master plan encourages infill development to bring more amenities downtown and protect open space for flood mitigation.⁷³

To encourage redevelopment downtown, in 2010, the city created the Sustainable Design and Energy Efficient Development (SEED) overlay zone. In the SEED zone, which covers the city's core, property owners who build a building that meets certain national green building standards can get reduced parking requirements and more height and density.⁷⁴

The master plan directed the city to explore stormwater management strategies, and in 2013, the planning board adopted development standards that require commercial developments and large residential developments to use low impact design techniques such as green roofs, porous pavement, vegetated swales, and cisterns to reduce, slow, and filter runoff.⁷⁵ According to the city, the "key to responsibly managing stormwater is integrating development into the natural landscape," and the city plans to "ensure that development considers its effects on the entire [natural] system."⁷⁶

Keene adopted a complete streets policy in 2015 and developed design guidelines for the various types of streets in the community: slow streets, gateway streets, bicycle streets, neighborhood streets, and rural streets. The guidelines outline sidewalk width, pedestrian crossings at every intersection, plantings and street furniture, lighting, bike lanes, and parking, among other elements. The guidelines direct the city to consider using pervious pavement for parking areas and sidewalks on all street types except for rural streets, which have no on-street parking or sidewalks. On gateway streets, which are major roads that connect downtown to state routes, the city is to consider using bioswales or rain gardens to infiltrate stormwater.⁷⁷



Figure 12: Keene's downtown is a pleasant place to walk, with interesting shops and street design that protects pedestrians.

Despite its small size and limited resources, the city used strong mayoral leadership, academic and institutional partnerships, and support from a variety of city departments to integrate climate change into all city activities. Although flooding remains a problem in Keene—in 2012, the city experienced floods reminiscent of those in 2005—the city plans to continue its adaptation efforts by adopting additional building and zoning code amendments, aligning its capital improvement program and budget with the master plan, implementing smart growth policies, and creating stormwater management plans.

More information on Keene's climate change mitigation and adaptation efforts is available at www.ci.keene.nh.us/sustainability/climate-change-action.

⁷² Byrne, Kristina, "Spotlight: Sustainable City Planning."

⁷³ City of Keene. "The Six Vision Focus Areas." <http://www.ci.keene.nh.us/departments/planning/keene-cmp-2010/communitiy-vision/six-vision-focus-areas>. Accessed Jan. 4, 2013.

⁷⁴ City of Keene. *Code of Ordinances*. Chapter 102, Article XIII. 2010. <http://www.ci.keene.nh.us/sites/default/files/SEED%20Regs.pdf>.

⁷⁵ City of Keene. *Development Standards*. Section 1: Drainage. Amended Nov. 25, 2013.

http://www.ci.keene.nh.us/sites/default/files/2014_02_24_Planning_Board_Standards_Adopted_FINAL.pdf.

⁷⁶ Daley, Beth. "Small N.H. City Takes on Global Warming Challenge." *Boston Globe*, Dec. 16, 2007.

http://archive.boston.com/news/local/new_hampshire/articles/2007/12/16/small_nh_city_takes_on_global_warming_challenge/?page=full.

⁷⁷ City of Keene. *Keene Complete Streets Design Guidelines*. 2015.

https://www.ci.keene.nh.us/sites/default/files/Complete%20Streets%203_Keene%20Design%20Guidelines.pdf.

4. Adapting to Flooding and Extreme Precipitation

Introduction

Average annual precipitation across the United States has increased by about 5 percent since 1900, but the increase has been much larger in some regions, while other regions have seen a decrease. The increase has been particularly high in recent decades in the Northeast, Midwest, and southern Great Plains. Seasonal variation varies by region; the northern part of the country is projected to see wetter conditions in the winter and spring while the Southwest is expected to be drier, and most of the contiguous United States is projected to see drier summers.⁷⁸

In addition, in most of the country, “the heaviest rainfall events have become heavier and more frequent.”⁷⁹ The largest increases in heavy rain have been in the Northeast and Midwest, causing more floods, while floods have decreased in the Southwest. The trend of heavier rainfall events is projected to continue, even in regions such as the Southwest where overall precipitation is projected to decrease.⁸⁰

Most communities rely on FEMA’s flood risk maps, which use the 100-year flood plain.⁸¹ The boundaries of that flood plain are changing due to precipitation and flooding trends, but most maps are still based on historical trends that no longer accurately predict future conditions. As a result, development is happening in places where flood risks are not accurately assessed or priced. Development in these more-hazardous areas puts more people, structures, and infrastructure in harm’s way. New development in the flood plain and along stream banks also exacerbates flooding by causing erosion, sedimentation, and ecosystem damage.

Development often converts pervious surface (such as soil), which might have previously absorbed rainfall or a flooding creek, to impervious surface (such as concrete or pavement), which increases stormwater runoff. That runoff picks up pollutants, debris, and sediment as it flows into waterways. Rain can also collect in streets, parking lots, and other areas, creating localized flooding. Flooding also affects combined sewers, which handle both sanitary sewage and stormwater runoff in the same system. When these systems overflow because of heavy precipitation, they discharge untreated effluent into local waterways, which can threaten public health and the environment. Many older cities in particular have combined sewer systems, and most are working to reduce the number of overflow events, often under enforcement agreements with EPA or state environmental agencies.

Sea level rise also contributes to flooding. Chapter 5 covers strategies specific to that impact but does not repeat the flooding-related strategies covered here, many of which are also relevant to sea level rise.

⁷⁸ Walsh, J., et al. “Chapter 2: Our Changing Climate.” *Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Change Research Program, 19-67. 2014. <http://nca2014.globalchange.gov/report/our-changing-climate/introduction>.

⁷⁹ Ibid, p. 36.

⁸⁰ Ibid.

⁸¹ The 100-year flood plain is the area that is expected to be inundated in a flood that has a 1 percent chance of “being equaled or exceeded in any given year.” The 500-year flood has a 0.2 percent chance of occurring in a given year. FEMA. “Flood Zones.” <https://www.fema.gov/flood-zones>. Accessed Aug. 2, 2016.

Response to the Problem

Communities are responding to the threat of storms and floods by better managing stormwater runoff from new development and encouraging growth in already-developed areas. Green infrastructure strategies mimic natural processes by using vegetation, permeable pavement, and other elements to capture, slow, filter, and infiltrate stormwater runoff on-site. Redeveloping already-developed sites can replace impervious cover with pervious surfaces, reducing stormwater runoff.

Land use planning and design can reduce a community's long-term vulnerability to flooding and other extreme weather events. Policies can encourage compact development in less-vulnerable locations and divert development pressure away from areas near natural flood protection features such as wetlands, stream buffers, and salt marshes. These natural areas and adjacent uplands also create green space that people can use for recreation and that can provide habitat for wildlife and ecological services such as capturing and filtering stormwater runoff.

Potential Benefits

- Protecting and improving water quality, aquatic ecosystems, and public health.
- Maintaining stormwater infrastructure capacity by limiting runoff from new development and using green infrastructure to infiltrate runoff on-site.
- Accruing economic benefits, including increased property values and lower capital costs for water infrastructure.
- Beautifying neighborhoods and creating new amenities such as parks.
- Protecting natural flood “sponges” such as wetlands or marshes that also provide wildlife habitat, recreational open space, and aesthetic value.
- Protecting property and structures from flood damage and reducing the need for rebuilding.
- Reducing the need for evacuation and emergency response in more hazardous areas.
- Using government resources more efficiently and effectively.
- Creating predictability for developers, residents, and businesses.
- Reducing property owners' flood insurance premiums (Figure 13).

Figure 13: Community Rating System

FEMA's National Flood Insurance Program (NFIP) offers the Community Rating System (CRS), an incentive program that recognizes and encourages community flood plain management activities that exceed minimum NFIP requirements. The CRS rates a community based on a point system; the community earns points by enacting one or more of 18 flood plain management activities. The more points a community earns, the higher the discount its property owners can receive. The most flood-resilient communities can earn as much as a 45 percent discount on flood insurance premiums.⁸² Activities that earn discounts include:

- Adopting regulatory maps that delineate flood plains at a higher standard than required by FEMA (e.g., mapping the 500-year flood rather than just the 100-year flood or using projections instead of historical data).
- Preserving open space in flood plains, including prohibiting development in certain areas, implementing a transfer of development rights or similar incentive program, or establishing clustering or setback rules.
- Requiring new development and redevelopment to use green infrastructure or low impact development techniques to manage stormwater runoff.⁸³

⁸² FEMA. *National Flood Insurance Program Community Rating System: A Local Official's Guide to Saving Lives, Preventing Property Damage, Reducing the Cost of Flood Insurance*. 2015. <http://www.fema.gov/media-library/assets/documents/16104>.

⁸³ FEMA. *National Flood Insurance Program Community Rating System Coordinator's Manual*. 2014. <https://www.fema.gov/media-library/assets/documents/8768>.

Implementation Approaches

I. Modest Adjustments

- **Pilot a sustainable streetscape program** that installs features that infiltrate stormwater on-site while creating other benefits such as reducing ambient air temperatures, beautifying streets and sidewalks, reducing localized flooding, and making roads safer and more appealing for pedestrians, bicyclists, and drivers. Features might include slotted curbs, pervious paving, rain gardens, and tree pits that are designed to absorb and filter runoff. The pilot program can demonstrate the benefits of green streets to build public and political support, which can lead to making the program permanent.
 - Chicago created a Green Alleys pilot program in 2006, starting with six initial locations. The alleys use permeable pavement to allow rainwater to seep through the pavement and filter into the ground, and light-colored pavement to reduce the heat island effect. The program helped the city learn how to adapt these materials and techniques to get the best performance while also demonstrating the benefits of green alleys to nearby residents.⁸⁴ Over the first four years of the program, more than 100 green alleys were installed.⁸⁵
- **Help private property owners better manage stormwater using education and incentives.** By educating property owners about the benefits of green infrastructure solutions, teaching them how to properly maintain stormwater-absorbing and -filtering features, and providing financial or procedural incentives to convert impervious surfaces to pervious areas, communities can expand green infrastructure beyond streets, parking lots, and publicly owned land.
 - To encourage property owners to install stormwater treatment elements such as rain barrels, rain gardens, permeable pavement, and green roofs, Prince George's County, Maryland's Rain Check Rebate Program provides up to \$4,000 for single-family residential projects and up to \$20,000 for multifamily dwellings; commercial and nonprofit projects; and homeowner, condominium, and civic association projects.⁸⁶
 - Buffalo, New York, gave 1,000 down spouts and rain barrels to residents, which the Buffalo Sewer Authority delivered and installed. A local foundation funded the program. Capturing rain in barrels instead of letting it run into the combined sewer system will help keep the sewers from overflowing during heavy rain.⁸⁷



Figure 14: Creative, artistic rain barrels can add character to a street.

⁸⁴ Fiegel, Erin. "Green Alleys: How Chicago's Pilot Program Seeks to Alleviate Flooding." Undated. LandscapeOnline.com. <http://www.landscapeonline.com/research/article.php/11357>. Accessed Nov. 9, 2016.

⁸⁵ City of Chicago. "Green Alleys." https://www.cityofchicago.org/city/en/depts/cdot/provdrs/street/svcs/green_alleys.html. Accessed Jun. 9, 2015.

⁸⁶ Chesapeake Bay Trust. "Prince George's County Rain Check Rebate." http://www.cbtrust.org/site/c.mijPKXPCJnH/b.9146461/k.6D3F/Prince_George8217s_Rain_Check_Rebate.htm. Accessed Jan. 14, 2016.

⁸⁷ Schulman, Susan. "Buffalo Offering 1,000 Free Down Spouts, Rain Barrels to City Residents." *Buffalo News*, Apr. 20, 2015. <http://buffalonews.com/2015/04/20/buffalo-offering-1000-free-down-spouts-rain-barrels-to-city-residents>.

- **Design open space in flood plains to provide everyday amenities**, but preserve its ability to absorb or redirect flood waters.

- Boulder, Colorado, has the nation's second-highest percentage of bicycle commuters. When Boulder Creek floods, however, the popular bike paths along the creek are blocked off to serve as channels that convey water downstream, away from the central city.⁸⁸
- After decades of Cedar River flooding, Charles City, Iowa, used the FEMA buyout program to acquire flood plain land and create an engaging riverfront park (Figure 15).⁸⁹



Figure 15: Charles City's Riverfront Park disguises stormwater management features as amenities, including a fountain and ravine play area, that slow water flow and trap sediment before it enters the river.

- **Require new development or redevelopment to capture and infiltrate the first 1 or 1.5 inches of rain from the impervious portion of the development site**, which could be accomplished by replacing a percentage of impervious paved area with permeable paving or by requiring the reduction of paved surfaces in planned developments.
 - Philadelphia's stormwater regulations require development or redevelopment projects that disturb more than 15,000 square feet to infiltrate at least the first 1.5 inches of runoff from impervious areas. If on-site infiltration is feasible, the project must infiltrate all of the runoff. To encourage developers to use green infrastructure to reduce runoff, the water department will expedite review of the post-construction stormwater management plan for projects that include elements such as green roofs, porous pavement, and trees.⁹⁰
- **Update any Clean Water Act Section 402 National Pollutant Discharge Elimination System permits to consider climate change aspects**, including strategies like increased use of green infrastructure, which can improve water quality while often also providing additional green spaces and recreational opportunities, enhanced ecosystem services, improved air quality, increased property values, energy savings, economic development, reduced ambient air temperatures, and job creation opportunities. In addition to helping to adapt to climate change impacts, green infrastructure can be a climate mitigation strategy because plants and soils sequester carbon dioxide.⁹¹

⁸⁸ Doig, Will. "You Can't Stop Urban Flooding." *Next City*, Jan. 27, 2014. <https://nextcity.org/features/view/you-cant-stop-urban-flooding>.

⁸⁹ EPA, *2013 National Award for Smart Growth Achievement*.

⁹⁰ Philadelphia Water. *Stormwater Management Guidance Manual V3.0*. Updated 2015. <http://www.pwdplanreview.org/manual-info/guidance-manual>.

⁹¹ EPA. "Integrating Green Infrastructure into Federal Regulatory Programs." <https://www.epa.gov/green-infrastructure/integrating-green-infrastructure-federal-regulatory-programs>. Accessed Oct. 4, 2016.

2. Major Modifications

- **Adopt the 500-year flood plain boundary as the “locally regulated flood plain”** that exceeds the typical FEMA-recognized 100-year flood plain. This action does not affect flood insurance requirements, as FEMA requires flood insurance based on the 100-year flood boundary and flood elevations. It can earn the community CRS credits (see Figure 13).
 - Cedar Falls, Iowa, adopted the 500-year flood plain boundary as its locally regulated flood plain. Within this boundary, structures have to be raised 1 foot above the 500-year flood elevation and no new lots can be established for development. Critical facilities such as “hospitals, municipal government buildings, schools and residential facilities for elderly or infirmed/handicapped persons” cannot be located within the 500-year flood plain.⁹²
- **Restrict development activities in areas buffering waterbodies and wetlands** that would have an adverse impact on the area’s flood control or water quality.
 - After suffering flooding from multiple tropical storms, Alachua County, Florida, adopted low-impact development wetland buffer protection requirements in 2011, mandating an average 75-foot buffer or a 150-foot buffer for areas of Outstanding Waters (areas requiring special protection due to their natural vulnerability). No development activities are allowed in wetland or wetland buffer areas that would have an adverse impact on flood control or water quality.⁹⁴
 - Kansas City, Missouri’s Stream Setback Ordinance, part of a larger strategy to reduce flash flooding, creates a stream buffer with three specified zones based on distance from the water body. Development is more restricted closer to the stream, but developers who build in the zone farthest from the stream can get density bonuses and other flexibility.⁹⁵ See the case study in this chapter for more information on the program.
- **Adopt green and complete streets design standards** to make streets safe and comfortable for pedestrians, drivers, bicyclists, and transit users. Green and complete streets incorporate green infrastructure such as street trees, permeable pavement, curb inlets, and planter boxes to capture, slow, filter, and absorb stormwater runoff. These green features beautify the street and cool the air as well. Green and complete streets are designed to make walking and biking easier and more appealing, which reduces pollution from vehicles, helps people incorporate physical activity into their daily routines, and gives more transportation options to people who cannot or choose not to drive.

Practice Pointer

Although the term “100-year flood” is widely used, it does not give people a good sense of the true risk of flooding in a given year. Some experts suggest instead talking about floods that have a 1 percent chance of happening in a given year (a 500-year flood is one that has a 0.2 percent chance of occurring in a given year). Noting that a parcel of land has a 26 percent chance of flooding over the life of a 30-year mortgage can give homeowners a more concrete sense of the risk.⁹³

⁹² Cedar Falls, Iowa. *Code of Ordinances*. Sec. 29-156 - F-F floodway fringe overlay district. Adopted Jul. 11, 2011.

https://www.municode.com/library/ia/cedar_falls/codes/code_of_ordinances.

⁹³ National Research Council. *Levees and the National Flood Insurance Program: Improving Policies and Practices*. “Ch. 7: Understanding and Communicating Flood Risk Behind Levees, and Appendix E: Flood Zone Designations.” National Academies Press. 2013. <https://www.nap.edu/catalog/18309/levees-and-the-national-flood-insurance-program-improving-policies-and>.

⁹⁴ Alachua County. *Alachua County Comprehensive Plan 2011-2030*. Adopted 2011. <https://growth-management.alachuacounty.us/planning>.

⁹⁵ Kansas City. “Stream Setback Ordinance Fact Sheet.” Undated. <http://www4.kcmo.org/planning/devmgmt/zoningord/Stream%20setback%20fact%20sheet.pdf>. Accessed Nov. 29, 2016.

- Washington, D.C.’s complete streets policy promotes streets that “ensure that all users, especially the most vulnerable can travel safely, conveniently and efficiently” and that consider “environmental enhancements” including reducing stormwater runoff and prioritizing space for trees.⁹⁶
- **Acquire properties at risk of flooding, use the land for infiltration, and help the property owners resettle in the community.** Some FEMA hazard mitigation programs provide funds that communities can use to buy vulnerable properties from willing sellers.⁹⁷ This open space can become an everyday community amenity in addition to helping to prevent flooding. Helping businesses and property owners find new locations in the community can help maintain social cohesion, support local businesses, protect jobs, and ensure that people can stay in the community if they want.



Figure 16: Fourth Street SW in Washington, D.C., is a green and complete street, with a bike lane, a wide sidewalk, and planting areas.

- After a devastating flood in 1993, Cherokee, Iowa, used money from FEMA’s Hazard Mitigation Grant Program, along with funds from the city and state, to buy 187 homes that had been damaged. Most of the homes were demolished, but 31 were relocated to higher ground.⁹⁸ The city bought and platted land on higher ground for the relocated homes and upgraded the houses’ basements and foundations. The city helped residents whose houses were demolished find new homes, most of them within the city. Cherokee also offered down payment assistance to low-income residents to help them afford a new home.⁹⁹
- Grand Forks, North Dakota, suffered a devastating flood in 1997 that flooded three-quarters of the town and destroyed 9,000 homes and 751 commercial buildings. The city used funds from HUD’s Community Development Block Grant and FEMA’s Hazard Mitigation Grant programs to buy and demolish nearly 1,500 structures, meeting regularly with residents to keep them informed.

⁹⁶ District of Columbia, Department of Transportation. “DDOT Complete Streets Policy.” Departmental Order No. 06-2010, Oct. 18, 2010. <https://comp.ddot.dc.gov/Documents/Complete%20Streets%20Policy.pdf>.

⁹⁷ FEMA. “Hazard Mitigation Assistance.” <https://www.fema.gov/hazard-mitigation-assistance>. Accessed Nov. 29, 2016.

⁹⁸ FEMA. “Cherokee’s Hazard Mitigation Measures Pay Off.” *Secure & Prepared*, Vol. 7, Issue 2. Jan. 28, 2011. Iowa Homeland Security & Emergency Management Division. http://homelandsecurity.iowa.gov/documents/newsletters/2011/S&P_012811.pdf.

⁹⁹ Siders, Anne. *Managed Coastal Retreat: A Legal Handbook on Shifting Development Away From Vulnerable Areas*. Columbia Law School Center for Climate Change Law. 2013. https://web.law.columbia.edu/sites/default/files/microsites/climate-change/files/Publications/ManagedCoastalRetreat_FINAL_Oct%2030.pdf.

