

EVIDENCE MATTERS

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Transforming Knowledge Into Housing
and Community Development Policy



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CLIMATE AND HOUSING

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PD&R





Message From PD&R Leadership

It is my great honor to provide the leadership introduction for this issue of *Evidence Matters*, which focuses on climate. Climate change is impacting communities across the United States, recently highlighted by droughts and wildfires in the west and flooding in the east. President Biden made addressing climate change a priority of his administration. Several days after taking office, the president released Executive Order (EO) 14008: Tackling the Climate Crisis at Home and Abroad. A key objective of the executive order is reducing net greenhouse gas emissions by at least 50 percent below 2005 levels by 2030. To accomplish this objective, the president created a National Climate Task Force, which includes leaders of all federal agencies and is charged with developing strategies and submitting policy recommendations for addressing the climate crisis, creating more resilient communities, and strengthening the economy through growth-stimulating measures, including green job creation.

resilient communities, and strengthening the economy through growth-stimulating measures, including green job creation.

In addition to its contribution to EO 14008, HUD is tasked with addressing related executive orders. The Executive Order on Climate-Related Financial Risk (EO 14030) directs HUD to collaborate with the U.S. Department of Veterans Affairs and the U.S. Department of Agriculture to consider approaches to better integrate climate-related financial risk into underwriting standards, loan terms and conditions, and asset management and servicing procedures. The Executive Order for Advancing Racial Equity and Support for Underserved Communities Through the Federal Government (EO 13985) requires HUD to allocate resources in a way that addresses the historic failure of the federal government to invest sufficiently, sustainably, and equitably in underserved communities, particularly communities of color. The Executive Order Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input (EO 13690) requires HUD to implement the Federal Flood Risk Management Standard and update HUD's floodplain management regulations.

At the end of 2021, HUD responded to each of these executive orders in its Climate Action Plan. Among the goals put forward were the following:

- To update programs, policies, and regulations to foster resilient projects, reverse environmental inequities, and ensure environmental justice in future HUD-assisted projects.
- To encourage investments in climate-resilient and energy-efficient retrofits of existing housing, incentivize green building design in new construction, and advance climate mitigation and adaptation strategies across HUD programs.
- To ensure that climate impacts and related environmental justice issues are considered in all HUD-assisted projects and actions by updating environmental review processes and standards through a combination of rulemaking, new guidance and resources, and updates to online tools.
- To help HUD stakeholders identify the most effective climate mitigation and adaptation options by improving access to data, particularly in low-income and minority communities.

HUD also established the Climate and Environmental Justice Council to implement and track progress toward satisfying the Climate Action Plan. The council is composed of senior management from across HUD's offices.

Although the Climate Action Plan was established only in November 2021, HUD already has achieved some of its goals. For example, the Office of Housing has published updated Federal Housing Administration mortgage standards that allow lenders to provide a 2 percent stretch on debt-to-income ratios for borrowers purchasing or refinancing a home that meets minimum energy-efficiency standards and that recognize the energy cost savings of a manufactured home with ENERGY STAR® certification when qualifying a borrower. HUD's Office of Community Planning and Development published a Resilient Building Codes toolkit for recipients of Community Development Block Grant – Disaster Recovery and CDBG Mitigation funds, and it produced an accompanying webinar series to help HUD customers incorporate resilience measures and stronger building codes when rebuilding after a disaster. My office, the Office of Policy Development and Research, partnered with the U.S. Department of Energy to host departmentwide training on energy efficiency. HUD is also currently working with other federal agencies to implement the Inflation Reduction Act, which is the most significant climate legislation in U.S. history and includes provisions to reduce energy costs for all families and allow owners of HUD-assisted multifamily properties to preserve tens of thousands of affordable rental homes by making them more efficient, healthier, and resilient.

In closing, I will echo Secretary Fudge in saying, "We have a tremendous opportunity to deliver climate justice to disadvantaged communities, lower energy expenses in affordable housing, and accelerate mitigation efforts to protect at-risk communities from natural disasters and the impacts of climate change." I look forward to working with HUD partners and stakeholders to make this opportunity a reality.

— Solomon Greene, *Principal Deputy Assistant Secretary for Policy Development and Research*

Editor's Note

This issue of *Evidence Matters* covers housing and climate change. In this issue, you will learn about the relationship between climate and housing and the ways we can adapt housing to be more sustainable and resilient to the changing environment.

The lead article, “The Role of Housing in Climate Change Mitigation and Adaptation,” discusses the relationship between housing and climate change, including the impact of housing on the environment and HUD’s role in climate mitigation and adaptation.

The Research Spotlight article, “Opportunities to Reduce Climate Risks Through Land Use Regulations,” examines land use regulations and zoning requirements and their effects on the environment and climate mitigation policies. Common zoning practices such as setback and parking requirements can negatively affect the environment.

The In Practice article, “Resiliency at Work,” highlights a number of climate change initiatives across the United States in response to natural disasters. These efforts include rebuilding projects in Paradise, California; green infrastructure building in New Orleans; and work done in Norfolk, Virginia, to increase environmental justice and resiliency to climate change.

We hope that this issue of *Evidence Matters* will offer readers an informed and comprehensive review of the relationship between climate and housing. We welcome feedback at www.huduser.gov/forums.

— Sean Martin, *Editor*

FEATURE

The Role of Housing in Climate Change Mitigation and Adaptation

Climate change poses a grave threat to the world, and action to mitigate its effects is urgently needed. Reducing greenhouse gas emissions, in particular, is necessary to slow the pace of climate warming.¹ Achieving significant reductions in emissions will require altering many aspects of human activity, including the construction and energy efficiency of residential housing.

Yet, even as we move to curb the speed of climate change and forestall further damage, the dangers of climate change are already apparent in slow-onset disasters such as permafrost melt, sea level rise, drought, and extreme heat as well as the increasing frequency, severity, and costs of immediate natural disasters such as hurricanes, floods, and wildfires. A home’s location, materials, size, design, and construction affect the degree to which it contributes to

climate change, exposes its occupants to climate-change-related hazards and financial risks, and protects its residents from such hazards. Many strategies are available to both communities and individuals to mitigate the risks posed by climate change and to increase resilience to future disasters.

This article examines the ramifications of housing for climate change, followed by relevant climate-related HUD initiatives.

Climate Change Consequences

The consensus of the international scientific community is that human activity, primarily through greenhouse gas emissions resulting from burning fossil fuels, has contributed to the warming of the planet over the past century.² The sweeping effects of climate change include disruptions to “human health,

HIGHLIGHTS

- **Housing intersects with climate change through its influence on greenhouse gas emissions and in the ways it both exposes and protects residents from the consequences of climate change.**
- **Using energy-efficient construction methods, adopting electrically powered appliances and heating and cooling systems, and locating housing near public transit are several strategies that can reduce the impact of housing on climate change.**
- **Housing and communities can be designed and built to be more resilient to natural disasters, which have become more frequent and severe because of climate change.**
- **HUD can lead by example by promoting energy efficiency and resilience within its own housing portfolio and helping localities build for resilience and climate adaptation.**

agriculture and food security, water supply, transportation, energy, ecosystems, and others.”³ Climate change can stress



Climate change has increased the frequency and severity of natural disasters, including severe flooding events, which have also become increasingly costly.

and damage infrastructure systems and ecosystems, make areas less hospitable to traditional economic activities such as farming and tourism, and alter energy efficiencies and demands in ways that create a vicious cycle.⁴ Climate change has increased the frequency and severity of natural disasters, whose aftermaths have also become increasingly costly. Among the many consequences of climate change, the United States has experienced diminishing water quality and supplies; extreme heat and droughts that have produced longer fire seasons and larger wildfires; and rising sea levels that, along with coastal storms, increase the dangers associated with storm surges, flooding, and coastal erosion.⁵ Lower-income and other marginalized populations tend to be the groups most vulnerable to these changes and the least able to protect themselves and recover from their effects.⁶ These groups also bear the greatest burdens of climate change mitigation policies and practices.⁷

How Does Housing Affect Climate Change?

Housing relates to climate change in two ways. First, the location, construction, and energy consumption of homes directly affect their contributions to greenhouse gas emissions and climate change. Second, where housing is located and how it is constructed offer residents varying degrees of exposure to (and protection from) climate-related risks and hazards.

The manufacturing, transportation, and building processes of the residential construction industry constitute approximately 10 percent of total global energy consumption, mostly from nonrenewable sources.⁸ Energy use for those homes, once built, accounts for 19 percent of U.S. greenhouse gas emissions, an amount equivalent to that of the sixth-largest emitting country on Earth.⁹ As Krista Egger, vice president of Building Resilient Futures at Enterprise Community Partners, says,

“People may not be aware [of it], but when we use fossil fuels in our homes [for example, by cooking or heating with natural gas]... we are contributing to climate change.” The good news, according to Egger, is that “it’s powerful to know that if you live in a home, you can make a difference” in the pace of climate change by making adjustments in your everyday home life to use less energy, both through small acts such as adjusting or automating a thermostat and through larger changes such as converting from gas-fueled appliances to electric appliances.¹⁰

The location of housing relative to residents’ work and other destinations and the modes of transportation required and available to make those trips can contribute to greenhouse gas emissions.¹¹ Research shows that “low-density suburban environments generate more emissions than compact environments in the same city, and the more a city is marked by sprawl overall,

the more emissions it generates.”¹² This relationship is complex, however. According to Jones and Kammen, “Population density does correlate with lower HCF [household carbon footprints] when controlling for income and household size,” but mean emissions increase until a population density of 3,000 persons per square mile and then decline as density increases until leveling out at densities of 50,000 persons per square mile.¹³ Across metropolitan areas, the reduced emissions per household in high-density areas often are more than offset by higher emissions in the lower-density, largely suburban areas of the same metropolitan areas.¹⁴ Evidence suggests that increasing the share of multifamily housing and pursuing efforts to densify housing could net significant reductions in emissions. University of California, Berkeley professor Daniel Kammen says, “We now know how to build much greener housing, whether it is single-family or multifamily, but the real key is [to] link it smartly to public transit — you can dramatically change the carbon footprint and make peoples’ lives better.”¹⁵ Transit-oriented development can combine greater density, energy-efficient construction, and reduced car dependence to reduce energy usage and emissions.¹⁶ Yet zoning, regulatory barriers, and neighborhood opposition remain impediments to denser housing, including transit-oriented development.¹⁷ Trends such as increasing telework and the unaffordability of housing in cities are also reinforcing residential patterns in which more people live in less dense areas.¹⁸

The way housing is constructed can affect its contribution to greenhouse gas emissions. Offsite construction can streamline processes in ways that decrease overall energy consumption during construction and produce tighter building envelopes that reduce the amount of energy needed to heat and cool homes (see also the Winter/Spring 2020 issue of *Evidence Matters*).¹⁹ For onsite construction, using local materials and engaging in practices

that reuse or otherwise recycle demolition and construction waste can lower energy consumed in the transport of materials. Using materials that store carbon dioxide and that have clean production processes can also reduce the climate impact of housing construction.²⁰ Because concrete production emits greenhouse gases, alternative materials such as quarry dust, demolition waste, copper slag, steel slag, and fly ash can cut construction emissions.²¹ Other strategies, such as extending the life of a building, also reduce overall emissions.²²

Various building methods and materials can make homes more or less energy efficient, and, by extension, generate more or less greenhouse gas emissions (see also the Spring 2017 issue of *Evidence Matters*). In addition to tight building envelopes, buildings that maximize insulation and passive solar gains can be more efficient. Homes built to Passive House design standards combine these features with a heat recovery system to minimize heat loss while maintaining comfortable indoor conditions.²³ Innovations in wall assemblies such as panels, double-stud walls, and optimal value engineering framing retain structural soundness while providing higher insulation value, thereby keeping homes warmer in the winter and cooler in the summer.²⁴

Another route to reducing the contribution of housing to climate change is to convert nonelectric power sources to electric for air cooling, clothes drying, and especially water and air heating and cooking, which remain fossil-fueled to a high degree.²⁵ Shifting to electric power for all household systems is an important component of a broader shift to electrification in commercial and residential buildings, transportation, and industry that could reduce fossil fuel combustion emissions by 41 percent from 2005 levels even without reducing carbon in power generation and by as much as 74 percent with power system decarbonization, according to the National Renewable Energy

Laboratory.²⁶ For example, accounting for emissions from electricity generation, natural gas combustion emissions, and methane and refrigerant leaks, an electric heat pump offers a reduced 20-year greenhouse gas effect of 53 to 67 percent, including a 38 to 53 percent reduction in carbon dioxide emissions, compared with a gas furnace.²⁷ The potential reduction in emissions is greatest if the new electric equipment is energy efficient, and the shift will be more cost effective if the equipment is incorporated into all new construction rather than retrofitted at a later date.²⁸