The land from the buyout properties became the Grand Forks Greenway, more than 2,000 acres of parkland along the Red River that is now a valued community amenity (Figure 17). Along with other flood protection measures, the green space helped the city weather a 2006 flood that was nearly as high as the 1997 flood with no major damage.¹⁰⁰



FEMA/Brenda Risky

Figure 17: The Grand Forks Greenway attracts residents and tourists while also buffering the city from floods.

Grand Forks has used the greenway to help revive its downtown. It used some of the recovery funding and activities to reconnect the street grid, rebuild downtown, and create a new public plaza. It gave downtown businesses grants to help them fix damaged structures.¹⁰¹ The city and county also showed a public commitment to downtown by building new municipal buildings there.^{102,103} As one analysis of the city's recovery noted, "The Greenway and other flood protection measures facilitated Grand Forks' recovery in two crucial ways. First, with the risk of future flooding high, Grand Forks had to rebuild in such a way that stakeholders would feel their investments, particularly in the downtown area, were protected. Second, the Greenway, as one of Grand Forks' main amenities for recreation and tourism, helped anchor new development in the city's downtown."¹⁰⁴

- **Enter into a community-based public-private partnership to install and maintain green infrastructure and other nature-based stormwater controls.** These partnerships are similar to conventional public-private partnerships but focus on investing in green infrastructure to spur economic growth and improve quality of life in underserved communities. An EPA guide to creating these partnerships notes, "A major benefit of [community-based public-private partnership] structures is that through greater private involvement and use of market forces (e.g., competition, efficiencies, flexibility, economy of scales), urban retrofits can be made more affordable, technology can improve, and overall costs can be reduced."¹⁰⁵

¹⁰⁰ HUD. "Preparing for the Next Disaster: Three Models of Building Resilient Communities." *Evidence Matters*, Winter 2015. <https://www.huduser.org/portal/periodicals/em/winter15/highlight3.html>.

¹⁰¹ Ibid.

¹⁰² City of Grand Forks. "Milestones: 1997-2007." Undated. <http://www.grandforksgov.com/home/showdocument?id=514>. Accessed Nov. 29, 2016.

¹⁰³ Davies, Phil. "Who Needs Downtowns, Anyway?" *Fedgazette*. Federal Reserve Bank of Minneapolis. Sept. 1, 2006. <https://www.minneapolisfed.org/publications/fedgazette/who-needs-downtowns-anyway>.

¹⁰⁴ HUD, "Preparing for the Next Disaster: Three Models of Building Resilient Communities."

¹⁰⁵ EPA. *Community Based Public-Private Partnerships and Alternative Market-Based Tools for Integrated Green Stormwater Infrastructure: A Guide for Local Governments*. 2015. p. 25. <https://www.epa.gov/waterfinancecenter/community-based-public-private-partnerships>.

- Prince George's County, Maryland, next to Washington, D.C., lies in the Chesapeake Bay watershed, which is under a federal plan to reduce pollution flowing into the bay. The communities in the watershed have agreed to implement stormwater management controls by 2025. Prince George's County must convert 15,000 acres, or almost 5 percent of its land area, into surfaces that will absorb or treat rainwater, which translates to adding 46,000 stormwater devices and creating "tens of thousands of little ecosystems."¹⁰⁶

The county is working with a private company, Corvias Solutions, to install the green infrastructure elements while also creating social and economic benefits. Under this public-private partnership, known as the Clean Water Partnership, Corvias agreed to "ensure that 30 percent of the project's workforce in year one consists of local businesses, to be increased at a rate of 5 percent in years two and three. The company has also committed to ensuring that local residents will comprise 15 percent of the workforce in year one and will reach 50 percent by the end of year three. [Within less than a year, the company had] exceeded that goal, currently [as of November 2015] tracking 85 percent."¹⁰⁷

By working on multiple projects at once, the company gains efficiencies, and this partnership has spurred other governments to ask about partnering with Corvias on other projects. In addition, Corvias will also handle maintenance once the projects are done, which will bring the company more revenue but cost less overall than if the county government maintained the projects itself.¹⁰⁸ In addition to saving money, the county benefits from the immediate jobs created as well as career training and mentoring that will help residents learn valuable skills. The partnership creates an Urban Watershed Restoration Contractor Training Course offered at the county community college to teach people how to build, operate, and maintain stormwater management practices.¹⁰⁹ Corvias has a "contractor concierge service" that gives design and general contractor firms coaching and support to help them better compete for the project's subcontracts.¹¹⁰



Maryland Environmental Service

Figure 18: Prince George's County residents benefit from the jobs created in installing green infrastructure elements.

¹⁰⁶ Vock, Daniel C. "A New P3 Model for Building Green Infrastructure." *Governing*, May 27, 2015.

<http://www.governing.com/topics/transportation-infrastructure/gov-tapping-private-sector-build-green-infrastructure.html>.

¹⁰⁷ Littleton, Peter, Clean Water Partnership operations manager, quoted in "NCPPP Exclusive: A Conversation With Corvias Solutions' Clean Water Partnership Team." National Council for Public-Private Partnerships. Nov. 11, 2015. <http://www.ncppp.org/ncppp-exclusive-a-conversation-with-corvias-solutions-clean-water-partnership-team>.

¹⁰⁸ Vock, "A New P3 Model for Building Green Infrastructure."

¹⁰⁹ Prince George's County Department of the Environment. "White House and EPA Recognize County's Stormwater Retrofit Public-Private Partnership (P3) Among Most Innovative in the Nation." Press release, Apr. 3, 2015. <http://www.princegeorgescountymd.gov/ArchiveCenter/ViewFile/Item/707>.

¹¹⁰ Washington, David, Clean Water Partnership operations director, quoted in "NCPPP Exclusive: A Conversation With Corvias Solutions' Clean Water Partnership Team" op cit.

This partnership's direct benefits will largely be seen in economically disadvantaged neighborhoods. The county's environmental director, Adam Ortiz, noted, "This is less a federal regulatory program and more of a community development program. We're talking about streetscapes and green and lush elements in asphalt- and concrete-laden neighborhoods. That's a tremendous opportunity and investment in capital dollars that many of these neighborhoods would not otherwise see."¹¹¹

3. Wholesale Changes

- **Create an overarching framework for water-related initiatives dealing with stormwater management, sewer overflows, and infrastructure improvements.** A central coordination point can help avoid duplication, control costs, and achieve objectives such as protecting water quality and reducing flooding. Kansas City's Wet Weather Solutions Program is one example; see the case study in this chapter for more information.
- **Adopt a site plan requirement that requires all new development to retain all stormwater on-site.** The community could also create a stormwater runoff credit-trading program that allows new development projects to purchase credits and ensure offsite mitigation that still results in a net-zero new runoff.
 - Washington, D.C., offers Stormwater Retention Credits. Property owners who install green infrastructure can sell the credits to large development sites, which can use the credits to meet up to half of their regulatory stormwater reduction requirements. The city also buys some credits, as paying private property owners to install green infrastructure is more cost-effective than if the city government built the green infrastructure itself.¹¹²
- **Develop a municipal stormwater design manual** that illustrates context-appropriate green infrastructure strategies for new development and redevelopment to allow these practices to be easily incorporated into site plans for private development and capital improvement plans for public projects. Engage subject matter experts, including design and stormwater management professionals, in developing the manual.
 - Working with Mecklenburg County Stormwater Services, Huntersville, North Carolina, published a *Water Quality Design Manual* to establish stormwater management requirements and controls to prevent new development from degrading surface water quality. The manual provides the information and design tools necessary to comply with the stormwater requirements of Huntersville's Post-Construction Ordinance.¹¹³
- **If elevation is necessary, establish elevation requirements for street grade, building first floor, and infrastructure to exceed current municipal, state, and FEMA standards, but that also include design guidelines or form-based standards to promote accessibility and street life.**

Practice Pointer

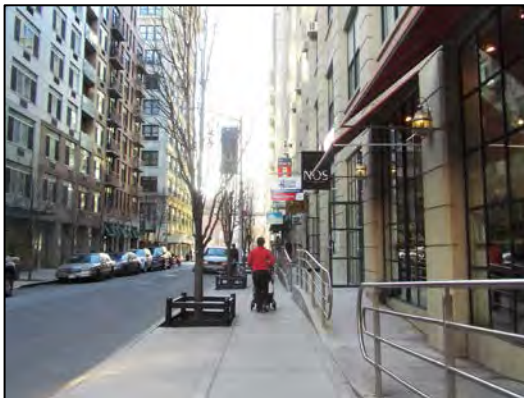
Elevating buildings is a complicated issue. It is expensive and can create a false sense of security. People with limited mobility might have difficulty getting into elevated buildings. Design guidelines such as those in New York City can ensure elements like ground-floor transparency that keep streets where building elevation will be used pleasant for pedestrians.

¹¹¹ Vock, "A New P3 Model for Building Green Infrastructure."

¹¹² District Department of Energy and the Environment. "DOEE Announces \$12,750,000 for Innovative program to Incentivize Cost-Effective Green Infrastructure." Press release, May 10, 2016. <http://doee.dc.gov/node/1160582>. More information about the program is available on the Stormwater Retention Credit Trading Program page at <http://doee.dc.gov/src>.

¹¹³ Mecklenburg County Storm Water Services, Water Quality Program. *Town of Huntersville Water Quality Design Manual*. Town of Huntersville. 2008. <http://www.huntersville.org/Portals/0/Departments/Planning/Documents/Misc/Huntersville%20Water%20Quality%20Design%20Manual%20June%202013%20Edition.pdf>.

- After flooding and other damage from Superstorm Sandy, New York City passed zoning code updates to make new construction and retrofitted buildings more resilient to floods. The city recognized that “FEMA and Building Code standards for flood-resistant construction require new or substantially improved buildings in flood zones to be elevated or flood proofed above projected flood levels. However, elevating buildings more than a few feet above the sidewalk can have negative effects on streetscape, building access, ground floor activity, architectural quality, and neighborhood character.”¹¹⁴ The city planning department and advisors from the architecture and design community developed principles for designing elevated, flood-resilient buildings (Figure 19). In 2013, the New York City Council adopted a flood resilience amendment to the zoning code that incorporated these design principles.¹¹⁵



Visual Connectivity used with permission of the New York City Department of City Planning. All rights reserved.

Visual connectivity: Maintaining architectural elements such as doors, porches, stoops, and windows along the street.



Facade Articulation used with permission of the New York City Department of City Planning. All rights reserved.

Facade articulation: Ensuring that elevated buildings have interesting elements along the street instead of a blank wall.



Inviting Access used with permission of the New York City Department of City Planning. All rights reserved.

Inviting access: Making sure that people with limited mobility can still easily get in and out of the building.



Neighborhood Character used with permission of the New York City Department of City Planning. All rights reserved.

Neighborhood character: Integrating elements of the existing neighborhood design when rebuilding or building new construction.

Figure 19: New York City’s “Designing for Flood Risk: Urban Design Principles.”

¹¹⁴ NYC Planning. “Designing for Flood Risk: Urban Design Principles.” 2013. http://www1.nyc.gov/assets/planning/download/pdf/plans-studies/sustainable-communities/climate-resilience/urban_design_principles.pdf.

¹¹⁵ New York City Council. “Flood Resilience Text Amendment.” Article VI, Chapter 4. Enacted Oct. 9, 2013. http://www1.nyc.gov/assets/planning/download/pdf/plans/flood-resiliency/final_text.pdf.

- **Create sustainable funding for stormwater infrastructure.** Many communities assess a stormwater fee based on the measurement of a property's impervious ground coverage and stormwater runoff contribution. Compactly developed lots incur smaller fees, as do parcels that use green infrastructure techniques such as permeable paving and rain gardens to reduce runoff and impervious coverage. Stormwater fees can be controversial; to gain public acceptance, clearly link the fee to preventing or paying for impacts to water quality and flooding, and encourage green infrastructure by reducing fees if the property owner installs cisterns, rain gardens, permeable paving, and similar features.
 - Dubuque, Iowa, formed a stormwater utility that calculates a stormwater runoff fee determined by the measurement of a property's impervious ground coverage. This ensures that those who contribute more runoff must also contribute more to its management. Single-family homes with 1,471 to 4,375 square feet of impervious surface are charged one billing unit called a Single Family Unit. Homes with less impervious area are charged half a unit, while homes with more are charged 1.5 units. The city charges non-residential properties a set fee for every 2,917 square feet of impervious area.¹¹⁶

Resources

- EPA's Flood Resilience Checklist (2014) can help a community assess its preparedness for flooding and determine areas for improvement: <https://www.epa.gov/smartgrowth/flood-resilience-checklist>
- Green infrastructure projects are eligible for Clean Water State Revolving Funds, and several states offer incentives to encourage them. Local governments can contact their state Clean Water Revolving Fund program to learn about specific incentives and financing mechanisms for green infrastructure projects. For general information on these funds, see EPA's Clean Water State Revolving Fund webpage: <https://www.epa.gov/cwsrf>
- EPA's "Green Infrastructure for Climate Resiliency" webpage offers information about how green infrastructure practices can help communities prepare for and manage various climate change impacts: <https://www.epa.gov/green-infrastructure/green-infrastructure-climate-resiliency>
- EPA's "Learn About Green Streets" webpage links to green and complete streets resources: <https://www.epa.gov/G3/learn-about-green-streets>
- EPA's *Flood Resilience: A Basic Guide for Water and Wastewater Utilities* (2014) is an interactive guide that outlines simple measures water utilities can take to become more resilient to flooding, along with funding options for communities: <https://www.epa.gov/waterutilityresponse/flood-resilience-basic-guide-water-and-wastewater-utilities>
- The American Society of Landscape Architects' "Resilient Design" webpages have landscape planning solutions to help communities with drought, extreme heat, fire, and floods, among other challenges: <https://www.asla.org/resilientdesign.aspx>
- FloodSafety.gov has a useful chart showing the relative risk of a flood happening in the next year compared to other events such as being in a car accident, being a crime victim, and a residential fire: <http://floodsafety.com/national/property/risk>

¹¹⁶ City of Dubuque. "Stormwater Utility." <http://www.cityofdubuque.org/877/Stormwater-Utility>. Accessed Apr. 15, 2015.

Guidance and Metrics

LEED for Neighborhood Development

Smart Location and Linkage Prerequisite: Floodplain Avoidance

Projects must either locate on a site that is entirely out of the 100-year flood plain as designated by the locality or state, or, if any parts of the site lie within the 100-year flood plain, projects must comply with either the American Society of Civil Engineers standard or the National Flood Insurance Program requirements for developing those portions. If the project includes construction of any critical facility, the facility must be designed and built so as to be protected and operable during a 500-year event.

Smart Location and Linkage Prerequisite: Wetland and Water Body Conservation

Locate development away from lands within 50 feet of wetlands or within 100 feet of water bodies, or earn the Rainwater Management credit and minimize development of land buffering the water body or wetland.

Green Infrastructure and Buildings Credit: Rainwater Management

Use green infrastructure or low impact development techniques to manage on site at least 80 percent of the runoff from the development.

STAR Community Rating System

Climate & Energy Objective 1: Climate Adaptation

Adopt building codes or land use ordinances that address specific climate change impacts. Require or encourage residents and businesses to change their behaviors to prepare for climate change impacts.

Health and Safety Objective 6: Hazard Mitigation

Reduce over time the number of homes below code standards that are located in designated high-risk areas or the percentage of residents living in designated high-risk areas. Adopt land use regulations that limit development in areas highly vulnerable to hazards.

Natural Systems Objective 1: Green Infrastructure

Demonstrate that 35 percent of the jurisdiction's land area has green infrastructure or that no more than 65 percent of the land area is covered with impervious surface. Create a communitywide green infrastructure plan that is integrated with other relevant local plans. Adopt design criteria and codes to require green infrastructure in new developments. Offer incentives to encourage property owners to install green infrastructure elements.

Living Community Challenge

Imperative 1: Limits to Growth

Projects can be built only on previously developed sites that are not within the 100-year flood plain.

Imperative 5: Net Positive Water

All stormwater and water discharge must be treated and managed at the community scale through reuse, a closed loop system, or infiltration.

Case Study: Kansas City, Missouri

Kansas City, Missouri, is on the Missouri and Kansas rivers, putting parts of the city at a high risk of flooding from rivers and streams. The city's 100-year flood plain contains more than 2,000 buildings, and some businesses experience flooding of up to 10 feet every five years.¹¹⁷ Additional development in the flood plain and on stream banks could exacerbate flooding by causing erosion, sedimentation, and destruction of ecosystems. In addition, the city's sewers are aging and poorly equipped to handle high volumes of stormwater; sewer overflows annually discharge 6.5 billion gallons of untreated sewage into nearby water bodies.¹¹⁸ Protecting flood plains and streams and reducing sewer overflows were crucial to preventing or reducing damage from flooding.

In 2003, the mayor created a Wet Weather Community Panel, which developed the goals and guiding principles for the Wet Weather Solutions Program. From 2003 to 2008, the panel held numerous public meetings, presentations, and "wet weather fairs" to engage and educate residents.¹¹⁹ In 2005, in part thanks to the extensive engagement effort, residents approved a \$500 million bond for water and sewer initiatives.¹²⁰

The Wet Weather Solutions Program was conceived as an ambitious, 25-year plan to upgrade street and sewer infrastructure, improve water quality, and prevent flood damage. Multiple city departments participate in the program, and the city works closely with regional and federal agencies to implement it. The Overflow Control Plan, one element of the program, encourages green infrastructure and design upgrades and recommends amendments to the city's zoning ordinance to prevent development in the flood plain and stream buffer zones.¹²¹

Practice Pointer

Create implementation plans for programs with benchmarks for accomplishments, such as number of green infrastructure projects completed, after one, five, 10, and 20 or more years. Communicate the short-term achievements to the public and elected officials. People respond to initiatives with quick results that can be leveraged into long-term, substantial outcomes.

The Overflow Control Plan focuses on quick fixes for the first 10 years and major structural and infrastructure changes for years 11 through 25. Its goals include not only preventing as much stormwater as possible from entering the city's sewer system, but also implementing a citywide "comprehensive green solutions initiative."¹²² The plan outlines several land use planning, zoning, design, and infrastructure-related activities, including integrating native landscaping and green infrastructure such as permeable pavements or curb extensions into streetscapes.¹²³ By targeting infrastructure improvements and regulations at the same time, the program provides a comprehensive framework for managing the city's water risks.

The city has made major infrastructure and land use planning changes, including adopting the American Public Works Association standards for stormwater facility design¹²⁴ and best management practices, an ordinance to integrate green water solutions in all city planning and development processes, and a stream

¹¹⁷ City of Kansas City. "Wet Weather Solutions Program – Flooding." Web page no longer available. Accessed Dec. 30, 2012.

¹¹⁸ EPA. "Kansas City, Missouri, Clean Water Act Settlement." May 18, 2010. <https://www.epa.gov/enforcement/kansas-city-missouri-clean-water-act-settlement>.

¹¹⁹ City of Kansas City. "Wet Weather Solutions Program – Public Participation." Web page no longer available. Accessed Dec. 30, 2012.

¹²⁰ City of Kansas City. "Wet Weather Solutions Program – FAQs." Web page no longer available. Accessed Dec. 30, 2012.

¹²¹ Kansas City, Missouri, Water Services Department. *Overflow Control Plan*. Revised Apr. 20, 2012. https://www.kcwaterservices.org/wp-content/uploads/2013/04/Overflow_Control_Plan_Apr302012_FINAL.pdf.

¹²² Kansas City, Missouri, Water Services Department, *Overflow Control Plan*, p. 12-2.

¹²³ City of Kansas City. "Water, A Vital and Valuable Natural Resource: Green Solutions Position Paper." 2007. http://www.nwk.usace.army.mil/Portals/29/docs/civilworks/blueriver/GreenSolutions_PositionPaper.pdf.

¹²⁴ American Public Works Association, Kansas City Metropolitan Chapter. *Section 5600: Storm Drainage Systems and Facilities*. 2011. <http://kcmetro.apwa.net/content/chapters/kcmetro.apwa.net/file/Specifications/APWA5600.pdf>.

setback ordinance.¹²⁵ The stream setback ordinance could limit development on approximately 12 percent of the city's undeveloped land, 8 percent of which lies in the 100-year flood plain, and an additional 4 percent of which will be preserved as permanent open space.¹²⁶ Developers must submit stream buffer plans for projects where the stream setback ordinance is in effect.¹²⁷ Many aspects of the ordinance use smart growth strategies, including density bonuses, smaller lot sizes, and flexible design standards.

In 2011, under the Overflow Control Program, the city began construction on green infrastructure projects that are estimated to reduce stormwater runoff flow for a 1.4 inch storm event by approximately 80 percent.¹²⁸ The city also completed a pilot capital improvement project in the Middle Blue River Basin that included green infrastructure solutions like rain gardens, porous pavements, pavers, curb extensions, and bioretention basins (Figure 20), which improved the area's streetscapes.¹²⁹ By the end of the Overflow Control Program, the city estimates that the current 6.4 billion gallons of citywide sewer overflow will be reduced to 1.4 billion gallons.¹³⁰



Figure 20: This rain garden in Kansas City's Marlborough neighborhood was built as part of the improvements in the Middle Blue River Basin.

The actions Kansas City took will help preserve open space and natural habitats, create greener and better-designed neighborhoods, and protect public health by improving water quality. Officials also anticipate economic benefits, such as increased property values and over \$10 million in savings on capital costs through the use of green infrastructure.^{131,132}

Kansas City's Overflow Control Program ties climate change adaptation efforts to city beautification on a wider scale. While the installation of green infrastructure helps reduce and prevent flooding, it also revitalizes and beautifies neighborhoods. Similarly, stream setbacks not only protect structures from water damage, they also preserve natural habitat and open space. The city has challenges going forward, including finding funds. But strong support from city officials and residents will help the city implement the program—the largest capital improvement project in Kansas City's history—and help better prepare the city for flooding in the future.

More information on Kansas City's Overflow Control Program is available at <https://www.kcwaterservices.org/programs/ocp>.

¹²⁵ Cahail, Scott A. "Green Solutions for Kansas City." Sustainable Communities Conference, Mar. 10, 2008.

<http://www.cleanairinfo.com/sustainablecitylines/documents/Presentations/Track%205/Session%204%20-%20Stormwater%20Mitigation%20Issues%20and%20Strategies%20Part%201/03%20-%20Scott%20Cahail%20EPA%20Dallas%203-10-09.pdf>.

¹²⁶ City of Kansas City, "Stream Setback Ordinance Fact Sheet."

¹²⁷ City of Kansas City. "Stream Buffer and Setback Regulations – Preliminary and Final Buffer Plan Requirements Checklist." Dec. 30, 2008.

¹²⁸ Dods, David, and Jessi Veach. "Kansas City's Green Solutions Pilot Project Brings Success to the Surface for Combined Sewer Overflows." *Stormwater*, Sep. 25, 2012.

¹²⁹ KC Water Services. "Green Infrastructure: Middle Blue River Basin Green Solutions Pilot Project." https://www.kcwaterservices.org/wp-content/uploads/2013/04/Project_Overview_MBR_Pilot_Project_1126131.pdf. Accessed Nov. 29, 2016.

¹³⁰ Kansas City, Missouri, Water Services Department, *Overflow Control Plan*.

¹³¹ Dods and Veach, "Kansas City's Green Solutions Pilot Project Brings Success to the Surface for Combined Sewer Overflows."

¹³² City of Kansas City, "Stream Setback Ordinance Fact Sheet."

5. Adapting to Sea Level Rise

Introduction

Sea levels are rising globally due to ocean water expanding as it absorbs atmospheric heat and glaciers and ice sheets melting. The National Climate Assessment notes that global sea level has risen by about 8 inches since 1880, and levels could plausibly rise 1 to 4 more feet by 2100.¹³³ In some places, sea level rise is exacerbated by land subsidence. One study estimated that 6.8 million homes along the Atlantic and Gulf coasts are currently at risk of being flooded by storm surge, a number that will increase as the sea level rises.¹³⁴

For vulnerable coastal communities, rising sea levels and the associated higher storm surges can threaten lives and cause serious damage to properties, infrastructure, and ecosystems. Saltwater intrusion into water sources can raise water treatment costs. Damage from a major storm surge can force residents to evacuate and businesses to close or relocate, straining finances and mental health. The local economy will feel the impact of even temporary business closures as well as the costs of rebuilding.

Even without a major storm, sea level rise is resulting in higher tides. Communities such as Norfolk, Virginia, and Miami regularly see some streets flood at the highest tides, known as king tides. While some people might dismiss it as “nuisance flooding,” the saltwater damages infrastructure and property, disrupts travel, and can infiltrate into aquifers that supply drinking water. In the long term, the sea will permanently inundate some coastal areas.

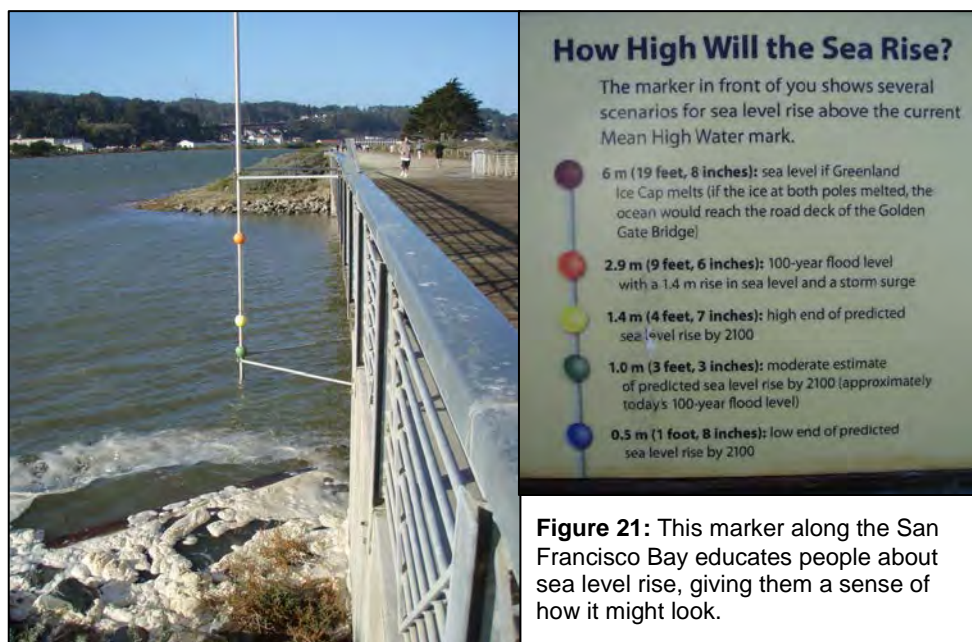


Figure 21: This marker along the San Francisco Bay educates people about sea level rise, giving them a sense of how it might look.

Sea level rise affects property rights in several ways. As the sea rises, high tides and storm surges cover more land, effectively reducing property owners' land. As the impacts of sea level rise become more obvious, “it will affect littoral land's market price, generally lowering it. Such land may become uninsurable.”¹³⁵ Many property owners see a threat from government action reducing or eliminating their use of the land, but “the economic effects of the regulation must be distinguished from the economic effects of sea-level rise itself.”¹³⁶

¹³³ Walsh et al, “Chapter 2: Our Changing Climate,” *Climate Change Impacts in the United States*, p. 44.

¹³⁴ Botts, Howard, et al. 2016 *CoreLogic Storm Surge Report*. CoreLogic. 2016. <http://arcg.is/1MspBNy>.

¹³⁵ Byrne, “The Cathedral Engulfed,” p. 81.

¹³⁶ *Ibid.*

Response to the Problem

Coastal communities are adapting to this threat by more accurately assessing which areas are currently or are projected to be flooded by king tides (especially high tides), storm surges, and sea level rise. They are preserving undeveloped land where possible to buffer against rising seas, or limiting development intensity or uses in more-vulnerable areas to minimize the risk to lives and property.

Where it is not possible to prohibit or remove development, communities use zoning ordinances and building codes to make sure that structures are safer. Some places are preparing to gradually move development away from the coast as the sea level rises.

Potential Benefits

- Protecting lives by reducing the number of people in harm's way.
- Reducing or eliminating property damage through safer zoning ordinances and building codes in high-risk areas.
- Protecting future development by limiting growth in areas that are particularly vulnerable to higher storm surges and sea level rise.
- Creating predictability for coastal property owners, developers, and businesses and allowing gradual transition of development as sea levels rise, which reduces sudden impacts or changes.
- Maintaining mobility by better protecting transportation infrastructure.
- Preserving natural coastal areas, habitats, and beaches for public enjoyment and ecological value.
- Using government funds more efficiently by not investing in hazardous areas.

Implementation Approaches

I. Modest Adjustments

- **Add projected sea level rise to flood zone hazard maps that are based exclusively on historical events.** This action would not affect flood insurance requirements, which would continue to use FEMA-created flood zone hazard maps. Mapping sea level rise projections can help a community start now to plan for future conditions. New maps should identify civic facilities that are vulnerable to storm surge and sea level rise, paying special attention to those critical to protecting life, property, or the environment. Use these maps to create or update an extended coastal flood hazard zone to delineate potential inundation areas, critical emergency facilities, evacuation routes, road elevation projects, and culvert replacements.

Practice Pointer

Use a minimum 50-year planning horizon that assumes a specific, plausible range of sea level rise projections during that time, taking into account land subsidence and uplift as well as other locally specific conditions.

- **Designate and protect “transition zones” near tidal marshes between more-vulnerable areas and developed areas, and prohibit incompatible land uses in these zones.** Protecting the transition zones gives marshes room to migrate inland as the sea level rises. Local governments can protect these lands through easements or outright acquisition that would also allow the public to enjoy these areas.



Figure 22: Tidal marshes, such as this one in Delaware, will need room to migrate inland as sea levels rise.

- **Change the definition of “normal high water” for land adjacent to tidal waters to change regulatory shoreline setbacks.** This amendment effectively changes the setback without having to change the setback size itself.
 - Ogunquit, Maine, amended its definition of “normal high water” to account for sea level rise. “The highest annual tide predicted for the region is generally about 7 feet above mean high water. By amending its definition of ‘normal high water’ to 11 feet above mean sea level, the town includes a margin of about 4 feet for sea level rise, which is also 2 feet higher than the FEMA 100-year designated floodplain.”¹³⁷

2. Major Modifications

- **Using projections rather than historical trends, incorporate sea level rise impacts like coastal erosion, higher storm surge, and shoreline change in all future land use planning, building regulations, and capital improvement projects.**
 - The San Francisco Bay Conservation and Development Commission’s *San Francisco Bay Plan* manages shoreline development in the San Francisco Bay. The plan was amended in 2011 to address climate change¹³⁸ and now requires that, “When planning shoreline areas or designing larger shoreline projects, a risk assessment should be prepared by a qualified engineer and should be based on the estimated 100-year flood elevation that takes into account the best estimates of future sea level rise and current flood protection and planned flood protection that will be funded and constructed when needed to provide protection for the proposed project or shoreline area. A range of sea level rise projections for mid-century and end of century based on the best scientific data available should be used in the risk assessment.”¹³⁹
- **Strengthen building codes in coastal zones** by requiring additional adaptation strategies, such as restricting the construction of basements, and, below grade, requiring buildings to be moveable or

¹³⁷ Schechtman, Judd, and Michael Brady. *Cost-Efficient Climate Adaptation in the North Atlantic*. Connecticut Sea Grant College Program. 2013. <http://seagrant.uconn.edu/CEANA>. p. 27.

¹³⁸ San Francisco Bay Conservation and Development Commission. “Climate Change Bay Plan Amendment.” 2011. http://www.bcdc.ca.gov/proposed_bay_plan/bp_amend_1-08.html.

¹³⁹ San Francisco Bay Conservation and Development Commission. *San Francisco Bay Plan*. As amended Oct. 2011. http://www.bcdc.ca.gov/plans/sfbay_plan.html.

raised (e.g., manufactured homes or pin foundations, which are precast foundations designed to avoid the need to excavate or fill and to be moved easily).¹⁴⁰

- **Modify the steep-slope ordinance to account for coastal slopes exposed to increased moisture due to changes in precipitation patterns and sea level rise.** These conditions can increase the risk of landslides or coastal bluffs collapsing, which can destroy property and threaten lives (Figure 23). Shoreline residential development, including accessory structures and uses, should be set back from steep slopes and shorelines vulnerable to erosion far enough that structural improvements, including bluff walls and other stabilization structures, are not required to protect these structures and uses.
- **Create an overlay district where flood regulations and standards would apply,** or establish context-sensitive shoreline classifications with appropriate development standards for each.
 - The Georgetown Climate Center developed a model sea level rise ordinance that “extends the boundaries of the regulated floodplain to protect development that will become increasingly vulnerable to impacts as [sea level rise] drives flooding further inland” and designates two sub-districts:
 - The Floodplain Conservation District, for land that is very vulnerable and has sensitive natural resources. In this sub-district, the model ordinance limits development to “low-density and low-intensity uses” and smaller structures, increases setbacks, and restricts rebuilding storm-damaged buildings.
 - The Floodplain Accommodation District, for land that could continue to be developed but still is vulnerable to sea level rise. This sub-district would include increased setbacks and structure elevations, limit development of critical facilities, and allows only small structures.¹⁴¹
 - King County, Washington, updated its Shoreline Master Program land use policies to include eight new shoreline classifications that fit the varied shoreline. New development regulations for the classifications reflect a range, from very low-impact development for sensitive lands to flood prevention measures in areas where higher levels of development are appropriate. These classifications are incorporated into the county’s comprehensive plan.¹⁴²
- **Require building-level design for disassembly/adaptability planning** (also known as design for deconstruction) to reduce the environmental impacts of buildings that must be moved or

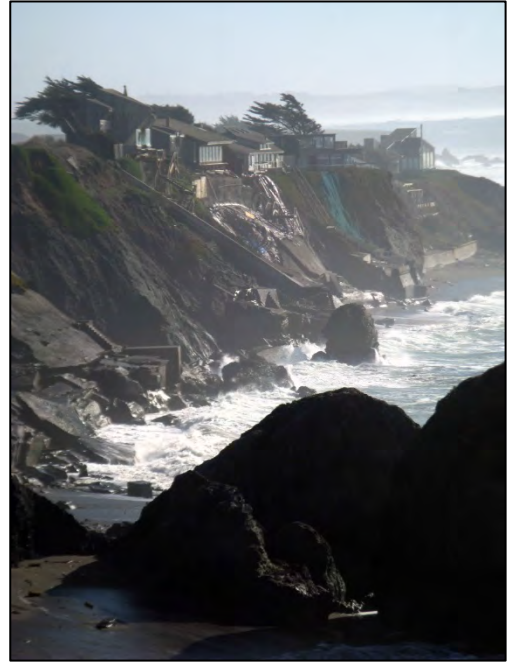


Figure 23: These homes on a coastal bluff in California illustrate how erosion exacerbated by sea level rise can threaten property.

¹⁴⁰ Northwest EcoBuilding Guild. “Pin Foundations for Low Impact – Clearwater Commons.” <http://www.ecobuilding.org/code-innovations/case-studies/pin-foundation-for-low-impact-development-at-clearwater-commons>. Accessed Nov. 18, 2016.

¹⁴¹ Grannis et al, *A Model Sea-Level Rise Overlay Zone for Maryland Local Governments*.

¹⁴² King County. “Shoreline Management in King County, Washington.” <http://kingcounty.gov/environment/water-and-land/shorelines.aspx>. Accessed Jul. 27, 2016.

disassembled due to sea level rise (Figure 24). Buildings designed for disassembly can be cost-effectively deconstructed rather than demolished. Training disadvantaged community members to deconstruct buildings helps train them for jobs in construction and related fields. The building materials can be reused, which saves resources and lets people buy these materials at a lower cost than new materials. Designing for adaptability makes it easier to disassemble and move buildings if needed or reconfigure structures to fit a site better if the environmental conditions change.

3. Wholesale Changes

- **Designate and protect existing working waterfronts.** Make these areas part of the local and regional economic development strategies. Preserving these working waterfronts protects a sense of place and community history, and clusters similar industries together, which can spur innovation and collaboration. However, be careful of concentrating noisy, polluting industries in low-income neighborhoods. Also, consider resilience provisions that protect active working waterfronts from pollution releases in a storm surge or temporary inundation. Measures might include elevated material storage or redundant flood protection measures to avoid exposing nearby populations or ecosystems to pollution releases.
 - Portland, Maine, has a historic working waterfront but found it challenged by aging infrastructure and the threat of sea level rise. The city needed to find funding to keep infrastructure in good repair and prepare it for the rising sea. An overlay zone, adopted in 2010, allows compatible non-marine uses to locate in certain places on the working waterfront. The city also encourages incremental improvements where possible to prepare for sea level rise.¹⁴³
- **Implement rolling development restrictions.** These restrictions “move landward, or ‘roll,’ as the tide line moves landward.”¹⁴⁴ These rolling restrictions help property owners by allowing them to use their land under the regular, applicable land use laws up until the sea level rises to the point that it affects the safety of land uses in that area. Because this movement will be relatively gradual, property owners will have some predictability about how they can use their land for the short and long terms. Rolling restrictions are directly linked to a measurable impact—the level of the sea—so their goal and result is more clear. The restrictions might take the form of an easement that prohibits development on the seaward side of a certain line, or they could require less intensive uses within a certain distance of the landward side of that line.¹⁴⁵

Figure 24: Key Principles of Designing for Disassembly/ Adaptability

- “Document materials and methods for deconstruction.
- Select materials using the precautionary principle.
- Design connections that are accessible.
- Minimize or eliminate chemical connections.
- Use bolted, screwed, and nailed connections.
- Separate mechanical, electrical, and plumbing systems.
- Design to the worker and labor of separation.
- Simplicity of structure and form.
- Interchangeability.
- Safe deconstruction.”

Source: Guy, Brad, and Ciarimboli, Nicholas. *Design for Disassembly in the Built Environment: A Guide to Closed-Loop Design and Building*. <http://www.lifecyclebuilding.org/docs/DfDseattle.pdf>. Accessed Sep. 15, 2016. p. 6.

¹⁴³ National Working Waterfront Network. “Case Study: Portland, Maine: Balancing Maritime Uses and Waterfront Diversification Through Municipal Zoning.” Aug. 19, 2015. http://www.wateraccessus.com/case_study.cfm?ID=32.

¹⁴⁴ Byrne, “The Cathedral Engulfed,” p. 109.

¹⁴⁵ Byrne, “The Cathedral Engulfed.”

- **Begin to plan for managed retreat away from the shoreline where appropriate.** Managed retreat involves gradually moving structures and infrastructure away from an area that has become too hazardous. Education is essential to make sure that property owners understand the risks of remaining in these areas and the benefits and trade-offs of moving. Tools such as restricting rebuilding a repetitively damaged structure, implementing setbacks and rolling easements that take into account sea level rise and erosion, and acquiring land can help move development away from the shore.¹⁴⁶

Practice Pointer

For initiatives with long timelines that can expect to see multiple political leadership changes along the way, a strong community engagement process can set a guiding framework to be carried out by multiple administrations. A steering committee made up of diverse community members can help keep long-term plans on track.

If necessary, relocate people and facilities in extremely vulnerable areas. A community might determine that certain areas are so potentially hazardous that, over the long term, it would be preferable to relocate the people and/or structures in these areas to ensure their safety. Whether before or after a disaster, the decision to relocate is difficult and emotional and often disproportionately affects people in areas that are already experiencing social equity or environmental justice issues. People are reluctant to leave their homes or to give up a business location they have enjoyed for many years.¹⁴⁷

Local governments can work with residents who choose to relocate to help them understand the need to move, learn about their needs, and find new homes in safer areas of the community.¹⁴⁸ Some residents might want to move away from risky areas but cannot afford to do so on their own. To help people voluntarily relocate, the local government could buy properties at high risk, offer low- or no-interest loans for moving expenses or a down payment, or help find a new home in the community. Assistance is particularly important for renters, who do not have properties to sell and thus fewer options to fund a relocation. If new development is needed to house the displaced people, the local government has the opportunity to encourage or require energy-efficient, mixed-use neighborhoods that will be safe, appealing, and cost-effective for residents.

- Kinston, North Carolina, was flooded by three hurricanes in the 1990s: Fran in 1996 and Dennis and Floyd in 1999. Most residents in the flood plain were African-American, and many were elderly and/or low-income. Kinston used FEMA funding to buy repetitively flooded properties; 97 percent of eligible property owners accepted the buyout. Almost all of the bought-out property owners relocated to neighborhoods in Kinston. Because the homes outside the flood plain were generally more expensive than the bought-out homes, the state created a State Acquisition Relocation Fund that covered the difference between the buyout price and the cost of a new home. This fund also gave renters money to move out of flood-damaged properties.¹⁴⁹

¹⁴⁶ Siders, *Managed Coastal Retreat*.