Renewable energy sources, such as photovoltaic systems or geothermal energy accessed by heat pumps, can also power homes. To support the adoption of solar and other clean energy sources, the Biden administration has invoked the Defense Production Act to authorize the U.S. Department of Energy (DOE) to expand domestic production of solar panel parts, building insulation, and heat pumps. The administration seeks to expand solar manufacturing capacity to levels that would support more than 3.3 million homes to convert to solar energy sources each year.²⁹ “Every bit of housing, whether it is public or private, should have both solar power and heat pumps moving forward” with this push, Kammen says.³⁰ Homes that pair onsite renewable energy production with energy-efficient design and appliances can produce as much energy as they use over the course of a year; these are known as net-zero energy homes.³¹

Housing relates to climate change not just as a contributor to greenhouse gas emissions but also as a factor that both exposes us to and protects us from climate-related risks, depending on where it is sited and how it is constructed. Although climate change poses increased risks in all locations, some areas face particularly acute increases in danger. Residential development often has occurred in especially vulnerable places. For example, approximately 5.7 million U.S. residences are located in areas at risk of flooding and millions

more in areas at risk of wildfire.³² More than 40 percent of Americans live in a county that experienced a climate-related disaster in 2021.³³ A 2021 U.S. Environmental Protection Agency report showed that minority and low-income populations are more likely to live in areas with the highest level of climate-related disasters and conditions and therefore are more vulnerable to climate-related disasters. According to the National Oceanic and Atmospheric Administration (NOAA), in 2021, the United States experienced 20 natural disasters that cost at least \$1 billion each and \$145 billion in total. These high numbers reflect a long-term trend: after adjusting for inflation, the United States experienced more than twice the number of billion-dollar disasters in the 2010s than in the 2000s.³⁴

Another slow-moving disaster rooted in climate change is the historic 23-year drought in the Colorado River Basin and critical drought conditions and low reservoir levels throughout the western United States, where, as of June 2022, roughly 93 percent of land is experiencing drought or abnormally dry conditions and approximately 70 percent is experiencing severe or extreme drought conditions. Development patterns that promote or depend on high-intensity water consumption in low-resource, arid environments

are increasingly unsustainable in such conditions. Regional collaboration and planning among state and local governments, Tribal nations, and communities, along with strategic investments and conservation, are necessary to help these areas adapt and increase their resilience.³⁵

Research shows that renters are more physically vulnerable to disasters, in terms of both the neighborhoods in which they live and the buildings they occupy. Renters are disproportionately located in neighborhoods that have experienced disinvestment, have neglected infrastructure, and are in climate-vulnerable areas. They also are disproportionately living in older, poorly maintained buildings that are less able to withstand disasters. From 2015 to 2017, hurricanes, flooding, and wildfires, among other disasters, damaged more than a half-million units of rental housing, displacing 324,000 renters from their homes. Renters also may lack the resources to respond to and recover from disasters. Furthermore, as Brennan et al. write, “The intersection of economic marginalization, racial discrimination, social isolation, poor health, and legal exclusion creates cumulative vulnerability and means that both the immediate consequences of disasters and long-term obstacles to recovery are particularly acute for low-income renters of color.”³⁶

Just as homes, home construction, and housing locations can be modified to reduce the contributions of households to climate change, says Egger, “[t]here are strategies to make homes better prepared to withstand the impact of climate change. For instance, if you are in an area threatened by floods or sea level rise, you can elevate your home above baseline flood level to prevent damage or you can construct a roof out of noncombustible material so that it won’t burn in the event of a wildfire. There are so many strategies that can be taken.”³⁷ Nature-based solutions that people can implement at the household or community level include green infrastructure, which uses natural features such as green space and planted vegetation to help manage stormwater runoff, and blue infrastructure, which uses ponds, wetlands, and other water to cool spaces and collect stormwater (see “Resiliency at Work,” p. 22). Building owners can install rainwater collection systems, install vegetated roofs, plant trees, and replace hard surfaces with porous ones to aid in cooling and water management. Buildings can also be sited, landscaped, and oriented to optimize sun and wind exposure for temperature control. In cold climates, insulation and double-glazed, low-emissivity windows in homes can reduce heat transfer to outside.³⁸ Some individuals will be able to afford to implement these strategies themselves, with incentives, or with compensating benefits such as reduced insurance premiums, but government programs and subsidies likely will be needed for these strategies to reach the lower-income people who are often at greatest risk.

HUD’s Climate Change Opportunity

HUD has numerous responsibilities that could influence greenhouse gas emissions and energy consumption. HUD has an extensive portfolio of assisted housing and properties with mortgage insurance and establishes the national code for manufactured housing. HUD also funds disaster recovery efforts and community development



For areas affected by natural disasters, such as St. Thomas in the Virgin Islands, HUD’s CDBG-DR, CDBG-MIT, and other federal funding streams foster rebuilding that increases resilience to storms.

U.S. Department of Housing and Urban Development, Flickr

infrastructure, which offers the agency an opportunity to promote mitigation and resilience against the consequences of climate change. These roles allow HUD to contribute meaningfully to the diffuse challenge of climate change.³⁹

HUD's portfolio of about 4.5 million public and assisted housing units generate an estimated 13.6 million metric tons of carbon emissions annually. Approximately 1.2 million of these units are public housing units over which HUD has direct influence.⁴⁰ The department spends \$6.9 billion each year on utilities across its portfolio, an amount representing 14 percent of its overall budget.⁴¹ Reducing energy usage in HUD-assisted housing can reduce these costs for HUD and benefit households paying all or a portion of their utility bills.

HUD also invests Community Development Block Grant (CDBG) funds in community infrastructure, including \$89.8 billion since 1993 in CDBG-Disaster Recovery (CDBG-DR) grants — of which a subset is the CDBG Mitigation program (CDBG-MIT). Since 2019, HUD has granted more than \$16 billion in CDBG-MIT funds to 22 states and local governments. One CDBG-MIT project, the Louisiana Watershed Initiative, seeks to end unsustainable cycles of disaster and recovery through flood risk reduction. Using \$1.2 billion in CDBG-MIT-funds, the state of Louisiana is shifting to a watershed-based floodplain management and mitigation approach. The state will proactively collect data to understand, model, and project flood risks and address them by shifting development patterns to reduce risk, educating the public about flood risk, and adopting regional coordination of watershed management.⁴²

In 2013, HUD's Hurricane Sandy Rebuilding Task Force launched the Rebuild by Design competition, an innovative initiative to promote resilience-oriented planning and design strategies in the region affected by Hurricane Sandy in 2012. The competition awarded



Rebuild by Design Hudson River Project

HUD's Rebuild by Design competition encouraged communities to plan for resilience. One of the winning projects seeks to improve storm surge management along the Hudson River in New Jersey.

CDBG-DR funds to seven winning proposals while engaging all participants in resiliency planning and design.⁴³ One of the winning projects focused on protecting people and property from storm surges and high tides along the Hudson River. The project combines hard infrastructure, including floodwalls and seawalls, and soft infrastructure, such as berms and levees, to serve as a physical barrier to water on the coastline. It also improves stormwater management with green and grey infrastructure, including green roofs, bioretention basins, and swales. The state of New Jersey received a \$230 million award from HUD to execute the project.⁴⁴ Building on the success of the Rebuild by Design Competition, HUD funded the National Disaster Resilience Competition (NDRC), making \$1 billion available to applicants in 48 states, Puerto Rico, and Washington, DC, as

well as 17 local governments affected by natural disasters. As with Rebuild by Design, NDRC encouraged data-driven, community-led approaches to rebuilding so communities can better withstand future disasters.⁴⁵

HUD can also influence energy consumption and greenhouse gas emissions in manufactured housing, because it sets the national building code for this construction. In consultation with HUD, DOE recently has updated energy standards for some manufactured housing that will cut energy use and emissions and save residents money over the life cycle of the unit through reduced utility costs.⁴⁶ Any HUD program that funds investments in new housing or community infrastructure, such as the Rental Assistance Demonstration program, can incorporate climate mitigation and adaptation measures.

HUD's Climate Action Plan

Carlos Martín of the Joint Center for Housing Studies of Harvard University notes that integrating climate mitigation and adaptation into housing policy can be difficult or even overwhelming, particularly when considering persistent, pressing challenges such as affordability.⁴⁷ Nevertheless, HUD is acting to elevate climate mitigation, adaptation, and resilience alongside other important goals such as affordability and fair housing. In keeping with the Biden administration's goal to reduce greenhouse gas emissions by 50 to 52 percent below 2005 levels by 2030, HUD and other departments are pursuing a governmentwide approach to addressing climate change. In November 2021, HUD announced a climate action plan

to “implement a broad approach to the climate crisis that reduces climate pollution; increases resilience to the impacts of climate change; protects public health; delivers environmental justice; and spurs well-paying union jobs and economic growth.”⁴⁸ The plan has three goals: increasing climate resilience, reducing greenhouse gases, and pursuing environmental justice.⁴⁹

Increasing Climate Resilience: HUD and Climate Adaptation

HUD, through CDBG-DR, has long assumed a major role in rebuilding efforts following disasters. Increasingly, these efforts have aimed not just to rebuild, but to rebuild in ways that will help communities better withstand future disasters. Being forward looking

and resilience centered during disaster recovery may present communities with an opportunity to address slow-onset climate hazards, such as permafrost melt, sea level rise, drought, and extreme heat, that have not traditionally been declared disasters with accompanying funding but nevertheless are very costly disruptions.⁵⁰

HUD can also help individuals and communities adapt to climate-related threats by collecting and sharing data about building- and community-level climate risk; conducting and sharing research on the effectiveness of adaptation and resilience measures; assessing climate-related financial risk and incorporating it into asset management, underwriting standards, and

HUD Supports Mitigation and Resilience in Tribal Communities

Many Native Americans live in areas that are particularly vulnerable to natural disasters. In 2019, the U.S. Census Bureau created a measure of a community's capacity to respond to a disaster, the Community Resilience Estimate. Of the eight counties with at least 50 percent of residents deemed “at-risk” according to at least three resilience measures in the Community Resilience Estimate, five include tribal lands (two on the Navajo reservation and one each on the Crow Creek, Pine Ridge, and Cheyenne River Indian reservations), and another, Kusilvak Census Area, has a population that is approximately 90 percent American Indian or Alaska Native.¹ HUD's Climate Action Plan acknowledges “the history of environmental inequities that has created barriers to achieving climate resilience in Tribal communities.”² Inequities can be quite severe and significantly inhibit climate resilience and general health. For example, many tribal communities have limited access to clean water; approximately 15 percent of Navajo Nation has no access to piped water in their homes.³

Across several programs, HUD seeks to support tribal communities in increasing climate resilience. HUD's Indian Housing Community Development Block Grant (CDBG) program provides both competitively awarded single-purpose grants and first-come, first-served “imminent threat” grants to address immediate health and safety threats.⁴

HUD's Office of Native American Programs (ONAP) has funding sources that localities can use for climate change and disaster mitigation initiatives, including energy- and water-efficiency retrofits in HUD-assisted housing. ONAP also gives technical assistance to support sustainable, net-zero buildings and has created a climate resilience and adaptation website that describes funding and other resources to help tribes address climate change.⁵

Other federal government programs that offer tribes funding and assistance to increase climate resilience include the Bureau of Indian Affairs' Tribal Climate Resilience Program (TCRP), the U.S. Environmental Protection Agency's Tribal Green Building Toolkit, and the Federal Emergency Management Agency's hazard mitigation assistance grants.⁶ In fiscal year 2021, TCRP awarded nearly \$14 million to 79 tribes and 13 tribal organizations for climate adaptation planning and management.⁷

Climate Mitigation in Tribal Communities

An award-winning exemplar of climate mitigation, the Puyallup Nation Housing Authority's Places of Hidden Waters in Tacoma, Washington, provides culturally and environmentally responsive housing for Native American residents. Two

lending terms and conditions; and adopting stronger resilience standards, such as flood resilience, for HUD-assisted and Federal Housing Administration (FHA)-insured properties.⁵¹ HUD's Office of Community Planning and Development (CPD) has created a Community Resilience Toolkit to help recipients of grants from CPD programs, which include CDBG-DR, CDBG-MIT, and NDRC, identify and address climate-related hazards in their communities. The toolkit offers guidance on potential strategies and activities, many of which are eligible for CPD funding. The toolkit covers inland flooding, wildfires, drought, sea level rise, and coastal storms, among other climate-related threats. Since the 2016 HUD regulation "Modernizing HUD's

Consolidated Planning Process to Narrow the Digital Divide and Increase Resilience to Natural Hazards," jurisdictions have been required to consider how to increase their resilience to climate-related hazards in their Consolidated Plan.⁵² Jurisdictions can complete some resilience activities at the planning level or on a building-by-building basis, whereas others involve changes to community infrastructure.