¹⁴⁷ EPA, *Using Smart Growth Strategies to Create More Resilient Communities in the Washington, D.C., Region*.

¹⁴⁸ Siders, *Managed Coastal Retreat*.

¹⁴⁹ University of North Carolina Institute for the Environment. "Floodplain Buyout Case Study: Kinston, North Carolina." Environmental Law Institute. 2016. <https://www.eli.org/research-report/floodplain-buyout-case-study-kinston-nc>.

Resources

- EPA's *Rolling Easements* (2011) is a primer that explains tools communities could use to implement rolling easements: <https://www.epa.gov/cre/climate-ready-estuaries-rolling-easements-primer>
- The Georgetown Climate Center's *Adaptation Tool Kit: Sea Level Rise and Coastal Land Use* (2011) analyzes land use tools to help communities prepare for sea level rise: <http://www.adaptationclearinghouse.org/resources/adaptation-tool-kit-sea-level-rise-and-coastal-land-use.html>
- The Lifecycle Building Challenge website offers specific language used in green building rating systems to encourage designing for disassembly: <http://lifecyclebuilding.org/rating-systems.php>

Guidance and Metrics

LEED for Neighborhood Development

Smart Location and Linkage Prerequisite: Floodplain Avoidance

Projects must either locate on a site that is entirely out of the 100-year flood plain as designated by the locality or state, or, if any parts of the site lie within the 100-year flood plain, projects must comply with either the American Society of Civil Engineers standard or the National Flood Insurance Program requirements for developing those portions. If the project includes construction of any critical facility, the facility must be designed and built so as to be protected and operable during a 500-year event.

Smart Location and Linkage Prerequisite: Wetland and Water Body Conservation

Locate development away from lands within 50 feet of wetlands or within 100 feet of water bodies, or earn the Rainwater Management credit and minimize development of land buffering the water body or wetland.

STAR Community Rating System

Health and Safety Objective 6: Hazard Mitigation

Reduce over time the number of homes below code standards that are located in designated high-risk areas or the percentage of residents living in designated high-risk areas. Adopt land use regulations that limit development in areas that are highly vulnerable to hazards. Adopt local building codes or enforce state building codes that have higher standards for buildings in areas that are highly vulnerable to hazards.

Case Study: Seabrook, New Hampshire

Seabrook, a town of about 9,000 residents along the New Hampshire coast, has a high risk of flooding due to higher storm surge and tides from sea level rise because almost all of the town is less than 60 feet above sea level. In addition, coastal New England is experiencing land subsidence of about 6 inches per century.¹⁵⁰ The town's wastewater treatment plant and elementary-middle school could be affected by flooding as the sea level rises.¹⁵¹ Flooding also threatens residents, who could be displaced if their homes are damaged by a flood or flooded daily by rising tides. The town's municipal drinking water wells could be affected in the future by saltwater intrusion.¹⁵²



Credit: Otto Luna

Figure 25: Seabrook sits on the saltwater marsh of the Hampton-Seabrook Estuary.

The Rockingham Planning Commission, Seabrook's regional planning agency, completed a pilot study in 2009 that explored the town's vulnerability to flooding. The study included recommendations such as revisions to the town's zoning and building codes and encouraged Seabrook to incorporate climate change adaptation strategies into its planning. Some of the commission's specific recommendations on land-use planning, zoning, and building code revisions included:

- Incorporate sea level rise impacts in the development of all future land use planning, building regulations, and capital improvement projects.
- On existing and future land use maps in the master plan, identify areas that are currently flood prone and those that are likely to be inundated as the sea rises and, "as much as possible, locate future development, infrastructure and essential facilities" outside of these areas.
- Define and protect land near tidal marshes, called "transition zones," and explore ways to permanently protect undeveloped coastal land.
- In coastal and transition zones, develop a comprehensive planning and zoning policy that takes into account vulnerability to sea level rise and saltwater intrusion.
- Create an Extended Coastal Flood Hazard Overlay District for areas that will be subject to tidal flooding and storm surges if sea level rises as projected. In this district, new or reconstructed buildings and public infrastructure would need to be elevated by 1 to 5 feet above the base flood elevation.
- Establish new street grade and first-floor elevation requirements that exceed current local, state, and FEMA standards.¹⁵³

In 2010, Seabrook and two nearby coastal communities, Hampton and Hampton Falls, were part of an EPA-funded project to determine the economic impact of sea level rise on major assets.¹⁵⁴ Working with the New Hampshire Coastal Adaptation Workgroup, a group of entities helping coastal New Hampshire communities prepare for climate change impacts, the towns used the Coastal Adaptation to Sea Level Rise Tool, or COAST, an interactive tool that helps coastal communities evaluate the costs and benefits of adaptation planning. Using

¹⁵⁰ Rockingham Planning Commission. *Adaptation Strategies to Protect Areas of Increased Risk from Coastal Flooding due to Climate Change, Seabrook, NH*. 2009. http://des.nh.gov/organization/divisions/water/wmb/coastal/documents/seabrook_adaptation.pdf.

¹⁵¹ McDermott, Deborah. "Planners Urge Preventive Action as Sea Levels Rise." *Seacoastonline.com*. Jun. 29, 2012. <http://www.seacoastonline.com/article/20120629/NEWS/206290398>.

¹⁵² Rockingham Planning Commission, *Adaptation Strategies*.

¹⁵³ *Ibid.*

¹⁵⁴ McDermott, "Planners Urge Preventive Action as Sea Levels Rise."

COAST, the workgroup estimated the cost of protecting critical public facilities against projected sea level rise to range from \$1.6 million to \$4.2 million—far lower than the estimated \$39.4 million to \$40.4 million of damage if no adaptation action is taken.¹⁵⁵

When the town released its 2011-20 master plan, it included the 2009 adaptation plan as an attachment, noting that “as Seabrook continues to grow and change there will be new issues to consider in the planning process,” particularly sea level rise. As the master plan is implemented over the next five to 10 years, Seabrook’s goal is to “preserve and protect its natural and beach/estuarine environment in balance with recreational, economic, business and employment opportunities for its citizens.”¹⁵⁶

In 2015, the Rockingham Planning Commission completed the *Tides to Storms* vulnerability assessment of seven Atlantic municipalities, including Seabrook, to identify the vulnerability of their roads, critical facilities, infrastructure, and natural resources to sea level rise and storm-related flooding.¹⁵⁷ The study recommended using at least a 50-year planning horizon that assumes a 0.6 to 2.0-foot sea level rise by 2050 and a 1.7 to 6.3-foot sea level rise in 100 years. The project was funded by New Hampshire’s Homeland Security and Emergency Management through a grant from FEMA. The planning commission is working with towns to incorporate information from the assessment report into hazard mitigation plans as they are updated.

The lack of uniform building codes in the coastal zone and the abundance of older development not built to recommended standards are major challenges in planning for sea level rise and regulating development in the flood plain.¹⁵⁸ Seabrook is starting to reconsider its zoning codes, master plan, and land protection strategies to better adapt to sea level rise. Adaptation steps that Seabrook has taken include:

- Partnering with the Piscataqua Region Estuaries Partnership, the Southeast Land Trust, and the Rockingham Planning Commission to identify and preserve “transitional” lands near the salt marshes that are especially susceptible to flooding.
- Evaluating an amendment to the zoning ordinance to incorporate an extended flood hazard overlay zone, per the adaptation plan’s recommendations.¹⁵⁹
- Preparing a “Coastal Risks and Adaptation” chapter for the master plan (in draft as of September 2016, planned to be adopted by the end of 2016). This project was completed as part of the *Tides to Storms 2—Adaptation Implementation* project funded by the Northeast Region Ocean Council.¹⁶⁰

More information on Seabrook’s adaptation planning is available on the Rockingham Planning Commission website at www.rpc-nh.org/regional-community-planning/climate-change/resources.



Figure 26: Homes on Seabrook Beach sit on a strip of land between the ocean and the salt marsh.

Credit: Otto Luna

¹⁵⁵ The COAST model generates these estimates to help communities make decisions about land use, but the estimates are not meant as concrete projections of costs. Merrill, S., et al. *COAST in Action: 2012 Projects from New Hampshire and Maine*. New England Environmental Finance Center Series Report #12-05. 2012. http://efc.muskie.usm.maine.edu/docs/cre_coast_final_report.pdf.

¹⁵⁶ Seabrook Master Plan Steering Committee. *Town of Seabrook 2011-20 Master Plan*. 2011.

¹⁵⁷ Rockingham Planning Commission. *Tides to Storms: Assessing Risk and Vulnerability to Sea-Level Rise and Storm Surge: A Vulnerability Assessment of Coastal New Hampshire*. 2015. <http://www.rpc-nh.org/regional-community-planning/climate-change/resources>.

¹⁵⁸ LaBranche, Julie. “Floodplain Regulation: Challenges and Opportunities in Preparing for Climate Change.” Georgetown Climate Center webinar, Dec. 6, 2012. <http://www.georgetownclimate.org/articles/floodplain-regulation-challenges-and-opportunities-in-preparing-for-climate-changes-webinar.html>.

¹⁵⁹ Ibid.

¹⁶⁰ Personal communication with Julie LaBranche, Senior Planner, Rockingham Planning Commission, on Sep. 19, 2016.

6. Adapting to Extreme Heat

Introduction

The National Climate Assessment notes, “Heat waves have generally become more frequent across the U.S. in recent decades” and “the number of extremely hot days is projected to continue to increase over much of the United States.”¹⁶¹ If global greenhouse gas emissions keep growing, “the same summertime temperatures that ranked among the hottest 5% in 1950-1979 will occur at least 70% of the time by 2035-2064.”¹⁶² Hot days are exacerbated by the heat island effect, in which built-up areas are hotter than less-developed areas because buildings, roofs, and pavements absorb the sun’s heat. Nighttime offers little relief, as these surfaces release heat slowly after dark. The heat island effect can make a city several degrees warmer than surrounding rural areas, raising cooling costs, exacerbating health risks, and increasing greenhouse gases.¹⁶³

Extreme heat threatens people’s health, putting them at greater risk for heat exhaustion, heat stroke, and heat-related death. It can exacerbate chronic illnesses such as respiratory and cardiovascular diseases. The elderly, children, pregnant women, people with underlying health problems, homeless people, those who work outdoors, and people who cannot afford to cool their homes are particularly at risk.¹⁶⁴ High temperatures exacerbate ground-level ozone, which harms respiratory health.¹⁶⁵ During heat waves, emergency services are often overextended as responders struggle to keep up with increased demand. High temperatures can also overtax water and power supplies, resulting in brownouts, blackouts, and water shortages.

Extreme heat can also damage infrastructure and the environment. It can cause roads to crack or buckle and can harm native plants and wildlife. Economically, it can affect industries that involve outdoor work, such as construction, by delaying schedules because of unsafe work conditions. It can also affect outdoor activities and tourism if people prefer not to spend time outside because of the heat and associated air pollution.

Response to the Problem

Communities are encouraging or requiring developers and builders to use shade trees, permeable pavement, and roofs that incorporate vegetation or highly reflective materials. The same strategies can be incorporated into public infrastructure improvements such as green streets and green alleys. Lower parking requirements also help to reduce heat gain by reducing the amount of pavement. Many green building strategies reduce the energy needed to keep buildings at a comfortable temperature. Green building standards align well with passive survivability measures—passive survivability means that a building can maintain “critical life-support conditions in the event of extended loss of power or water; or in the event of extraordinary heat spells, storms, or other extreme events.”¹⁶⁶ Many of the elements that give a building survivability, such as a highly efficient thermal envelope, ventilation, passive heating and cooling, daylighting, rainwater harvesting, and on-site renewable energy generation, are also green building elements included in LEED and other green building standards. If a community has already

¹⁶¹ Walsh et al, “Chapter 2: Our Changing Climate,” *Climate Change Impacts in the United States*, pp. 38-39.

¹⁶² Ibid, p. 39.

¹⁶³ EPA. “Learn About Heat Islands.” <https://www.epa.gov/heat-islands/learn-about-heat-islands>. Accessed Jul. 28, 2016.

¹⁶⁴ Sarofim, M.C., et al. “Ch. 2: Temperature-Related Death and Illness.” *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment*. U.S. Global Change Research Program. 2016. <https://health2016.globalchange.gov/temperature-related-death-and-illness>.

¹⁶⁵ EPA. “Heat Island Impacts.” <https://www.epa.gov/heat-islands/heat-island-impacts>. Accessed Oct. 13, 2016.

¹⁶⁶ New Jersey Green Building Manual. Version 1.0. “Passive Survivability,” New Commercial section. Updated Apr. 28, 2011. <http://greenmanual.rutgers.edu/newcommercial/strategies/survivability.php>.

adopted a green building code or a net-zero-energy standard, it might already be promoting passive survivability.¹⁶⁷

Green infrastructure elements such as street trees and vegetation, discussed in Chapter 4, also help cool ambient air temperatures. Philadelphia's Green City, Clean Waters, a program to protect water quality by greening approximately 20 square miles of what is now impervious cover, estimates that the green infrastructure it installs could lower temperatures enough to reduce up to 140 deaths caused by extreme heat over the next 45 years.¹⁶⁸ Local public health departments and health practitioners can be valuable partners; in addition to their traditional role in preparing to respond to heat emergencies, many are helping promote green infrastructure to reduce heat issues over the longer term. Public health practitioners can bring in different audiences and resources than planners.

The design of a neighborhood affects how its residents cope with extreme heat in less obvious, indirect ways as well. In the 1995 Chicago heat wave that killed more than 700 people, neighborhoods with similar percentages of African-American residents and elderly residents, and similar levels of poverty, unemployment, and crime, had very different death rates.¹⁶⁹ Research found that the neighborhoods with lower death rates in the heat wave had stores and restaurants where elderly residents felt safe, meaning they could easily get to nearby places with air-conditioning. These commercially healthier places also built more social capital by drawing more residents out onto the sidewalks. By contrast, in the neighborhoods with higher death rates, the businesses largely consisted of liquor stores and check-cashing shops, and elderly residents likely did not feel safe leaving their homes.¹⁷⁰ A thriving, walkable neighborhood with amenities that bring people together can help build a sense of community that can encourage residents to check on each other in emergencies—not to mention its everyday quality of life benefits for everyone in the community.

Potential Benefits

- Protecting vulnerable people from heat-related illnesses and death.
- Developing a sense of community.
- Saving money on energy bills.
- Providing a more reliable energy supply.
- Protecting air and water quality.
- Beautifying neighborhoods with trees and plants.
- Creating jobs installing and maintaining green or cool roofs and weatherizing buildings.

¹⁶⁷ EPA, *Using Smart Growth Strategies to Create More Resilient Communities in the Washington, D.C., Region*.

¹⁶⁸ Philadelphia Water Department. *Green City, Clean Waters (Amended)*. City of Philadelphia. 2011. http://www.phillywatersheds.org/doc/GCCW_AmendedJune2011_LOWRES-web.pdf.

¹⁶⁹ Klinenberg, Eric. "Adaptation." *The New Yorker*, Jan. 7, 2013.

¹⁷⁰ Browning, Christopher R., et al. "Neighborhood Social Processes, Physical Conditions, and Disaster-Related Mortality: The Case of the 1995 Chicago Heat Wave." *American Sociological Review* 71.4 (2006): 661-678.

Implementation Approaches

I. Modest Adjustments

- **Offer financial or procedural incentives to encourage builders to use passive survivability measures in new construction or retrofits.** Techniques such as daylighting and allowing natural ventilation can lower daily building energy use while also helping to keep the building at a reasonably comfortable temperature if it loses external power.
 - Austin, Texas, offers builders incentives to include green roofs on their projects. For example, green roofs can help meet certain open space and green building requirements. The city also offers a density bonus: 1 square foot of vegetated roof cover can earn a developer as much as 7 additional square feet of “bonused” floor area, depending on the percentage of the roof that is vegetated, whether the roof is publicly accessible, and whether it meets the city’s standards for a downtown public plaza.¹⁷¹
- **Map “hot spots”—areas where temperatures are particularly high because of large expanses of dark, paved surfaces or a lack of vegetation—and conduct pilot projects in these places to reduce ambient air temperatures** by adding trees and other vegetation and reflective, light-colored, and/or permeable pavement, which can also help reduce stormwater runoff. The pilot projects can help the community figure out which materials and techniques work best for different types of sites such as parking lots, alleys, and streets.
 - As part of its climate adaptation actions, Chicago mapped its hot spots and directs its efforts on cooling and energy efficiency to those places. The city also “overlaid a map of 311 and 911 calls regarding heat-related emergencies to assess the correlation between urban heat islands and heat stress-related issues.”¹⁷²
- **Support the people and neighborhoods that are most vulnerable and least able to adapt on their own.**
 - **Designate, establish, or improve cooling centers in neighborhoods with particularly vulnerable populations** such as the elderly, chronically ill, pregnant women, and children. Mapping hot spots in vulnerable neighborhoods can help prioritize locations for cooling centers. Cooling centers can be civic buildings such as libraries, community centers, or public pools; in some cases, private businesses might agree to let people spend the hottest hours of the day in their buildings. Because many of the people most vulnerable to health impacts from extreme heat are also likely to have limited mobility because they cannot drive, afford a vehicle, or walk long distances, cooling centers should be easy to reach—for example, in or close to apartment complexes with many elderly residents or next to public transit stops. The local government should work with vulnerable communities to find the best places for cooling centers, clearly mark these centers, and do ongoing outreach to make sure residents know where they are and how to reach them.

Practice Pointer

Make sure that communication materials are available in the languages that the vulnerable populations speak.

Many cooling centers might also be able to act as emergency shelters in severe storms or other natural disasters, or their convenient location might make them a good rendezvous

¹⁷¹ City of Austin. “Existing Credits for Green Roof Projects in Austin.” 2014.

https://www.austintexas.gov/sites/default/files/files/Sustainability/GR_Existing_Credit_Fact_Sheet_Revised_2014.pdf.

¹⁷² Chicago Climate Action Plan. “Adaptation.” <http://www.chicagoclimatereaction.org/pages/adaptation/49.php>. Accessed Jul. 28, 2016.

point in case of a city- or neighborhood-wide evacuation. Having a single location in the neighborhood would be easier for residents to remember, so local governments might want to consider strengthening cooling centers to withstand high winds, seismic damage, and flooding, as well as locating them outside of areas that are at high risk of flooding or wildfires. They should also ensure the cooling centers either have backup power or use passive survivability measures that will keep the building at a safe temperature if the power goes out.

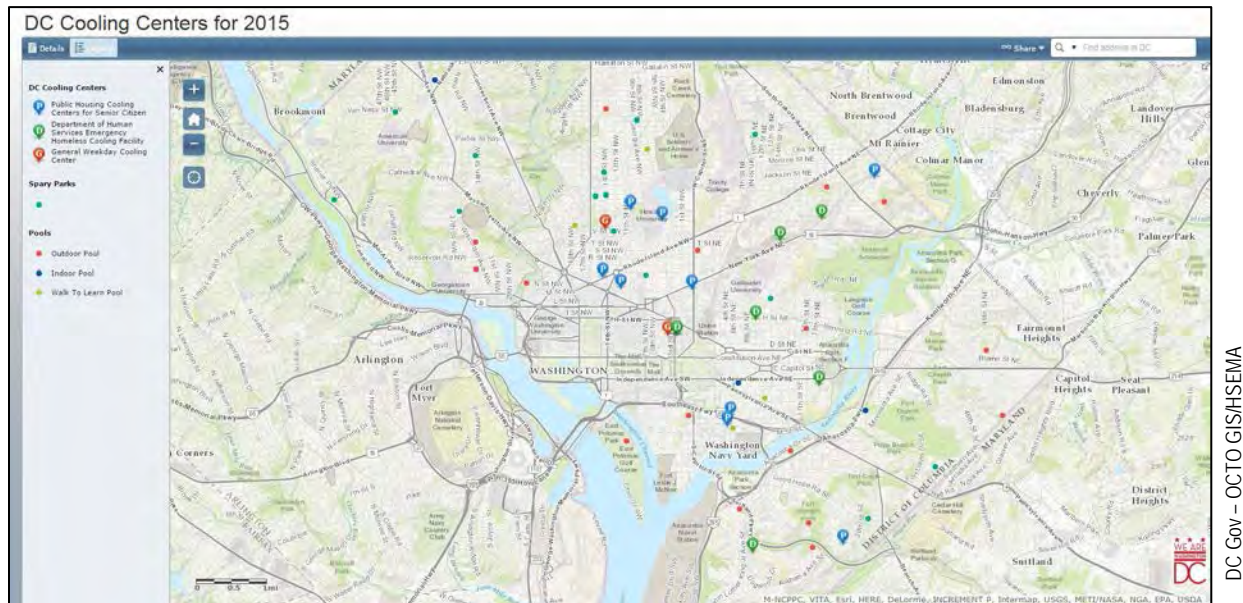


Figure 27: Washington, D.C., provides a map on its city website showing the locations of cooling centers, spray parks, and pools so that residents can find a safe place to spend a hot day.

- **Identify vulnerable populations such as the elderly, people with chronic illnesses, pregnant women, children, residents without air conditioning, outdoor workers, and the homeless and develop an outreach plan for communicating with them before and during extreme heat periods, as well as in other emergencies.** This outreach plan might include finding the most appropriate messenger to reach different populations; for example, houses of worship, community groups, or health clinics.
 - Baltimore created a preparedness campaign called “Make a Plan, Build a Kit, Help Each Other.” At neighborhood events, city staff sat down with residents to help them learn about hazards, build an emergency kit, and build their neighborhood’s resilience. The city distributed cards that say “Help” in orange on one side and “Safe” in green on the other. In an emergency, residents can put these cards in their windows to let their neighbors know if they need help.¹⁷³

¹⁷³ Baja, Kristin. “Building Community Conversations Around Preparedness in Baltimore.” Climate Access. Aug. 7, 2014. <http://www.climateaccess.org/blog/building-community-conversations-around-preparedness-baltimore>.

- **Offer incentives to plant and protect trees.** The hot-spot mapping can help identify areas where more tree canopy is particularly needed; in these places, the community could do more targeted outreach about its incentives or perhaps offer higher incentives. In low-income neighborhoods where people might not be able to afford to pay upfront to plant trees, even if they will receive a rebate, the local government could find ways to plant trees for free, perhaps working with the local utility, nonprofits, or private companies willing to donate trees and/or labor.
 - Several communities offer rebates (sometimes called “tree-bates”) to encourage homeowners to plant trees. Roseville, California, offers a rebate of up to \$50 for planting shade trees. The city’s publicly owned utility also offers free consultations with urban tree experts and guidance on planting trees to shade a home without blocking solar panels.¹⁷⁴
 - TreeBaltimore, a city program that works with the local, state, and federal governments and nonprofit partners, gives away trees to be planted on private property. It offers a tool to help people determine the best location for the tree and guidance on how to plant and care for the tree.¹⁷⁵
- **Include reducing heat island effects as an objective in complete streets projects.** Evaluate options to use cool pavement strategies such as permeable pavement in sidewalks and on-street parking areas, using light-colored materials in the pavement or for the pavement seal coat or overlay, and planting canopy shade trees in the median and sidewalks.
 - Boston’s complete streets design guidelines have guidance on using street trees, green walls (walls that have plants growing on them), light-colored pavement treatments, and planted areas in medians and curb extensions to reduce heat island impacts.¹⁷⁶
 - California’s *Green Building Standards Code*, which can be a model for local green building codes, includes voluntary standards for reducing the heat island effect in areas such as sidewalks, driveways, and other paved areas. It suggests at least a 0.3 solar reflectance value.¹⁷⁷



Figure 28: Green walls, such as this one in downtown Pittsburgh, Pennsylvania, can help reduce the heat island effect.

¹⁷⁴ City of Roseville. “Roseville Shade Tree Program.” http://roseville.ca.us/electric/shade_tree/default.asp. Accessed Oct. 4, 2016.

¹⁷⁵ TreeBaltimore. “Get a Tree for My Yard.” <http://treebaltimore.org/get-a-free-tree/get-a-tree-for-my-yard>. Accessed Nov. 14, 2016.

¹⁷⁶ Boston Transportation Department. *Boston Complete Streets: Design Guidelines*. 2013. <http://bostoncompletestreets.org>.

¹⁷⁷ California Building Standards Commission. *2013 California Green Building Standards Code*. Jul. 1, 2015 supplement. Appendix A4, Section A4.106.7. <http://codes.iccsafe.org/app/book/toc/2015/CALIFORNIA/2013%20CALIFORNIA%20GREEN%20BUILDING%20STANDARDS.%20SUPPLEMENT%20JULY%202015/index.html>.

2. Major Modifications

- **Require or encourage green or reflective roofs on new buildings with little or no roof slope.** These roofs help reduce a building's heat gain while also insulating it, which reduces energy needed for cooling. In addition, green roofs can be pleasant places for building residents or workers to have lunch or just relax. Green building rating systems and model codes, including the *International Green Construction Code*,¹⁷⁸ include provisions for cool roofs.

 - Philadelphia amended its building code in 2010 to require low-slope roofs (with a slope of less than 2:12) over conditioned spaces to be Energy Star®-rated as highly reflective. The requirement applies to new buildings and additions to existing buildings.¹⁷⁹
 - Washington, D.C.'s RiverSmart Rooftops Program offers rebates of up to \$15 per square foot for any property that installs a green roof. Properties with a roof area of less than 2,500 square feet can also get a rebate toward structural engineering.¹⁸⁰ Properties with green roofs can also apply for discounts on their stormwater fee and their water bill.¹⁸¹
- **Revise the zoning ordinance to allow urban agriculture.** The trees and plants help cool the air. Community gardens and other urban agriculture make productive use of vacant land, which can help revitalize blighted neighborhoods, and bring neighbors together. People can grow their own healthy, fresh food, or they can start food-based businesses. The soil should be tested for contamination first to ensure that produce grown in the garden will be safe to eat.¹⁸²

 - Chicago's climate action plan identified urban agriculture as one way to help reduce the heat island effect, as well as beautify neighborhoods and provide food. In 2011, the city changed its zoning ordinance to allow urban agriculture projects, such as community gardens and urban farms, in certain parts of the city.¹⁸³
- **Require shade trees to be incorporated in all municipal projects and private parking lot projects.** Update municipal design or landscape manuals, if they exist, to include the shade tree policy.

 - Fayetteville, Arkansas, offers a manual to help developers comply with its tree preservation and landscaping requirements.

Practice Pointer

Measure the success of cool roof initiatives by the number of projects and the square footage of roofs incorporating cool roof technology.

Practice Pointer

Measure the success of shade tree initiatives by the number of projects that incorporate the shade tree standard and the number of trees planted.

¹⁷⁸ The *International Green Construction Code* is available at: International Code Council. "Overview of the IgCC."

<http://www.iccsafe.org/codes-tech-support/codes/2015-i-codes/igcc>.

¹⁷⁹ City of Philadelphia. Bill 090923: Amendment to *Philadelphia Building Construction and Occupancy Code*. Enacted 2010.

<http://legislation.phila.gov/attachments/10096.pdf>.

¹⁸⁰ Anacostia Watershed Society. "RiverSmart Rooftops." <http://www.anacostiaws.org/green-roofs>. Accessed Jul. 28, 2016.

¹⁸¹ District Department of Energy and Environment. "RiverSmart Rewards and Clean Rivers IAC Incentive Programs."

<http://doee.dc.gov/riversmartrewards>. Accessed Jul. 28, 2016.

¹⁸² For more information on testing for contamination and resources on urban agriculture, see: EPA. "Urban Agriculture Frequent Questions." <https://www.epa.gov/brownfields/urban-agriculture-frequent-questions>. Accessed Sep. 20, 2016.

¹⁸³ City of Chicago. "Urban Agriculture FAQ." https://www.cityofchicago.org/city/en/depts/dcd/supp_info/urban_agriculturefaq.html. Accessed Jan. 10, 2013.

The manual gives concrete guidance on how to submit a plan, what the required minimum tree canopy is, and acceptable tree species. It also encourages developers to meet with the city's urban forestry team before submitting plans.¹⁸⁴

- **Adopt a tree canopy or urban forest master plan and implementing ordinances to enforce it.**

These plans typically include an inventory of existing trees; identification of places with stormwater runoff and heat island problems; and goals for adding tree canopy by a certain percentage, keeping trees healthy, protecting parks, or creating pilot programs to increase green infrastructure. If the community is in a region that sees many strong wind storms, it will also need to consider how to increase its tree canopy while also preventing as much as possible falling trees and tree limbs from bringing down power lines, damaging property, and harming people.

- Miami, Florida: The city's Tree Master Plan sets a policy to restore and enhance the city's tree canopy with benchmark goals by 2020, including:

- Identify the city's tree canopy needs and target areas that require the most attention for reforestation.
- Track all tree plantings to quantify contributions to the tree canopy.
- Develop public-private partnerships to maximize and leverage community resources and funding.
- Develop a public education and awareness campaign to inform residents and businesses about the city's tree canopy needs.
- Establish professional development standards to ensure trees are planted and maintained properly.¹⁸⁵



Figure 29: Miami's Tree Master Plan helps protect and improve the city's tree canopy.

- Atlanta's tree ordinance enforces its goal of no net loss of trees in the city. It applies to private and public property. Elements include requiring parking lot owners to get the city arborist's approval of plans to meet minimum landscaping requirements; creating a tree trust fund, funded by private property owners who remove healthy trees legally or illegally, to pay for tree planting and maintenance; and prioritizing tree planting along streets and other heat islands and in erosion-prone areas.¹⁸⁶

- **Require or offer incentives for using reflective, light-colored, and/or permeable pavement in municipal capital improvement projects and private parking lots. Consider passing a cool paving ordinance to require cool paving technologies.**

¹⁸⁴ City of Fayetteville. *Tree Preservation and Landscape Manual*. 2016. <http://www.fayetteville-ar.gov/3106/Tree-Preservation-and-Landscape-Manual>.

¹⁸⁵ Miami Green Commission. *City of Miami Tree Master Plan*. Undated. <http://miami-dade.ifas.ufl.edu/pdfs/disaster/Hurricane%20Preparation%20files/City%20of%20Miami%20Master%20Plan.pdf>. Accessed Sep. 20, 2016.

¹⁸⁶ City of Atlanta. *Code of Ordinances*. Chapter 58, Article II: Tree Protection. Nov. 10, 2016. https://www.municode.com/library/ga/atlanta/codes/code_of_ordinances?nodeId=COORATGEVOII_CH158VE_ARTIITRPR.

- Chula Vista, California’s climate adaptation plan recommended using cool pavements to help reduce the heat island effect. The city has conducted studies to evaluate appropriate cool paving technologies and has had some success in using cool paving for municipal projects where applicable. It is working to identify funding for a more complex test of various technologies to showcase the feasibility to developers and create an ordinance to incorporate cool paving into projects that include streets and parking lots.¹⁸⁷ See the case study in this chapter for more information on Chula Vista’s policies.
- **Amend the city’s site plan requirements and design guidelines to better adapt hardscape areas to extreme heat.** Specific strategies include:
 - Design to reduce surface temperatures with light paving, permeable paving, and increased shading, including requiring a minimum amount of light or permeable pavement in hardscape areas.
 - Require green alleys and other site infrastructure that provides infiltration.
 - Preserve and expand planted areas.
 - Require landscaped islands in parking lots with plantings that create shade and capture runoff.
 - Increase tree canopy cover through street tree planting.
 - Glenview, Illinois, has design guidelines for trees and other vegetation in parking lots to clearly show what is acceptable. It includes guidance on tree placement, species, and maintenance, among other things.¹⁸⁸

Practice Pointer

Measure the success of cool paving initiatives by tracking the square footage of surfaces that use cool paving techniques and the temperature reduction of those surfaces.



City of Chula Vista

Figure 30: Chula Vista is evaluating cool paving technologies, such as the asphalt chip seal shown here.

3. Wholesale Changes

- **Adopt an energy conservation code to establish minimum design and construction requirements for energy efficiency in buildings,** such as the *International Green Construction Code*. Consider adopting a “stretch” code (also known as a reach code), which sets more stringent energy-efficiency goals and promotes innovative practices. The stretch code would be voluntary, but projects that build to its standards could have a faster approval process or get other incentives. Massachusetts has a stretch code that many towns in the state have adopted.¹⁸⁹

¹⁸⁷ Personal communication with Cory Downs, LEED-Green Assoc., City of Chula Vista, on Nov. 23, 2016.

¹⁸⁸ The Village of Glenview. *Parking Lot Landscaping Ordinance and Design Guidelines*. Undated.

http://glenview.il.us/government/Documents/Parking_Lot_Landscaping.pdf. Accessed Sep. 7, 2016.

¹⁸⁹ Massachusetts Executive Office of Public Safety and Security. “Stretch Energy Code – Information.”

<http://www.mass.gov/eopss/consumer-prot-and-bus-lic/license-type/csl/stretch-energy-code-information.html>. Accessed Nov. 23, 2016.

- **Incorporate passive survivability into building codes;** require it for all new or reconstructed buildings that serve as emergency shelters, and encourage it for other buildings, particularly affordable housing.
 - Seattle offers Priority Green Expedited permitting for buildings that meet the Passive House Institute US standards. Under this program, permits are issued on average a month faster than if they did not meet the standard.¹⁹⁰
 - LEED Building Design and Construction: New Construction v. 4 offers a pilot credit for “Passive Survivability and Functionality During Emergencies.”¹⁹¹

Resources

- EPA’s Heat Island Program maintains a database of community actions, including code changes, demonstration projects, and other actions: <https://www.epa.gov/heat-islands/heat-island-community-actions-database>
- EPA’s Heat Island Program also offers the guidebook *Reducing Urban Heat Islands: A Compendium of Strategies*, which gives an overview of heat islands, describes key heat island reduction strategies, and discusses voluntary and policy efforts undertaken by state and local governments to mitigate heat islands: <https://www.epa.gov/heat-islands/heat-island-compendium>
- The Georgetown Climate Center’s *Adapting to Urban Heat: A Tool Kit for Local Governments* (2012) has detailed information, including policy tools, to help communities prepare for more heat emergencies: <http://www.adaptationclearinghouse.org/resources/adapting-to-urban-heat-a-tool-kit-for-local-governments.html>
- *Cool Policies for Cool Cities: Best Practices for Mitigating Urban Heat Islands in North American Cities* (2014), developed by the American Council for an Energy-Efficient Economy and the Global Cool Cities Alliance, describes the policies, programs, and practices implemented by 26 cities to reduce the heat island effect: <http://aceee.org/research-report/u1405>
- Enterprise Green Communities’ *Ready to Respond: Strategies for Multifamily Building Resilience* (2015) offers detailed strategies for owners of affordable multifamily housing to protect their buildings from extreme weather and flooding, adapt buildings to changing climate conditions such as higher temperatures, keep buildings safe and habitable if power or other services are lost, and encourage a sense of community so residents will support each other in an emergency: <http://www.enterprisecommunity.org/resources/ready-respond-strategies-multifamily-building-resilience-13356>
- The National Integrated Heat Health Information System has heat forecasts, tools, case studies, and other resources to help communities cope with extreme heat: <https://toolkit.climate.gov/nihhis>

¹⁹⁰ Seattle Department of Construction & Inspections. “Priority Green Expedited.”

<http://www.seattle.gov/dpd/permits/greenbuildingincentives/prioritygreenexpedited/default.htm>. Accessed Aug. 11, 2016.

¹⁹¹ U.S. Green Building Council. “Passive Survivability and Functionality During Emergencies.” Undated. <http://www.usgbc.org/credits/passivesurvivability>. Accessed Sep. 7, 2016.

Guidance and Metrics

LEED for Neighborhood Development

Neighborhood Pattern and Design Credit: Tree-Lined and Shaded Streetscapes

Provide street trees on both sides of at least 60 percent of streets (new and existing) at intervals of no more than 50 feet, or use trees or permanent structures to provide shade along at least 40 percent of sidewalks. All projects must get a determination from a landscape architect that trees are planted in a way that ensures their long-term health.

Neighborhood Pattern and Design Prerequisite: Mixed-Use Neighborhoods

Ensure that at least half of the project's dwelling units are within 0.25 miles walking distance of a variety of uses.

Green Infrastructure and Buildings Credit: Heat Island Reduction

For roofs, use roofing materials that have a Solar Reflective Index (SRI) appropriate for roof slope (low slope at least 64 SRI; steep slope at least 32 SRI) for at least 75 percent of the roof area, or install a green roof for at least 75 percent of the roof area.

For non-roof paving, such as sidewalks, courtyards, or roads, on at least 50 percent of the non-roof paved area, provide shade with trees or structures, plant vegetation, use paving materials with an SRI of at least 0.28, or install an open-grid pavement system that is at least 50 percent pervious.

STAR Community Rating System

Equity & Empowerment Objective 1: Civic Engagement

Partner with businesses, nonprofits, and neighborhood organizations to engage the community in decision-making. Establish regular opportunities for local government staff and officials to meet residents to answer questions and listen to concerns.

Equity & Empowerment Objective 4: Equitable Services & Access

Demonstrate that neighborhoods with the highest percentage of low-income residents and people of color have increased access and proximity to community facilities, services, and infrastructure.

Health & Safety Objective 3: Emergency Management & Response

Encourage residents to develop emergency kits, or distribute emergency kits or supplies to low-income and vulnerable residents.

Health & Safety Objective 6: Hazard Mitigation

Build or renovate to higher building code standards public facilities that will be used as shelters.

Natural Systems Objective 1: Green Infrastructure

Demonstrate that 85 percent of the population lives within one-third of a mile of green infrastructure features that provide localized cooling. Assess the community's urban forest.

Living Community Challenge

Imperative 2: Urban Agriculture

Integrate opportunities for agriculture appropriate to the community's scale and density.

Case Study: Chula Vista, California

In California, from 1991 to 2006, heat waves claimed more lives than all other disasters combined¹⁹²—partly due to prolonged and more frequent heat waves caused by climate change, exacerbated by the heat island effect.¹⁹³ Chula Vista, a city 10 miles south of downtown San Diego with a population of approximately 250,000, is responding to this threat. In 2010, the city adopted 11 Climate Adaptation Strategies to combat climate change effects like sea level rise, extreme heat, and wildfires.¹⁹⁴ Under the first three strategies—cool paving, shade trees, and cool roofs—the city’s Climate Change Working Group recommended amending the city’s building codes, land use policies, and design ordinances to better prepare for the effects of extreme heat.

The Chula Vista city council approved the Climate Adaptation Strategies on May 3, 2011. The 11 strategies propose:

1. Cool paving.
2. Shade trees.
3. Cool roofs.
4. Local water supply and reuse.
5. Stormwater prevention pollution and reuse.
6. Education and wildfires.
7. Extreme heat plans.
8. Open space management.
9. Wetlands preservation.
10. Sea level rise land development codes.
11. Green economy.¹⁹⁵

The Climate Adaptation Strategies outline timelines, costs, performance metrics, and action items for each strategy. According to the report, the total cost of implementing the strategies is \$554,000 for each of the first three years (2011 to 2014) and \$337,000 annually after that. These efforts were anticipated not to add new costs to the city’s general fund but rather to be integrated into existing city programs.¹⁹⁶



City of Chula Vista

Figure 31: Trees planted under Chula Vista’s shade tree policy not only help cool the air but also beautify streets.

¹⁹² The San Diego Foundation. *San Diego’s Changing Climate: A Regional Wake-Up Call*. 2008. <https://www.sdfoundation.org/wp-content/uploads/2015/10/2009-Focus2050glossySDF-ClimateReport.pdf>.

¹⁹³ City of Chula Vista. *Climate Adaptation Strategies Implementation Plans*. 2011. <http://www.chulavistaca.gov/home/showdocument?id=5443>.

¹⁹⁴ Searle, Robert. “A Tree Grows in Chula Vista.” *Stanford Social Innovation Review*, Sep. 21, 2012. https://ssir.org/articles/entry/a_tree_grows_in_chula_vista.

¹⁹⁵ Kershner, Jessi. “Climate Change Adaptation Planning in the City of Chula Vista, California.” *CAKE - Climate Adaptation Knowledge Exchange*. Dec. 17, 2010. <http://www.cakex.org/case-studies/climate-change-adaptation-planning-city-chula-vista-california>.

¹⁹⁶ Searle, “A Tree Grows in Chula Vista.”