Flooding. Climate change may cause inland flooding — resulting from heavy rains, rapid snowmelt, runoff, overwhelmed stormwater management systems, or failing dams or levees — to become more frequent and happen in areas that have not previously been prone to flooding. The National Flood

Insurance Program's National Flood Hazard Layer database can help homeowners and communities assess their flood risk. At the community level, planning can limit or exclude development in hazardous places and incentivize development in less flood-prone areas. Policymakers can encourage new development and rehabilitation through incentives to maximize permeable surfaces and better manage stormwater. Developers can construct individual buildings above the floodplain, and the utilities; water heaters; and heating, ventilation, and air conditioning systems in existing structures can be moved to a position above the floodplain. Building owners can also install sump pumps and backflow prevention devices.⁵³

stretches of 10 contiguous townhomes mimic the traditional longhouse form and are oriented to optimize passive solar heating and cooling. Ground-source heat pumps in the first phase of building and a solar installation in the second phase, combined with structural insulated panels forming a tight building envelope, help reduce energy use and the resulting greenhouse gas emissions dramatically. The homes achieved Leadership in Energy and Environmental Design for Homes Platinum certification.⁸

Climate Adaptation and Resilience in Tribal Communities

In some cases, the consequences of climate change demand dramatic adaptation measures. On Louisiana's Gulf Coast, coastal erosion and sea level rise have diminished the Isle de Jean Charles from more than 22,000 acres to only 320 acres. People of American Indian ancestry have made up most of the island's population, but remaining on the island has become increasingly untenable. In 2016, HUD awarded \$48.3 million in CDBG funds to begin the voluntary relocation of residents from the island to places less vulnerable to disaster. The project includes the development of a planned community with more than 500 homes, commercial and retail space, walking trails, and a community center, among other amenities.⁹ In this development, which residents named The New Isle, relocated residents will hold a mortgage, one-fifth of which will be forgiven each year for 5 years; residents will not be required to make payments as long as the property remains a primary residence and is insured.¹⁰

Because of the historic environmental inequities and the particular geographic vulnerabilities facing many tribal communities, ongoing support from HUD and other federal agencies is essential to help these communities mitigate climate change and build resilience against current and future climate-related threats.

¹ Alex Leeds Matthews. 2021. "Where Americans Are Most Vulnerable to Disaster," *U.S. News & World Report*, 13 October.

² U.S. Department of Housing and Urban Development. 2021. "Climate Action Plan," 33.

³ U.S. Department of Homeland Security. 2021. "National Preparedness Report," 9.

⁴ U.S. Department of Housing and Urban Development 2021, 13.

⁵ "Tribal Climate Resilience and Adaptation," U.S. Department of Housing and Urban Development website (www.hud.gov/program_offices/public_indian_housing/ih/tribal_climate_resilience_and_adaptation). Accessed 16 June 2022.

⁶ Ibid.

⁷ U.S. Department of Indian Affairs. n.d. "BIA announces Tribal Climate Resilience Grants totaling \$13.84 million awarded for FY 2021," Accessed 7 April 2022.

⁸ Jamie Blosser, Nathaniel Corum, Daniel Glenn, Joseph Kunkel, and Ed Rosenthal. 2014. "Best Practices in Tribal Housing: Case Studies 2013," Prepared for U.S. Department of Housing and Urban Development, Office of Policy Development and Research, 42–5.

⁹ "Isle De Jean Charles Resettlement," Isle De Jean Charles Resettlement website (isledejeancharles.la.gov). Accessed 15 June 2022.

¹⁰ "Resettlement Plan," Isle De Jean Charles Resettlement website (isledejeancharles.la.gov/resettlement-plan). Accessed 15 June 2022.



Louisiana Office of Community Development

With support from a National Disaster Resilience Competition grant, many residents of Isle de Jean Charles, which has suffered coastal land loss from saltwater intrusion, subsidence, sea level rise, and hurricanes, relocated to a more sustainable area that they named “The New Isle.”

Wildfires. The increasing frequency of storms with lightning, hot temperatures, and drought conditions is increasing the likelihood of frequent and severe wildfires and a longer wildfire season.⁵⁴ One study predicts that by the middle of the 21st century, areas in the western United States may see as much as a sixfold increase in the number of weeks that they could be at risk of large fires.⁵⁵ Even as the risk from fire has increased, the number of residences in fire-prone areas has increased dramatically since 1990.⁵⁶ In addition to destroying properties, wildfires pollute the air and can increase erosion and flooding risks.⁵⁷ Communities can take several actions to reduce their risk from wildfires. As with flooding, planners can reduce or restrict the construction of housing in high-risk areas. Individual homeowners can use fire-resistant materials such as composite shingles and brick siding, install ember-proof vents, remove combustible vegetation near the home, and keep yards free of debris.⁵⁸

Drought. Extended periods with little or no precipitation can lead to water

shortages, reduced soil moisture, poor water quality, and increased risk of wildfires and erosion. Although droughts can occur anywhere in the United States, they are a particular threat in the Southwest, Great Plains, and Southeast regions. Individuals and communities can learn about drought indicators in their area from NOAA’s National Integrated Drought Information System. Communities can explore the diversification of their water supply and develop conservation measures. They can set criteria for activating voluntary or mandatory conservation periods during which nonessential water uses are limited. Communities can also adopt incentives for household conservation efforts such as rain barrels, greywater systems, and water-saving appliances and fixtures.

Sea Level Rise and Coastal Storms.

Sea level rise — resulting from melting glaciers and ice sheets caused by climate warming — and the increasing frequency of coastal storms threaten properties and ecosystems in coastal areas. These areas face higher tides,

storm surges, and flooding, which, in turn, can exacerbate coastal erosion. Storms bring high winds that can cause damage directly or through the debris they carry. As with floods and fires, policymakers can discourage future development in high-risk areas. Coastlines can be better protected through structural interventions, such as sea walls and bulkheads, and nonstructural interventions, such as wetland protection programs.⁵⁹ Buyout programs can reclaim property that has been or might be developed and instead use it for water management or to remove homes from vulnerable sites.⁶⁰ As with inland flooding, buildings and utilities can be built or elevated above projected water heights or with open or deep foundations.⁶¹

Reducing Greenhouse Gas Emissions: HUD and Climate Mitigation

To reduce greenhouse gas emissions, a goal of HUD’s Climate Action Plan, HUD “must significantly improve the energy performance of HUD-assisted and FHA-insured assets while scaling up deployment of renewable energy... by

increasing investments in climate and energy retrofits of existing housing, incentivizing green building design in new construction, and proactively advancing climate mitigation and adaptation strategies across HUD programs.”⁶² HUD also seeks to create incentives for land uses that reduce dependence on cars, such as transit-oriented development.⁶³

HUD has implemented several programs to promote energy efficiency, including voluntary, incentive-based programs as well as mandatory ones. The Renew300 Initiative encouraged managers of federally assisted housing properties to adopt solar and renewable energy, resulting in a commitment from 80 owners to install renewable energy sources. Another incentive-based program, the Green Mortgage Insurance Premium, encourages multifamily housing properties with FHA insurance to commit to a green building standard with an ENERGY STAR® score of 75 or better and to benchmarking utilities. Benchmarking utilities, tracking usage statistics, and committing to reduced energy consumption are central to the Multifamily Better Buildings Challenge. Ninety-two partners joined the challenge, and as of 2020, 70 percent had successfully implemented benchmarking for more than 400,000 units and facilitated more than 21 trillion British thermal units in energy savings.⁶⁴

Rental Assistance Demonstration (RAD) conversions offer another opportunity to build for mitigation. RAD projects are required to conduct a capital needs assessment that analyzes energy- and water-saving systems and to adopt the most efficient, financially feasible option with a minimum requirement that they use ENERGY STAR® and WaterSense® products. HUD encourages new construction in the RAD, Choice Neighborhoods, Section 202 Supportive Housing for the Elderly, and CDBG-DR programs to meet or exceed green building standards such as ENERGY STAR for Multifamily High-Rise, ENERGY STAR® for New Homes, the U.S. Green Building Council’s Leadership in Energy and Environmental

Design rating system, and the National Green Building Standard.⁶⁵

Pursuing Environmental Justice

The goal of pursuing environmental justice runs through every aspect of the Climate Action Plan. Recognizing that communities of color, low-income communities, and historically underserved communities disproportionately face climate-related risks and hazards, are often least able to afford mitigation strategies and actions, and could be negatively affected by mitigation efforts (for example, escalating rents and home prices in areas that undergo mitigation improvements), HUD is targeting investments to support these communities with a goal of directing at least 40 percent of federal climate and clean energy investments to disadvantaged communities — consistent with the Biden administration’s governmentwide Justice40 Initiative.⁶⁶ As HUD supports climate adaptation and mitigation efforts, environmental justice — “ensuring equal protection from environmental and health hazards and providing equal and meaningful opportunity to participate in the decision-making process to achieve a healthy environment” — will be a guiding principle.⁶⁷

Broadly, HUD program participants and grantees are obligated to affirmatively further fair housing, acting to overcome patterns of segregation and remove barriers to opportunity for protected classes.⁶⁸ As part of the Climate Action Plan, in the coming years, HUD’s Office of Fair Housing and Equal Opportunity will identify and share guidance on best practices for community land use, such as zoning reforms and transit-oriented development, and on equitable implementation of disaster recovery and resilience funding. The office will also develop online resources and toolkits on climate resilience and environmental justice and work with HUD’s Office of Policy Development and Research and Home Innovation Research Labs to develop residential resilience guidelines for homebuilders and developers.⁶⁹

HUD has identified specific initiatives to promote both environmental justice and climate resilience. HUD will designate resources to provide access to data, technical support, and funding to help Tribal communities build resilient housing and infrastructure (see “HUD Supports Mitigation and Resilience in Tribal Communities,” p. 8). Consistent with the Section 3 program, HUD grantees should recruit low- and very low-income people and HUD-assisted residents for jobs supporting HUD-funded projects, including the green job opportunities needed for resilience projects. HUD can also deploy an equity lens to community engagement and environmental review processes and practices — for example, to ensure that people with limited English proficiency have access to HUD programs and personnel. Finally, HUD can promote the development of affordable housing in areas with fewer climate and environmental hazards and address longstanding environmental hazards, such as lead contamination, that disproportionately affect low-income communities and communities of color.⁷⁰

Conclusion

“There is an urgency for acting on climate change in terms of housing given the limited time we have to make a difference. We need transformative new investment to upgrade housing, particularly housing for low-income residents, to meet higher standards of energy efficiency,” says Egger.⁷¹ HUD can lead by example through changes to the housing over which it has direct or indirect influence and through producing and funding research focusing on climate mitigation and adaptation for housing and communities. Communities and property owners can immediately adopt a number of mitigation and adaptation activities, large and small, to slow climate change, prevent the worst of its impacts, and move toward a more resilient and sustainable future. “We have the start,” says Kammen. “We just have to do it.”⁷² **EM**

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Opportunities To Reduce Climate Risks Through Land Use Regulations

Land use regulations have been in the news over the past several years as the production of new housing has failed to keep up with demand, particularly in areas with strong economic growth.¹ The media has focused on high housing prices resulting from rules dictating large minimum lot sizes and setbacks, parking, and impact fees, among other requirements, along with zoning ordinances that limit housing in certain areas to single-family detached homes, and other regulatory components. These rules not only contribute to high housing costs and a shortage of homes, but they push housing farther away, leading to sprawl. Living in suburbs may seem part of the American Dream, but those areas come at a significant environmental cost and contribute to climate change.