The first three strategies focus on using land use planning and building code amendments to adapt to extreme heat. The report outlines the following recommendations and performance metrics for each strategy:

- **Cool paving:** Develop an ordinance to incorporate reflective pavement, or “cool paving” technologies, into all municipal capital improvement and private parking lot projects over a certain size. The city can measure the strategy’s success by the square footage of paved surfaces using cool paving technologies and the temperature reduction they create.
- **Shade trees:** Adopt a shade tree policy that requires incorporating shade trees in all municipal projects and private parking lot projects. The report also suggests amending the municipal landscape and design manuals to comply with the new policy. The strategy’s success would be measured by the number of new projects incorporating the shade tree standard.
- **Cool roofs:** Amend the city’s municipal building codes to include cool roofs in new residential developments with air conditioning systems three years before required by state code. The amendment would make the state of California’s voluntary CalGreen cool roof building code standard¹⁹⁷ mandatory in Chula Vista. The strategy’s success would be measured by the number of new units incorporating cool roofs and Energy Star[®] cool roof technology.¹⁹⁸

The remaining strategies target other climate change effects, such as decreased water availability, sea level rise, and wildfires. Strategy 7, “Extreme Heat Plans,” recommends incorporating extreme heat into the city’s emergency response and hazard mitigation plans but does not propose any land use changes.¹⁹⁹

The San Diego Foundation’s 2008 report, *San Diego’s Changing Climate: A Regional Wake-Up Call*, prompted Chula Vista city officials to begin thinking about climate change mitigation and adaptation. The report, based on the research of over 40 climate experts from universities, local government, nonprofit agencies, and private-sector organizations, examines how the San Diego region might look in 2050 if climate trends continue along current trajectories.²⁰⁰ In addition to laying out the risks posed by future climate change impacts, the report provides “a level of detail that makes it possible for local leaders to have some idea of what action to take” to adapt to climate change.²⁰¹

The report warns of the potentially devastating effects of increased temperatures and more frequent heat waves, including increasing peak energy demand, which could grow by more than 70 percent by 2050, putting a strain on the region’s energy supplies. Extreme heat can also affect public health, increasing the likelihood of illness and death, poor air quality, wildfires, the spread of infectious diseases, and demand on emergency and health services.²⁰² According to the report, “The cost of ‘no action’ could be significant in the long term through public and private infrastructure damages, public safety and health issues, and energy and water shortages.”²⁰³

Taking a bottom-up approach to climate change adaptation planning, in 2009, the city established the Climate Change Working Group. The group held 11 public meetings to examine the city’s adaptation priorities. Experts from utilities, construction firms, colleges, public health groups, environmental organizations, and local foundations made presentations to help identify climate change impacts and evaluate data. The group also hosted two public presentations during which attendees voted on the issues and strategies they felt were the most important. In 2010, the group presented the 11 recommended adaptation strategies to city council, which approved the strategies in 2011.²⁰⁴

The Climate Adaptation Strategies were supported by multiple city departments, perhaps in part because they do not affect the city’s general fund. Adamant that the strategies not disrupt business as usual, the working group

¹⁹⁷ The current versions of the residential and nonresidential California Green Building Standards Code can be found on the California Building Standards Commission website at <http://www.bsc.ca.gov/Home/CALGreen.aspx>.

¹⁹⁸ City of Chula Vista, *Climate Adaptation Strategies Implementation Plans*.

¹⁹⁹ Ibid.

²⁰⁰ The San Diego Foundation, *San Diego’s Changing Climate*.

²⁰¹ Searle, “A Tree Grows in Chula Vista.”

²⁰² The San Diego Foundation, *San Diego’s Changing Climate*.

²⁰³ City of Chula Vista, *Climate Adaptation Strategies Implementation Plans*, p. 3.

²⁰⁴ Kershner, “Climate Change Adaptation Planning in the City of Chula Vista, California.”

recommended that any additional funding needed to implement the strategies should come from outside sources.²⁰⁵ The California Public Utilities Commission, for example, funds many of Chula Vista's adaptation efforts that also improve energy efficiency, such as the cool roof requirements. By building on established efforts, the city not only saves on costs, it also "mainstreams" climate change adaptation into existing policies and plans.

As of November 2013, 63 percent of the actions outlined in the Climate Adaptation Strategies were completed, and another 33 percent were underway. For example, the city:

- Completed a cool paving study to evaluate pavement options and is formulating cool paving standards for new development.²⁰⁶
- Completed a formal shade tree policy that requires 50 percent shade cover of all parking stalls in the city within 15 years and street trees on new public and private streets. It allows the use of cool pavement where tree cover is not possible.²⁰⁷ The city updated its design manual to include the shade tree policy.²⁰⁸
- Established formal standards to incorporate cool roofs into building codes, three years before it was required by the state, requiring all new low-rise residential units to use cool roofs.²⁰⁹ The city estimates that implementing the cool roof policy will cost \$75 per unit and that energy savings will pay back that amount in three years.²¹⁰

Chula Vista's implementation of its Climate Adaptation Strategies brought additional economic, environmental, educational, and civic benefits, including emergency response and hazard mitigation plans, more community awareness of extreme heat issues, and creating a notification system for poor air quality and extreme heat. The city's work on climate change mitigation and adaptation has also led to more focus on smart growth and compact development.

Chula Vista is helping other local and regional municipalities prepare for climate change. In 2012, the city helped launch the San Diego Regional Climate Collaborative in partnership with the city of San Diego, the county of San Diego, the Port of San Diego, the San Diego Association of Governments, the San Diego Foundation, the University of San Diego, and San Diego Gas & Electric. The collaborative brings together representatives from a range of interests to help local governments in the region share information and learn about how to meet the challenges of climate change.²¹¹

Chula Vista has been praised for incorporating climate change adaptation efforts into its "normal operations, without adding materially to local budgets," demonstrating that climate change adaptation need not require massive public spending.²¹² Additionally, the city's inclusive planning process allowed residents; public officials; and representatives of the nonprofit, private, and institutional sectors to help form the climate change adaptation goals and strategies. By streamlining activities and prioritizing public engagement, the city has made significant changes to its land use policies and building codes, helping prepare for a hotter future.

More information on Chula Vista's Climate Action Planning is available at

www.chulavistaca.gov/departments/public-works/environmental-fiscal-sustainability/conservation/climate-action-plan.

²⁰⁵ City of Chula Vista, *Climate Adaptation Strategies Implementation Plans*.

²⁰⁶ City of Chula Vista, *Climate Action Plan Implementation Progress Report*. 2013. <http://www.chulavistaca.gov/home/showdocument?id=5441>.

²⁰⁷ City of Chula Vista, Council Policy 576-19 (Shade Tree Policy). Effective May 22, 2012. <http://www.chulavistaca.gov/home/showdocument?id=8093>.

²⁰⁸ City of Chula Vista, *Climate Action Plan Implementation Progress Report*.

²⁰⁹ City of Chula Vista, Ordinance No. 3227. Adopted Mar. 27, 2012. <http://38.106.5.202/home/showdocument?id=5479>.

²¹⁰ Searle, "A Tree Grows in Chula Vista."

²¹¹ San Diego Regional Climate Collaborative. "US EPA Honors San Diego Regional Climate Collaborative With National Award." Press release, Feb. 25, 2015. http://sdclimatecollaborative.org/wp-content/uploads/2015/02/2015-EPA-Award-Climate-Collab-release_FINAL.pdf.

²¹² Searle, "A Tree Grows in Chula Vista."

7. Adapting to Drought

Introduction

Although precipitation has increased across the United States on average since 1900, seasonal and regional variations, as well as rising temperatures that speed up evaporation, mean that drought is also increasing in many parts of the country.²¹³

Dry spells and increased surface temperatures dry up rivers and reservoirs, reducing water supply for drinking, energy production, irrigation, wildlife habitat, and other uses. Population growth compounds the problem, further increasing water demand in areas already strained. Drought can also increase the risk of wildfires.

Response to the Problem

Some land use regulations and development ordinances require water-conserving landscaping and low-flow appliances, such as EPA WaterSense-rated fixtures. Guidelines for new residential development can encourage graywater reuse (where allowed by state law). New commercial development can be required to capture rainwater and use it to irrigate landscaping, which preserves potable water.

Long-term land use strategies can promote or require development patterns, such as compact communities, that use less water per household and reduce the burden on existing water supply infrastructure, making water delivery more efficient. Shorter pipes mean less opportunity for leaks, and water pumped shorter distances does not have to be pumped as forcefully, which also reduces leakage. In addition, smaller lots use less water outdoors because they have less lawn to irrigate.²¹⁴

In extreme cases, some communities have stopped all development because of concerns about adequate water supply. While this action helps protect current residents and businesses in a drought, it also can reduce the housing supply, which makes homes more expensive.²¹⁵ Lower-income people might have trouble finding a home they can afford. Developing compactly in areas well-connected with existing infrastructure can help a community continue to grow and meet housing demand.

Potential Benefits

- Letting a community continue to grow without straining its water supplies.
- Beautifying and cooling neighborhoods by planting appropriate vegetation.
- Conserving city- or utility-delivered water for drinking by harvesting rainwater or graywater²¹⁶ to use for irrigation and other non-drinking uses.
- Giving communities more options in a drought by diversifying and conserving water resources.
- Using taxpayer money more efficiently by cutting water waste.

²¹³ Walsh et al, "Chapter 2: Our Changing Climate," *Climate Change Impacts in the United States*.

²¹⁴ EPA. *Growing Toward More Efficient Water Use: Linking Development, Infrastructure, and Drinking Water Policies*. 2006. <https://www.epa.gov/smartgrowth/growing-toward-more-efficient-water-use>.

²¹⁵ Gittelsohn, John. "Drought Dogs Developers in California's Soaring Housing Market." *Bloomberg Business*, Sep. 10, 2015. <https://www.bloomberg.com/news/articles/2015-09-10/drought-dogs-developers-in-california-s-soaring-housing-market>.

²¹⁶ Graywater is "water from showers, bath tubs, washing machines, and bathroom sinks... that contains some soap but is clean enough to water plants." San Francisco Water Power Sewer. "Graywater." <http://sfwater.org/index.aspx?page=100>. Accessed Dec. 14, 2016.

Implementation Approaches

I. Modest Adjustments

- **Encourage compact development policies** such as smaller block sizes and transit-supportive density (generally seven or more dwelling units per acre) to use water more efficiently.²¹⁷ Flexible design standards are important in compact development. A comprehensive strategy including a variety of elements like density bonuses, mixed use, smaller lot sizes, and permitted accessory dwelling units makes it possible for incremental increases to occur across designated zoning districts.
- **Recommend the use of drought-tolerant plants as part of water conservation, landscaping, and water waste ordinances.**²¹⁸ Recommend using native plants when possible if they are drought resistant, and creating drought-resistant soils with compost and mulch. Using compost as a soil amendment can increase permeability and water-holding capacity and reduce the need for irrigation; organic mulch applied to exposed surfaces can reduce evaporation.
 - The San Diego County Water Authority created a guide to help homeowners convert turf areas into a WaterSmart landscape. The guide includes tips on evaluating the site, designing the landscape and irrigation, selecting plants, and installing and maintaining the landscape. It lists plants that are native or from similar climatic regions and require low or moderate water use.²¹⁹
- **Promote the use of EPA WaterSense-rated or other water-efficient fixtures** through incentive programs or giveaways.
 - Titusville, Florida, a WaterSense partner community, offers rebates to replace older toilets with high-efficiency models and free replacement showerheads and faucet aerators.²²⁰

Practice Pointer

Offer clear, plain language guidance for residents and businesses interested in implementing strategies on their properties. For example, many cities with xeriscaping or low-water-use turf requirements or incentives provide a list of appropriate plants. See the Resources section in this chapter for examples.

2. Major Modifications

- **Implement a water impact fee that reflects each property's consumption based on the building type and size.** Municipalities can also work with water utilities to explore ways to price water to encourage conservation and reflect the actual costs of providing service. Strategies might include changing prices seasonally or by time of day to charge more for water used during peak demand periods, or increasing the rate as the amount of water used increases.²²¹
- **Offer rebate programs or other incentives to encourage the use of native, drought-tolerant plants; planting, irrigating, or caring for climate-appropriate trees; installing rainwater harvesting equipment; buying water-efficient fixtures; or other water-saving practices.**

²¹⁷ EPA, *Growing Toward More Efficient Water Use*.

²¹⁸ A water waste ordinance generally prohibits using water in a way that causes it to pool on a paved area or flow steadily across a paved area for an extended period. For a sample definition and sample ordinances, see: Southern Nevada Water Authority. "Water Waste Ordinances." <https://www.snwa.com/conservation/waste-ordinances.html>. Accessed Jul. 22, 2015.

²¹⁹ San Diego County (CA) Water Authority. *A Homeowner's Guide to a WaterSmart Landscape*. 2015. <http://www.watersmartsd.org/content/homeowners-guide-watersmart-landscape>.

²²⁰ City of Titusville. "Retrofitting Older Homes." <http://www.titusville.com/Page.asp?NavID=843>. Accessed Oct. 12, 2016.

²²¹ EPA. "Pricing and Affordability of Water Services." <https://www.epa.gov/sustainable-water-infrastructure/pricing-and-affordability-water-services>. Accessed Oct. 4, 2016.

- New Braunfels Utilities, in Texas, offers a rainwater harvesting rebate of 50 cents per gallon of water storage installed.²²²
- The Southern Nevada Water Authority offers Las Vegas-area homeowners and businesses a rebate to convert grass lawns to xeriscapes (landscaping that needs little or no irrigation): \$2 per square foot up to 5,000 square feet and \$1 per square foot after that. The authority also offers free landscape designs and plant lists.²²³ It estimates that converting 15,000 square feet of grass can save 825,000 gallons of water per year.²²⁴
- Chula Vista, California, lets homeowners and commercial property owners finance water- and energy-efficiency upgrades through a PACE (Property Assessed Clean Energy) program. Property owners pay back the initial financing through their property taxes.²²⁵



City of Chula Vista

Figure 32: Chula Vista's water-saving initiatives also include educating residents about water conservation and reuse.

- **Mandate graywater-ready residential development** (where state law allows graywater reuse). This regulation does not require homeowners to install a graywater system; it only requires the builder to include graywater “stub-outs” in the plumbing system. The community might need to offer incentives such as technical assistance or rebates to encourage homeowners to actually install the graywater system.
 - Tucson, Arizona’s City Ordinance No. 10579, known as the Residential Gray Water Ordinance, requires developers to include a portion of the plumbing needed to facilitate the use of graywater in all residential construction. Two drains for each laundry hook-up are required; laundry drains must exit the home and be accessible to irrigate landscaping. Lavatory, shower, and bathtub drains must be separate from all other drains serving the residence and must extend at least three feet from the house’s foundation. These drains will require connection to a tank and distribution system before they can be used. These measures allow a homeowner to install the plumbing necessary to use graywater later, without having to disturb the existing plumbing system.^{226,227}

Practice Pointer

Verify that using nonpotable water for toilet flushing or laundry is legal in your state.

²²² New Braunfels Utilities. “Rain Barrel Rebate.”

<http://www.nbutexas.com/Conservation/Rebates/WaterConservationRebates/RainBarrelRebate.aspx>. Accessed Nov. 29, 2016.

²²³ Southern Nevada Water Authority. “Water Smart Landscapes Rebate.” <https://www.snwa.com/rebates/wsl.html>. Accessed Oct. 7, 2016.

²²⁴ Southern Nevada Water Authority. “Water Smart Landscape Rebate for Business.” https://www.snwa.com/biz/rebates_wsl.html. Accessed Oct. 7, 2016.

²²⁵ City of Chula Vista. “Water Conservation & Reuse.” <http://www.chulavistaca.gov/departments/public-works/environmental-fiscal-sustainability/conservation/water-conservation-reuse>. Accessed Nov. 29, 2016.

²²⁶ City of Tucson. Ordinance No. 10579. Adopted 2008. <https://www.tucsonaz.gov/files/agdocs/20080923/sept23-08-527a.pdf>.

²²⁷ Ramos, Raphael F. “Tucson Implements New Rainwater And Graywater Ordinances.” Quarles & Brady, LLP. Apr. 23, 2009. <http://www.quarles.com/publications/tucson-implements-new-rainwater-and-graywater-ordinances>.

- **Adopt a citywide policy that promotes water recycling for nonpotable uses.** Recycled water is wastewater that has been treated to be safe for uses such as irrigation.
 - As part of Redwood City, California's Recycled Water Project, the city adopted an ordinance that requires recycled water to be used for nonpotable uses in the designated Recycled Water Service Area wherever feasible.²²⁸ The city also provides recycled water free to residents to use on their landscaping; it gave out 437,000 gallons in 2015.²²⁹
- **Require the use of water-efficient fixtures, such as EPA WaterSense-rated fixtures, for new construction through the building code.** Green building rating systems and the *International Green Construction Code* include provisions for water-efficient fixtures.

Practice Pointer

Explore partnering with large institutions such as universities that are interested in investing in cutting-edge projects that can cut their water use to install graywater and/or reclaimed water demonstration projects. Educational signs can help teach building visitors about the systems.

3. Wholesale Changes

- **Enact a building energy and water benchmarking ordinance.** Benchmarking programs provide solid data on energy and water use that help municipalities set a baseline and determine progress toward reducing energy and water use. If communities choose not to pass an ordinance, they can still encourage building owners to use a benchmarking program by emphasizing the cost savings of using energy and water more efficiently and by offering incentives.
 - New York City Benchmarking Local Law 84 of 2009 has helped reveal infrastructure leaks and water loss in New York City.²³⁰ Since 2010, building owners have been required to annually record energy and water use through Portfolio Manager®, an Energy Star® online reporting system.²³¹ The city then makes this information public.
 - Denver's voluntary Watts to Water program encourages commercial buildings to use Portfolio Manager® to measure their energy and water use. The building owners get free technical support and educational programs, public recognition, and access to rebates and other programs to help improve building operations.²³² In 2014, 170 properties participated in the program and reported savings of 9.3 million gallons of water, equivalent to a year's supply for 40,000 people.²³³
- **Enact a water conservation, landscaping, and/or water waste ordinance to restrict the type of landscaping that can be used on new development and public properties.** For example, require residential and commercial builders to install xeriscaping or green infrastructure rather than turf grass or water-intensive plants for newly constructed homes or businesses. Where turf grass is permitted, require builders to select from an approved list of drought-tolerant varieties.
 - Adopted in 2007 and updated in 2014, San Antonio, Texas' Conservation Ordinance requires residential and commercial builders to install turf grass from an approved list of drought-tolerant varieties for newly constructed homes or businesses.

²²⁸ City of Redwood City. Ordinance No. 2235. Adopted 2008. <http://www.redwoodcity.org/home/showdocument?id=1628>.

²²⁹ Redwood City. "Programs." <http://www.redwoodcity.org/departments/public-works/water/recycled-water/programs>. Accessed Dec. 22, 2015.

²³⁰ City of New York. *New York City Local Law 84: Benchmarking Report*. 2014.

http://www.nyc.gov/html/planyc/downloads/pdf/publications/2014_nyc_ll84_benchmarking_report.pdf.

²³¹ Energy Star. "Portfolio Manager." <https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager>. Accessed Aug. 3, 2016.

²³² Watts to Water. "What Do I Get?" <http://www.wattstowater.org/what-do-i-get.php>. Accessed Aug. 3, 2016.

²³³ Personal communication with Amanda Timmons, LEED AP, Ampajen Solutions LLC, on Dec. 9, 2016.

The approved grass varieties were chosen for their ability to survive with very little or no water for extended periods.

- **Mandate rainwater harvesting for all new commercial construction.**

- Tucson's City Ordinance No. 10597, known as the Commercial Rainwater Harvesting Ordinance, mandates the use of captured rainwater to meet at least 50 percent of a new commercial development's landscape water needs.²³⁴ Implementation of this requires developers to submit site plans that include a rainwater harvesting plan, a landscape water budget, details on metering outdoor water use, and plans for irrigation controls that respond to soil moisture conditions as part of the rainwater harvesting requirements.²³⁵

Practice Pointer

Verify that rainwater harvesting is legal in your area. Some jurisdictions prohibit harvesting to keep local watersheds healthy or due to water rights conflicts with downstream entities.

- **Integrate water resource management with land use plans** to ensure that the community has enough water for the growth it has planned, and that the growth happens in places that make the best use of the community's investments in water infrastructure.

- Albuquerque, New Mexico: In 2004, the city and county adopted the "Planned Growth Strategy," which prioritizes development in existing communities, concentrates growth in areas where infrastructure already exists, and protects the natural environment.²³⁶ The city coordinates with the water authority to help ensure that growth aligns with the water supply. See the case study in this chapter for more information on Albuquerque's policies.