The relationship between housing and climate change involves numerous factors, including greenhouse gas

emissions from the construction and operation of housing and its supporting infrastructure; longer travel distances when homes are not located near jobs, shops, resources, and amenities; and a larger portion of the population living in areas at risk of natural disasters. Current practices, including trends in location choices, are not sustainable. This article examines how development choices affect the environment and then explores the ways land use reforms can reduce negative environmental impacts and promote climate resilience. As jurisdictions consider revising land use regulations to reduce greenhouse gas emissions, they can address a range of related issues, such as increasing affordable housing and improving public health.²

Development Choices and the Environment

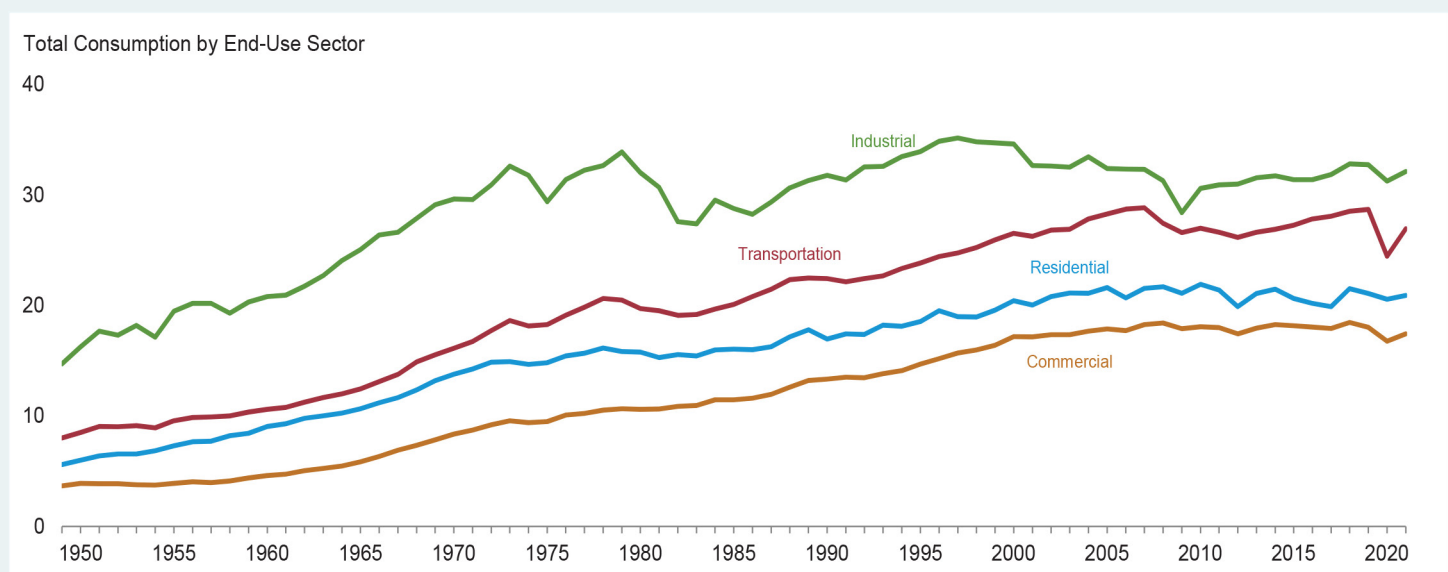
In the United States, states have delegated authority to local jurisdictions

HIGHLIGHTS

- Land use regulations, such as zoning ordinances and building codes that determine the location and type of residential development, impact the environment.
- Policies that promote higher-density, mixed-use developments with access to public infrastructure, along with energy-efficiency improvements to older housing stock, can reduce greenhouse gas emissions.
- Climate mitigation and adaptation policies should consider social equity and environmental justice and be tailored to a community's individual risks and resources.

to determine how land is used, what structures can be built, and how to balance competing priorities. Jurisdictions have developed a body of land use regulations that govern development, including zoning ordinances, subdivision rules, adequate public facility ordinances, traffic standards, design requirements, and other local rules. Building codes and environmental statutes impose additional requirements. Land use regulations and their implementation

Figure 1. Residential Use Constitutes More Than 20 Percent of the Energy Used in the United States



Source: U.S. Energy Information Administration. 2022. "Monthly Energy Review," Tables 2.1a, 2.1b. Accessed 8 August 2022.

determine where building occurs, what is built, and how it is built, all of which affect the environment. Because residential uses account for more than 20 percent of the nation's energy consumption (see figure 1), housing policies can play an important role in reducing energy use. Such policies can also reduce individuals' vehicle miles traveled. The U.S. Environmental Protection Agency estimates that 38 percent of greenhouse gas emissions from transportation come from passenger cars (which include personal and commercial-use vehicles).³

Location

Zoning ordinances establish geographic zones that guide land use. For example, land may be zoned for industrial use, commercial or retail use, residential use at various densities, or a combination of these. When zoning separates residential uses from retail uses — such as the grocery store and daycare center — individuals must travel longer distances to accomplish their daily tasks. Mixed-use zones, which allow retail and commercial establishments near housing, allow people to drive less and thus emit fewer greenhouse gases. People must spend more time in their vehicles when homes near job centers are too expensive, forcing them to live in more affordable housing farther away. Built environments are typically long lasting, locking in the carbon-intensive buildings and infrastructure that land use policies create.⁴

In 2011, journalist Emily Badger wrote that “suburban lifestyles represent one of the most serious threats to the climate.” Research finds urban environments with greater density and accessibility reduce greenhouse gas emissions.⁵ For example, Monkkonen, Guerra, Escamilla, and Cos examined 400 cities in 40 countries and found dense, compact cities with built-up downtowns and shorter roadway segments had lower carbon dioxide emissions per capita.⁶ A comparison among American, Australian, and Canadian cities similarly found a negative correlation between

density and emissions.⁷ Jones and Kammen found that although dense city centers have lower household emissions, the extensive suburbanization of the region may result in an overall net increase in emissions compared with those of smaller metropolitan areas. According to their analysis, suburban areas accounted for nearly 50 percent of the total U.S. household carbon footprint — in stark contrast to suburbanites' perceptions that their single-family homes, with their spacious yards (thanks to large setback requirements) and nearby parks, are environmentally friendly.⁸

An analysis of land use scenarios by the Metropolitan Area Planning Council in Massachusetts found the growth of vehicle miles traveled in a sprawl scenario was 5.2 percentage points higher than in a scenario with more development in urban areas and denser suburbs, even before accounting for any benefits from transit improvements or transit-oriented development.⁹ The authors conclude that smart growth policies and user fees, designed to advance racial and economic equity, must be part of a comprehensive transportation sustainability strategy; governments cannot rely solely on technology-based solutions to meet greenhouse gas reduction targets. As Badger explains, “Give people a hybrid, and they drive more. Give people a state-of-the-art home heating system, and sometimes they turn up the temperature. But there's no backsliding with land-use changes.”¹⁰ Xu et al. similarly note that relying on technological advances, alternative energy, and engineering protection solutions are not sufficient; land use planning provides an important tool in developing strategies.¹¹

When workers in a community cannot access nearby housing, they will live in more distant homes that require additional infrastructure to be built, such as streets, water mains, sewage pipes, and gas lines. Installing this infrastructure can create negative environmental impacts; for example,

the addition of impermeable surfaces leads to greater runoff and flash flooding, and concrete and asphalt radiate heat.¹² Low-density neighborhoods also require more building materials per capita, with the associated emissions of manufacturing concrete, asphalt, piping, and other inputs.¹³ Extending housing farther from the city center takes an additional toll on the environment when the development eliminates natural areas — including fields, forests, and wetlands — while placing homes closer to areas susceptible to flooding or wildfires. Such practices also take their toll on residents, particularly low- and moderate-income households, who face longer commutes with higher transportation costs and may live in areas of greater risk.

With the increase in wildfires, flooding, storms, heat waves, drought, and other weather-related risks, current residential patterns leave millions at risk of a disaster.

What Is Built

Land use regulations, often through zoning ordinances, govern the types of residences that can be built as well as lot size, lot coverage, and setbacks. These components are important influences on the urban form, and these policy choices have significant environmental implications.

For example, infill development, which occurs in areas that are already developed, often involves smaller buildings that are designed to fit into the available space and use existing infrastructure. Such development, however, often requires numerous approvals that are time consuming, expensive, and unpredictable. Local land use policies can make building homes in a previously undeveloped area, known as greenfield development, a much easier process, although doing so requires installing roads, sidewalks, water and sewer systems, and other infrastructure. An analysis from California's scenario planning



Research finds that urban environments with greater density and accessibility reduce greenhouse gas emissions.

found an average household in a high-density urban community in the San Francisco area produces 6 metric tons of carbon emissions a year from transportation and household heating compared with 21 metric tons of annual carbon emissions from a single-family household in a nearby suburban area.¹⁴ A recent analysis examining Los Angeles and Boston found that greenhouse gas emissions are higher in higher-income neighborhoods than in low-income neighborhoods, which have a more compact form and higher population density and consist primarily of multifamily apartments.¹⁵

Similarly, jurisdictions that require only single-family homes in a community, rather than permitting a range of structures such as townhomes, garden apartments, and multifamily buildings impose environmental costs. Units with shared walls, such as townhomes, consume less energy for heating and cooling than single-family homes, which have an inherent structural inefficiency.¹⁶ The environmental costs are even greater in jurisdictions that impose large minimum lot sizes,

significant setbacks, and other parameters that prohibit building units with greater efficiency in both construction and energy usage over the life of the home.

Choices about urban form directly affect water demand. For example, compact development, infill development, and homes on smaller lots use less water than do single-family homes on large lots.¹⁷ Land use policies often require developers to include green spaces and may even prescribe landscaping yet also impose significant parking requirements, which create runoff; the parking areas also reduce the land available for housing units and drive up development costs. Coordination between staff at the water management agency and staff in the land use department might result in a better plan with a more thoughtful approach incorporating both green and blue infrastructure such as parks, trees, garden roofs, reserves, wetlands, and sustainable urban drainage systems.¹⁸

The built environment results from responding to market needs in the context of the regulatory environment.

These factors drive not only the urban form and location of housing but also the construction and resulting operation of units. This broad scope is important because once housing is built, it tends to last for a long time.

Construction

Housing construction directly contributes to greenhouse gas emissions in multiple ways, including the production of construction materials as well as the energy efficiency of the units built. Efforts are underway to reduce embodied carbon, which refers to

the total impact of all the greenhouse gases emitted by the supply chain of a construction material, including raw material extraction, transport to the manufacturing plant, the manufacturing process, the transport of finished goods to the construction site, construction site activities and material losses, materials use phase, repair, maintenance and replacement, as well as the end of life processing.¹⁹

When land use regulations, such as design standards, parking requirements, or building codes, require materials with higher embodied carbon, they increase greenhouse gas emissions. Concrete, steel, and aluminum are three of the most carbon-intensive building materials to produce.²⁰ Requiring the use of specific carbon-intensive materials has what Cole describes as “intergenerational environmental consequences,” locking in future carbon emissions.²¹ Identifying materials and construction methods that are environmentally friendly can support new construction. For example, replacing energy-intensive materials with lower-impact alternatives, such as using engineered timber rather than steel, can reduce the negative environmental effects of construction.²²

Only a small supply of the housing stock, historically ranging between 1 and 2 percent, is built annually. The result is that more than half of existing single-family homes in the United

States are more than 40 years old (see figure 2). Most multifamily units were also built before 1980.²³ The prevalence of older housing stock means that a large portion of U.S. homes are not energy efficient. Aging homes are more likely to be in low-income, minority neighborhoods (see figure 3); as a result, low-income households use more energy because they live in older units with less efficient technology. As a percentage of income, low-income households spend three times more on energy costs than do higher-income households (8.1% and 2.3%, respectively).²⁴ Reducing residential energy use will require increasing the energy efficiency of these homes. Although resources such as the U.S. Department of Energy’s Weatherization Assistance Program are available for energy retrofits, many low-income residents do not qualify for the program because their units are not fit for habitation, have asbestos or mold, or have other disqualifying factors.²⁵

Because new construction often involves significant embodied carbon and old homes are inefficient, the benefits of renovating and retrofitting older units

when possible, rather than demolishing them to build new housing, are clear. Deconstructing older buildings to salvage scarce and high-quality materials also offers significant benefits for both the environment and local communities.²⁶

Land Use Reforms to Reduce Negative Environmental Impacts

Land use reforms can reduce climate risks in two distinct ways: mitigation and adaptation. Mitigation focuses on changing practices that increase greenhouse gas emissions to reduce future damage to the environment. Mitigation efforts may involve building at greater density with mixed land uses and having effective transportation networks. Adaptation considers how to reduce the risks households face from current climate conditions, such as by developing and maintaining floodplains to protect populated areas from coastal flooding and providing sufficient green space to reduce the urban heat island effect.

Some researchers note the conflict between mitigation and adaptation. Xu et al., based on their empirical study

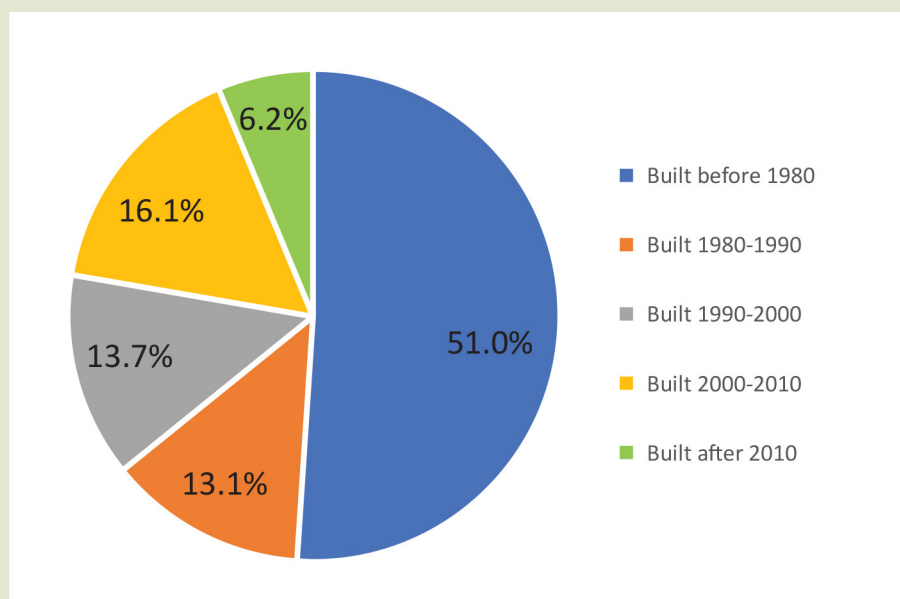
of a coastal area in China, recommend a combined approach, with moderate population density to limit sprawl while avoiding overcrowding of urban centers; a mix of residential, employment, retail, and leisure uses; high road connectivity with adequate intersections; and planned and protected green open space that supports the urban density.²⁷ Viguié and Hallegatte similarly note tradeoffs among policy goals when comparing a greenbelt policy to reduce sprawl, a zoning policy to reduce flood risk, and a transportation subsidy. They found that each policy interfered with the other policy goals, but when combined, the policies supported mitigation and adaptation goals.²⁸ Furthermore, mitigation and adaptation efforts can create economic returns, including making the area more desirable for investors, raising local property values, and lowering insurance costs.²⁹

Climate mitigation and adaptation require consideration of social equity because low-income households, households of color, the very young and very old, and people with health conditions, among others, are more vulnerable to the effects of climate change and are at a higher risk of damage from it. For example, Boston implemented its city-wide plan to reduce urban heat islands in the five neighborhoods with the greatest heat challenges, all of which stemmed from the neighborhoods’ history of environmental injustices and systemic racism.³⁰

The Institute for Tribal Environmental Professionals developed a toolkit that offers a set of guiding principles for designing climate adaptation strategies:

- Adopt integrated approaches.
- Prioritize the most vulnerable.
- Use best-available science.
- Build strong partnerships.
- Apply appropriate risk-management methods and tools.
- Apply ecosystem-based approaches.
- Maximize mutual benefits.
- Continuously evaluate performance.³¹

Figure 2. Most Single-Family Homes in the United States Are More Than 40 Years Old



Source: Sijie Li. 2020. “Where is the Aging Housing Stock in the United States,” Exhibit 1, Freddie Mac.

Cole recognizes the need for a new, regenerative form of development that emphasizes place and local communities when considering responses to climate change. He places the local ecosystem — the combination of people, sociocultural systems, and ecological systems — at the center of the process of rethinking building design in relation to natural systems.³² The Institute for Tribal Environmental Professionals’ toolkit and the regenerative development approaches are both designed to bring a broader perspective to addressing reforms.

Mitigation efforts cover activities such as buildings, transportation, energy, and individual behavior, all of which are incorporated in land use policies. The activities described below are categorized into community- or house-level actions.

Communities

Land use policy drives the location of housing, as previously discussed. Jurisdictions can protect residents by revising their zoning ordinances to prevent or limit development in high-risk locations.³³ In March 2018, Norfolk, Virginia, implemented new zoning overlays that direct new and more intense development to higher ground, evaluating projects according to standards set for flood risk reduction, stormwater management, and energy resilience.³⁴ Projects that do not meet a minimum threshold must undergo a more complex site review that examines additional goals such as conserving water resources, protecting water quality, supporting multimodal transportation and mobility, and providing mixed-income residential or mixed-use developments.³⁵

Land along the ocean shoreline or near lakes or forests is often the most valuable because of the amenities nature provides. Jurisdictions can counter the value lost from restricting development in such areas by allowing more development, or more intense development, in other areas and by providing transfers of development rights to offset

the economic losses.³⁶ An example provided in Gale³⁷ is Charlotte County, Florida, which revised its transfer of density units ordinance in 2018 to, in part:

- Assist in and encourage the replacement of an unsustainable and inefficient form of development with compact, higher density, mixed-use development that is more sustainable and efficiently uses resources.
- Offer incentives for retaining long-term agricultural activities and clustering rural development densities to create an alternative to rural large-lot sprawl and to reduce the premature conversion of rural lands and preserve rural character and viewsheds.
- Create incentives for the voluntary preservation of environmentally sensitive lands.³⁸

The role of dispersed housing in increasing greenhouse gas emissions is significant. Land use policies that promote appropriate density with accompanying infrastructure can counter this effect. The use of “appropriate” in this context acknowledges that no single solution is ideal for all geographies and housing markets; housing needs to be optimized for different location types. Density does not necessarily mean large apartment buildings — it could mean smaller homes on smaller lots with a corner store and barbershop nearby. All communities would benefit from reducing parking requirements or at least recognizing the benefits of sharing parking between residential and commercial uses.³⁹ In addition, sufficient density to support public transportation — along with quality walking and biking routes — has environmental and health benefits. Pain et al. recommend combining public transportation that has sufficient capacity, quality, and accessibility with reduced parking and limitations on car circulation.⁴⁰

Transit-oriented development (TOD) and form-based codes are both established

tools for supporting well-planned density. Transit-oriented development creates people-centered neighborhoods along transit corridors.⁴¹ These designs can result in shorter travel times, reduced congestion, lower utility bills, improved public health, and better air quality (see Chester et al. for an analysis of the life-cycle benefits of a TOD in Phoenix).⁴² Form-based codes enable communities to think beyond parameters such as setbacks, height, and lot coverage and consider factors that will help meet climate objectives, such as orientation, exposure, and interaction with other buildings and public spaces.⁴³

Placement of housing, not just in relation to other buildings but also in relation to roads, water lines, utilities, and parks, can help limit emissions. Optimizing housing placement requires a holistic approach to infrastructure that involves coordinating among local agencies when planning major investments, such as those provided under the Bipartisan Infrastructure Law. The Organisation for Economic Cooperation and Development (OECD) developed a list of 25 climate policy actions. One of the action items recommends making sustainable building an integral element in urban and rural planning. Integrating infrastructure and urban planning would include placing public transportation near housing, offices, shopping districts, and green spaces to enhance a city’s vitality and economic development while reducing greenhouse gas emissions by decreasing travel. OECD also proposes encouraging compact, denser cities with regulations that provide for green spaces and water areas to prevent congestion and overheating.⁴⁴ Underlying these recommendations is the need for systematic transformation in the way jurisdictions invest in their communities to create and improve housing and transportation.

The Institute for Tribal Environmental Professionals recognizes the need to consider risks in three sectors — the natural, built, and social environments — when developing a climate resilience

plan. Within the built environment, the institute outlines three areas for consideration: land use (such as housing, hazardous sites, recreation, and agriculture), utilities (such as water supply, wastewater, energy, waste management, and communications systems), and transportation (including access, infrastructure, public transit, and marine/port facilities).⁴⁵ This approach recognizes the interconnectedness among housing, transportation, water, communications, and other infrastructure systems. Accordingly, no single component can fully mitigate the negative effects of climate change or improve the ability of communities to withstand its effects.

Visualizations that capture flood risk, groundwater, permeability, infrastructure, topography, geology, and zoning can play an important role in understanding the challenges and looking more systematically for solutions, including through land use policies.⁴⁶ Other tools are being developed to help local agencies understand how to consider urban form and urban mobility to reduce energy consumption.⁴⁷

An important component for mitigation in both rural and urban areas is sufficient green and blue infrastructure. Blue infrastructure refers to water elements such as rivers, canals, ponds, wetlands, floodplains, water treatment facilities, and storm drainage systems. Blue infrastructure involves the system for addressing water usage, stormwater management, and flooding risks; it interacts directly with green infrastructure. Green infrastructure describes the network of multifunctional green space that includes parks, open space, recreational fields, woods, trees, private gardens, and green roofs. Systems such as rain gardens and bioswales that are designed to capture and filter stormwater are important “blue-green infrastructure,” which involves using plants and soils to filter pollutants, reduce runoff, and recharge groundwater in aquifers.⁴⁸

Buildings, roads, and other infrastructure elements absorb and re-emit

more heat than natural landscapes such as forests and bodies of water. Urban areas, where structures are highly concentrated, can experience daytime temperatures that are 1 to 7 degrees Fahrenheit higher than temperatures in outlying areas and nighttime temperatures 2 to 5 degrees Fahrenheit higher, a phenomenon referred to as the urban heat island effect.⁴⁹ Heat islands can create risks for urban residents living in areas with poorly planned density, particularly as communities throughout the United States increasingly are experiencing dangerous heat waves. Adding water elements and green spaces to these areas can reduce the effect of urban heat islands.

Some communities are taking more expansive measures. For example, the Blackfeet Nation is working to capture groundwater and restore riparian areas through a restoration project to increase resilience to drought and reduce flooding.⁵⁰

Philadelphia implemented its Green City, Clean Waters plan in 2009 to address problems caused by its combined sewer overflow system. Rather than creating a traditional grey infrastructure system involving pipes, storage tanks, and expanded treatment capacity, the city turned to a green stormwater infrastructure that included creating green spaces, rain gardens, bioswales, and other interventions to reduce stormwater runoff and improve infiltration.⁵¹ Compared with a grey infrastructure approach, the Green City, Clean Waters plan was less expensive; more rapidly implemented; and resulted in a better quality of life for residents, increased property values, offset carbon emissions, reduced heat island effects, and improved public health.⁵²

In Baltimore County, Maryland, 70 percent of residents did not have accessible open space within a quarter mile of their homes. Local watersheds had been polluted by stormwater runoff. The nonprofit NeighborSpace of

Baltimore County works with the county government, local universities, community organizations, and residents to create small pocket parks, gardens, trails, and other green areas. The program is funded by the county’s open space waiver fees. Developers who are unable to set aside 1,000 square feet of open space for each newly constructed dwelling unit may seek waivers from the county and pay a fee, 20 percent of which is given to NeighborSpace.⁵³

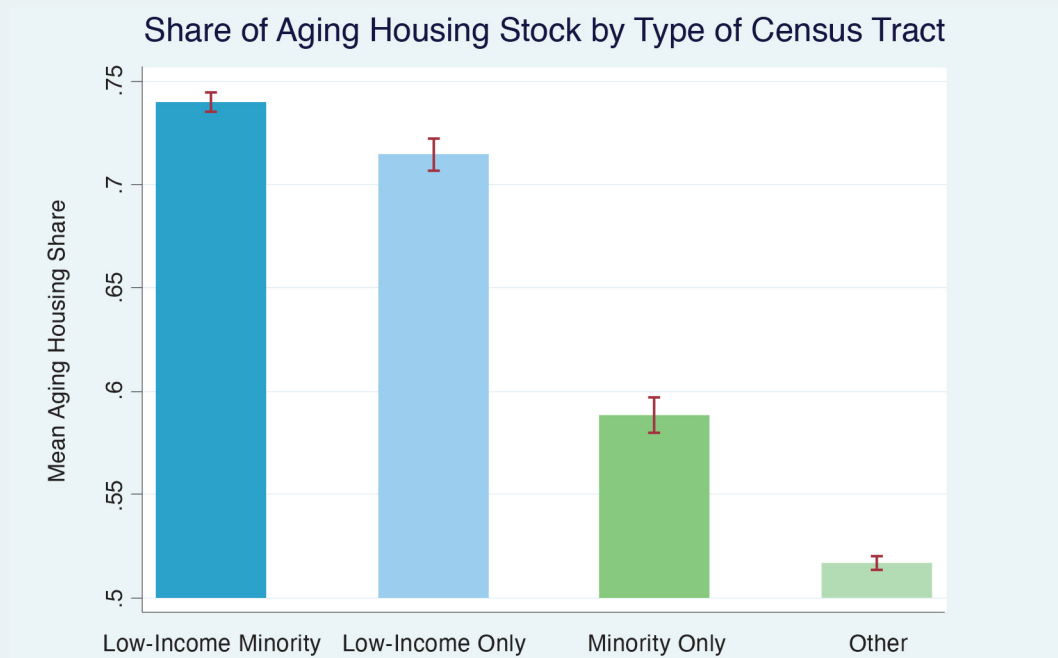
Rural communities provide opportunities to invest in clean energy while rebuilding housing and commercial developments, installing broadband internet connections, and upgrading other infrastructure. With their wide-open areas, rural communities contain most of the nation’s onshore wind capacity and utility-scale solar capacity.⁵⁴ Renewable energy investments can promote economic growth if supported by any necessary land use regulatory changes. The pandemic and the subsequent rise in remote work have encouraged households to relocate to smaller towns and rural areas. Researchers from the University of Toronto propose that “managed retreat,” the concept of rebuilding in safer locations before disasters occur, could further contribute to a network of reinvigorated small towns.⁵⁵

Climate mitigation efforts involving land use choices and interconnected infrastructure investments at the community level must also be applied at the individual building level to promote individual and environmental well-being.