Practice Pointer

Many communities' water is managed by water authorities or utilities. Municipalities would need to work with those entities to encourage water efficiency. Having municipal planning staff participate in water planning activities and vice versa can help align growth plans and water supply.

Resources

- EPA's *Drought Response and Recovery Guide: A Basic Guide for Water Utilities* (2015) relays lessons learned from seven diverse drought-impacted small- to medium-sized water systems and their communities. The interactive guide features worksheets, best practices, and overview videos to build short- and long-term drought resilience:
<https://www.epa.gov/waterutilityresponse/drought-response-and-recovery-guide-water-utilities>
- The Alliance for Water Efficiency has useful comparisons and summaries of green building standards that include water-conservation elements. The "National Efficiency Standards and Specifications for Residential and Commercial Water-Using Fixtures and Appliances" and "Water-Efficient Indoor Products and Systems - U.S. Green Standards, Codes, and Voluntary Initiatives" papers (both updated in 2014) are particularly relevant to the material in this publication:
http://www.allianceforwaterefficiency.org/Background_on_Green_Building_Specifications.aspx

²³⁴ City of Tucson. Ordinance No. 10597. Adopted 2008.

https://wrrc.arizona.edu/sites/wrrc.arizona.edu/files/COT_Commercial%20Water%20Harvesting%20Ordinance.pdf.

²³⁵ Ramos, "Tucson Implements New Rainwater And Graywater Ordinances."

²³⁶ City of Albuquerque. "Planned Growth Strategy." 2004. <https://www.cabq.gov/council/projects/completed-projects/2004/planned-growth-strategy>.

- Examples of resources that give clear guidance on strategies include:
 - EPA’s WaterSense Program maintains a “What to Plant” database of low-water-use or drought-tolerant plants searchable by geographic area:
https://www3.epa.gov/watersense/outdoor/what_to_plant.html
 - San Diego, California, published an easy-to-understand *Rainwater Harvesting Guide* (undated) to help residents install rainwater-collecting devices:
<https://www.sandiego.gov/water/pdf/conservation/rainwaterguide.pdf>

Guidance and Metrics

LEED for Neighborhood Development

Neighborhood Pattern and Design Prerequisite: Compact Development

Build residential components at a density of at least 7 dwelling units per acre and nonresidential components at a density of 0.50 or higher FAR for the available land, with higher densities within walking distance of transit service.

Green Infrastructure and Buildings Prerequisite and Credit: Indoor Water Use Reduction

The prerequisite is to reduce indoor water use by an average of 20 percent from a baseline. To achieve the credit, new nonresidential buildings, mixed-use buildings, and multifamily residential buildings must use an average of 40 percent less water than in baseline buildings. All newly installed water fixtures that are eligible for labeling must be WaterSense labeled.

Green Infrastructure and Buildings Credit: Outdoor Water Use Reduction

Either show that the landscaping does not need a permanent irrigation system, or reduce outdoor landscape irrigation by at least 30 percent from a calculated baseline for the site’s peak watering month.

Green Infrastructure and Buildings Credit: Wastewater Management

Retain on site at least 25 percent of average annual wastewater generated, and treat and reuse it to replace potable water use.

STAR Community Rating System

Built Environment Objective 2: Community Water Systems

Demonstrate the ratio of water withdrawals for human use to the total renewable, stored, and allocated water resources is less than 0.2. Ensure the jurisdiction can enact water conservation measures in a drought.

Built Environment Objective 3: Compact & Complete Communities

Demonstrate that the community achieves thresholds for residential and non-residential density. Demonstrate that plans and policies support compact development.

Climate and Energy Objective 5: Water Efficiency

Demonstrate a 10 percent reduction in per capita water use since 2010 or reduce water use by 2 percent per year from a 2010 baseline. Adopt a communitywide water management plan to improve water efficiency. Adopt plumbing, building, and/or zoning codes that promote water-efficient practices and products. Offer incentives for water-efficient buildings and landscaping.

Living Community Challenge

Imperative 5: Net Positive Water

All of the community’s water needs must be supplied by captured precipitation or other natural, closed-loop water systems, and/or by recycling used community water purified as needed without the use of chemicals.

Case Study: Albuquerque, New Mexico

The city of Albuquerque and surrounding Bernalillo County receive an average annual rainfall of a little over 9 inches.²³⁷ To use water more efficiently and better prepare for drought, the city and county adopted water conservation efforts that have dramatically reduced water consumption. The local water authority notes:

“When the conservation program began in 1995, the service area’s water use was 251 gallons per person per day (GPCD). ...The original conservation goal was to reduce use to 175 GPCD by 2005. This goal was achieved in 2005 when a GPCD of 172 was reached. A new goal was then established of 150 GPCD by 2014. This goal was reached three years early in 2011.”²³⁸

Albuquerque’s drop in water use happened despite a rise in population. In 2013, the city used roughly the same amount of water that it used in 1983, even though its population grew by 70 percent in that 30-year period.²³⁹

Several policies, programs, and ordinances, many of which the city started in the 1990s and the water authority subsequently took over, encourage water-conserving landscaping and water-efficient appliances in new development. For example:

- Requiring low-flow toilets in all new residential construction and public buildings, and offering a rebate program for homeowners who buy high-efficiency toilets.²⁴⁰
- Restricting the type of landscaping that can be used on new development and public properties. For example, high-water-use grasses can occupy no more than 20 percent of the space in landscaped areas,²⁴¹ and the city and water authority promote xeriscaping—using native, drought-tolerant plants or other landscaping elements that require little irrigation (Figure 33).
- Encouraging compact development,²⁴² which uses water more efficiently.
- Recommending that water-conserving trees be part of the design of entire neighborhoods, not just single residential sites.²⁴³



Figure 33: To encourage xeriscaping, Albuquerque implemented a rebate program in 1996. The water authority continues that program, as of 2016, and also offers templates for xeriscape garden designs and lists of appropriate plants.

In 2001, the city established a Drought Management Strategy Task Force, whose members represented a wide range of interests, including the Sierra Club, the Albuquerque Economic Forum, the local chamber

²³⁷ U.S. Climate Data. “Albuquerque (West) Weather Averages.” [http://www.usclimatedata.com/climate/albuquerque-\(west\)/new-mexico/united-states/usnm0005](http://www.usclimatedata.com/climate/albuquerque-(west)/new-mexico/united-states/usnm0005). Accessed Nov. 22, 2016.

²³⁸ Albuquerque Bernalillo County Water Utility Authority. *Water Resources Management Strategy Implementation: 2024 Water Conservation Plan Goal and Program Update*. 2013. http://www.abcwua.org/uploads/files/2024_Water_Conversation_Plan_Update.pdf.

²³⁹ Fleck, John. “Total ABQ Water Use Lowest in 30 Years.” *Albuquerque Journal*, Jan. 11, 2014.

<https://www.abqjournal.com/334881/news/albuquerques-total-water-use-in-2013-lowest-in-30-years.html>.

²⁴⁰ Combs, Susan. *The Impact of the 2011 Drought and Beyond*. Texas Comptroller of Public Accounts. 2012.

²⁴¹ City of Albuquerque. *City Water Conservation Landscaping and Water Waste Ordinance*. Adopted 1995.

<http://www.cabq.gov/planning/documents/appendd.pdf>.

²⁴² City of Albuquerque. “Planned Growth Strategy.”

²⁴³ City of Albuquerque. *Climate Action Plan*. 2009. <https://www.cabq.gov/cap/CAPREV11forWEB.pdf>.

of commerce, and the Coalition of Neighborhoods, among others.²⁴⁴ After the task force released the Drought Management Strategy in 2003, the state of New Mexico imposed a legally binding benchmark on Albuquerque to reduce its water usage to 155 gallons per person per day by 2024.²⁴⁵ To reach the benchmark, city and county officials launched community engagement activities. Resident input was gathered through public forums, outreach programs, business and civic groups, and a Customer Advisory Committee.

In parallel with drought planning, the city developed its Planned Growth Strategy, which encouraged smart growth strategies to conserve water. In 1998 and 1999, with help from Shared Vision, a local nonprofit, the city held public forums to get input on the strategy. One of the residents' priorities was to develop in areas where infrastructure already existed. As a result, creating compact neighborhoods connected to existing infrastructure and transportation became a central feature of the strategy. The city officially adopted elements of the strategy in 2002.²⁴⁶

By 2007, the Albuquerque Bernalillo County Water Utility Authority (ABCWUA) had taken over the water and wastewater utility. It adopted a Water Resources Management Strategy to build on the city's drought strategy. ABCWUA regularly reviews and updates the strategy with input from a citizen board, stakeholder groups, and customers. In the 2016 update, ABCWUA set a new consumption goal of 110 gallons per person per day by 2037 and adapted policies and programs based on public and stakeholder input.²⁴⁷

ABCWUA does not make land use decisions, but ensuring a reliable water supply is crucial to development. The Water Resources Management Strategy includes a policy on linking land use planning with water management, which recommends that ABCWUA:

- Work with the city and county to update the comprehensive plan and other plans to ensure that development plans align with infrastructure.
- Base its capital planning process on the city and county's growth master plan to make land use and infrastructure policies consistent.
- Support infill development and more compact development because they use water more efficiently.
- Encourage the city, county, and state to adopt water-efficient building codes and landscaping standards for new construction.²⁴⁸

Albuquerque, Bernalillo County, and ABCWUA have demonstrated that adapting to drought need not incur high costs. Communities can use methods such as amending building codes, offering rebates and other incentives, and running public education programs—many of which can save residents and businesses money in addition to conserving water. As other communities face climate change scenarios that project more severe droughts, Albuquerque can be a model—it has diversified and protected its water resources by establishing a culture of conservation that engages every resident.

More information on Albuquerque's water planning is available on the ABCWUA website at www.abcwua.org.

²⁴⁴ City of Albuquerque. *Drought Management Strategy*. 2003.

²⁴⁵ Fleck, John. "Water Goals Met Early." *Albuquerque Journal*, Mar. 13, 2012. <https://www.abqjournal.com/main/2012/03/13/news/water-goals-met-early.html>.

²⁴⁶ City of Albuquerque. Council Bill F/S O-02-39, Adopting Elements of a Planned Growth Strategy. 2002. <http://www.cabq.gov/council/documents/pgs/o-39fs3.pdf>.

²⁴⁷ Albuquerque Bernalillo County Water Utility Authority. *Water 2120: Securing Our Water Future*. 2016. <http://www.abcwua.org/uploads/files/Water%202120%20Approved%20Policy%20Document.pdf>.

²⁴⁸ Albuquerque Bernalillo County Water Utility Authority, *Water 2120*.

8. Adapting to Wildfire

Introduction

Higher temperatures and drought contribute to more frequent, severe, and expansive wildfires.²⁴⁹ The area where development meets undeveloped land, known as the wildland-urban interface (WUI), is at particularly high risk from wildfires. One study estimated that about 14 percent of the privately owned land in the WUI in western states has been developed, leaving a considerable amount of land that could yet be developed. Of the developed land, very little—about 2 percent—has been built compactly, with lot sizes of less than 1 acre. The vast majority, 73 percent, has been developed with lot sizes between 10 and 40 acres.²⁵⁰ As of 2010, “the WUI of the lower 48 states includes about 44 million houses, equivalent to one of every three houses in the country, with the highest concentrations of houses in the WUI in California, Texas, and Florida.”²⁵¹



US FWS Southeast Region via flickr.com

Figure 34: The wildland-urban interface is illustrated here on Merritt Island in Florida.

Other research has found that “the arrangement and location of structures strongly affects their susceptibility to being destroyed in a wildfire, and... empirically based maps developed using housing density and location better identify hazardous locations than fuel-based maps.” This study found that “Property loss was more likely in smaller, more isolated housing clusters with low- [sic] to intermediate housing density and fewer roads.... Property loss was more likely to occur when structures were surrounded by wildland vegetation rather than by urban or impervious areas.” The study concluded that “new development would have a lower likelihood of burning if it were located away from fire-prone areas, such as wind corridors or steep slopes, and if new structures were arranged in intermediate- to high-density neighborhoods designed to minimize the amount of interface between homes and wildland vegetation. New development within large, existing urban areas, which typically also have better firefighter access, would also lower the likelihood of burning, compared to new development in more isolated, remote settings.”²⁵²

While more compact development is less susceptible to fire, buildings that are closer together can spread fire from structure to structure, making fire-resistant materials and techniques more important in compactly developed neighborhoods.

Wildfires can have immediate and lingering health effects on people in affected communities. Most healthy adults and children will recover quickly from smoke exposure and will not suffer long-term health

²⁴⁹ EPA. “Climate Change Indicators: Wildfire.” <https://www.epa.gov/climate-indicators/wildfires>. Accessed Aug. 4, 2016.

²⁵⁰ Gude, Patricia, Ray Rasker, and Jeff van den Noort. “Potential for Future Development on Fire-Prone Lands.” *Journal of Forestry*, Jun. 2008. https://headwaterseconomics.org/wphw/wp-content/uploads/PGude_2008_Forestry.pdf.

²⁵¹ U.S. Department of Agriculture. “As Wildfires Continue to Burn, New Maps Shows Expansion of Wildland-Urban Interface.” Press release, Sep. 10, 2015. <http://www.usda.gov/wps/portal/usda/usdahome?contentid=2015/09/0250.xml>.

²⁵² Syphard AD, et al. “Housing Arrangement and Location Determine the Likelihood of Housing Loss Due to Wildfire.” *PLoS ONE* 7(3) (2012): e33954.

consequences. However, sensitive populations might experience more severe acute and chronic symptoms. Risk to fine particle-related health effects varies throughout a lifetime, generally being higher in early childhood, lower in healthy adolescents and younger adults, and increasing in middle age through old age as the incidence of heart and lung disease and diabetes increases.²⁵³

Wildfire is a challenging climate change-related threat to address through land use policies because of resistance to regulation in many of the areas currently most prone to wildfires. Often, people move to homes in remote areas on large lots for privacy; they might perceive regulations as telling them how and where to live. Particularly in western states, localities that govern land in the WUI are often reluctant to use regulation and land use planning to address wildfire risk.²⁵⁴ Other states, such as Florida, see less resistance to regulation. Any regulation will win more support if the public understands the risk and how the policy or regulation reduces it.

Response to the Problem

Most of the policy options in this chapter deal with reducing or preventing new development in the WUI or designing it to be safer. However, many communities also have to consider what to do about existing development that is already in harm's way and too spread out to protect effectively with land use measures like preserving open space as a fire break. In these cases, effective strategies to reduce fire risk can include thinning vegetation and brush to reduce the fuel available to wildfires, requiring and periodically inspecting water storage and sprinkler systems, and using educational programs like Ready, Set, Go! to help homeowners in the WUI protect themselves.²⁵⁵ As these strategies do not have any additional benefits related to smart growth and green building, they are not discussed here, but they can be valuable tools for communities in wildfire-prone areas.

To protect areas vulnerable to wildfire, communities can offer incentives and education to encourage voluntary compliance and can update their land use regulations to incorporate wildfire protection measures with complementary smart growth strategies. For areas in the WUI that do not regulate zoning, updating building codes to meet at least minimum International Fire Code standards ensures structures are less vulnerable. In some instances, fire protection districts can also be a mechanism to enforce some fire protection building codes. Wildfire protection education is essential for property owners in these areas.²⁵⁶ Some rural communities that do not use zoning do have subdivision regulations, and these regulations can be used to encourage or require development patterns that keep homes away from wildlands and to require adequate road access to ensure that residents can evacuate and firefighters can safely get to and from a fire in the area.²⁵⁷

Many communities use Firewise Communities, a set of site design, construction, and landscaping guidelines developed by the National Fire Protection Association.²⁵⁸ However, communities should recognize that Firewise Communities focuses on protecting structures from fire and does not address other economic, environmental, health, or societal goals the community might have for its development.

²⁵³ EPA, U.S. Forest Service, U.S. Centers for Disease Control and Prevention, and California Air Resources Board. *Wildfire Smoke: A Guide for Public Health Officials*. Revised May 2016. https://www3.epa.gov/airnow/wildfire_may2016.pdf.

²⁵⁴ Headwaters Economics, *Local Responses to Wildfire Risks and Costs: Case Studies and Lessons Learned*.

²⁵⁵ In Ready, Set, Go! programs, firefighters teach WUI residents to "be Ready with preparedness understanding, be Set with situational awareness when fire threatens, and to Go, acting early when a fire starts." Ready, Set, Go! "Frequently Asked Questions." <http://www.wildlandfirersg.org/About/FAQs>. Accessed Jun. 23, 2016.

²⁵⁶ Artley, Donald K. *Wildland Fire Protection and Response in the United States*. International Association of Fire Chiefs. 2009. https://www.iafc.org/files/wild_MissionsProject.pdf.

²⁵⁷ Duerksen, Chris, Don Elliott, and Paul Anthony. *Addressing Community Wildfire Risk: A Review and Assessment of Regulatory and Planning Tools*. Fire Protection Research Foundation. 2011. <http://www.nfpa.org/news-and-research/fire-statistics-and-reports/research-reports-for-emergency-responders/fire-prevention-and-administration/addressing-community-wildfire-risk>.

²⁵⁸ Firewise Communities. *Safer from the Start: A Guide to Firewise-Friendly Developments*. NFPA. 2009.

In the longer term, some communities are encouraging development in already-developed areas and discouraging it in the WUI. Limiting development in the WUI not only helps preserve open space for recreation and ecological functions, it also reduces the number of people in harm's way and, particularly in subdivisions that have only one or two exits, helps ensure that current residents can evacuate quickly if need be.

Potential Benefits

- Protecting the lives and health of residents and firefighters.
- Protecting homes and other buildings.
- Preventing the spread of wildfires.
- Using public funds wisely.

Implementation Approaches

I. Modest Adjustments

- **Establish a task force that includes representatives from the public, nonprofit, private, and institutional sectors and have them review building codes, development patterns in the WUI, and other relevant elements like brush management codes.** This group could also examine development issues such as growth plans, existing and future land use, and zoning to understand how these policies affect emergencies and emergency response. Their input can help inform updates of building and zoning codes as well as fire response plans. They can also help reach out to developers, residents, and businesses to get their input and to educate them about the risks of developing in the WUI.
- **Incorporate wildfire scenario planning into local planning** to get a better sense of historical and projected wildfire-prone areas. Use this information to include wildfire issues in the comprehensive plan to reduce or prevent future development in wildfire-prone areas, and designate areas prone to wildfire in the future land use element and future land use maps.²⁵⁹
- **Strengthen requirements for building and roof materials to be both fire-resistant and green.** Some fire-resistant building materials would not meet green building standards because they are treated with flame-retardant chemicals that can harm people's health, while fire fighters are concerned about green building techniques and materials that might make fires more hazardous. Involve fire protection experts and green building experts in setting standards.²⁶⁰ Communities can make it easier for homeowners and builders by compiling examples of materials that meet both fire and green building standards and making this information publicly available. For example, fire-rated glass can meet energy-efficiency standards. Fire-resistant insulation can be made from minerals instead of using chemicals that might pose health hazards.

Practice Pointer

Create wildfire risk reduction policies proactively, based on development location and density, historical fire occurrences, fuel loads, projected changes to wildfire-prone areas, and similar information, rather than in response to a major wildfire.

²⁵⁹ Florida Department of Agriculture and Consumer Services, Division of Forestry. *Wildfire Risk Reduction in Florida: Home, Neighborhood, and Community Best Practices*. 2010. http://freshfromflorida.s3.amazonaws.com/Wildfire_Risk_Reduction_in_FL.pdf.

²⁶⁰ Gollner, Michael, Amanda Kimball, and Tracy Vecchiarelli. "Fire Safety Design and Sustainable Buildings: Challenges and Opportunities: Report of a National Symposium." National Fire Protection Association and Fire Protection Research Foundation. Nov. 7-8, 2012. http://www.gollnerfire.com/wp-content/uploads/2013/05/Foundation_Sustainable_Building_Design_Symposium_Proceedings-Final.pdf.