Homes

Choices regarding housing size, type, building materials, and heating systems all directly affect carbon emissions.⁵⁶ The land use policies that specify the details of what homes can be built, what materials must be used, and what utility standards apply offer policymakers opportunities to improve energy efficiency and reduce greenhouse gas emissions. OECD recommends stringent climate-friendly building codes and standards

Figure 3. Nearly 75 Percent of the Housing Stock in Low-Income, Minority Census Tracts Was Built Before 1980



Note: "Aging Housing Stock" is defined as housing built before 1980.
 Source: Sijie Li. 2020. "Where is the Aging Housing Stock in the United States," Exhibit 6, Freddie Mac.

that require sustainable materials, low-energy homes, and integrated sustainable waste and water management.⁵⁷

Many resources are available to guide jurisdictions in implementing climate-friendly practices. The American Council for an Energy-Efficient Economy identifies several opportunities to reduce greenhouse gas emissions, including constructing zero-energy homes, which produce at least as much energy as they use; retrofitting homes, which can reduce a home's energy usage by an average of 30 percent; optimizing energy use with automated controls and other sensors, reducing consumption by 15 percent or more; and using electricity (primarily heat pumps) for space and water heating.⁵⁸ The Carbon Neutral Cities Alliance explains how to reduce carbon in buildings through zoning rules, which include renovating existing buildings to increase efficiency, changing zoning rules to require more

efficient building shapes, and changing design standards to require low-impact materials.⁵⁹

Levitt and Adams note that low-rise buildings are less carbon-intensive to build.⁶⁰ Incorporating passive cooling into the building design of homes can limit air conditioning use by limiting heat buildup and accelerating heat dispersal; various traditional or modern passive cooling techniques may be suitable depending on the local climate.⁶¹ As buildings are being built or renovated, material banks can encourage the reuse of materials.⁶² These banks track each item being used to supply information on the components to those harvesting the building in the future.

In Tukwila, Washington, a community land trust, in partnership with the state and local governments, is building a net-zero affordable housing development

with 18 three- and four-bedroom homes, including units for people with disabilities.⁶³ The project builds on efforts connected to the state of Washington's Ultra-High Energy Efficient Affordable Housing Demonstration Program. The building innovations will reduce residents' utility costs and improve air quality.⁶⁴

Retrofits are important because of the inefficiency of old homes and the embodied carbon involved in replacing those homes with new buildings. Despite the benefits, each year less than 1 percent of the building stock is being renovated to reduce carbon emissions.⁶⁵ OECD recommends implementing tax and financial incentives to renovate existing buildings and develop retrofit solutions.⁶⁶

Because more than 50 percent of the existing housing stock was built more than 40 years ago, improving the energy efficiency of these homes



Transit-oriented development is an established tool for supporting well-planned density.

introduces a significant opportunity to reduce greenhouse gases. The federal Weatherization Assistance Program funds the repair or replacement of heating, ventilation, and air conditioning systems; upgrades to windows and doors to increase energy efficiency; and other repairs. However, the program requires that eligible homes have no mold, asbestos, or structural issues, which excludes many of the lowest-income households that could benefit from the program.⁶⁷ According to one estimate, 10 to 30 percent of potential income-eligible weatherization clients nationally are deferred because of health and safety issues. The costs to remedy deficiencies to become eligible for the federal program can be high; for example, Virginia officials estimate that the average weatherization barrier remediation costs are \$5,000 to \$8,000.⁶⁸

The Pennsylvania legislature is considering a bill to create a fund that would award grants to address habitability concerns, improve energy and water efficiency, and make units accessible for individuals with disabilities.⁶⁹ More than 280,000 occupied homes in Pennsylvania are estimated to have moderate to severe physical issues, and the grant program

would be designed to position these homes to access federal weatherization funds.⁷⁰ As one legislator explained, the program would help fix housing in struggling mining communities “before they completely go to rot . . . that’s better for the people living in the homes, better for the next-door neighbor, and better for the taxpayer if they don’t have to fund millions and millions in demolition costs.”⁷¹

Beyond weatherization, other specific retrofits, such as shutters, can position the housing stock to better withstand more frequent storms, flooding, and heat. Such adaptations can minimize risks while raising home values and lowering insurance costs.⁷²

Conclusion

No single approach will reduce greenhouse gas emissions sufficiently to meet the country’s goals and residents’ needs. Yet jurisdictions often focus on individual problems as they arise rather than considering the interplay among causes, contexts, and resulting conditions. Reducing the negative effects of the built environment on the natural environment requires considering a larger ecosystem. Land use decisions need

to consider density, the mix of uses, connectivity among street networks, accessibility to a wide range of locations with low travel distance and time, and green and blue infrastructure — the full range of physical, socioeconomic, and policy drivers. Policymakers also need to consider the many co-benefits of climate mitigation and adaptation initiatives, including long-term environmental health, economic viability, and residents’ health and well-being, as well as how to ensure that these decisions and investments consider equity and environmental justice. Inherent in this approach is the recognition that no one-size-fits-all approach can succeed, because jurisdictions face different risks; have varying resources; and have experienced different histories and patterns of development, investment, and disinvestment.

Urban planning must be part of an intersectional climate policy solution, particularly through the many land use regulations that determine what is built and where. Many resources are available to inform changes to land use regulations and policies to reduce the negative impact on the environment and improve communities. Developing

a climate-friendly network of housing, transportation, and other infrastructure is necessary but not sufficient. People’s day-to-day activities in their communities are an important component. Reducing emissions will require transforming how individuals think, work, and interact. **EM**

— Pamela M. Blumenthal, *HUD*

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Resiliency at Work

As climate change makes extreme weather events more frequent, states and localities are developing solutions to make housing and infrastructure more resilient to risks and costs. These resilience efforts are also addressing environmental inequity and remediating the historical disadvantages that frequently manifest themselves in the damage, deaths, and long-term suffering that disasters cause. Several recent mitigation and abatement initiatives by communities that have experienced major disasters offer useful lessons. In response to Hurricane Isaac in 2012, the city of New Orleans created the Gentilly Resilience District, which, in addition to implementing large-scale grey and green infrastructure projects, features a retrofit assistance program for homeowners to construct flood risk-reduction systems on their properties. The frequent flooding in Norfolk, Virginia, required implementing projects that manage stormwater and address environmental justice concerns, especially in areas where low-income and minority residents have been disproportionately affected. Devastated by the 2018 Camp Fire, the town of Paradise, California, has several public and private efforts underway to increase resilience to wildfires, including developing safer evacuation routes and creating innovative building designs that use noncombustible materials. Funding from various HUD programs, including the National Disaster Resilience Competition (NDRC), Community Development Block Grant-Disaster Recovery (CDBG-DR), and Choice Neighborhoods Implementation (CNI) grants, helped realize many of the resilience projects in these communities.

New Orleans Adapts to a Changing Environment

New Orleans' location along the Gulf of Mexico leaves the city more vulnerable to the effects of climate change-related flooding than any other city in the nation.¹ This risk is unevenly distributed across

New Orleans — major flooding and storm damage disproportionately affect the low-income households and people of color who predominantly live in low-lying areas, creating an environmental justice issue.² Pumps and canals that drained land for development in the early 1900s enabled low-income, African-American residents to move into single-family homes in areas that were affordable because of their low-lying topography. At the same time, inhabiting such areas placed these groups at risk of sinking soil and chronic flooding. The city's century-old drainage system underscores how early efforts to build single-purpose infrastructure such as canals and walls work against the area's ecology rather than in concert with it.³ In addition to building stronger storm walls, New Orleans is also reducing flooding impacts by embracing its natural landscape and using it to develop green infrastructure projects.⁴

In the aftermath of Hurricane Isaac in 2012 and numerous prior hurricanes, the city of New Orleans sought to reimagine its recovery efforts with a renewed focus on resiliency. In particular, the Greater New Orleans Urban Water Plan, unveiled in 2013, guides the city's long-term vision for managing stormwater while also ensuring that residents and businesses thrive.⁵ The plan recommends adding native vegetation and wetlands to help absorb stormwater naturally.⁶ In 2013, the Rockefeller Foundation selected New Orleans for the 100 Resilient Cities (100RC) network, which spurred discussions with other member cities to share best practices and resources.⁷ Participation in the 100RC network led New Orleans to become the first city in the world to develop a comprehensive resilience strategy, which was unveiled in 2015.⁸ The city also created the Mayor's Office of Resilience and Sustainability in 2015 to serve as a hub for implementing adaptation initiatives.⁹

HIGHLIGHTS

- **The Community Adaptation Program in New Orleans has helped homeowners install green infrastructure features to reduce flooding in their yards and increase the city's overall capacity to collect and store stormwater.**
- **The city of Norfolk, Virginia, is reducing environmental inequities by deconcentrating poverty in the St. Paul's Area and transforming it into a climate-resilient community.**
- **After being devastated by the Camp Fire, the town of Paradise, California, is rebuilding with a focus on strengthening visible and invisible infrastructure, resilient housing, evacuation routes, and early warning systems.**

Leveraging Recovery Funding

In 2016, HUD awarded New Orleans \$141.3 million in NDRC funding to repair lingering damage from Hurricane Isaac. This funding was the second-largest award among the 13 grantees in that allocation round. The city's NDRC application proposed the creation of the Gentilly Resilience District (GRD), the first of its kind in New Orleans.¹⁰ Located just north of downtown New Orleans, Gentilly is bordered on the north by Lake Pontchartrain and on the east and west by canals, making the neighborhood particularly prone to flooding.¹¹ According to the 2019 American Community Survey 5-year estimates, approximately 76 percent of Gentilly residents are African-American. Approximately 43 percent of Gentilly households earn less than \$35,000 per year, and 14 percent of families in Gentilly live below the federal poverty level. Approximately 60 percent of Gentilly households are homeowners. The area's demographics and heightened environmental risks require policymakers and stakeholders to pay close attention to developing equitable solutions.¹²

According to Seth Knudsen, director of real estate development and planning



Photo courtesy of New Orleans Redevelopment Authority

Along with permeable materials such as gravel, many homeowners participating in New Orleans' Community Adaptation Program have added trees, plants, and pine straw to help absorb rain.

at the New Orleans Redevelopment Authority (NORA), the NDRC award has been instrumental in leveraging Hazard Mitigation Grant Program funds from the Federal Emergency Management Agency to finance several large-scale green infrastructure improvements in the GRD. For example, the Mirabeau Water Garden is a 25-acre site that will have the capacity to store up to 10 million gallons of stormwater once complete.¹³ In addition, NORA's past work on vacant lots, which tend to be located in low-lying, flood-prone areas, strengthened the city's NDRC application, said Knudsen.¹⁴ As of May 2022, the city had developed green infrastructure projects on 45 vacant NORA lots as part of the Pontilly Neighborhood Stormwater Network within the neighborhoods of Pontchartrain Park and Gentilly Woods. In addition, the city has invested more than \$1 million in CDBG-DR funds to transform 42 other vacant lots into rain gardens, detention basins, and passive green space that serve as both stormwater management systems and public amenities.¹⁵ Although the city allocated the bulk of the NDRC funding to large projects in the GRD that improve parks, streets, open spaces, and vacant lots, the city

also works with homeowners through NORA to manage stormwater in residential neighborhoods.¹⁶

Community Adaptation Program

Because traditional grey infrastructure has limited capacity, New Orleans has also adopted another approach to expanding stormwater storage: capturing rainfall in residential neighborhoods. NORA received an initial allocation of \$5.9 million in NDRC funds to implement the Community Adaptation Program (CAP), which provides up to \$25,000 to low- to moderate-income homeowners within the GRD for stormwater management interventions.¹⁷ According to Knudsen, CAP has three main goals: educating the public about green infrastructure, storing stormwater, and developing a green infrastructure workforce and industry.¹⁸

Following an extensive outreach campaign to educate homeowners about CAP and green infrastructure strategies such as rain barrels, stormwater planter boxes, infiltration trenches, and permeable paving systems, NORA received approximately 180 applications for the program in summer 2018.¹⁹ Upon

written notice of application approval, NORA and the homeowner proceed to the environmental review phase. The homeowner and contractor then sign an agreement detailing the timeline and responsibilities of each party and discuss the best options for the property, after which the contractor proceeds with the installation.²⁰ NORA requires contractors to offer a 1-year warranty on all labor and materials except for permeable paving systems, which have a 2-year warranty. The timeline from application to installation currently ranges from 3 to 6 months depending on how quickly homeowners complete the required documentation and the availability of the selected contractor. The completion timeline also depends on homeowners' ability to schedule appointments with designers and finalize plans. NORA exercises flexibility in scheduling for homeowners with extensive family responsibilities, health challenges, or multiple jobs. This process empowers homeowners to be decisionmakers and places them in the driver's seat of resilience.²¹

Once the work is complete, residents receive a manual explaining how to maintain the green design elements.