- As an example of how to ensure fire safety without harming public health, California changed its state furniture flammability standard to allow increased fire safety without the use of potentially hazardous flame retardants. The state is investigating a similar change for foam plastic insulation materials, which could help local governments and builders find environmentally safe, effective insulation for wildfire-prone areas.²⁶¹
- **Require sites for new emergency facilities, hospitals, municipal buildings, and buildings where large numbers of people gather (such as schools or houses of worship) to be outside of areas at high risk for wildfire, well-connected to existing development, and easy for people to access without driving.**
- **Require new developments to submit a fire protection plan during site plan review.** Plans should demonstrate where water can be obtained, how defensible space will be maintained, and how residents and firefighters can quickly and safely get in and out of the development.

Practice Pointer

Encourage xeriscaping in the defensible space around a building. The design of the defensible space and the plants selected can require less water for irrigation while preventing fire from spreading. Regulations or guidelines for defensible space could cite xeriscaping as a preferred option. The community could offer free guides on plants and landscape designs that use less water and meet Firewise guidelines.

2. Major Modifications

- **Encourage or require compact development away from the WUI through comprehensive plans, area plans, and zoning codes.** These strategies protect environmentally sensitive lands and land within the WUI from development pressure. Specific strategies can include:
 - Increasing the density of development and redevelopment allowed in or near existing towns and neighborhoods and along transit corridors.
 - Prioritizing infill development.
 - Promoting mixed uses.
 - Using transfer of development rights to create incentives to preserve land in wildfire-prone areas and develop in safer areas.
- **In subdivision regulations or zoning, require clustered development that is well-connected to existing development, has multiple points of entry/exit, and has good internal street connections to make walking and biking easier.** Clustering development lets homes be placed closer together because some of their defensible space is shared (e.g., green space encircling the homes that acts as a control line to stop the spread of fire).²⁶² This green space can house trails, parks, recreational activities, and water bodies, making it an everyday amenity for the community. If it is designed with both landscape- and neighborhood-scale green infrastructure techniques, the green space can also help capture and filter stormwater runoff, protecting water quality.
- **Adopt wildfire hazard or WUI overlay districts** with development regulations based on factors like slope hazard, structure hazard, and fuel hazard. These districts can require certain design and construction standards to minimize the risk of structures catching fire, as well as landscaping standards and infrastructure requirements for emergency vehicles to access the development.

²⁶¹ American Public Health Association. "Reducing Flame Retardants in Building Insulation to Protect Public Health." Policy Statement 20156. Nov. 3, 2015. <http://www.apha.org/policies-and-advocacy/public-health-policy-statements/policy-database/2016/01/05/18/39/reducing-flame-retardants-in-building-insulation-to-protect-public-health>.

²⁶² Florida Department of Agriculture and Consumer Services, *Wildfire Risk Reduction in Florida*.

Because they are overlay districts, the underlying zoning remains in effect, so communities that already have smart growth zoning can ensure that new development in the WUI adheres to the same standards.

- Douglas County, Colorado's Wildfire Hazard Overlay District requires the county's wildfire mitigation specialists to determine a wildfire hazard rating for structures based on the combined effects of slope, aspect, topography, climatic conditions, weather, wildfire behavior, and existing vegetation. The rating can incorporate additional factors such as evacuation conditions, density of structures, history of fire occurrence, and availability of local emergency services.²⁶³ See the case study in this chapter for more information.
- **Consider adopting the Firewise Communities Program**, administered by the National Fire Protection Association, which encourages local solutions for site design, construction, and landscaping guidelines for homeowners. However, recognize that the program does not consider any issues beyond protecting homes from fire—it does not discourage development in WUI lands, and it could promote dispersed development and cutting down trees, which can run counter to a community's other goals. In addition, it might create a false sense of security that can encourage people to build in the WUI. One analysis noted, "Firewise may unintentionally increase fire risk by encouraging local officials, developers, and home owners to buy and develop property in high-risk fire areas, thus resulting in more rather than fewer homes that are vulnerable to future forest fires."²⁶⁴

Practice Pointer

Keep your community's long-term goals in mind when making risk management decisions. For example, defensible space techniques can conflict with environmental goals and homeowners' desires because of their impacts on heavily wooded areas and natural habitats.

3. Wholesale Changes

- **Require subdivisions to have a highly connected street network with multiple connection points to the external street network.** Residents will be able to evacuate faster if they have multiple routes to choose from, and firefighters can more easily get to the subdivision to protect it. If one route is blocked or unsafe, other routes will be available.
- **Acquire, through outright purchase or an easement, open space between dense forested areas and residential development to help prevent fire from spreading to developed areas.** A Community Protection Zone of open, green space at least 100 to 300 feet wide can separate homes from wildlands. This space could include recreational amenities such as trails or community gardens.²⁶⁵ Making the protection zone a community amenity would also help ensure that it is maintained to prevent it from becoming overgrown.

Practice Pointer

Take the community's priorities and values into consideration when developing policies. People often choose to live in the WUI to be surrounded by nature and left to themselves. Non-regulatory solutions, such as incentives to preserve open space, might be more palatable to residents.

²⁶³ Douglas County. *Zoning Resolution*. Section 17: Wildfire Hazard - Overlay District. Amended 2007.

²⁶⁴ <http://www.douglas.co.us/documents/section-17-3.pdf>.

²⁶⁵ Headwaters Economics, *Local Responses to Wildfire Risks and Costs: Case Studies and Lessons Learned*.

²⁶⁶ Florida Department of Agriculture and Consumer Services, *Wildfire Risk Reduction in Florida*.

Resources

- The University of Florida IFAS Extension’s “Fire in the Wildland-Urban Interface: Reducing Wildfire Risk While Achieving Other Landscaping Goals” (undated) offers landscape design and specific plants Florida homeowners can use that meet Firewise landscaping standards and use less water: <http://edis.ifas.ufl.edu/fr162>
- Some communities use the International Wildland Urban Interface Code and/or National Fire Protection Association codes and standards. *NFPA 1141, Standard for Fire Protection Infrastructure for Land Development in Wildland, Rural, and Suburban Areas* could be particularly relevant, as it “addresses the design of subdivisions and development in areas where threats of natural disasters or human-caused hazards in suburban/rural areas are not addressed by other planning and development documents.” These codes are primarily about fire protection; municipalities would need to balance them with other community goals: https://www.usfa.fema.gov/wui_toolkit/wui_codes.html
- Fire-Adapted Communities offers resources and a learning network where communities can share information: <http://www.fireadapted.org>

Guidance and Metrics

LEED for Neighborhood Development

Neighborhood Pattern and Design Prerequisite: Connected and Open Community

For projects under 5 acres, requires the project to have within one-quarter mile of its boundary connectivity of at least 90 intersections per square mile. For projects larger than 5 acres, requires internal connectivity to be at least 140 intersections per square mile. These larger projects’ circulation networks must have at least one connection intersecting the project boundary at least every 800 feet.

STAR Community Rating System

Built Environment Objective 3: Compact & Complete Communities

Adopt a mobility or circulation plan for compact development. Identify areas appropriate for compact development on the community’s future land use map.

Health & Safety Objective 6: Hazard Mitigation

Reduce over time the percentage of residents living in high-risk areas. Adopt land use regulations that limit development in high-risk areas.

Living Community Challenge

Imperative 1: Limits to Growth

Projects can be built only on previously developed sites that are not on or adjacent to any sensitive ecological area.

Case Study: Douglas County, Colorado

Douglas County is a fast-growing county between Denver and Colorado Springs that has been largely rural but is becoming part of the Denver suburbs. To better prepare for wildfires, the county amended its zoning and building codes, adopted policies in its Comprehensive Master Plan, and completed a Community Wildfire Protection Plan (CWPP).

Zoning and building codes: Douglas County amended its zoning ordinance to create a Wildfire Hazard Overlay District. It amended its building code to create Wildfire Mitigation Standards that apply to property and structures in the overlay district. These standards analyze a site's fire hazard using components that rate the slope hazard, fuel hazard, structure hazard, WUI rating, and other factors such as whether the area has municipal fire hydrants.

Wildfire mitigation specialists use these components to assign ratings to development sites to determine what mitigation measures will be needed. The higher the rating, the higher the hazard: for example, a site with small, light vegetation will receive a fuel hazard rating of 1, while a site with heavy brush will receive a 3.²⁶⁶

Comprehensive Master Plan: In the 1990s, the county opted into the Colorado State Growth Management Act, which required the county to participate in growth management planning as the region's population and built environment continued to expand.²⁶⁷ In 2010, Douglas County signed the Mile-High Compact, an agreement among municipalities in the Denver region to work together to manage growth. It incorporated the regional growth management vision, along with wildfire protection strategies, into its 2035 Comprehensive Master Plan, adopted in 2014. The plan directs urban development (generally, development that is denser than one unit per 2.5 acres) to already-developed, designated urban areas and outlines strategies to improve public health, protect open space and parks, and encourage walkable neighborhoods, among other goals. The plan encourages "low-impact, nonurban land uses" in environmental hazard areas such as land susceptible to wildfires. It notes:

"Uses such as agriculture or grazing, open space, parks, or certain low-intensity recreational uses are compatible because of the lack of permanent structural improvements. Limiting development in hazard areas creates dual benefits: residents are spared the expense of hazard mitigation and maintenance, while the most scenic land in the County can be preserved for open space or as land-use buffers."²⁶⁸

Specific policies in the plan include:

- "Residential development in severe-wildfire areas, where mitigation methods are determined impractical or excessive, is generally inconsistent with this Plan.

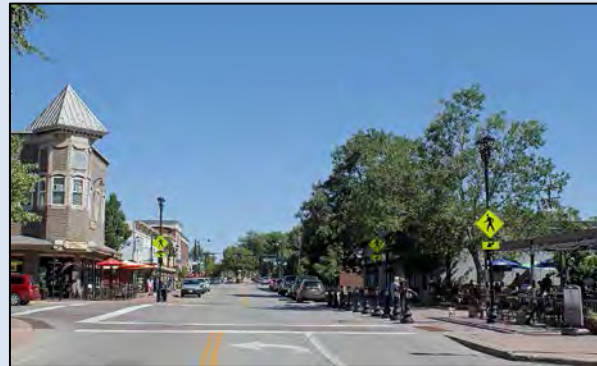


Figure 35: Downtown Parker, Colorado, illustrates Douglas County's policies encouraging walkable neighborhoods.

Jeffrey Beall via Wikimedia.org

²⁶⁶ Douglas County. Resolution No. R-012-110. Exhibit B: Wildfire Mitigation Standards. Adopted Sep. 25, 2012.

<http://www.douglas.co.us/documents/2012-code-amendments.pdf>.

²⁶⁷ Douglas County. *2030 Comprehensive Master Plan*. 2008.

²⁶⁸ Douglas County Department of Community Development. *2035 Comprehensive Master Plan*. Adopted Jun. 16, 2014. <http://www.douglas.co.us/land/comprehensive-master-plan>. p. 9-1.

- Locate facilities with high concentrations of people (churches, schools, employment centers, residential development and recreation facilities, etc.) away from severe wildfire hazard areas where mitigation is impractical or excessive.
- Link existing development to new development to provide multiple access points, where practical.
- Ensure that wildfire mitigation practices and policies are implemented throughout the development review process.”²⁶⁹

From 1990 to 2000, Douglas County was the fastest-growing county in the United States, growing by 191 percent.²⁷⁰ From 2000 to 2010, the county’s rate of growth slowed, but it was still the fastest-growing county in the state, adding 140,000 people. In part because of the county’s commitment to direct development to existing communities, about 91 percent of homes are in designated urban areas.²⁷¹

Measures to direct development to existing communities also improve quality of life. For example, the comprehensive plan encourages neighborhood connectivity so that emergency services can better reach residents in the event of a fire. Better connectivity also promotes compact development and walkable neighborhoods that enhance public health. These policies also help preserve open space and natural areas, protecting ecosystems and wildlife.

Community Wildfire Protection Plan (CWPP):

The county completed its CWPP in 2011. The plan incorporates Firewise Communities standards and includes a wildfire hazard assessment, identification of communities at risk, and recommendations on how to reduce that risk. For example, the plan recommends that structures in the WUI have a minimum 70 feet of defensible space.²⁷² This amount of defensible space generally would not be possible in compactly developed neighborhoods, but the Comprehensive Master Plan encourages only low-impact uses in wildfire hazard areas.

Community participation and input were important in developing the CWPP. Between 2010 and 2011, public meetings were held in each of the county’s fire protection districts, and the county website encouraged residents to attend. Although the plan was completed in December 2011, it is a “living document” that will be updated based on expert advice and resident input.²⁷³

By incorporating wildfire protection measures into its zoning ordinances, building codes, and comprehensive master plan, the county has linked public safety efforts to wider goals related to growth, demographic change, and quality of life and helped show how smart land use strategies, whether they are implemented by individuals or by the county, can reduce vulnerability to fire threats.

More information on Douglas County’s wildfire mitigation efforts is available at www.douglas.co.us/land/wildfire-mitigation.



Jeffrey Beall via Wikimedia.org

Figure 36: Encouraging development in designated urban areas can help Douglas County absorb growth while protecting its farmland and land in the WUI.

²⁶⁹ Ibid, p. 9-4-9-5.

²⁷⁰ Perry, Marc J., and Paul J. Mackun. “Population Change and Distribution: 1990 to 2000.” Census 2000 Brief, Apr. 2001. U.S. Census Bureau. <https://www.census.gov/prod/2001pubs/c2kbr01-2.pdf>.

²⁷¹ Douglas County Department of Community Development. “Douglas County Demographic Summary.” Updated Apr. 2016. <http://www.douglas.co.us/documents/douglas-county-demographics-summary.pdf>.

²⁷² Douglas County. *Community Wildfire Protection Plan*. 2011. <http://www.douglas.co.us/land/wildfire-mitigation/community-wildfire-protection-plan>.

²⁷³ Ibid.

Appendix: Additional Resources

Each chapter includes resources specific to the strategies discussed in that chapter. This appendix lists more general resources on:

1. Smart growth
2. Green building
3. Social equity
4. Climate adaptation
5. Identifying potential climate change impacts

1. Smart growth

- EPA’s Smart Growth Program offers tools, publications, research, technical assistance, and other resources to help implement smart growth strategies: <https://www.epa.gov/smartgrowth>
- EPA’s *Essential Smart Growth Fixes for Rural Planning, Zoning, and Development Codes* (2012) and *Essential Smart Growth Fixes for Urban and Suburban Zoning Codes* (2009)—the models for this publication—have specific fixes that can help local governments amend their codes and ordinances to promote more environmentally and economically sustainable growth: <https://www.epa.gov/smartgrowth/essential-smart-growth-fixes-communities>
- NOAA’s Coastal & Waterfront Smart Growth website provides tools, techniques and case studies highlighting smart growth approaches for coastal and waterfront communities: <http://coastalsmartgrowth.noaa.gov>
- The National Complete Streets Coalition has extensive resources on complete streets policies: <https://smartgrowthamerica.org/program/national-complete-streets-coalition>

2. Green building

- EPA’s *Tribal Green Building Toolkit* has tools to help tribes implement green building strategies. The Resilience and Adaptability Section might be particularly relevant: <https://www.epa.gov/green-building-tools-tribes/tribal-green-building-toolkit>
- EPA’s *Sustainable Design and Green Building Toolkit for Local Governments* (2013) helps local governments, developers, and other building professionals identify and remove barriers to sustainable design and green building in permitting processes: <https://www.epa.gov/smartgrowth/sustainable-design-and-green-building-toolkit-local-governments>

3. Social equity

- EPA’s EJSCREEN screening and mapping tool provides a nationally consistent dataset and approach for combining environmental and demographic indicators. Users can identify areas with minority or low-income populations, possible environmental quality problems, and related factors: <https://www.epa.gov/ejscreen>
- EPA’s “Climate Change, Health, and Populations of Concern” materials summarize key points from the U.S. Climate and Health Assessment for eight populations that are disproportionately affected by climate change impacts: <https://www.epa.gov/climate-impacts/climate-change-health-and-populations-concern>
- PolicyLink’s Social Equity Atlas lists national and local sources for data and maps, as well as other social equity resources: <http://nationalequityatlas.org/about-the-atlas/resources>

- The NAACP developed a sample list of indicators that communities can use to help make sure they are considering equitable climate adaptation, *Equity in Building Resilience in Adaptation Planning* (2015): http://action.naacp.org/page/-/Climate/Equity_in_Resilience_Building_Climate_Adaptation_Indicators_FINAL.pdf
- Enterprise Green Communities' *Ready to Respond: Strategies for Multifamily Building Resilience* (2015) offers detailed strategies for owners of affordable multifamily housing to protect their buildings from extreme weather and flooding, adapt buildings to changing climate conditions such as higher temperatures, keep buildings safe and habitable if power or other services are lost, and encourage a sense of community so residents will support each other in an emergency: <http://www.enterprisecommunity.org/resources/ready-respond-strategies-multifamily-building-resilience-13356>

4. Climate adaptation

- EPA's Climate Change Adaptation Resource Center lets local government decision-makers create a package of information tailored to their needs. Users can find information about the risks posed by climate change to the issues they are concerned about, relevant adaptation strategies, case studies illustrating how other communities have adapted to those risks and tools to replicate their successes, and EPA funding opportunities: <https://www.epa.gov/arc-x>
- EPA's *Being Prepared for Climate Change A Workbook for Developing Risk-Based Adaptation Plans* (2014) provides guidance for conducting risk-based climate change vulnerability assessments and developing adaptation action plans. It is aimed at organizations that manage places, watersheds, or coastal environments: <https://www.epa.gov/cre/risk-based-adaptation>
- EPA's *Hazard Mitigation for Natural Disasters: A Starter Guide for Water and Wastewater Utilities* (2016) describes how water utilities can integrate with community hazard mitigation plans for greater climate resilience and potentially pursue federal funding opportunities: <https://www.epa.gov/waterutilityresponse/hazard-mitigation-natural-disasters-starter-guide-water-and-wastewater>
- EPA's Resilience and Adaptation in New England database (RAINE) provides examples of codes, ordinances and policies that communities have used to become more resilient: <https://www.epa.gov/raine>
- The Federal Highway Administration's *Assessment of the Body of Knowledge on Incorporating Climate Change Adaptation Measures into Transportation Projects* (2013) includes resources on cost-benefit analysis specifically related to climate change in "Section 5: Assessing Costs and Benefits of Adaptive Strategies": http://www.fhwa.dot.gov/environment/climate_change/adaptation/publications/transportation_projects/page05.cfm

5. Identifying potential climate change impacts

- The 2014 National Climate Assessment Report includes observed changes and projected impacts on regions and sectors: <http://nca2014.globalchange.gov>
- Regional climate scenarios developed for the National Climate Assessment: <https://scenarios.globalchange.gov>
- The U.S. Climate Resilience Toolkit links to resources from across the federal government: <https://toolkit.climate.gov>

- Climate Explorer offers create graphs, maps, and data of observed and projected temperature, precipitation, and related climate variables for every county in the contiguous United States: <https://toolkit.climate.gov/tools/climate-explorer>
- The U.S. Global Change Research Program's 2016 publication, *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment*, provides information on the growing risks that a change climate poses to human health and welfare: <https://health2016.globalchange.gov>
- EPA has two-page fact sheets with climate change impacts for each state: <https://www.epa.gov/climate-impacts/climate-change-impacts-state>
- EPA's Climate Change Indicators in the United States compiles key indicators that show the causes and effects of climate change: <https://www.epa.gov/climate-indicators>
- EPA's Scenario-Based Projected Changes Map, an easy-to-use mapping tool, provides local projected changes in annual total precipitation, precipitation intensity, annual average temperature, 100-year storm events, and sea level rise: <https://www.epa.gov/crwu/view-your-water-utilitys-climate-projection-scenario-based-projected-changes-map>
- NOAA's Regional Integrated Sciences and Assessment program provides links to regional teams that have developed detailed climate change scenarios and projected impacts: <http://cpo.noaa.gov/ClimatePrograms/ClimateandSocietalInteractions/RISAProgram.aspx>
- NOAA's Coastal Flood Exposure Mapper for the East Coast and Gulf of Mexico allows a user to quickly generate and share maps that show shallow coastal flooding areas, FEMA flood zones, storm surge, and sea level rise: <https://coast.noaa.gov/digitalcoast/tools/flood-exposure>
- NOAA's Sea Level Rise Viewer is a web mapping tool to visualize community impacts from coastal flooding or sea level rise: <https://coast.noaa.gov/digitalcoast/tools/slr.html>
- FEMA's Risk Mapping, Assessment, and Planning provides flood hazard maps: <https://www.fema.gov/national-flood-insurance-program-flood-hazard-mapping>

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