Although homeowners are required to maintain the green infrastructure for only 5 years, NORA hopes that the installations will be maintained in perpetuity. NORA aims for the green infrastructure elements to “become part of the homeowner’s yard and landscape and be maintained just the way they would cut the grass or do other types of yard maintenance.”²² NORA returns to the properties periodically to monitor the green infrastructure throughout the 5-year period.²³

NORA also coordinates with the city to run CAP’s workforce development program, which recruits contractors to install green infrastructure and train other installers to help maintain the projects. As Knudsen explained, “It does not do us a whole lot of good to install all of these things that are both publicly and privately owned across the city without a workforce and cohort of small businesses to realize the economic benefits of the installation... [and] to help us in the future with the maintenance for these types of systems.”²⁴

Measuring Impact

The CAP-funded improvements to homeowners’ properties contribute to the city’s overall capacity to collect and store stormwater. Knudsen indicated

that the city’s grey infrastructure system can pump a half-inch of rainfall per hour, and the network of pipes can store a half-inch. Each CAP project is designed to detain roughly 3,000 to 3,500 gallons of water. As of May 2022, CAP had installed green infrastructure on 173 properties and plans to reach its goal of nearly 200 properties by fall 2022. Knudsen said, “It would be ideal if each property in the city could manage the first inch of water on its own before we actually get to the pumping system... [which would] double the first-hour capacity of the stormwater management system.” A \$25,000 investment in green infrastructure on residential property through CAP captures, on average, more than the first inch of rainfall. Once complete, the CAP projects collectively will be able to detain up to 700,000 gallons of stormwater. Because of the program’s success and the widespread interest it has generated in Gentilly, NORA is actively collaborating with the city to allocate additional NDRC funds to CAP and expand the program to finance green infrastructure projects on more residential properties.²⁵

Although most of the NDRC funds went toward larger projects in the city, said Knudsen, “CAP may be the

most meaningful project and have the greatest impact because of its direct engagement with homeowners” and the program’s ability to bring green infrastructure directly to the neighborhoods where people live. One of the most significant benefits of the green infrastructure, according to Knudsen, is psychological. People learn to understand and appreciate the value of investing in the resilience of their homes and neighborhoods. In addition, these projects contribute to placemaking and pride among residents who know that their properties are better suited to withstand the challenges of climate change.²⁶

Managing Expectations

NORA strives to set appropriate expectations among homeowners about CAP’s capabilities. Homeowners may expect the green infrastructure interventions in their yards to prevent all flooding, whereas the interventions actually are designed to “add some amount of storage that will change the way stormwater is handled on their property,” Knudsen explained. Some yards improved through CAP still flooded following heavy rainfall but nevertheless managed to capture approximately 3,000 gallons of stormwater. Homeowners must obtain flood insurance to qualify for CAP, and they must keep the policy active during the compliance period. Obtaining flood insurance serves as “an acknowledgment that any improvements made through our program will not be able to prevent flooding in all circumstances,” Knudsen said. At the same time, the increased cost of premiums under Risk Rating 2.0, the National Flood Insurance Program’s new pricing methodology, can be challenging for many low- to moderate-income households and seniors with fixed incomes.²⁷

In addition, NORA has identified a need for an economic impact analysis to quantify the benefit of green infrastructure investments for homeowners and neighborhoods. Knudsen observed that it is difficult to calculate the individual and combined economic value of



Photo courtesy of New Orleans Redevelopment Authority

The city of New Orleans has transformed several vacant lots into detention basins and rain gardens with vegetation that can retain stormwater before it overwhelms pumps.



Photo courtesy of City of Norfolk

New roads raised above the floodplain around the future site of the new Tidewater Gardens will improve connectivity between the St. Paul's Area and downtown Norfolk.

capturing approximately 3,000 gallons of water per property over the lifetime of the improvements. According to Knudsen, capturing just an additional half-inch of stormwater could have “a monumental impact” on the degree of damage to a particular home or community. For example, if the CAP improvements decrease water levels from 5 inches to 4 inches, then “we’re actively decreasing the amount of standing water, ... and there’s probably some massive economic benefit that’s accruing to property owners in that area,” Knudsen stated.²⁸

Advancing Resilience and Environmental Equity in Norfolk

According to the National Oceanic and Atmospheric Administration, the Hampton Roads region in Virginia ranks second only to New Orleans in its risk of harm from sea level rise.²⁹ Norfolk, a port city and hub of the Hampton Roads region, has sustained the highest rate of sea level rise on the east coast since 1930. With 144 miles of shoreline and an established network of waterways, the city is especially vulnerable. Norfolk’s economic health relies heavily on its port, a vital asset

that generates jobs for the region and attracts new residents and businesses. Over the past few decades, however, the city’s waterfront location has become a major weakness because of an increase in major storms, land subsidence due to sea level rise, and flooding. Recurrent storms have disrupted the city, requiring action plans that address the natural, social, and economic risks of environmental vulnerability.³⁰

In recent years, Norfolk has developed climate resilience strategies that focus on environmental justice in communities that have been disproportionately affected by severe weather. In 2013, the Rockefeller Foundation selected Norfolk for the 100RC network, which supported the development of a multi-pronged resilience strategy to improve grey and green infrastructure.³¹ The strategy focuses on advancing initiatives that enhance citizen connectivity and access to information and technology, deconcentrate poverty, and improve social cohesion.³² The resilience strategy has also complemented other planning processes that are guiding sustainable growth in the city such as a green infrastructure plan and plaNorfolk2030, Norfolk’s General Plan. A consistent

theme in these planning documents is addressing the needs of Norfolk communities that are simultaneously experiencing economic, social, and environmental distress.³³ The St. Paul’s Area of Norfolk is one example of such a community.

The St. Paul’s Area not only has been disconnected from the economic opportunities of the adjacent downtown but also has experienced the negative effects of severe weather as well as the deterioration of its housing stock and neighborhood infrastructure.³⁴ According to the 2012–2016 American Community Survey 5-year estimates, the average income of neighborhood residents is less than \$30,000, and more than 50 percent of residents in the area, which is more than 90 percent African-American, live below the federal poverty level. In addition, the St. Paul’s Area has the region’s highest concentration of public housing. Numerous units fall within a 100-year floodplain and have experienced severe flooding because of their location on top of the filled-in Newton Creek.³⁵ Flooding in the St. Paul’s Area has become so intense that it occasionally has hindered children’s access to school.³⁶ According to Susan Perry, director of Norfolk’s Department of Housing and Community Development, this flooding was one of the primary concerns residents articulated during community engagement activities.³⁷ Following visioning sessions, Norfolk initiated the St. Paul’s Area Transformation Project, which advances its resilience goals and helps realize Norfolk’s commitment to environmental equity.³⁸

A Resilient Vision for the St. Paul’s Area

Plans for the St. Paul’s Area materialized thanks to a \$250,000 HUD Choice Neighborhoods Initiative Planning grant awarded in 2011. The grant funded an extensive community participation process involving residents and officials from both the city and the Norfolk Redevelopment and Housing Authority.³⁹ This process laid the

groundwork for the 2014 Transformation Plan, which focuses on Tidewater Gardens, the first of the three public housing communities selected for redevelopment and the one most at risk of severe flooding. The city successfully articulated its plan for the St. Paul's Area to become a mixed-use, mixed-income, and climate-resilient community in its application for a \$30 million CNI grant awarded in 2019.⁴⁰

The St. Paul's Area Transformation Project advances the third goal of the city's resilience strategy to connect communities, deconcentrate poverty, and strengthen neighborhoods.⁴¹ The project exemplifies Norfolk's commitment to environmental justice through resilient features that protect residents from environmental harm, including the Blue/Greenway, a resilient park that will also serve as a valuable community asset.⁴² The comprehensive redevelopment of the Tidewater Gardens public housing community advances environmental equity by making the area's housing, roads, public utilities, and community amenities more sustainable.⁴³

Tidewater Gardens

Built in 1955, the 618 units of Tidewater Gardens, encompassing 44 acres, have substantially deteriorated, and these negative physical conditions compound the residents' distressed economic situation.⁴⁴ The 714 new housing units called for in the plan — which include 260 replacement, 238 affordable, and 216 market-rate units — will be relocated outside of and/or elevated above the floodplain, away from the historic but flood-prone creek beds.⁴⁵ The new units will be environmentally sustainable with features that meet the criteria for certification by Enterprise Green Communities, including ENERGY STAR® appliances; floodproof designs that require exit doors and central heating and air equipment to be installed above flood elevations; and adequate backup generators and water systems.⁴⁶

The city of Norfolk will transform a portion of the former Tidewater Gardens site into the Blue/Greenway, a 26-acre resilient park that will include active and passive green spaces intended

to manage stormwater runoff through constructed wetlands.⁴⁷ The Blue/Greenway will add more than 10.6 million cubic feet of stormwater storage, and the addition of a wide bioswale and native plants will help absorb excess rainfall and tidal waters. The city will uncover the former creek and restore it as the main water channel to return the watershed to its natural state.⁴⁸ The Blue/Greenway will be designed around this central water channel and several interconnected basins. Wet ponds and dry detention areas along the central water channel will offer more stormwater storage capacity.⁴⁹ Trails in the Blue/Greenway will connect the park to the Elizabeth River Trail and the waterfront as well as other parks where residents can enjoy a "beautiful recreational amenity," according to Perry.⁵⁰ These spaces will also include features that Tidewater Gardens residents requested, such as learning, relaxation, and family activity spaces along with art that captures the community's rich history.⁵¹ Some pedestrian pathways will be constructed above stormwater berms, and large



House designs such as the one above from the Rebuild Paradise Foundation's floor plan library use noncombustible building materials and follow local guidelines for defensible space surrounding the lot.

Photo courtesy of Rebuild Paradise Foundation

meadows will serve as both recreation spaces and stormwater detention.⁵²

In addition to housing, the St. Paul's Area Transformation Project provides critically needed infrastructure improvements intended to connect residents to additional economic opportunities. St. Paul's Boulevard is a major north-south corridor that has long acted as a barrier to downtown's economic opportunity, neighborhoods, resources, and amenities because few streets connect it to St. Paul's Area.⁵³ With the support of a \$14.4 million U.S. Department of Transportation Better Utilizing Investments to Leverage Development grant, the city will upgrade the entire street network of Tidewater Gardens to enhance east-west connections on roads that are multimodal, raised above the floodplain, and designed around historic trees to aid stormwater management. The plan calls for the realignment of Church Street, a historic commercial corridor for the area's African-American community, to restore its former status as a vibrant, mixed-use hub of activity.⁵⁴ The realignment of the street grid, the phased housing redevelopment, and the construction of the Blue/Greenway are happening concurrently and are slated for completion by 2025.⁵⁵

People First

The existing residents of Tidewater Gardens at the time of the redevelopment may return to St. Paul's Area by accepting a direct replacement unit on-site, for which they receive preference for 5 years; exercising the right of first refusal for the onsite affordable units and using their housing choice vouchers; or moving into replacement units that will be built in offsite private developments that will have project-based rental assistance.⁵⁶ According to Perry, early data from the redevelopment process indicate that nearly 55 percent of Tidewater Gardens residents would like to return to the new community and that 85 percent of relocated residents, as of June 2022, have moved to

neighborhoods with a poverty rate of less than 40 percent.⁵⁷

Residents expressed concerns about disruptions posed by relocation during the redevelopment of Tidewater Gardens.⁵⁸ In response, the city crafted a People First initiative offering intensive supportive services for all public housing residents. An assigned case manager assists Tidewater Gardens residents with relocation, education, health, employment, financial wellness, and other services. To finance People First, Norfolk created a dedicated, citywide tax increase that raises approximately \$3.5 million annually to support Tidewater Gardens residents. People First will provide these services for 5 years after residents relocate to ensure that they are stable and thriving.⁵⁹ Thus far, the People First initiative is yielding positive outcomes, with 73 percent of residents employed (47% at baseline) and resident annual income increasing by more than \$8,000. As of July 2022, 91 percent of Tidewater Gardens residents had health insurance and had access to services to manage their chronic health conditions. The initiative focuses on all members of the household and connects adults and children with high-quality educational opportunities and early learning programs, creating resilient families of the future.⁶⁰

Paradise, California, Recovers From Wildfires

Climate change not only contributes to rising sea levels but also exacerbates the risk and severity of wildfires, especially in drought-stricken areas.⁶¹ Located in northern California in the foothills of the Sierra Nevada mountains, the town of Paradise is recovering from the November 2018 Camp Fire that destroyed 80 percent of the town, including nearly 90 percent of its single-family detached homes and more than 70 percent of its multifamily attached units. Years of drought and high temperatures have heightened the region's risk of wildfires. Estimates suggest that 18 million trees died in California in 2018, increasing fuel load and

making the forests even more prone to fires. Roughly 90 percent of Paradise residents live in areas classified as Very High Fire Hazard Severity Zones by California's Office of the State Fire Marshal. The Camp Fire displaced approximately 40,000 people and caused the town's population to plunge by 82 percent. Seniors were especially likely to relocate at least 30 miles away from Paradise.⁶² Nearly 40 percent of the population in the fire-affected areas of Butte County, which includes Paradise, consisted of low- to moderate-income households.⁶³ The town's Long-Term Community Recovery Plan presents best practices for fire resilience and outlines several strategies, including improving evacuation routes and clearing trees to improve safety.⁶⁴ Community organizations, the state, and the town of Paradise have also offered residents financial and technical support to help them return and rebuild their homes.

Long-Term Community Recovery Plan

After a series of community listening sessions and public engagement activities, the Paradise Town Council adopted the Long-Term Community Recovery Plan in 2019, which outlines 39 initiatives to improve safety and resilience to wildfires.⁶⁵ According to Kate Anderson, housing program manager in the town's Community Development Department, funding constraints allow some projects to move faster than others, but the town is learning which projects will best mitigate future disasters.⁶⁶

Residents and local officials expressed the need to widen roads as well as pedestrian and bicycle pathways to accommodate emergency vehicles during an evacuation.⁶⁷ The town aims to repair and widen 93 miles of damaged roads to ease traffic flow and facilitate rapid evacuations. Construction is already underway and is slated for completion in 2025.⁶⁸ In March 2022, the town completed the Pentz Road Safe Routes to School project, which added turn lanes and a wide path for pedestrians and bicyclists along a high-traffic



Photo courtesy of Rebuild Paradise Foundation

With a fully noncombustible design that uses steel for framing, joists, and roofing, Q Cabins provide a fire-safe alternative to traditional stick-built homes.

corridor that previously was unsafe for area elementary school students walking to and from school. In addition to improved walkability, the new sidewalk serves as an evacuation route.⁶⁹ The project also undergrounded all utility lines and removed overhead cables and utility poles, thereby reducing fire hazards along the street.⁷⁰ Wooden utility poles are prone to falling in high winds, which can cause them to spark and cause fires. To eliminate this risk, the town is working with local utility companies to place all utility lines underground by 2025.⁷¹ One month after the Camp Fire, the town also added fire-resistant concrete pipes to replace damaged pipes that caused roadways to cave in. By July 2021, the town had removed more than 88,000 trees that could obstruct roads and evacuation routes if they caught on fire.⁷²

Programs Help Property Owners Rebuild

The long-term recovery plan indicates that the town will seek funding to help homeowners and property owners construct housing using fire-resistant materials.⁷³ Federal and state funding has been a critical source of aid. In January 2020, the state of California received more than \$1 billion in CDBG-DR funds, of which \$55.9 million was allocated to

Paradise. The town used the funds to provide developers at least \$250,000 in deferred interest loans to rebuild multifamily housing for displaced seniors, low- to moderate-income families, and people with disabilities.⁷⁴ The state also allocated more than \$205 million in CDBG-DR funds to the California Owner-Occupied Housing Rehabilitation and Reconstruction (OOR) program, which provides grants of up to \$200,000 to homeowners affected by the 2017 and 2018 fires. The CDBG-DR funding also covers infrastructure development, and, according to Anderson, the state has received many funding requests for infrastructure projects from jurisdictions both inside and outside the bounds of the burn scar.⁷⁵ Since 1995, Paradise has administered its own OOR program supported by HUD HOME and CDBG program funding and state redevelopment agency and CalHome funding. In 2020, Paradise received \$23.5 million in CalHome Disaster Assistance funds for its OOR program to issue low-interest, deferred loans of up to \$150,000 for residents to rehabilitate and reconstruct their homes. As of May 2022, the town's OOR program had helped residents build 15 homes and begin construction on 20 more. "Ultimately, we hope that the combined [CDBG-DR and CalHome] funding will help numerous

households return home to Paradise and help our community with our infrastructure, economic, workforce, and mitigation needs," Anderson stated.⁷⁶

Another source of funding is the Rebuild Paradise Foundation, a local nonprofit formed in response to the Camp Fire, which has disbursed \$1.5 million to eligible homeowners through two grant programs as of May 2022.⁷⁷ The Missing Middle Grant reimburses residents up to \$5,000 for preconstruction land surveys, water connections, and architecture and engineering costs, which typically are not covered by insurance. To be reimbursed, residents must obtain a building permit and provide receipts. Because nearly half of the septic tanks in Paradise have been damaged, the Rebuild Paradise Foundation offers a Septic Infrastructure Grant that provides homeowners with up to \$7,500 to repair or replace septic systems.⁷⁸ Although the funding is limited to preconstruction costs, the foundation instructs residents on finding contractors.⁷⁹

One local company, Design Horizons, is on the ground in Paradise constructing noncombustible, prefabricated housing based on its model Q Cabin. Traditional stick-built homes are easily engulfed in flames through embers that seep through window frames and between roof shingles; the Q Cabin, however, lacks these access points.⁸⁰ The 100 percent noncombustible Q Cabin uses steel for the studs, floor joists, roof, and interior framing, along with several layers of noncombustible siding and concrete composite sheathing encapsulating the building envelope.⁸¹ Because of its prefabricated design, a typical Q Cabin costs less than \$275 per square foot and can be constructed much faster than stick-built homes.⁸² Once the foundation is set, a Q Cabin can be constructed in 7 days.⁸³ Design Horizons meets with homeowners to create the home on a computer, using 3D modeling software to incorporate their preferences for layout, finishes, and add-on features such as decks, patios, and garages. Design Horizons ensures

that the styles and floorplans comply with local standards, and the company can help homeowners obtain building permits to begin construction.⁸⁴ As of June 2022, at least two Q Cabins have been built in Paradise.⁸⁵

The Rebuild Paradise Foundation's floor plan library allows residents to choose from several master-planned designs that comply with the local wildland-urban interface (WUI) code, a standard building practice that establishes requirements for setbacks, density, vegetation, and building materials in areas at risk of wildfire.⁸⁶ The designs incorporate noncombustible materials for roofing and gutters, and one plan uses insulated concrete for additional fire protection. Although the plans are free to access online, homeowners must pay for a site plan specific to their property's topography and other unique features.⁸⁷ These floor plans save residents not only time but also \$5,000 to \$10,000 in design costs, noted Jen Goodlin, executive director of the Rebuild Paradise Foundation. As of May 2022, more than 80 properties had permits based on the designs, and roughly half of these were either complete or nearing completion. As of May 2022, an additional 130 homeowners were in the process of obtaining a permit and awaiting site plans.⁸⁸

The various approaches and programs to help Paradise property owners rebuild their housing have helped speed construction. Goodlin reported that, as of May 2022, the town had rebuilt 23 percent of its original housing stock, totaling 1,358 single-family homes and 263 multifamily units, with 2,000 more building permit applications for single-family homes in the pipeline.⁸⁹

Looking Ahead

As more funding becomes available, Paradise will implement an early warning system incorporating mobile alerts and sirens to notify residents of hazardous events. Paradise will also increase the walkability of its downtown and add defensible space and fire breaks

between roads and vegetation. In addition, upcoming guidelines will stipulate setbacks for trees to further reduce roadway hazards during an evacuation.⁹⁰ The state of California is in the process of determining the return on investment for projects that might produce strong outcomes in economic and workforce development.⁹¹ As outlined in the long-term recovery plan, the town will offer residents and property owners guidance on choosing local builders and contractors knowledgeable in green building design techniques. The town intends to partner with the U.S. Green Building Council's Leadership in Energy and Environmental Design program to establish standards for green building design in fire hazard communities. Additional efforts are underway to create incentives for town residents, contractors, builders, and developers to promote fire-resistant construction that exceeds WUI requirements.⁹²

A Resilient Future

Although considerable work remains, the projects in New Orleans, Norfolk, and Paradise serve as strong examples of local rebuilding efforts to reduce climate change risks and incorporating resilience strategies into the existing built environment. The HUD funding allocated to these communities has been vital for launching these projects. New Orleans directed most of the HUD NDRC funding in the GRD to large infrastructure projects, but CAP makes the concept of green infrastructure more tangible because residents see its positive impact in yards throughout the neighborhood. NORA's direct engagement with residents enrolled in CAP ensures the long-term maintenance of the green infrastructure features installed on homeowners' properties and residents' willingness to share the benefits of stormwater management with others.⁹³ In Norfolk, the St. Paul's Area Transformation Project — guided by Norfolk's resilience strategy — reconnects public housing residents to the city's downtown and, through innovative stormwater management techniques, advances environmental equity by

improving infrastructure and affordable housing.⁹⁴ Paradise's Long-Term Community Recovery Plan underpins its multifaceted approach to fire resilience through innovative building designs and strengthened visible and invisible infrastructure. Local initiatives offering technical and financial support are rejuvenating Paradise and supporting steady repopulation, making it the fastest growing town in the state.⁹⁵ As the impacts of climate change continue to be felt worldwide, adapting to and mitigating climate change risks are imperative for a resilient future. Comprehensive, thoughtful local strategies that engage community residents with an eye to addressing vulnerabilities are essential to achieving that future. **EM**

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Additional Resources

- Volume 32, issue 1 of *Housing Policy Debate* is a special issue devoted to the intersection of housing policy and climate change. The issue's articles touch on topics such as evictions and disasters, home buyout programs, and disparities in climate adaptation. www.tandfonline.com/toc/rhpd20/32/1.
- "Climate and Housing Crisis: A Research Agenda for Urban Communities" (2021), by Michael P. Johnson, Patricio Belloy, Heather MacLean, and Sajani Kandel, proposes a research framework for cities to understand and respond to the intersection of the climate change and housing unaffordability crises, with special attention to the needs of the residents most vulnerable to these threats. www.lincolninst.edu/publications/working-papers/climate-housing-crisis.
- The Georgetown Climate Center hosts the Adaptation Clearinghouse, an online repository of resources to help policymakers and local communities implement climate adaptation strategies, including those related to energy and land use. www.adaptationclearinghouse.org/.
- "Shifting to Zero: Zero Carbon Buildings Policy Toolkit: A Guide to Municipal Incentives and Policies to Drive Market Development of Zero Carbon Buildings in Washington State" (2020), by Shift Zero, offers local governments guidance on a mix of mandates and incentives to move buildings toward zero carbon emissions. Although the toolkit is geared specifically to the context of Washington State, its broader points also can be applied to other local contexts. shiftzeroorg.files.wordpress.com/2020/12/shift-zero-policy-toolkit-2nd-edition.pdf.
- "Preliminary Outcome Evaluation: The National Disaster Resilience Competition's Resilience Academies" (2016), by the Rockefeller Foundation, describes lessons learned from the Resilience Academies and Capacity Building Initiative and the progress jurisdictions have made in incorporating resilience into their National Disaster Resilience Competition applications. www.rockefellerfoundation.org/wp-content/uploads/NDRC-Resilience-Academies-Evaluation-Report-2016.pdf.
- "Springfield Climate Action & Resiliency Plan Vulnerability and Resilience" (2017), by Elisabeth Hamin, August Williams-Eynon, and Catherine Ratte, discusses the geographic and socioeconomic vulnerabilities in communities in Springfield, Massachusetts, and presents recommendations for increasing resilience to flooding in high-risk areas. scholarworks.umass.edu/cgi/viewcontent.cgi?article=1052&context=larp_grad_research.
- "5th Anniversary Report, Five Years Later: A Retrospective," by the New York Governor's Office of Storm Recovery, discusses New York State's progress in housing, economic development, and green infrastructure projects in the aftermath of Superstorm Sandy and best practices for disaster planning. stormrecovery.ny.gov/sites/default/files/crp/community/documents/Fifth%20Anniversary%20Report.pdf.
- "Living with Water Hampton: A Holistic Approach to Addressing Sea Level Rise and Resiliency" (2017), by Waggonner & Ball Architects, presents progress made in the Hampton Roads region during Phase I of the Resilient Hampton initiative. hampton.gov/DocumentCenter/View/20644/Resilient-Hampton-Phase-I-Report?bidId=.

For additional resources archive, go to www.huduser.gov/portal/periodicals/em/additional_resources_2022.html.

Evidence Matters

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